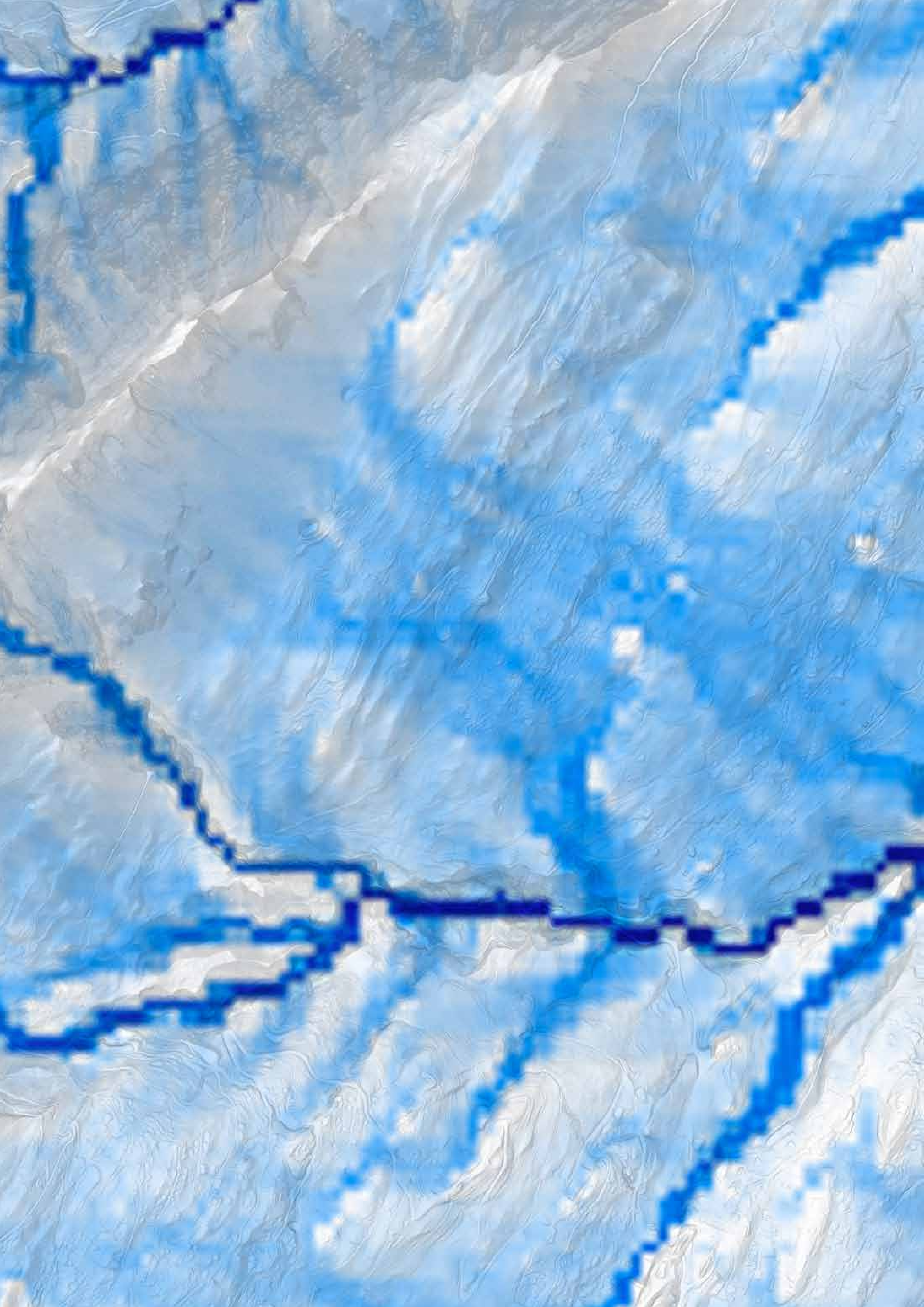
Floodscapes

Contemporary landscape strategies in times of climate change

Doctoral thesis ETH Zurich No 23192

Frédéric L.M. Rossano



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FLOODSCAPES
CONTEMPORARY LANDSCAPE STRATEGIES IN TIMES OF CLIMATE CHANGE

A thesis submitted to attain the degree of DOCTOR OF SCIENCES of ETH ZURICH

(Dr. sc. ETH Zurich)

by

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Table of Content

Abstract (English/Français)

Humankind's relationship with flooding is a dual story of fight and symbiosis. It oscillates between the angst for destruction, deeply rooted since the oldest Mesopotamian deluge tales, and the adaptation mores developed to turn plains and valleys into rich, inhabitable, and cultivated landscapes. The Enlightenment, however, changed this paradigm, and, since the seventeenth century, the belief has grown that technique could solidify landscapes into stable constructions, emancipate humans from riverine fluctuation, and guarantee an endless exploitation and permanent urbanization of floodplains. The radical landscape transformations that followed fueled Europe's agricultural and demographic surge in the nineteenth and twentieth century, but also began a presumptuous cycle of ever-rising levees and growing flood exposure up until the present. At the turn of the millennium, new spatial strategies were consequently developed and implemented in countries as diverse as Switzerland, Germany, France, and the Netherlands, with similar ambitions: making room for rivers and bringing elasticity back into landscapes "petrified" by centuries of "hard" engineering, in order to accommodate and mitigate natural fluctuations of large amplitude that cities alone will not be able to withstand. Two programs and six key projects of flood-adaptation located in the Alps and in the Rhine-Meuse Delta illustrate how various flood-mitigation measures (temporary of permanent retention, flood diversion or diffusion) can be combined with landscape redevelopment involving agriculture, recreation, nature and even urban growth. As this research reveals, the adaptation of inhabited landscape is highly specific, historically, geographically, and culturally, and dependent on economic and political ups and downs. Yet the pioneering work done in the past twenty years should be exploited to reflect on the modus operandi that can lead to consensual and successful transformations, and allow landscape architects to play a prominent role in future transitions.

L'humanité et l'inondation partagent une histoire duale faite de combats et de symbiose, oscillant entre l'angoisse de la destruction, ancrée dans les plus anciens mythes mésopotamiens, et les pratiques d'adaptation aux crues qui ont permis de transformer plaines côtières et vallées humides en territoires habités et cultivés. Ce paradigme a changé avec les Lumières, et depuis le 17e siècle s'est progressivement installée l'illusion que la technique serait en mesure de fixer les paysages dans un état stable, de garantir leur exploitation et leur urbanisation de façon permanente, et d'émanciper l'humanité des fluctuations naturelles. La transformation radicale du paysage européen qui a suivi a nourri l'essor agricole et démographique du continent ; elle a aussi engagé un dangereux cycle de rehaussement des digues et d'exposition croissante aux risques, perpétué jusqu'à une époque récente. Au tournant du millénaire, de nouvelles stratégies spatiales ont été en conséquence développées et mises en œuvre dans des pays aussi divers que la Suisse, l'Allemagne, la France ou les Pays-Bas, affichant des ambitions similaires: faire de la place pour la rivière, redonner de l'élasticité à des paysages pétrifiés par des siècles d'ingénierie «dure», et mitiger les effets des crues de large amplitude auxquelles les villes ne peuvent seules faire face. Deux programmes et six projets clé d'adaptation aux crues, actuellement mis en œuvre dans les Alpes et dans l'Estuaire Rhin-Meuse, illustrent comment des mesures de mitigation (rétention temporaire ou permanente, diversion ou diffusion de l'inondation) peuvent être associées à des projets de paysage, et intégrer loisirs, écologie, activité agricole et même croissance urbaine. Comme le montre cette étude, l'adaptation des paysages habités aux risques de crue est une entreprise éminemment spécifique, historiquement, géographiquement et culturellement, et dépendante des péripéties économiques et politiques. Néanmoins, le travail de pionnier réalisé lors des deux décennies passées et les modes opératoires qui ont mené à des transformations réussies et consensuelles gagnent à être mis en valeur et exploités, afin de permettre aux paysagistes de jouer un rôle significatif dans les transitions à venir.

Introduction

The first landscape designs I remember having implemented were pools, cascades, and dams of stones built in the bed of the Vaudaine torrent, in the French Romanche Valley, where I spent most of my holidays as a child. All my constructions were inevitably wiped out by the spring floods and avalanches that occasionally closed off the roads leading to my grand-parents' village, covered their kitchen gardens, and threatened the village schoolyard. No one seemed to worry about by the uncertainty brought by these unpredictable manifestations but instead accepted natural risks as a given, trying to avoid future damages and caring for what could resist – and yet no one knew of the term "resilience." Later living and working in various European cities, I came to wonder why people knew so little about tides, floods, or drainage, outsourcing their safety to distant authorities and yet fearing and fantasizing the natural forces hidden behind the levees. This led to more questions: What are we afraid of exactly? Should we actually fear flood? Should we repel it, control it, or let it happen? How did our predecessors live with or against floods, and how should we prepare ourselves for an uncertain hydrological future?

This thesis is the result of an investigation into the psyche and into the landscape practices of five European regions, which share a partly common cultural background and try in various way to implement "floodscapes": landscapes that make space for water where containment is no longer an option. It deeply benefited from the landscape design studios and the preliminary investigations conducted at the ETH Zürich under the aegis of Professor Christophe Girot, whose inspiring work and support allowed me to articulate the terms of this research.

The first part explores our past relationship to flood processes, from ancient mythical floods to the rise of environmental policies. Elliptical by necessity, this condense overview of past symbiotic, antagonistic, Promethean, and adaptive mores shows that the Western European relationship to natural fluctuations has taken many turns in history, which clarifies some of today's heritage, tendencies, and ambiguities.

Focusing on both ends of the river network, the second part investigates a selection of contemporary projects currently implemented upstream in the Swiss Canton of Valais, the French Isère Département, the German State of Bavaria, and downstream in the Dutch Groningen Province and the Lower Rivers Region. Two large programs and six projects were selected for their topicality, and the possibility of meeting with the actual authors and actors of the projects, along with for their various answers to the same question: how to make and design space for flood. For each one of them, a monograph articulates the results of historical research, field trips, interviews with designers and decision-makers, and 2D/3D terrain analysis. These cases are cross-referenced in the third part, which not only draws comparative conclusions from the conflicts and misunderstandings but also the fruitful combinations and successful transformations.

This result was only possible thanks to the generosity of the designers, experts, and decision-makers of four countries, who found time to share their experience, and to the remarks and inspiration brought by Christophe Girot, Dirk Sijmons, and Kelly Shannon.

Retrospectively, I realize myself that the ambition of bridging 5,000 years of fight, adaptation, and negotiation with flood processes will seem presumptuous – and undoubtedly it is. Yet I hope that this thesis will contribute to the understanding of the past and the present, and support the elaboration of those projects necessary in order to provide our landscapes with the elasticity they will need to face upcoming challenges.

Summary

Cultural perception of flood management in contemporary Western Europe

Humankind's relationship with flooding is a dual story of fight and symbiosis, oscillating between the angst for destruction, deeply rooted since the oldest Mesopotamian deluge tales, and the adaptation mores developed to turn plains and valleys into rich, inhabitable, and cultivated landscapes. For millenia, populations living in fluctuating floodplains have developed ways to divert and exploit flooding processes, taking advantage of the shores' and valleys' malleable topography. Partly seasonal and controllable, partly unpredictable and destructive, flood has forced territorial, technical, and political inventiveness, as shown by the ancient Frisian mounds built to safely inhabit the North Sea tidal plains, the French turcies built along the Loire to slow down the flood waters and collect their rich alluvium, the Italian and Alpine *colmata* techniques catching rivers' materials to build steady land, just to name a few. European floodplains today still show this combination of flood-made and man-made landscapes, revealing a long history of negotiation.

The Enlightenment, however, changed this paradigm, and, since the seventeenth century, the belief has grown that technique could solidify landscapes into stable constructions, emancipate humans from riverine fluctuation, and guarantee an endless exploitation and permanent urbanization of floodplains. Pious fear and temporary arrangements have made way for massive river corrections and land reclamations, supported by a Promethean vision of flood management. The joined forces of empowered nation-states, positivist philosophy, and increased engineering knowhow have constructed a common belief that technology would ultimately tame the waters for good, and provide a forever stable living environment. The radical landscape transformations that followed fueled Europe's agricultural and demographic surge in the nineteenth and twentieth century, but also began a presumptuous cycle of ever-rising levees and growing flood exposure up until the present.

The environmental concerns that arose in the second half of the twentieth century have, however, questioned this Promethean perspective. In the 1990s, a series of flood events in Western Europe, combined with the growing awareness of accelerated climate change, raised new doubts about the capacity of traditional containment measures to resist long-term evolutions, expected to bring more extreme precipitations, more frequent storms. While short-term measures were taken to maintain the old structures, plans were drawn to bring back and reinterpret past mitigation strategies, promoted as a new cosmogony that sought a dynamic balance between natural processes and human activity.

The spatial dimension reintegrated into flood management policy

At the turn of the millennium, the global enterprise of damming, reclamation, and drainage reached its maximum level in Western Europe. Within the context of fully exploited floodplains, containment techniques had generated rising exposure and rising costs, giving rise to doubts among funding institutions. The effects of channeling on local and supranational ecology were everywhere visible and lamented. Furthermore, the sustainability of solutions that were engineered for fixed discharge thresholds and water levels was challenged by the uncertainty of future climate evolution and sea-level rise. As a result, horizontal strategies were simultaneously developed and implemented in countries as diverse as Switzerland, Germany, France, and the Netherlands, with similar ambitions: bringing elasticity back into landscapes "petrified" by centuries of "hard"

engineering, in order to accommodate and mitigate natural fluctuations of large amplitude that cities alone will not be able to withstand. This represented a historical turn from pseudo-permanent solutions towards dynamic approaches; it also implies for West-European landscape to be again radically transformed in the coming decades and centuries, possibly at a scale and a pace comparable to what was seen during the industrialization era.

The spatial strategies developed in the last decade of the twentieth century are now translated into large-scale landscape programs and projects: Next to flood defense appear projects of floodplain restoration, river widening, flood deviation, and flood mitigation, often implying a radical redefinition of risk and land use. This translation is nowhere exclusive: Long-term mitigation measures generally complement rather than replace damming, dredging, and diking measures, and consist themselves in a combination of various ambitions and measures.

The motives of spatial strategies, however, differ according to the national and local context: Switzerland and Bavaria stress the ecological benefits as well as the identity value of river "renaturation," opposing past channeling works to a restorative approach. The Dutch and French projects remain, by contrast, focused on flood defense reaffirmed through horizontal measures, correlated to spatial quality and multiple land use.

The first approach allows for quantitative goals to be defined, but tends to generate false hopes of full nature restoration that appear unachievable in constrained contexts; It also exacerbate legitimacy conflicts when it comes to land use redistribution from productive functions to nature areas. The second approach appears more consensual and capable of tailored interventions, the resulting spatial quality being variable, however, and highly relative to the involvement and leverage of the designers involved in the development of the project. In both approaches, design operates increasingly as a negotiation platform rather than a reserved task, allowing for combinatory approaches, stronger consensus and occasionally for new insight.

Flood policy as a tool of urban and landscape development: conditions for successful combinatory strategies

In European dense and disputed floodplains, various types of land use compete for scarce space: farming, nature, housing, recreation, and transportation, to name only the main players. As it appears in the two large programs and the five projects investigated, additional space for rivers isn't necessarily a prejudice towards local uses: It can be a powerful tool of renewal through the combination of flood mitigation with farming activities, ecological restoration, public space development, urban extension, neighborhood regeneration, and recreational routes. The present case study shows that combinatory enterprises throughout European countries have crucial ingredients in common: a legal frame supporting spatial measures and public financial incentives available for their implementation; a pro-active attitude from local authorities and communities; positive economic trends that secure large and lasting investments; and the incorporation of spatial design at various stages, creating a negotiation platform for all qualified parties.

There are as well conditions for conflict, delay, or failure. Combinatory strategies are intrinsically more complex in their communication and their development, and therefore call for great monitoring and political skills from their initiators. Over-ambitious projects lead to frustration and conflict, whether the expected benefits concern ecology (Isar Plan) or real estate developments (Meerstad). Wide-ranging inclusion is often promoted as a requisite (Rhone 3), but generates costly delays and unwieldy procedures that hinder creativity. Powerful overarching authority is thus paradoxically needed to orchestrate the negotiations and to balance contradictory interests, in addition to local initiatives that by-pass heavy organizations and introduce embedded solutions.

Guidelines for good "floodscape design"?

With the reintroduction of the spatial dimension within the scope of flood management, qualitative questions arise together with more subjective criteria, engaging both governments and citizens in a complex exercise of cultural and aesthetic redefinition of their landscape. These issues emerge simultaneously within the scope of changing flood policy around Western European countries, although not in a coherent and legible order: Qualitative criteria greatly vary from one country to another, as they introduce changing values based on landscape history, cultural narratives, and physical perception. In terms of design, five key notions emerge, however, from a transnational perspective: authenticity, openness, robustness, coherency, and spatial quality.

The notion of authenticity is strongly present in the alpine context as the restoration of a lost identity for channeled streams. Authenticity is generally associated with the notion of freedom of movement for streams that have been constrained and channeled, and which have lost the capacity to regenerate alluvial habitats and influence riverine landscapes. Ambitions of genuine restoration appear successful in creating support for the reintegration of flood processes within the living environment, but form a double-edged instrument when they generate hopes of full renaturation that are hard to fulfill.

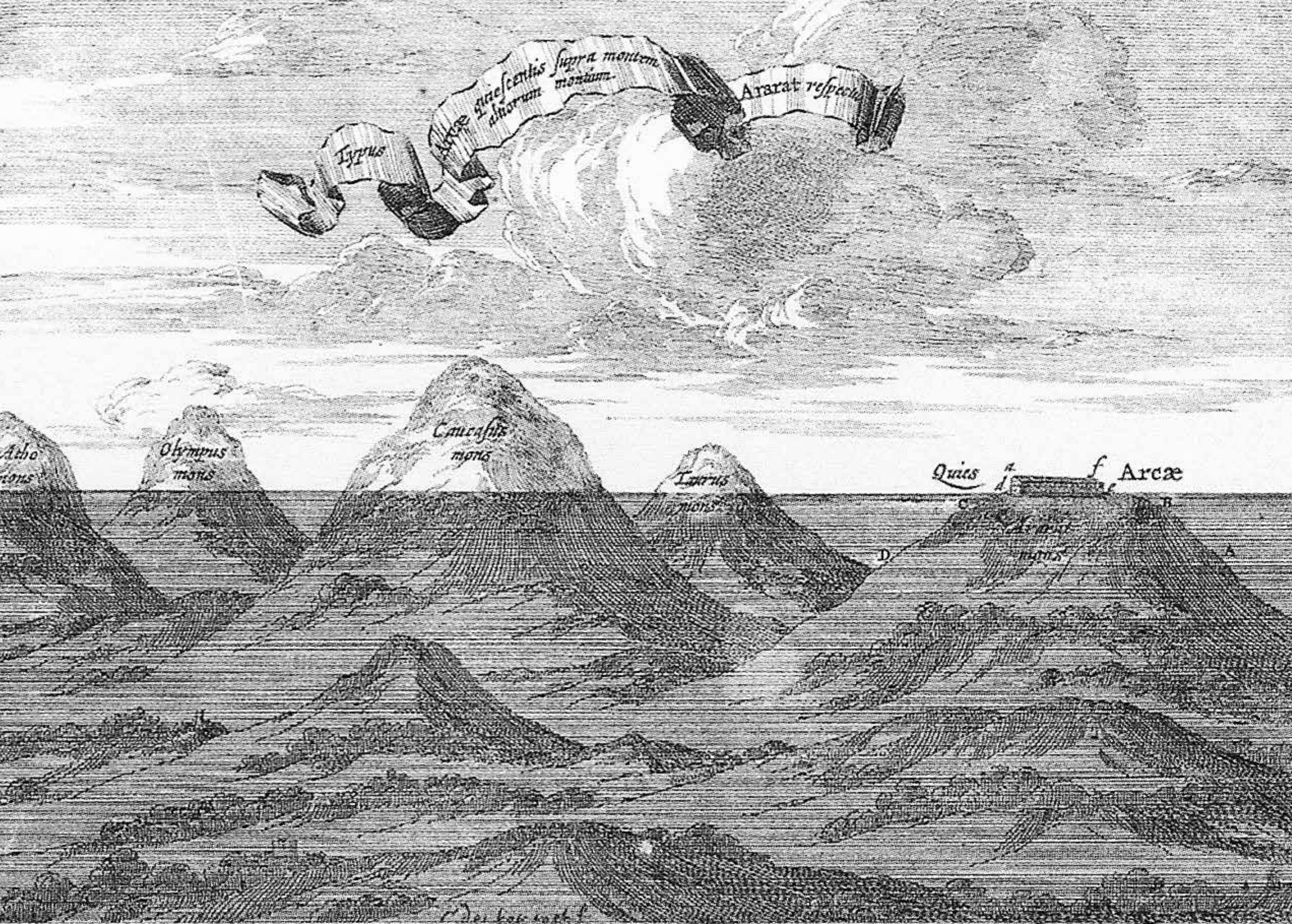
Visual and physical openness is a key dimension in the reintegration of river and flood within the realm of living environment, a dimension that brings urbanites in contact with natural processes long hidden by ever-growing levees. The tension between increased accessibility, enhanced visual perception, and ecological ambitions forms the base of floodscape design, which originates from the correlation of these three aspects.

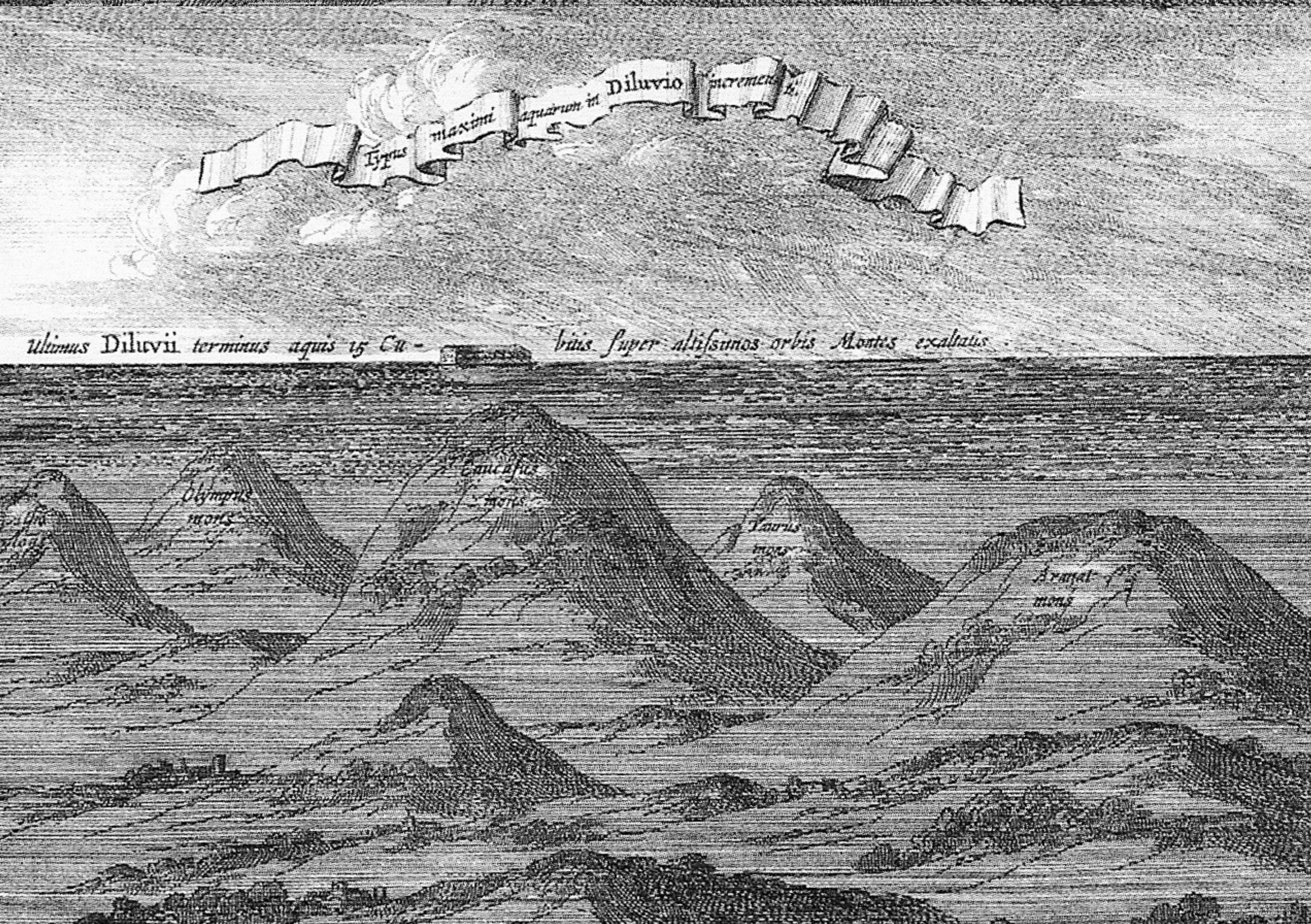
Restoring freedom and openness requires the design of robust landscapes: Floodscapes are not metaphorical reconstructions but form the spatial context of potentially violent processes, whether natural (flood and erosion) or anthropogenic (public appropriation and overuse). Furthermore, the timescale and the vastness of mitigation projects call for lasting economical solutions that ensure resistance and adaptability to unforeseen future conditions.

Ambitions of global coherency are claimed for all the projects investigated, but appear contradictory with the complexity inherent in dynamic processes, combinatory approaches, and democratic planning procedures. Coherent "Grand Designs" eventually appear beyond reach in the context of large adaptation programs, unless the programs are conceived in terms of strategies and skillfully monitored through clear but negotiable guidelines. In the context of the "Room for the River program," spatial quality proved to be a useful criterion and decision instrument: Inclusive by nature, the notion of spatial quality opened a necessary debate about the ingredients that should be incorporated into each local design, making space open for creative and consensual measures, eventually leading to locally tailored but globally coherent transformations.

New tools of landscape modelling as support for integrative and communicative design

Evolving tools of surveying, modeling, and landscape design are progressively being integrated into the practice of landscape designers and academies. More especially, the association of geographical information, terrain data, and 3D modeling tools is now made possible by the generalization of point-based information, an evolution that could bridge analytical and design-oriented approaches. The research by design associated with this thesis consists in an attempt to integrate information and design into a continuous chain for two sites undergoing high pressure from urban and natural processes: the region of Sion in Switzerland and the Island of Dordrecht in the Netherlands. The investigation includes the combination and development of geographical and design tools, which allowed us to model and visualize existing conditions and proposed measures within integrated digital environments, making it possible for the designers to display multiple options at multiple scales within an interactive environment. In the dynamic environment of digital tools, this investigation opens new perspectives for design and communication, yet to be further developed.


Typus Arcæ quiescentis supra montem Ararat respectu aliorum montium
Olympus mons
Caucasus mons
Taurus mons
Quies Arcæ
Ararat mons


Typus maximi aquarum in Diluvio incrementi.
Ultimus Diluvii terminus aquis 15 Cu- bitis super altissimos orbis Montes exaltatus
Olympus mons
Caucasus mons
Taurus mons
Ararat mons

I. God, the River and the Engineer

"A man is always a teller of tales, he lives somehow surrounded by his stories and the stories of others, he sees everything that happens to him through them; and he tries to live his own life as if he were telling a story."
Jean-Paul Sartre, Nausea.

While the Swiss "Third Rhône Correction" announces more coercive measures against an objectified nature, the Dutch Room for the River program suggests a spatial negotiation between man and a personified river. Both programs are, in fact, of comparable amplitude and undertake a similar task with similar means. How can they differ so radically in leitmotif? Which story is being told, how does it relate to pre-existing narratives, and what future does it propose?

Flood prevention plans are more than univocal solutions and more than just intervention proposals. The programs investigated as well as their predecessors show that all projects, beyond offering a set of practical transformations, are embedded in complex and multilayered narratives that differ in strategy in their ability to intertwine practical proposals with cultural elements, and create a meaningful ensemble that can be altogether manipulative, inspiring, and mobilizing. Vast, expensive, long-term enterprises need collective, broad, and lasting support: Most floods are the result of maintenance shortcomings or lack of foresight rather than exceptional natural conditions.

Various myths and figures are brought into play to oppose or promote flood-prevention measures – with a technical rationale being paradoxically one of the many narrative tools. Furthermore, narration answers the individual need for each one of us to participate in a meaningful epic that is beyond the erratic manifestations of natural processes, their happy or dramatic consequences, and the human subsequent reactions. A man "tries to live his own life as if he were telling a story": This is true also of collective enterprises. The plan narration differs greatly, depending on the cultural framework used to elaborate and communicate this plan, and the reflexive positioning of humankind and Nature within the context of the project. In a Western-European context, it also contains recurrent figures that can be tracked from millenarian myths. Understanding the success and the conflicts behind great river transformations implies uncovering those hidden prejudices that affect both the aim, the process, and the result. From the Flood sent by omnipotent gods,

Previous page:
C. Desker, Noah's ark in Mount Ararat, Illustration for: Arca Noe, Athanasius Kircher, 1675.

through the absolute protection promised by Promethean engineers, and on to the hopes of a final reconciliation with Nature, myths evolve and accumulate, and are worth investigating in order to better understand tomorrow's hopes, conflicts, pitfalls, and success factors.

Formation of the Flood myth

Although flooding might be associated with wealth and fertility along the Nile or the Mekong rivers, the Near-Eastern and European traditions focus on its dramatic rather than its nourishing aspects. The Flood is one of the most widespread myths, found in similar forms in a period stretching over 5000 years, starting from the Mesopotamian epics written on clay tablets, and spreading to Western Europe and possibly to the Indian sub-continent. For Buffon, already "everything seems to attest that the common stem of human knowledge belongs to this land of Upper-Asia" (Buffon, 1778: 234), and Rousseau imagined around the same time how natural catastrophes might have spread human language: "we may form a conjecture also concerning the manner in which various causes may have extended and accelerated the progress of language, by making it more and more necessary. Floods or earthquakes surrounded inhabited districts with precipices. or waters : revolutions of the globe tore off portions from the continent, and made them islands." (Rousseau, 1754, 1: 211) And it is in the Near-East regions that various signs of major past floods were found in the 20th century, to the great excitement of archaeologists believing to have found traces of the mother of all catastrophes. Contemporary research on that matter now relates this archaeological knowledge to geology and climate history, and more evidence is appearing of dramatic changes in lake and sea levels at the end of the last Ice Age, which could be linked to a millenarian myth and which propagates the fear of a final flood that even extends to present-day apocalyptic imaginings.

A hydrological and ethnological Big Bang?

Several scientific hypotheses could potentially explain the Flood myths originating in the Near East with actual hydrological events. To cite an example, several teams suspect that melting waters and rising sea levels might have led to the abrupt flooding of fresh lakes by open seas. These invasions by the sea into the land mass are likely to have taken on catastrophic proportions, since the levels of lakes and open sea did not necessarily evolve at the same pace, suggesting one or several incidences of violent rebalancing.

Around the Last Glacial Maximum, c. 21,000 BP, large quantities of water were imprisoned in the ice, and sea levels dropped to 120 meters below current levels, uncovering new lands, while others lay deep under the ice. Sea levels have been progressively rising since the Last Glacial Maximum, with this rise concentrating over the period between 15,000 and 5,000 BP (Gornitz, 2007: 889) at an average speed of about 1 meter/century, with various episodes of slower or accelerated variation. Each warming episode sees precipitation increase, ice melt, and sea levels rise: three factors of massive flooding. The abrupt end of the Younger Dryas between 12,800 and 11,500 BP is the most recent of these rapid climatic changes, with seas rising at an estimated pace of 40 mm per year from 11,500 to 11,200 BP (Liu and Milliman, 2004, quoted in Gornitz, 2007: 890). However, various records show similar variations between 9000 and 7600 BP (Gornitz: 2007), and glacial melting continued until 6000-5000 BP, with adjustments still occurring after this date: The oldest written records of a Flood date from this last period.

During the Younger Dryas, the Near Easter and southeastern Mediterranean regions are considered to have suffered from widespread aridity. Colder and dryer than is found today, the region was once covered with semi-desertic to desertic vegetation, locally dry steppe with some savanna (Rossignol-Strick, 1995). At the same period, Northern Europe suffered a severe and cold drought, and woodland was rapidly replaced by steppe and steppe-tundra. These conditions might have confined human populations to a limited number of refuge areas located in the warmer regions and close to fresh water resources, such as the shores of the Black Sea and the Persian Gulf basin, both possibly fresh lakes, smaller than today, and bordered with fertile shores and floodplains. With de-glaciation appeared new land, while "at times when the interior of Arabia became desiccated and uninhabitable, sea levels dropped and created new coastal habitats around the margins of the peninsula." Nomadic populations moved back and forth around the area, following climate fluctuations, and their direct effects on temperature, precipitation, sea level, and coastlines. In the last decades, three main hypotheses have stated the existence of past floods of Flood amplitude, located respectively in the Caspian Sea basin, the Black Sea basin, and in the Persian Gulf region, which all could have dramatically transformed the contours of human habitat.

The Black Sea hypothesis

Until 1997, the levels of the Black Sea and the Mediterranean Sea were consensually thought to have evolved in concert through alternate glaciation and de-glaciation periods (Ryan et al., 1997: 65). In an article published that year in the journal Marine Geology, an international team of researchers led by William B.F. Ryan and Walter C. Pitman exposed new arguments indicating that the two seas had been reconnected only around 7150 BP through an abrupt and catastrophic flood.

Based on various observations, including those made by Soviet scientists in the 1970s that had found traces of former shorelines at depth between 70-120m, Ryan suggested that the Black Sea level had not followed the level variations known for the Mediterranean basin. Significant differences in salinity between the Black Sea and the Sea of Marmara for identical periods of time had previously been attested, showing a more than 3000-year time gap. For Ryan, both basins had been disconnected for a long period, and abruptly reconnected though a massive overflow of Mediterranean salty water into the Black Sea. According to his reconstruction, an abrupt rebalancing had taken place around 7550 BP, with the Black Sea turning from a fresh lake into a brackish sea, and expanding its surface about 30% in a relatively short period. Ryan then also suggested that the lake rise could have reached a rate of tens of cm/day, forcing the population to relocate rapidly (Ryan et al., 1997). He later proposed a longer interval for the reconnection, starting from 8400 BP, and suggested that two floods had taken place, with a first rise from -120 to -30 meters between 11,000 and 10,000 BP, and a second and more dramatic one from -95 to -30 at 8400 BP (Ryan, 2007).

If proved true, this scientific hypothesis would seem able to be linked to religious traditions as well as major anthropological developments. The 1997 publication suggested that the great Black Sea Flood could explain the rapid spreading of farming practices along the main valleys of southeastern Europe during the so-called Neolithic Revolution. In various media, Ryan and Pitman suggested that the amplitude of the Flood might be able to explain the creation and the transmission of flood myths, from Sumerian mythology to Noah's Flood. An article in the New York Times (The New York Times, 17.12.1996) and a documentary broadcast by the BBC gave the hypothesis a wide audience, since it seemed that it could have great implications for the history of humankind and provide a strong link between natural sciences, theology, and archaeology. The enthusiasm and controversy that has since characterized the Black Sea Flood hypothesis is rather reminiscent of the wave of interest and support raised by the discovery of the first Flood tales among the 25,000 tablet fragments archaeologists brought back to London from the excavations held in Nineveh and Nimrud in the late 19th century (The Epic of Gilgamesh, 1972 edn.: 10), a discovery that was soon followed by a publication (Smith, 1873) and more excavations. The context was different, however: In 19th century England, the authenticity of the biblical Flood was not questioned, merely its location. Ralph Creyke, a man of science and main actor in England's land reclamation, could write confidently about the debris of a forest that it was "most probably laid prostrate at the time of the Flood, as the trees do not show the action of fire, and they are mostly laid in the same direction" (Creyke, 1845, 30).

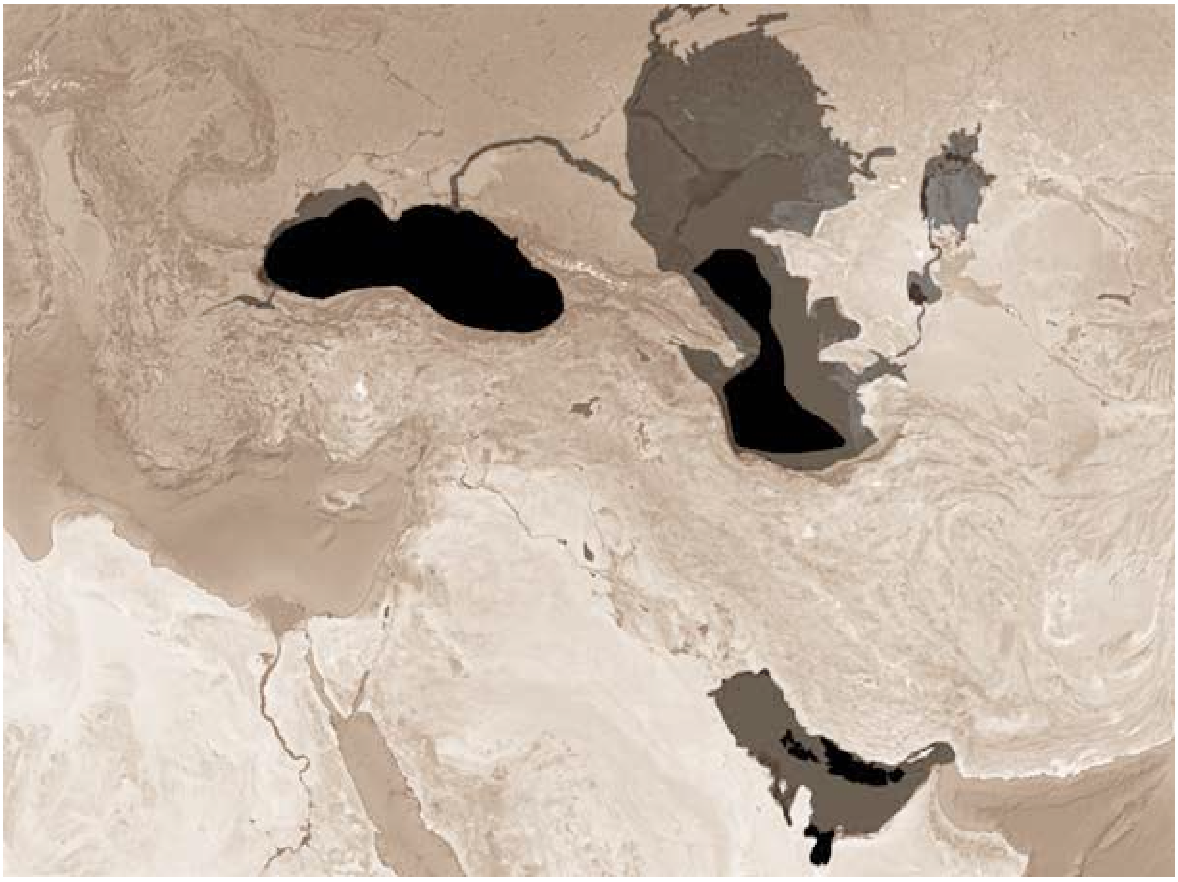
The Black Sea Flood hypothesis was, however, criticized on various grounds. In the book The Black Sea Flood Question: Changes in Coastline, Climate, and Human Settlement (Yanko-Hombrach, 2007), the opponents of Ryan's theory argued that the Black Sea was semi-fresh to brackish but never a freshwater lake. Its level was situated at about 100 meters below its present level during the Last Glaciation Maximum but had reached a level of -20 meters below current level already in 17,000 BP, never dropping again below -50 meters or experiencing fluctuations greater than twenty meters. Based on available archaeological knowledge, Yanko-Hombach doubted the possibility of a massive exodus and its cultural consequences: no significant cultural changes could be found in the surroundings at the time of the hypothetical Great Flood; furthermore, the area was then inhabited by small populations of foragers, who were unlikely to have generated any significant spreading of agricultural practices, practices that had already been attested to about 3000 years earlier in the Zagros Foothills, in modern-day Iran (Yanko-Hombrach, 2010: 27).

The Khvalynian transgression

The Caspian Sea Flood hypothesis suggests another possibility of historical Flood, located further east. Andrei L. Chepalyga stated in the early 2000s that geomorphological and paleontological evidence attested that between 17,000 and 10,000 BP, a cascade of Eurasian Basins was draining the Scandinavian ice sheet and the melting permafrost from a wide catchment area including central Asia. Chepalyga characterized this era as a period of Great Flood around the modern-day Caspian Sea, and where the most dramatic changes would have taken place; he identified three "superflood" waves, each lasting as long as 2000 years, with a maximum reached between 17,500 and 15,000 BP. The supposed pace of the sea level rise and the subsequent coastal shift indeed suggested catastrophic changes for human populations: one meter/year sea rise (during the rising phases), with coasts migrating at a speed of five to ten kilometers per year in the north Caspian region, and about ten kilometers a year at the mouth of the Volga River. Massive inundations would then have forced local populations to look for safe areas, consequently spreading their mores and knowledge outside their original habitat. According to Chepalyga, "such dramatic changes in sea level must have imposed substantial stresses upon coeval human populations, and the inundations probably remained in cultural memory as the Great Flood," and "might have stimulated the beginning of shipping, as well as horse domestication" (Chepalyga, 2007: 119).

The Black Sea would in the same period have been filled by an overflow from the Aral Sea and the early Khvalynian Basin, directing waters towards the Aegean Sea. This chain would have caused the Black Sea to rise 60 to 70 meters (Chepalyga, 2007). However, the amplitude of the changes seen in the Caspian Sea basin largely surpasses variations in the Black Sea: The Caspian Sea remains the epicenter of the Great Flood. This was a flood that, for Chepalyga, could only indirectly be related to the biblical Flood, and then supposes that "the collective memory of mankind may have retained these events for thousands of years, until they were later written in ancient Aryan scriptures, such as the Rigveda and Avesta," whereupon "the concept of the Flood was adopted by the ancient inhabitants of Mesopotamia, from whom it eventually came to the Bible." (id.:143)

Several researchers have opposed Chepalyga's theory. Alexander Svitoch countered most of the arguments used by Chepalyga, refuting the certainty of the cascade of basins, as well as the catastrophic nature of the flood involved (Svitoch, 2009). Yanko-Hombrach recently has also refuted the supposed water transfers and their catastrophic nature. She moreover considers it unrealistic that phenomena spread over several thousands of years would be remembered as a one-time catastrophe, such as the Flood described in the Old Testament (Yanko-Hombrach, 2010: 25).



Figuration in black of the former state of the Ponto-Caspian basins (from Chepalyga, 2007) and the Persian Gulf lakes (from Rose, 2010), at their lower level around the Last Glacial Maximum (Rossano, aerial picture Google Earth)

The 'Gulf Oasis Model'

According to the "Gulf Oasis Model," the Flood would have taken place at the end of the last glacial era around the Persian Gulf – or rather at the bottom section of today's Gulf. During the last glaciation, the Persian Gulf would have been disconnected from the Indian Ocean due to dropping sea levels. Instead, the region would then have formed a vast plain, and offered a fertile refuge for human populations escaping the continent's desiccation (Rose, 2010). For Rose, what we today know as the Perso-Arab Gulf, a salty sea surrounded by sandy coasts, was from 74,000 to 8000 BC a large inland depression, reaching its maximum size around 18,000 years BP, at the height of the Last Glaciation Maximum, with an area of about 200,000 km2 of emerged land, today covered by sea. This was a region that is "[t]hought to have formed one of the most important oases in the ancient world," offering "a rich mosaic of freshwater springs, river floodplains, mangrove swamps, and estuaries" (Rose, 2010: 853-854). It was an oasis surrounded by dry land, one that already by 7,000 years BP saw "the first detectable use of lowland irrigation farming to carry out intensive agricultural production, an innovation that some have speculated was the catalyst for the Urban Revolution" (Rose, 2010: 850).

After reaching its territorial maximum, the region began shrinking again in several phases, corresponding to several pluvial episodes. A sudden soaring in the number of human settlements dated after 8000 BP, at the periphery of today's gulf, suggests that the plain was then submerged for the most part by a massive and rapid incursion of water from the Indian Ocean, forcing populations to relocate upslope. The fertile garden described by Rose would then have been wiped out by tremendous amounts of brackish and salty water pouring over the land, destroying centuries of human labor, and shifting the coastline at a frightening pace.

The Flood, local flood turned global myth?

More recently, strong archaeological evidence found in the Mesopotamian region seems to support the hypothesis that ancient Mesopotamia was flooded prior to 2900 BCE. In 1928-1929, two archaeological campaigns carried out in the cities of Kish and Ur found sedimentary flood deposits in the ground, attesting to a major inundation in the area. The excavations made at Ur suggested that a flood had submerged the area around 3500 BCE. Excavations in Kish produced evidence of two more recent floods, dated around 3000 to 2900 BCE (Mac Donald, 1988:16). Excavations in Shuruppak also uncovered a flood stratum. These findings were quickly related to the biblical Flood by the archaeologists themselves, immediately adding a theological dimension to the archaeological debate. Mac Donald noted that the flood attested to in Shurrupal is of particular significance, since according to the Sumerian King's list the city is the home of Ziusudra, last king before the Flood, and a central character in the oldest known account of the Flood. Furthermore, the date of this would match that of the flood mentioned in various Mesopotamian epics and which is roughly datable thanks to the post-diluvian genealogy found in the Kings List, from which it has been deduced that the Mesopotamian Flood took place around 2900 to 2800 BC (Mallowan, 1964: 68-70).

The question remains as to whether the global post-glacial hydrological variations were catastrophic, gradual, or oscillating (Yanko-Hombrach et al., 2007). In the first instance, these hypotheses could give the mythological and biblical Flood descriptions a basis of authenticity, and shed new light on the history of humankind. An oscillating rise in water levels would imply a succession of more moderate floods, while a gradual rise would relativize the accounts of a nearly final Flood to that of one at a local level, or to the mythological domain, and thus dash the hopes of many who wish to see the biblical description confirmed by scientific evidence. However, even if progressively spreading over several centuries, the radical processes that took place after the Younger Dryas glacial episode would attest to effects on natural habitats and therefore on human communities, whether nomadic or sedentary. Changes in precipitation, the rise and fall of sea levels, shifting coasts and deltas, salinization of lakes and ground water, coastal and river floods, these are factors sufficient to attest to the decisive influence of water dynamics on the early history of human civilisation, enough to explain the presence of a flood at the very center of the oldest cosmogonies. In these unstable times, flood was probably no more lethal then drought, cold, famine, or pandemics; it is, though, the most dramatic of all catastrophes in its suddenness, the most horrific in its visual manifestation, and could still have found its way into oral culture and mythological accounts, elaborated on by generations of priests to remind their contemporaries of the provisional nature of their habitat and their existence, jolted by fluctuating and erratic environmental conditions. This is a situation one could easily find reminiscent of the current challenges to our sedentary civilization posed by accelerating climate change.

First accounts of a Flood

Whether based on real events or not, various epics describe the occurrence of a mighty flood that would have nearly annihilated humankind, and which led to a historical "reboot" thanks to a handful of survivors. This mythological line, first found in Mesopotamia, written in Sumerian and later translated into various languages used in the Near East, is clearly traceable through Greek and Roman literature, in the Jewish Torah and biblical Old Testament, as well as in Indian mythology, though with less evidence; it still today influences the perception of flood in a large part of the world. In all these cultural traditions, the Flood is a story of destruction, grief, and struggle, and reveals a deep and collective anxiety about natural fluctuations, their origins, and their possible anticipation. Within a continuous narrative framework, each tradition, however, suggests a particular relationship between humankind and nature, or its divine representatives, and divergent motives regarding the origins, the meaning and the consequences of the Flood - as it appears not always negative.

The oldest traces of flood records are found on Sumerian clay tablets excavated in Mesopotamia, where the character of Ziusudra (later Atrahasis in the Akkadian epics), King of Shuruppak, already emerges on tablets dating from the early third millennium BCE. The character is found in various texts and languages spread over vast time distances. This account forms the canon of a story that will be written again and again in various Indo-European cultures, using the same canvas in different religious or philosophical contexts. The Old Babylonian version of the Atrahasis epic was written on clay tablets by Ipiq-Aya around 1700 BCE. At the time, Mesopotamia was a "largely urban society" (Dalley, 2000: xv); its fertile landscape was intensively populated and exploited thanks to an extensive irrigation system. This irrigation system itself is said to have been made by the gods, before even the first human was created:

The gods had to dig out canals,

Had to clear channels, the lifelines of the land,

The Igigi [young gods] had to dig out canals,

Had to clear channels, the lifelines of the land.

3d millenium BCE
Reign of Gilgamesh, King of Uruk
Oldest known clay tablets mentionning Siuzudra

18th -7th cent. BCE (various copies on clay tablets)
Epic of Atrahasis

18th-13th cent. BCE (compilation)
The Epic of Gilgamesh

8th-7th centuries BCE
Development of Greek Mythology
“All the land seethed, and Ocean’s streams and the unfruitful sea”
(Hesiod, Theogony, ll. 687-712)

7th-5th centuries BCE
Torah, Genesis, 7
“I will cause it to rain upon the earth forty days and forty nights; and every living substance that I have made will I blot out from off the face of the earth.”

4th century BCE
Plato, Laws, III
“the cities situated in the plains and near the sea were totally destroyed at the time”

4th century BCE
Aristotle, Meteorology, I, 14.
“the same parts of the earth are not always land or sea and why that is so”

50 BCE
Lucretius. De Rerum Natura, 6.93.
Great Meteorological Phenomena, etc. ‘Wherefore Religion now is under foot, And us his victory now exalts to heaven.”

ca. 8 AD
Ovid, Metamorphoses, Book I, fables 8-11
“Jupiter extirpates mankind by a universal deluge”

ca. 125 AD
Lucian, De Dea Syria, 12.
“everything became water, and all men perished; Deukalion alone was saved for another generation, on the score of his wisdom and piety.”

c.100-200AD
Pseudo-Apollodorus.The Library, 1.7.1-2
Zeus poured heavy rain from heaven and “flooded the greater part of Greece, so that all men were destroyed, except a few”

c.200-250AD
Origen. Homily 2: Genesis
“To the degree that the narrative concerns the force of the rains and the flood, no form could be given to the ark more fitting and more suitable”

Deluge myths, from Atrahasis to Deucalion

The gods dug out the Tigris river (bed)

And then dug out the Euphrates. (Dalley, 2000: 10)

Although weather and irrigation are attributed to two distinct divinities, Ellil/Enlil and his son Ennugi/Ninurta, respectively, the rivers and canals together are described as one creation. They were built by the young gods (the Igigi) not by means of a divine miracle but through hard labor, labor so hard that the Igigi one day burned their tools and revolted against the authority of counselor warrior Ellil. Ellil finds a way to unburden the Igigi and avoid war: "Let the womb-goddess create offspring, / And let man bear the load of the gods!" (Atrahasis: 1.4.) And so Mami creates the first humans out of blood and clay, and humans receive, together with life, the endless task of shaping, working, and irrigating the land.

In the centuries following their creation, humans worked hard; they: "Made new picks and spades, / Made big canals / To feed people and sustain the gods." After 1200 years, humankind had multiplied to such an extent that they were disturbing the gods' sleep; Earth was threatened by chaos. Ellil convinced the Council of Gods to regulate the human population through the use of "natural" hazards, to prevent this chaos and allow him to sleep.

600 years, less than 600, passed,

And the country became too wide, the people too numerous.

The country was as noisy as a bellowing bull.

The God grew restless at their racket,

Ellil had to listen to their noise.

He addressed the great gods,

"The noise of mankind has become too much,

I am losing sleep over their racket. (...)" (Dalley, 2000: 18)

Several similar episodes follow, where Ellil again reports chaos and overpopulation, repeating this same passage, a characteristic typical of oral poetry (Sandars, 1972: 41). Ellil subsequently sends various catastrophes down upon humankind to remedy the situation: first a plague, and later drought and famine. It is during these dark times that the human character of Atrahasis comes in contact with the god Enki/Ea, to whom he prays and eventually sends a message, which is carried by the irrigation canals and rivers. Every time humankind threatens to disappear, Atrahasis succeeds, with Enki's support, in appeasing the gods' anger, and returns humankind to health and good harvests – leaving Ellil angry and dissatisfied.

The third catastrophe sent by Ellil upon humankind is the Great Flood. This event, related in the third tablet of the Old Babylonian Atrahasis epic, is missing too many lines to be fully comprehensible. However, the tale of the Flood was later included in the Epic of Gilgamesh (Sandars, 1972: 38), which informs us about the content of the missing parts. After complaining again about the excessive number and chaotic existence of humans, Ellil proposes to the Council of Gods that humankind be wiped out by releasing an almighty and final flood. Several of the gods are reluctant to destroy what they have created, but the powerful and influential Ellil eventually convinces them to follow his plan, and demands that all the gods swear an oath to keep the plan secret. However, his brother Enki is opposed to the proposal, wondering, "Why should I use my power against my people?" And so he secretly warns one righteous human, Atrahasis. In a dream, Atrahasis is instructed to "Dismantle the house, build a boat, / Reject possessions, and save living things." He is taught precisely how to build the boat and to "put aboard the seed of all living things." Enki instructs Atrahasis on how he is to justify his absence to his fellow citizens, and how to keep them unaware of the coming catastrophe. Atrahasis leaves the city, builds and loads the boat, and, once he seals the door, Enki begins the Flood:

For seven days and seven nights

The torrent, storm and flood came on.

The Flood is of such devastating proportions that "[e]ven the gods were afraid of the flood-weapon." Horrified by the damage caused, the goddess Mami laments the destruction, and, together with the other gods and goddesses, regrets having obeyed Ellil's command (fragments of the original are text missing):

Let daylight (?) ...

Let it return and . .. !

However could I, in the assembly of gods,

Have ordered such destruction with them?

(...)

Nintu [another name for Mami, who created humans from clay and blood] was wailing [ ]

'Would a true father (?) have given birth to the [rolling (?)] sea

(So that) they could clog the river like dragonflies? (Dalley, 2000: 33)

Ellil is, in his turn, furious when he realizes that Enki has helped Atrahasis escape the flood together with his family and representatives of all other living creatures. Ellil and Enki reconcile, however, and Atrahasis is eventually allowed into the assembly of the gods. Being only human, he is just granted everlasting life (The Epic of Gilgamesh, 1972 edn: 79), which makes his encounter possible with Gilgamesh, born several centuries after the flood.

Differing from the strictly religious Hebraic Torah of the Christian Bible, the Mesopotamian epics are primarily multi-facetted tales told orally, probably for various purposes: recreational, historical, philosophical, or religious. Dalley notes that "some of the most famous author-scribes were also incantation-priests" (Dalley, 2000: xviii), suggesting that literature and religion were not strictly differentiated. Although the narrative sequence of the Mesopotamian tale obviously forms the canvas of Noah's Flood, it comprises a rather different content. The first intrinsic characteristic that differentiates the Mesopotamian tale from that of the Old Testament is the motive for the Flood. Noah's Flood puts God's perfection, infallibility, and omnipotence in opposition to the weakness and wickedness of humans; the Flood is explicitly a unique occurrence, a one-time absolute punishment for moral failure. In the Mesopotamian tale, however, the Flood released upon humankind is not primarily motivated by moral judgment but rather is an ad hoc measure aimed at taming the uncontrolled growth of humanity. Dalley notes that, according to Mesopotamian mythology, the first humans had no predefined lifespan, and the gods thus needed "to regulate their population intermittently with plague, famine, or flood," with the last of these being just "one method by which the gods tried to reduce overpopulation" (Dalley, 2000: 8,43). Ancient Mesopotamia, considered to be the oldest urban civilization, one that was made possible by productive, fully irrigated agriculture, most probably experienced a demographic boom comparable to other developing communities when shifting from foraging, with its self-regulating survival mechanisms, to an organized collective and productive existence. The size and the density of Mesopotamian cities was furthermore an unprecedented phenomenon, and Ellil, complaining about his sleepless nights troubled by humankind's uproar, probably echoes the experience of his human contemporaries. In this context, relating flood to demographic regulation obeys basic causality, by merging the problem and the remedy: Flood is a human catastrophe but also a form of survival by keeping the population in phase with its production, with the Flood functioning as a radical demographic control, just like the plague and the drought previously sent by Ellil.

A second difference is the dubious legitimacy of Ellil's plan. In Sumerian polytheist mythology, as well as for in later Greek and Roman mythologies, the decision is initiated by one of many gods, and it is not equally appreciated by his peers, thus creating a source of discussion and conflict. Contrary to the biblical Flood, presented as a universal and exemplary punishment, Atrahasis exposes the Flood tale to Gilgamesh as a "closely guarded matter," the "secret of the gods," told only to comfort the hero tormented by human mortality after the death of his dearest friend (Dalley, 2000: 109). The Mesopotamian Flood is a catastrophe for humankind and for the gods, who nearly destroy their own creation, blindly following the orders of their irritable and radical leader Ellil. Before, during, and after the Flood, several gods remain haunted by feelings of doubt and regret (a vision found again later in Ovid's Metamorphoses).

Third, this early Flood tale is brought to us by a flourishing hydraulic civilization, whose cosmogony logically places the creation of rivers and canals at the very beginning of history, and assigns the control of irrigation to a singular god. For the dense Mesopotamian population, the main condition for survival is its capacity to control and redirect the waters brought by the fluctuating Tigris and Euphrates Rivers, to exploit regular river floods, and to sustain its agricultural production level, which depends on groundwater and irrigation more than on direct precipitation. This dependency upon irrigation, water storage, and flood control suggests a high level of social stability and administrative coordination, two vital aspects of hydraulic civilizations. When Ellil sees how "the world bellows like a wild bull," he might also be pointing out a level of dangerous disorder or social unrest, which could ultimately lead to flooding and famine, caused by absent or deficient control and maintenance of the vital water infrastructure.

These three specific origins thus differentiate the Mesopotamian Flood from those that follow: overpopulation, unpredictability, and disorder. A fourth distinction is its existential dimension, particularly explicit in the Epic of Gilgamesh. After the death of his beloved friend/brother Enkidu, Gilgamesh seeks to meet Atrahasis, the only human who has been given everlasting life. But instead of bringing Enkidu back to life, Atrahasis tells him the story of the Flood, and how the gods nearly exterminated humankind with the same arbitrary cruelty that killed Enkidu ("One of them [must die]," says Anu, to which Ellil replies: "Let Enkidu die, but let Gilgamesh not die" (Dalley, 2000: 84). The Flood forms a tale of wisdom and acceptance of man's mortality and exposure to the erratic behavior of nature/gods; flooding is later in the epic cited as a metaphor for life's impermanence:

Savage Death just cuts mankind down.

Sometimes we build a house, sometimes we make a nest,

But then brothers divide it upon inheritance.

Sometimes there is hostility in [the land],

But then the river rises and brings flood-water.

(Dalley, 2000: 108-109)

The ultimate weapon

In ancient Greek literature, flood is mentioned both as an agent of destruction and as a fertilizing process – as "from the flooding of the river abundant crops spring up" (Apollonius, Argonautica) – but also as the most dangerous weapon used by Hercules to defeat the Mynians, and by Zeus to destroy humankind in a similar way as Ellil did before him.

Plato's Laws evoke a widespread Flood, relating that "the world of men has often been destroyed by floods, plagues, and many other things, in such a way that only a small portion of the human race has survived." (Plato, Laws III, 1967&1968 ed.: 3. 677). In this dialogue, the two protagonists imagine in particular the destruction of civilization, assuming that "the cities situated in the plains and near the sea were totally destroyed at the time", and that, with the destruction of cities, "everything in the way of important arts or inventions that they may have had,—whether concerned with politics or other sciences,— perished at that time." (id.), implying a dramatic cultural "reset".

The story line of the Deucalion Deluge found in various sources follows the Mesopotamian canon quite closely, although its scale is subject to discussion: Aristotle considered that "the deluge in the time of Deucalion (...) took place chiefly in the Greek world and in it especially about ancient Hellas, the country about Dodona and the Achelous, a river which has often changed its course." (Meteorology)

According to Dalley, Prometheus, whose name literally means "forethinker," may be an approximate Greek translation of Atrahasis, "extra-wise." The parallel between the two mythological figures goes further, as Prometheus is also father of Atrahasis equivalent, Deucalion, who is saved from a destructive flood released by Zeus to punish humankind. Ovid describes in his Metamorphoses how the mightiest god, "not thinking the punishment of Lycaon sufficient to strike terror into the rest of mankind, resolves, on account of the universal corruption, to extirpate them by a universal deluge." Jupiter intends to punish humankind for its arrogance and restore his authority after Lycaon has dared to test his omniscience by serving him human flesh as a dish. Furious, the mighty and merciless god decides to wipe out the whole of humankind. Lycaon is not only famous for being a wicked man: he dares to doubt Jupiter's divine nature when he is visited by the god, and the deluge comes as an absolute demonstration of power and as a final punishment for humans who dare question their divinities. But, as was the case for Ellil's decision, Jupiter's lacks consensus among the gods, who wonder who will worship them then. "Yet the entire destruction of the human race is a cause of grief to them all, and they inquire what is to be the form of the earth in future, when destitute of mankind?" Jupiter like Ellil silences his critics by "promising, that from a wondrous source he will raise a generation unlike the preceding race." From a moment of destruction, the Deluge becomes a necessary step in the creation process, a repeat with better conditions and components.

Ovid's description of this deluge is particularly rich and evocative. It mixes mythological elements with descriptions of altogether dramatic and absurd scenes unique to flooded landscapes. Jupiter, in one of his most impressive transfigurations, shows "his terrible face covered with pitchy darkness; his beard is loaded with showers, the water streams down from his hoary locks, clouds gather upon his forehead, his wings and the folds of his robe drip with wet" (Ovid, Metamorphoses, trans. Riley: 1:8). The face of the Earth is dramatically transformed, as this great flood uniformly but also equally covers familiar landscapes and all recognizable features, returning the world to its original nothingness. "Sea and land had no mark of distinction; everything now was ocean" (id.). Even the laws of the animal realm were abrogated, since the "wolf swims among the sheep" and the "wandering bird (...) falls down into the sea."

Deucalion, warned by his father Prometheus, is the only survivor of the catastrophe, together with his wife Pyrrha. After nine days and nine nights, their ark lands on Mount Parnassus, according to Ovid (Metamorphoses, 1.9) and Appolodorus (Library, 1.7.2), or in the region of Dodona and Achelous according to Aristotle (Meteorology, I, 14). Together they "remain as mere samples of mankind" (Ovid). After this deluge, Deucalion and Pyrrha pray to the gods, and are instructed to repopulate the world. Like his father Prometheus who formed men out of clay, Deucalion repopulated the Earth by throwing stones over his shoulders; each stone falling onto the rich mud gives birth to a man, while Pyrrha does likewise, except that from each stone she throws, a woman is born. But contrary to Prometheus, who brought life to his creation with fire he had stolen from heaven, Deucalion obediently followed the instructions of the gods, and turned the destructive event into a rebirth of humankind.

Besides this Deluge, flooding has indeed more than just a catastrophic side in ancient mythology. In the Deluge tale, Ovid goes on to illustrate the nourishing virtue of this flood, since "the Earth, covered with mud by the late deluge, was thoroughly heated by the æthereal sunshine and a penetrating warmth, it produced species of creatures innumerable; and partly restored the former shapes, and partly gave birth to new monsters." (Ovid: 1.11)

Deucalion and Pyrrha repopulate the world after the deluge sent by Zeus.

Atrahasis / The Epic of Gilgamesh (The Epic of Gilgamesh, trans. Dalley, 2000, and.K. Sandars, 1972 edn.)	Old Testament (Holy Bible, New International Version)	Ovid, Metamorphoses (Metamorphoses, trans. Henry Thomas Riley)
[motive of the Flood]		
In those days the world teemed, the people multiplied, the world bellowed like a wild bull, and the great god was aroused by the clamour. Enlil heard the clamour and he said to the gods in council, “The uproar of mankind is intolerable and sleep is no longer possible by reason of the babel.” So the gods agreed to exterminate mankind. (Sandars: 1972)	The Lord saw how great the wickedness of the human race had become on the earth, and that every inclination of the thoughts of the human heart was only evil all the time. The Lord regretted that he had made human beings on the earth, and his heart was deeply troubled. So the Lord said, “I will wipe from the face of the earth the human race I have created—and with them the animals, the birds and the creatures that move along the ground—for I regret that I have made them.” (...) Now the earth was corrupt in God’s sight and was full of violence.God saw how corrupt the earth had become, for all the people on earth had corrupted their ways. So God said to Noah, “I am going to put an end to all people, for the earth is filled with violence because of them. I am surely going to destroy both them and the earth. (Genesis: 6:5-7,11-13)	Jupiter, not thinking the punishment of Lycaon sufficient to strike terror into the rest of mankind, resolves, on account of the universal corruption, to extirpate them by a universal deluge. (Riley: 1:8)
[Reserves]		
Enki made his voice heard And spoke to his brother gods, ‘Why should you make me swear an oath? Why should I use my power against my people? The flood that you mention to mt.~ What is it? I don’t even know! Could I give birth to a flood? That is Ellil’ s kind of work! Let him choose [ ] Let Shullat and [Hanish] march [ahead] [Let Erakal pull out] the mooring poles Let [Ninurta] march, let him make [the weirs] overflow. (Dalley: 29)		Some, by their words approve the speech of Jupiter, and give spur to him, indignantly exclaiming; others, by silent assent fulfil their parts. Yet the entire destruction of the human race is a cause of grief to them all, and they inquire what is to be the form of the earth in future, when destitute of mankind? who is to place frank incense on the altars? and whether it is his design to give up the nations for a prey to the wild beasts? The ruler of the Gods forbids them making these enquiries, to be alarmed (for that the rest should be his care); and he promises, that from a wondrous source he will raise a generation unlike the preceding race. (Riley: 1:8)
[The chosen one]		
The thoughtful man, Atrahasis Kept his ear open to his master Ea; He would speak with his god, [And his god (?)] Ea would speak with him (Dalley: 23-24)	But Noah found favor in the eyes of the Lord. (...) Noah was a righteous man, blameless among the people of his time, and he walked faithfully with God. (Genesis: 6:5-7,11-13)	When here Deucalion [...], with the partner of his couch, first rested; [...] No man was there more upright than he, nor a greater lover of justice, nor was any woman more regardful of the Deities than she. (Riley: 1:9)

Corresponding depictions of the Flood in the Mesopotamian epic, the Old Testament and the Metamorphoses of Ovid

Atrahasis / The Epic of Gilgamesh
(The Epic of Gilgamesh, trans. Dalley, 2000, and.K. Sandars, 1972 edn.)

[The Flood]

When the first light of dawn appeared,
A black cloud came up from the base of the sky.
Adad kept rumbling inside it.
Shullat and Hanish were marching ahead,
Marched as chamberlains (over) (?) mountain and country.
Erakal pulled out the mooring (?) poles,
Ninurta marched on and made the weir(s) overflow.
The Anunnaki had to carry torches,
They lit up the land with their brightness.
The calm before the Storm-god came over the sky,
Everything light turned to darkness.
[
On the first day the tempest [rose up] ,
Blew swiftly and [brought (?) the flood-weapon],
Like a battle force [the destructive kasusu weapon]
passed over [the people]
No man could see his fellow,
Nor could people be distinguished from the sky (...)
For six days and [seven (?)] nights
The wind blew, flood and tempest overwhelmed the land;
When the seventh day arrived the tempest, flood and onslaught
Which had struggled like a woman in labour, blew themselves out (?).
The sea became calm, the imhullu-wind grew quiet, the flood held back.
I looked at the weather; silence reigned,
For all mankind had returned to clay.
The flood-plain was flat as a roof.
I opened a porthole and light fell on my cheeks.
I bent down, then sat. I wept.
My tears ran down my cheeks.
I looked for banks, for limits to the sea .
Areas of land were emerging everywhere (?).
The boat had come to rest on Mount Nimush.
(Dalley: 112-114)

Old Testament
(Holy Bible, New International Version)

For forty days the flood kept coming on the earth, and as the waters increased they lifted the ark high above the earth. The waters rose and increased greatly on the earth, and the ark floated on the surface of the water.
They rose greatly on the earth, and all the high mountains under the entire heavens were covered.
The waters rose and covered the mountains to a depth of more than fifteen cubits.
Every living thing that moved on land perished—birds, livestock, wild animals, all the creatures that swarm over the earth, and all mankind.
Everything on dry land that had the breath of life in its nostrils died.
Every living thing on the face of the earth was wiped out; people and animals and the creatures that move along the ground and the birds were wiped from the earth. Only Noah was left, and those with him in the ark.
The waters flooded the earth for a hundred and fifty days.
(Genesis: 8:17-24)

Ovid, Metamorphoses
(Metamorphoses, trans. Henry Thomas Riley)

The standing corn is beaten down, and the expectations of the husbandman, now lamented by him, are ruined, and the labors of a long year prematurely perish. Nor is the wrath of Jove satisfied with his own heaven; but Neptune, his azure brother, aids him with his auxiliary waves. He calls together the rivers, which, soon as they had entered the abode of their ruler, he says, “I must not now employ a lengthened exhortation; pour forth all your might, so the occasion requires. Open your abodes, and, each obstacle removed, give full rein to your streams.” Thus he commanded; they return, and open the mouths of their fountains, and roll on into the ocean with unobstructed course. He himself struck the Earth with his trident, on which it shook, and with a tremor laid open the sources of its waters. The rivers, breaking out, rush through the open plains, and bear away, together with the standing corn, the groves, flocks, men, houses, and temples, together with their sacred utensils. If any house remained, and, not thrown down, was able to resist ruin so vast, yet the waves, rising aloft, covered the roof of that house, and the towers tottered, overwhelmed beneath the stream. And now sea and land had no mark of distinction; everything now was ocean; and to that ocean shores were wanting. One man takes possession of a hill, another sits in a curved boat, and plies the oars there where he had lately ploughed; another sails over the standing corn, or the roof of his country-house under water; another catches a fish on the top of an elm-tree. An anchor (if chance so directs) is fastened in a green meadow, or the curving keels come in contact with the vineyards, now below them; and where of late the slender goats had cropped the grass, there unsightly sea-calves are now reposing their bodies. The Nereids wonder at the groves, the cities, and the houses under water; dolphins get into the woods, and run against the lofty branches, and beat against the tossed oaks. The wolf swims among the sheep; the wave carries along the tawny lions; the wave carries along the tigers. Neither does the powers of his lightning-shock avail the wild boar, nor his swift legs the stag, now borne away. The wandering bird, too, having long sought for land, where it may be allowed to light, its wings failing, falls down into the sea. The boundless range of the sea had overwhelmed the hills, and the stranger waves beat against the heights of the mountains. The greatest part is carried off by the water: those whom the water spares, long fastings overcome, through scantiness of food.
(Riley: 1:8)

(J.-W. Baur, Deucalion and Pyrrha, c.1635, Harvard Art Museums)

Flood is also mentioned in ancient literature as a useful ally for Hercules in his battle against the Minyans. The story told by Pausanias in his Description of Greece (9.38.6-8) and by Diodorus Siculus, shows Hercules eager to avenge the Thebans enslaved by the Minyans, known for their formidable cavalry. In order to weaken his opponents, Hercules unleashes a massive flood over the plain: "by damming the stream which flowed near the Minyan city of Orchomenus he turned the country into a lake and caused the ruin of that whole region." (Diodorus Siculus, 4.18.7).

The story is described in more detail by the second-century author Polyaenus in his treaty on stratagems of war, later printed in Basel and spread in Western Europe from the 16th century on: "This river [Cephisus] flows by the two mountains Parnassus and Hedylium, and directs its course through the middle of Boeotia; but before it reaches the sea, it discharges its stream into a large subterranean chasm, and disappears. Heracles filled this chasm with great stones, and diverted the river into the plain where the Minyan cavalry was stationed. The plain soon became a lake, and the Minyan cavalry were rendered useless. After he had conquered the Minyans, Heracles opened the chasm again, and the Cephisus returned to its formal channel." (Polyaenus, Stratagems: 1.3.5.)

For Heracles, who is also said to have reclaimed the marshes of Tempe by digging a drainage ditch to the Peneus River (Diodorus Siculus, 4.18.6), flood is a reversible tool that can turn a peaceful plain into an impassable marsh, and back into fertile land again, a strategy since then used in more plains and estuary (the last time being in the Netherlands during the Second World War, by both German and Allied Forces).

The End and the Origin

The biblical Flood, which most certainly influenced western culture more directly than the Mesopotamian, Greek, and Roman tales, undoubtedly integrated many aspects of the story of Atrahasis. Dalley points out that "Akkadian myths and epics were universally known during antiquity, and they were not restricted to the Akkadian language. Some were definitely told in Sumerian, Hittite, Hurrian, and Hebrew" (Dalley, 2000: xviii). She furthermore suggests that an abbreviation of (Uta)-na"ish(tim) was pronounced "Noah" in Palestine from very early times (Dalley, 2000:2), which would confirm – if necessary – a direct affiliation between Mesopotamian mythology and the biblical Genesis, and thus make the Flood one of the oldest living myths, bridging pagan mythology and Abrahamic religions over more than five thousand years.

Both narrations share indeed various narrative aspects. The origin of this flood is similar: in both the Epic of Gilgamesh and Genesis, the Flood is commanded and monitored by Ellil/God; in both accounts, the god is angry at humankind and initially resolves to wipe it out. In the Old Testament, the Flood, however, differs from the Mesopotamian and Greek/Roman traditions in as much as the unique and infallible Judeo-Christian God differs from the numerous and human-like divinities that quarrel about the destruction of humankind. The biblical Flood is not the work of an inpatient, irritated god whose comfort is disturbed by humankind, but the action of the unique and omnipotent Creator, who uses the Flood to take back the life He initially gave. Deucalion and Pyrrha, like Atrahasis and his wife, escape the Flood thanks to external support, that is, internal divisions or betrayal among the gods; the survival of Noah and his siblings is part of God's plan to destroy humankind but to allow the beginning of a new era.

The biblical Flood, from the very beginning, aims at destruction, selection, and renaissance, and at no time can its origin, its progress, or its legitimacy be doubted or hindered: It is the proof of God's omnipotence and is the exemplary punishment for doubting it. In the warning sent to Noah, no doubt is left either about the violent character of God's plan: "I am now bringing the floodwaters over the earth to destroy everything under the sky that breathes." With this deliberate disaster, "God wiped away every living thing that was on the fertile land – from human beings to livestock to crawling things to birds in the sky" (Genesis, 6:17; 7:4,10-12, 23). There is no ambiguity about the moral nature of flooding: The Flood is intrinsically a demonstration of God's power and a resolution to prevent the degeneracy of his creation, however cruel this remedy might seem. The apostle Peter furthermore uses the Flood to remind his audience of God's mercilessness, when he states that He "did not spare the ancient world when He brought a flood on the world of ungodly people" (2 Peter 2: 5).

Besides being a destructive process, the Flood is also a process of selection and regeneration, which destroys the bad but spares the good. Noah, he who "walks with God," "a preacher of righteousness," is saved together along with seven others and with the creatures he gathered into the Ark, following upon God's instructions. While all other earthly creatures that "behaved corruptly on the earth" perished in the rising waters, the Ark contained enough survivors to populate the world anew, allowing a new start after an almost total destruction of life. In the New Testament, Peter draws a parallel between collective and individual regeneration by comparing the Flood to the effect of baptismal waters: "Those flood waters were like baptism that now saves you" (1 Peter 3: 21). On both scales, flood puts man/humanity through a destructive and regenerative process, leaving no choice but to accept the loss, abandon the past, and construct a new life on new ground.

Gustave Doré, Le Déluge. Illustration for the Bible (1866)

The Flood can be seen as well as an instance of revelation; it is mentioned in the New Testament when Matthew compares the ignorance of men before the Flood to the indifference witnessed upon the arrival of Jesus: "As it was in the time of Noah, so it will be at the coming of the Human One. When the Son of Man appears, things will be just as they were when Noah lived." "In those days before the flood, people were eating and drinking, marrying and giving in marriage, until the day Noah entered the ark. They did not know what was happening until the flood came and swept them all away. The coming of the Human One will be like that" (Matthew, 24:37-39). This comparison reoccurs in Luke: "As it was in the days of Noah, so it will be during the days of the Human One. People were eating, drinking, marrying, and being given in marriage until the day Noah entered the Ark and the flood came and destroyed them all" (Luke 17:26-27). Those who lack awareness and prefer a carefree and frivolous existence might lose the chance to save their lives and their souls.

Throughout the Middle Ages, floods were seen as divine manifestations, if not as divine punishments. In a period of evangelization, the Biblical Flood, just like actual flooding, offered a persuasive argument in converting pagan populations. The disastrous flood that ravaged the Rhine Delta in 838 was, in that way, successfully exploited by the Christian Franks to convert the pagan Frisians: Ecclesiastics claimed that the disaster was foretold to Bishop Hungerius and brought by God to punish the Frisian polytheists, whose own divinities failed to protect them, thus showing the superiority of the Christian God to Germanic paganism (Rooijendijk, 2009: 25). The Christian God could also turn into a protector against flood, as attested by Saint Willibrord, a Catholic archbishop who actively spread Frankish influence and the Christian faith in the Frisian lowlands. Willibrord described, in the early 8th century, how God had erected a row of dunes after the flood of 700, which resisted the waves "like a strong wall," one quite powerful argument in favor of the Christian God for a population regularly threatened by sea and river floods (id., 2009: 25).

Populations affected by floods in Catholic France were also likely to attribute their misery to God's anger rather then to environmental factors or human failure. Floods in the Middle Ages were often countered by carrying around holy relics in religious processions, followed by monks and the inhabitants. In 1206, a thorn from the Holy Crown of Thorns, brought a year earlier from Constantinople to the Basilica of Saint-Denis, was carried in procession to plead for an end to the flooding in the Seine Valley (Rigord, T.2, 1885:413). That same year, an arm of Saint Simeon was taken out the same Basilica for the same purpose (id.: 500). Rigord relates, in his Gesta Philippi Augusti completed in 1208, the role played by the Catholic Church in the interpretation and the mitigation of flood disasters. Concerning the 1196 flood, Rigord relates that "prayers, alms and processions were the only remedy against these ills; and when after all this, cross signs were made over the waters, they miraculously crawled back into their regular bed" (quoted in Champion, 1885: 192). However, the same miracle could lead to competing claims. The editor Delaborde, who published the Rigord oeuvre in 1882, points out in a footnote that Saint-Denis and Paris both claim to have repelled the same catastrophe: "The decrease of the inundation that Rigord, monk at Saint-Denis, says to be a result of his convent's prayers, is attributed by a canon from Sainte-Geneviève to the patron saint of the Parisians" (Rigord, T.1, 1883:165).

Unsurprisingly, the medieval representations of the Flood focus on the religious symbolism, showing the wooden Ark (the cross, the Church) of Noah (prophetic figure, prefiguration of Christ) floating on the waters (the baptism) that cover the old world. They celebrate the beginning of a new era (Wuhrmann, Cariel, 2006: 10) rather than empathize with the sinners, in a world where every natural catastrophe is meaningful, explained, and legitimized as the divine plan. They catechize more than they divert, and they stress the magic rather than demonstrate the authenticity of tales, which are not open to doubt or public discussion: The Flood itself makes clear what awaits those who lose faith.

From myth to phenomenon

In all periods of time, myth and rationale, however sporadically, meet in the texts of Greek thinkers and Christian theologians. Aristotle presents the mythological deluge ordered by Zeus as a historical fact to support his own theory of hydrodynamics. "The deluge in the time of Deucalion, for instance, took place chiefly in the Greek world and in it especially about ancient Hellas, the country about Dodona and the Achelous, a river which has often changed its course." (Meteorology: part 14). In the 3rd century AD, the Christian theologian Origen attempts to demonstrates the authenticity of the Flood by reconstructing in detail how the Ark was fabricated. He discusses among other things the origin of the wood, the form of the planks, the insulation of its door, and the capacity of the vessel, and targets his authentication "against those who endeavor to impugn the Scriptures of the Old Testament as containing certain things which are impossible and irrational" (Origen, Genesis Homilies: 77). Origen hereby attests that discussions concerning the veracity of the biblical account were not that rare, at least in the Alexandria where he is writing, and that the Flood already raised doubts and questions in the early centuries of Christianity.

The close coexistence of science and theology in flood studies stretches further through the Renaissance. While Galileo seeks to take liberties with Catholic dogma, Athanasius Kircher dedicates a full book to the detailed reconstruction of the Flood and Noah's ark. Arca Noe, beautifully illustrated by Desker for the 1675 edition, is simultaneously the devoted enterprise of a pious Christian, who accepts the most supernatural as historical fact and tries to demonstrate its veracity, and as a work of science, which by mean of rational inquiry tries to measure and decipher phenomena that are in 1675 not yet fully understood.

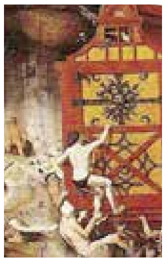
Desker's representation of the Flood covering the Earth, showing the Ark floating over the highest mountains before landing on Mount Ararat, is particularly striking in its topographical realism. Vertical geographical stages – mountains, hills, and valleys – are carefully represented. The representation of water itself is free from all cataclysmic exaggeration but instead is cleverly rendered through a fine hatching superimposed on a still landscape, producing an image of great eloquence and clarity that could illustrate a treatise on pre-glacial eras. Kirchner's essay still includes groundless beliefs common in his time – springs are still believed to flow from lakes hidden under the mountains, and all waters to eventually disappear into submarine whirlpools – but he actually uses the Flood to construct a theory of hydrological transfers, thus furthering the work on the systemic vision of the world proposed by Aristotle's Meteorology. Mythical representation and physical manifestation of hydrological processes are mixed, in an attempt to understand simultaneously the origins of humankind and its physical world.

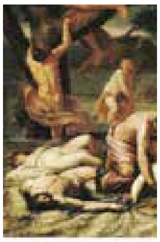

1436-40
Storie di Noè,
Santa Maria Novelle,
Paolo Uccello


1508-12
The Deluge,
Sistine Chapel,
Michelangelo

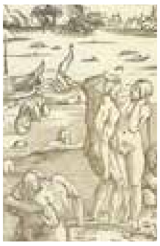

16th century
Scene di
diluvio
mytologico
Lielio Orsi


1515
Deluge
Leonardo da
Vinci

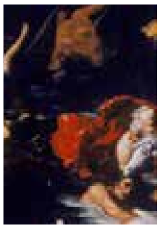

1515
The deluge
Hans Baldung ‘Grien’


after 1516
Deluge
Alessandro
Turchi


after 1519
The Deluge
Rafaello

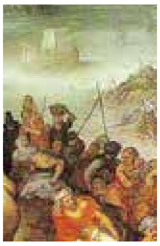

16th century
The Deluge,
Titien or Jan
van Scorel


1555
Noah’s
sacrifice,
Balthasar
Van den Bos


c.1600
Diluvio
Universale,
Antonio
Carracci


17th century
Deucalion and
Pyrrha,
Stefano della
Bella

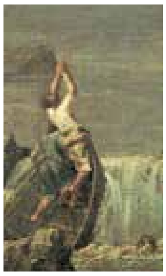

17th century
Le Déluge,
Nicolas
Chaperon

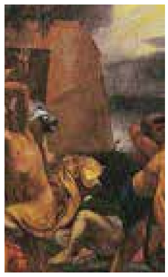

1601
Deluge with
Noah’s Ark
Bruegel the
Elder


1615 century
Himankind
before the
Deluge,
Cornelius
Cornelisz


1639
Deucalion
and Pyrrha
repopulate the
world
Johannes.W.
Baur

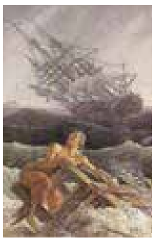

ca 1640
The Deluge,
Metamorphoses,
Johannes W.
Baur


1660-64
L’Hiver ou le
Déluge,
Nicolas Poussin

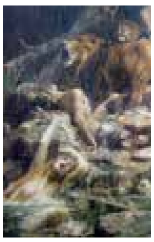

17th century
Le Déluge,
Nicolas
Chaperon


1675
Noah’s Ark on
Mount Ararat,
Arca Noë,
C. Desker


1690-1700
Le Deluge
A. Rivalz

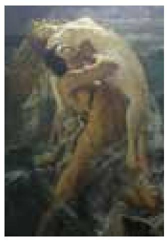

1762
Le Naufrage
C.-J. Vernet

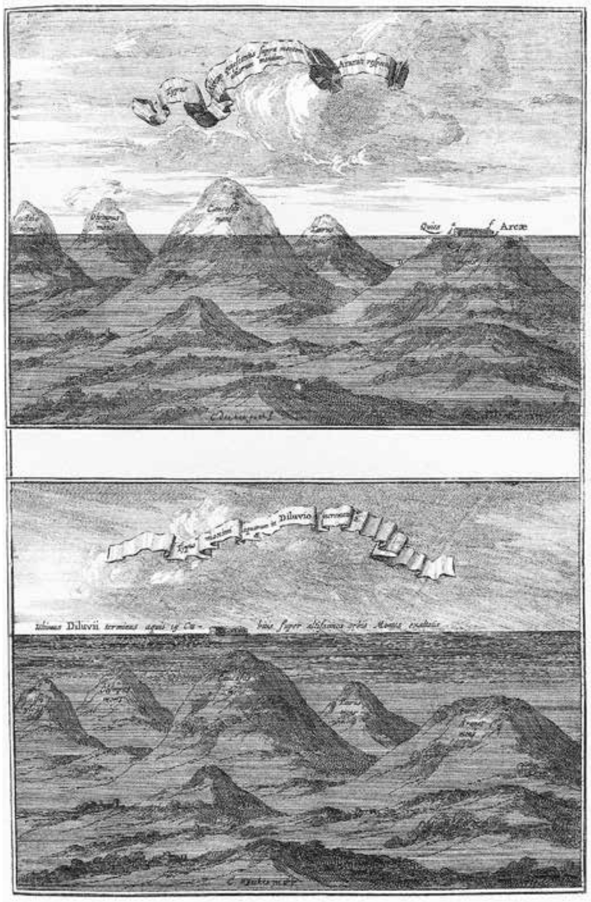

1789
Le Deluge,
J.-B. Régnault


19th century
Le Deluge,
Léon Comerre


c. 1800
Le Déluge
A.L.R. Ducros


1866
The Deluge
Holy Bible,
Gustave Doré


End 19th
Deucalion or
The Flood, Paul
Merwart



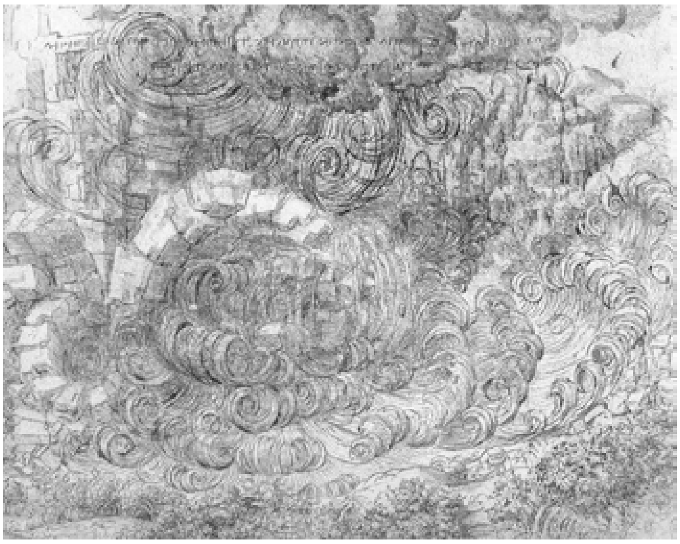
C. Desker, Noah's ark in Mount Ararat
Illustration for: Arca Noe, Athanasius Kircher, 1675.

Previous page: The Flood: a popular subject for painters from the Renaissance to the Romantics

The artists of the Renaissance – Ucello, Michelangelo, Hans Baldung Grien – abandon the medieval canon to explore new directions in the visual transcription of the Flood, developing its dramatic, figurative, historical, and scientific dimensions.

Da Vinci shows more interest in nephology and hydrodynamics than in the religious message. The various sketches of floods found in his sketchbooks show nothing of the human or the divine story but try to decipher the morphology of storms and sea surges in a kinetic figuration that evokes the photographic work of Edward Muybridge more than Noah's Flood. In his sketches, Da Vinci investigates the dynamics of flooding rather than seeking any grand meaning, as he searches for beauty and order in the morphology of waves and whirlpools, not in the magic or the divine.

In terms of dramaturgy, paintings unfold in complex narrations that stress more and more the earthly catastrophe rather than the miraculous survival of Noah. Instead of illustrating the biblical message, painters represent animal and human creatures in desperate situations: fighting for survival, praying to the sky, trying to save their families from the waves, dragging their belongings onto the last dry hills. Figuration evolves strongly, as flood representations become increasingly theatrical and complex, announcing the nineteenth-century Sublime. Painted at the dawn of the Enlightenment, Nicolas Poussin's gloomy representation of Winter – one of his Four Seasons painting series – takes the Déluge/Flood as a central narrative motif, and uses his great sense of composition to assemble the individual, intimate tragedy and the horrific but grandiose catastrophe, turning this Flood into a rich and complex drama. Dark clouds soak the surface of Earth, turned into one gigantic lake, lit by dramatic lightning that forecasts long-lasting rain. Attempts to rescue wives and children seem hopeless; a boat carrying four men is about to sink, one of them still imploring the heavens in a last effort to escape drowning. On the left of the picture, the Snake who brought God's curse down upon man, contemplates the scene from a distance, as if no more harm could be done. Of the inundated farms, only their roofs remains visible, while Noah's Ark is about to disappear behind the rocks and leave the dark scenery, taking away all hopes of survival. Sin and preparedness lead here again to inexorable death and destruction, affecting without mercy all creatures but those God has intended to save. Nevertheless, as Noah's Ark disappears on the horizon, the human scene remains in the foreground, leaving the viewer behind, forced to share the tragedy of those who abandoned to their fate.

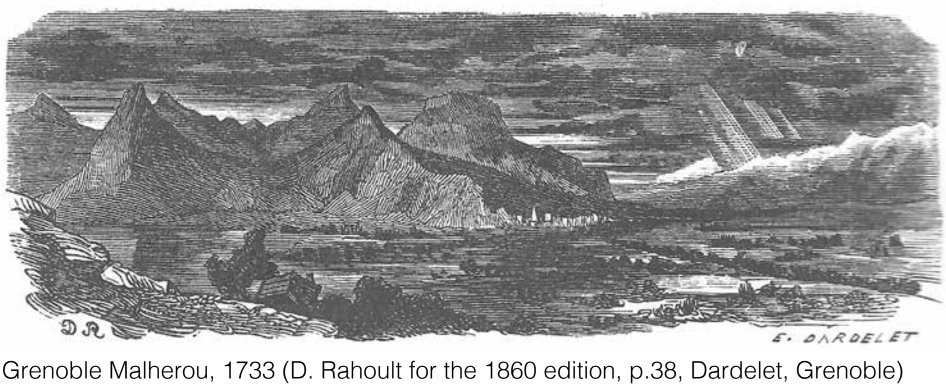


Leonardo Da Vinci. Deluge, ca. 1515.
(Royal Library, Windsor Castle, London, England)

Nicolas Poussin. Winter or The Deluge, 1660-64 (Paris, Louvre)

Religiosity and rationality coexist in the various accounts of flooding given by writers and chroniclers. This cautious shift from a religious to a rational perspective is manifest in the way the 1469 flood in Grenoble is depicted in a note written by a contemporary, a note reported by nineteenth-century historian Champion: "A note written by a contemporary on a manuscript of that time is made as such: 'The year 1469, eighth day of August, the Isère River, from the morning until the tenth hour before midnight, coming from the Mount Cenis, destroyed and submerged the low fields and green areas; seeing this, ecclesiastics from the [cathedral of] la Bienheureuse Marie in Grenoble, made a beautiful procession around bell's time, and water stopped rising right after that.' This inundation was doubtless the result of a storm, which explains the sudden swelling of the Isère, a river subject to these spontaneous floods, as well as the waters rapid discharge" (Champion, 1861, T.3: 205-206). The fifteenth-century chronicler rather accurately describes the flood but only to attest of its divine nature and the efficacy of prayer as means of mitigation. The nineteenth-century historian, without contradicting the note, analyzes the event in order to understand the concrete origins of the inundation, thus implicitly refuting its divine nature.

In between the Middle Ages and the Disenchantment, Grenoblo Malhérou, a poetic description of the devastating flood in 1733 in the region of Grenoble in the French Alps, carefully mixes pragmatism, religiosity, and paganism. The grocer and poet François Blanc describes how a sudden panic overtakes the city, as "one runs away without knowing where to go / Another, made captive, fears for his future" (Blanc, 1733: chap. X). Blanc attributes the catastrophe to various origins, and first evokes religious metaphors and apocalyptic visions: "Waters pour from a sky turned into hell / The moon, the sun suspend their journey / The Drac and Isère [rivers] climb back up to their sources." Blanc later blames a river personified into a furious and profane divinity: "Isère, everywhere your fury appears / You should have spared the Lord's temples. Up onto the altar and in sanctuaries / You dared to violate our sacred mysteries." In a no less dramatic but more rational vision, the author eventually points to the city's founders for their lack of foresight and poor understanding of basic topography: "Grenoble, you are lost! The monster swallows you / Fool he who founded you so low!" Although Blanc writes long before the Isère River was channeled, he shows, in addition to his faith in God's power and evocation of the river's evil Spirit, a clear understanding of the role played by topography in the amplitude of the inundation. This last verse expresses, on the one hand, the physical process – water harms most in the lowest areas – and, on the other, the human responsibility and, in this case, lack of foresight: Natural disasters might be caused by fate, but their consequences can be aggravated or limited by human choice, right from the very founding of new cities.



Grenoble Malherou, 1733 (D. Rahoult for the 1860 edition, p.38, Dardelet, Grenoble)

Religious interpretations and rational explanations of flood events begin to collide at the end of the 18th century. The fight had already lasted for centuries, opposing a vision of a meaningful world obeying an omnipresent God, to the vision of a world created by God but explainable by human reason, defended by Galileo, Descartes, Newton, and some movements within the Christian Churches (Jansenists, Calvinists). But while religious interpretations still dominate at the middle of the 18th century (Picon, 2006: 38), the Enlightenment and the European Revolutions accelerated the secularization of European societies, and parallel scientific and technological progress brought new means of controlling nature's dynamics. The Disenchantment of the World, depicted a century later by Max Weber, gradually frees flood from mystical interpretations and human guilt, and brings it back to the realm of tangible phenomena. The 1791 flood in Arles is representative of this historical turn, as a local and later national quarrel opposes the bishop of Arles, who organizes processions to calm God's anger against heretics, to the revolutionary and anticlerical Mayor of the City (Picon, 2006: 38). Religiosity still impregnates French society through the 19th century, compassion and charity remaining main aspects of Christian education, and religious vocabulary coexists with rational comments on the causes of flooding.

After the revolution, the use of flooding for religious propaganda could, however, be denounced freely by the liberal press, as seen in the coverage of the massive 1856 floods in France: "The recent floods give the Chronicler the opportunity to bring up again his old theme of 'the hand of God that weights on a world guilty of so many violations of the most sacred laws.' Yet the place hurt the most [by the floods] is the Catholic city of Lyon, seat of an archbishopric, seat of the Jesuit headquarters (...). The rest of us who believe in God's omnipotence, but also in the power of man upon the elements through science, we see purely natural origins to these disorders (...). When shall we stop blaming God for the evil that men do?" (Courrier du Valais, 10.06.1856: 4).

Although the religious interpretation of predestination progressively lost ground in favor of the notion of scientifically measurable risk (Picon, 2006: 39), the marriage between science and religion around the Flood question persisted throughout the Enlightenment, among others in the work of Nicolas Antoine Boulanger. Boulanger was an engineer at the prestigious French "Corps des Ponts et Chaussées," founded in 1716 to develop France's road and canal network, and was a contributor to Diderot's Encyclopedia. In L'Antiquité dévoilée par ses usages, Boulanger put the biblical Flood at the center of geology and anthropology (Wuhrmann, Cariel, 2006: 31), using the great Flood as the key to an understanding of the origins of the planets and human societies. Boulanger wrote in the introduction to Book 6, Description of the physical and moral effects of the Deluge: "We must consider it as the fecund source of all human institutions (...) the memory of it is preserved in all nations of the world & the naturalist finds its ravages written in legible and indelible characters in all parts of the globe" (Boulanger, 1766: 365). To stress the universal character of the deluge and the veracity of his deductions, Boulanger noted that even the "wild people" of the Caribbean believe that a Flood created the topographical features of their islands, such as mountains and cliffs. Boulanger compiles numerous flood and catastrophe myths, which he then related to geological observations in order to create hypotheses, that at a time where the formation of the Earth's landscape was still mysterious. He partly succeeded in reconstructing the de-glaciation and its effects on sea levels and topographical distortions, using the Flood as a central agent: "All seas could have surged instantly over our continents & destroyed all nations in a flash; they then later went back to their regular basin, to be brought back again onto the land, which they frequently and repetitively assaulted. Thereby the waters could change the surface of the terrestrial globe, form new valleys, shred mountain ranges, dig new gulfs, overthrow ancient heights, create new ones & cover the ruins of the old world with sand, mud & other substances they were able to carry in their extraordinary agitation."

Boulanger, in his turn, inspired Buffon's Histoire Naturelle, which still generously mixes scientific deductions and dramatic description to depict the cataclysmic origins of Earth surface. Buffon does not literally use Genesis to construct his geological theory, but he still thanks "the Creator for not letting man witness these horrific & terrible scenes which preceded, & so to speak prefigured the birth of intelligent and sensible Nature." A Nature with its own history and dynamics, which seems to eclipse the genesis of humankind, merely an epiphenomenon within the grandiose geological process.

This new fascination for Nature's powers upon fragile human lives, together with the dramatic floods taking place in Western Europe, inspired new artistic representations of the Flood, which figured prominently in the Paris Salons. The Flood is even chosen as subject for the 1872 Prix de Rome competition, the most prestigious art prize of nineteenth-century Paris. Artists compete with ever larger and more dramatic compositions to represent and transfigure the most epic and horrifying storms. Following the humanistic path opened by Poussin, a new generation of painters seized the Flood theme to explore the limits of horror and drama: Girolet, Gustave Doré, Leon Comerre, Francis Denby, and Merwart magnify the emotional tension, focusing even more on the distorted faces, bulging eyes, and floating corpses of the victims. In Great Britain, Turner, Westall, and Danby transfigured the violence of natural elements, bringing painting a step closer to abstraction. More than any other theme the Flood, whether biblical or factual, can reach the Sublime, when constructed by a combination of opposites: power and fragility, innocence and pointless destruction, bold materiality and spiritual elevation.

From angry Gods to heroic saviours

In the course of the eighteenth and nineteenth centuries, natural hazards finally left the divine and magical realm. They were, however, not freed from cultural narratives and Christian motifs. Nature might not be the expression of God's will or substance for enlightened minds but it still has to be characterized in moral terms to fit into a coherent cosmogony and participate in the collective narratives now defined by newly empowered European nations rather than religious authorities.

If the God figure tended to disappear from flood accounts (the violent, merciless God that unleashed the Flood), the Promethean character of the Engineer gained in importance in the political drama, with Frederick the Great and the Emperors Napoleon I and III as mighty representatives. The growing fascination for the Wild ran parallel to territorial transformation of unknown scale and rapidity along most European rivers and floodplains, a metamorphoses only possible thanks to the development and the rapid transmission of new technological knowledge throughout the continent, concomitant with strong demographic and economic growth. In this new context, water responded less and less to God's orders or to Nature's unpredictable temper, and more and more to the will of political authorities and the skills of their engineers. Flood protection integrated the domain of the land surveyor and the engineer, from the deltas up to the alpine valleys, with the techniques then used to reinforce river banks and reclaim new land, showing strong similarities in Holland, Italy, Germany, and France. Within decades, valleys, plains, and deltas changed from fluctuating landscapes of meandering rivers, alluvial woods, and marshlands into highly productive farmland ready to feed booming populations, increasing the tax base of the young states. Empowered nations could then, in turn, carry out bigger and more ambitious reclamation projects, made possible by abundant labor, and facilitated by their centralized organization and their growing authority over local communities.

These great enterprises need knowledge, and financial and political power, if not military, as this "progress" implied a certain violence to local ecologies and to the economy of the local community, depicted as unhealthy and unproductive. Referring to the achievements of Prussian King Frederick II in the Oderbruch lowlands in the 18th century, historian David Blackbourn notes that "Violence was an essential part of the transformation: without the use of soldiers and military coercion, the project would not have been completed when it was" (Blackbourn, 2007). King Frederick associated himself with reclamation works to a more global enterprise of (forced) civilization and policing, held for the good of a barbarian population: "In Prussia I abolished serfdom, reformed barbaric laws, promulgated more reasonable ones, dug a canal which joined the Vistula, the Nètre [sic], the Vaste, the Oder, and the Elbe; rebuilt cities destroyed in the plague of 1709; drained twenty miles of swamp; and established a police force in a countryside where the name itself was unknown…" (Voltaire, Frederick II, 1889 ed.: 24.10.1778)

A similar link between power over land and men is made by French historian Denis Coeur about the development of a flood defense policy in the Alpine region of Grenoble: "The return of destructive high waters, starting from the end of the 16th century, coincides with the affirmation, and even more specifically, with the territorial embedding [enracinement] of the royal power" (Coeur, 2008: 196). The physical transformation of rivers and wetlands was thus directly related to the political structuring of national powers, whose investment capacity and reflexive legitimacy in the field of water management redrew the power of initiative and the prerogatives of local communities, which until then had been fully responsible for the protection of their own land in most Western European regions.

As loving counterpart of the river "corrections" and reclamation "campaigns," the compassionate journey becomes a new figure in flood narratives. With the development of printed media, regional inundations recurrent in Western Europe throughout the 19th century could quickly reach national newspapers. The individualization of post-revolutionary societies, parallel to the integration of regional powers into bigger ensembles and the development of mass media, gave a new status to natural catastrophes. Regional floods soon became national dramas and political issues. For young European nations, flood defense is a tool of territorial integration par excellence, as it crosses regional boundaries and transcends local interests, and flood offers a stage for emotional bonding with distant leaders.

As widespread information calls for a rapid, political reaction at the national and local level, carefully staged compassionate journeys became a central element in political narratives, offering a public demonstration of national concern and personal commitment from the highest representatives of the state. The well-orchestrated communication of Emperor Napoleon III after the Loire and Rhône floods shows his personal engagement in the rescue of flood victims – not to mention that it paves the way for the subsequent territorial transformations planned from Paris. In the fight to structure and unify the country behind its self-proclaimed Emperor, the journey becomes a technical inspection, a rescue operation, and a propaganda tour, used to frame the fight against floods into specific narratives that reinforce the central power's legitimacy. In the year 1856 alone, Napoleon III is pictured in three large paintings comforting the victims of the Loire and Rhône floods. In William Bougerau's L'Empereur visitant les inondés de Tarascon, the Emperor is shown on a boat inspecting the flooded Rhône Valley and comforting the victims. That same year, the Emperor is painted by Lazergues helping the victims of Lyon in a devastated city still covered with mud. In both paintings, the Emperor is depicted as a man of action and compassion, dressed in military uniform, reaching his hand out to the victims. The dense and popular crowd shows simultaneously that the Emperor is close to his fellow citizens, no matter their social level, and is willing to experience and understand their situation.

William Bouguereau, L'Empereur visitant les inondés de Tarascon
(1856, Tarascon City Hall)

Hippolyte Lazerges. Sa Majesté l'Empereur
distribuant des secours aux inondés de Lyon
(1856, Musée national du Château de Compiègne).

H. Beauvais, Le Prince-Président visitant les inondés d'Angers, détail
(1856, Musée National du Château de Compiègne)
H. J. Flandrin, Jésus Christ et les petits enfants (Musée d'Art et d'Histoire de Lisieux, 1837)

In Hippolyte Beauvais's Le Prince-Président visitant les inondés d'Angers, Napoleon stands in the middle of the picture, holding out his left hand towards an imploring woman, his right hand towards young children. An animated crowd, escaping the flooded plain shown in the upper right corner, gathers behind him. The Emperor, while comforting the victims, turns a resolute look towards the spectator, standing in the middle of his compatriots, compassionate but ready to take the lead. Merging religious and secular iconography, the painting's narration and its composition are strongly reminiscent of the contemporary representations of Christ Blessing, such as the large Jésus Christ et les petits enfants from H. J. Flandrin (1837), exhibited at the Salon of 1839. On the political stage, the theme is probably not a coincidence either: Angers has for Napoléon a strategic value, as the city almost fell a year before into the hands of an insurrectionary movement that protested against low wages and defied the power of the new Emperor.

Although electronic media has replaced etchings and paintings, the motif of the compassionate journey has so far remained unchanged. From Emperor Napoleon the Third inspecting the flooded Rhône Valley on a boat in 1856 to Chancellor Angela Merkel visiting the inundated towns of Southern Germany in June 2013, the official visit still shows symbolically that the central power is playing its protective and restorative role, and gives politicians the opportunity to display concern and compassion.

Fourchambault
Cosne
GIEN
BRIARE
ORLÉANS
S-Dié
BLOIS
Chaumont
Rochecorbon
TOURS
Cinqmars
Savonnière
Cher
LANGEAIS
Port Boulet
Montsoreau
ANGERS
SAUMUR
Juigné
PONTS-DE-CÉ
St Georges
CHALONNES
Ingrande
Varades
Montjean
La Meilleraie
St FLORENT
ANCENIS
Oudon
Champtoceaux
Richebourg
Erdre R.
Les Ponts
Sèvre R.
NANTES
Vreutemoux

Pre-industrial floodplains

"The Frisian inhabitants of the 'terpen' carried a total volume of clay and sod at least ten times bigger than the volume contained in all Egyptian pyramids." (Ter Haar, Polhuis, 2004)

Although modern water management policies primarily focus on controlling and banning natural fluctuations from the living environment, Western Europe does have a long tradition of living with flood. In spite of the biblical prejudice that associates flood with punishment and destruction, several example of positive coexistence with natural fluctuations can be found along Western European rivers and coastal plains. The fertilizing effects of flood – at least the "good flood" that brought fine alluvium – was well known and welcomed by early farming populations. Adapted ways of living, such as elevated houses and villages, used to be commonplace in flood-prone regions. Hydraulic techniques were already developed in the Middle Ages to take advantage of natural silting and to benefit from seasonal flooding, from the North Sea along river valleys up to the Alps, and they continue in use until the 19th century. Today's binary landscapes, which restrict and isolate dynamic nature areas from petrified inhabited environments, are to a large extent the result of a progressive shift from decentralized, rural, and adaptive societies to an urban, centralized, and capitalized economy, willing to secure and upscale navigation and farming, eventually at the cost of local adaptive mores. Millenary "flood-compatible" traditions, however, are being rediscovered in light of necessary adaptation to rapidly changing hydrological conditions.

Early adaptive landscapes

Along the North Sea's undefined and ever-changing Southeastern coast, a vast coastal plain hosted a population that had long learned to live with tidal floods. Before dikes and windmills could turn the Netherlands into "hollow lands," the Frisians had learned to secure their homes and benefit from natural fluctuations in the regions located between the estuaries of the Rhine and Ems, an area colonized around 1000 BCE from the overpopulated sand ridges of the Drenthe region. In this wide coastal plain, sand and clay banks formed by the combined movements of rivers and tides offered vast open pastures, first used temporarily and later permanently inhabited.

In the year AD 47, the Roman naval commander Pliny the Elder was sent to today's Northwest Germany to lead a punitive campaign against the Chauci people, and brought back one of the first precise descriptions of the North Sea landscape. Pliny dedicated a chapter of his Natural History to the "Countries that have no trees" (Pliny the Elder: XVI,1), describing the Chauci coastal regions as particularly inhospitable. In his account, he first doubted "whether these regions are to be looked upon as belonging to the land, or whether as forming a portion of the sea." Like most ancient writers evoking the edges of the Empire (Lendering, 2002), Pliny saw foremost a

Opposite page: Carte Cavalière des inondations de la Loire (L'Illustration, 3 July 1856) barbarian people surviving in a hostile landscape. He described how this "wretched race" survived harsh natural conditions, settling on naturally elevated spots of land or onto artificial mounds "exstructa manibus," erected in the flat and endless landscape. These "eminences artificially constructed, and of a height to which they know by experience that the highest tides will never reach," were found in the Frisian territories as well, the oldest specimen known dating from about 500 years BCE, 1500 years before the first dikes were built to connect mounds to one another (Ter Haar, 2004: 28). They could measure up to seven meters in height (Lebecq, 1997: 365) and eighteen hectares in area (id.: 26). All along the North Sea, from today's Flanders to the Jutland peninsula, the specific word used to designate these mounds showed great similarity: in Dutch wierde, in old Frisian werd or wird, in German warft, wurt, or wierde, in Danish værft, varft, or verft (Boersma, 1970); this attests to the existence of a well-developed "flood-resistant" civilization stretching along 500 kilometers of fluctuating coastline. The word "terp," village in the Frisian language, is nowadays abusively used in Dutch and English publications to designate these mounds, but not all mounds had a full village, and not all Frisian villages were built on an artificial mound.

Pliny's description, however, did not apply to the whole coastal plain: His Encyclopedia described the environment of Chauci fishermen, unsuitable for hunting or farming, while the landscape of neighboring Frisia already showed a more developed image. But ancient authors were prompt to describe the populations living beyond Roman influence as brutal and underdeveloped, rather than stressing their knowledge and skills (Lendering and Bosman, 2012). Compared to the structured and civilized coasts of the Mediterranean sea and the flourishing cities of the Roman Empire, the endless and fluctuating landscape of the North Sea coastal plains, punctuated only by terpen and huts, must have seemed inconsistent and sterile to Roman generals and sailors, especially if they measured the value of the Frisian and Chauci people in terms of their capacity to structure their environment. Control and geometrical structuration seemed here less relevant than resilience and adaptation to a watery, flood-prone, unstable, and salty environment.

The Northern European lowlands were, however, not all sterile, despite being treeless, flood-prone, and inhospitable. Tidal movements and sea storms made it necessary to secure homes and cattle in times of high water, although the absence of artificial obstacles such as dikes and levees allowed these fluctuations to spread over vast areas and to lose part of their energy. Few natural elevations could be found in the region, and the construction of artificial mounds with local materials – clay, animal refuse, construction materials – was thus a simple way to create elevated shelters and provide the basis for a unique civilization living on a part-land part-sea archipelago. The extensive coastal plain, crisscrossed by tidal creeks between sea and ridges, provided vast pastures. Cattle was kept for milk, meat, and hides on the prairies surrounding the inhabited mounds, where stalls were built that could shelter up to 40 animals. Sheep were also common, and Frisian wool was famous in medieval Europe. Botanical research has since shown that saline vegetation formed the natural habitat around these artificial mounds, from their construction attested already around 600 BCE to their abandon around the 10th century. Nevertheless, the Frisian people succeeded in turning saline soils into productive land, while sustaining fishing and hunting activities. Although salt was found everywhere in various concentrations, various salt-tolerant crops were cultivated on and around the mounds in clayey soils, more fertile than swampy forests and sandy ground. Archaeological excavations of ancient mounds have attested to the presence of Hordeum vulgare (six-row barley), Linum usitatissimum (linseed) used for oil and fibers, and Camelina sativa (false flax). Fruit trees and legumes were found as well. The use of agrarian tools is confirmed, including the use of ploughs shown by traces of grooves found during archaeological excavations conducted on the Feddersen Wierde in Northern Germany (Lebecq, 1997: 365).

Traces of the terpen in today's land elevation around the Lauwers River in the northern Netherlands (Rossano, elevation data AHN1)

The terpen were initially divided according to a radial structure, with a circular field left open at the top of the mound, which would be occupied by Christian churches centuries later. Depending on its size, a terp could host one or several families, and small terpen could be progressively heightened, expended, and eventually connected to form a village. The land was initially not privately owned but periodically distributed among the inhabitants. Only later would the terpen be associated with and owned by families and privileged individuals, who held special rights and duties. Among the duties came later the "dijkplicht" (dike-service) that appeared with the first dikes, and overruled all other duties, as the servicer was required to remain near the dikes he was in charge of (Ter Haar, 2004: 28). Although life on a terp would appear to be isolated, the ubiquitous waters offered a large network of transport and communication, of particular importance for a country designed more for boats than horses. The first written Frisian law, therefore, severely punished the obstruction of a river: "If anyone obstructs a public passage in a river, he pays 12 solidi." This was a rather high fine identical to what one had to pay for wounding someone in the stomach (Lex Frisionum, ca 790: De Flumine obtruso).

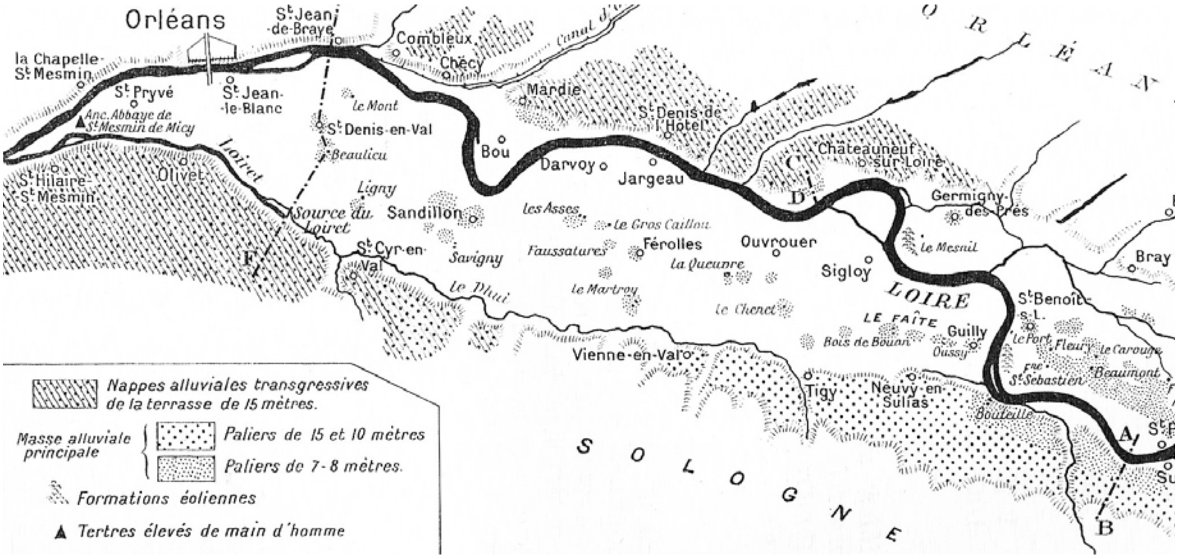
In the High Middle Ages, Frisia was still open to the sea, and formed a rich and populated country of fishermen, farmers, and traders. In his 1963 inventory, Halbertsma counts 1170 terpen in the northern regions of the Netherlands only. Around the year 900, before the first dikes were built, the core regions of Frisia (Oostergo and Westergo) had an estimated density of 20 inhabitants per hectare, similar to the density then found in the urbanized basins of Paris or Cologne (Lebecq, 1997: 366), this, despite the constant risk of flooding, the saline soils, and the lack of wood, but thanks to the Frisians' remarkable capacity for adaptation and exploitation of a fluctuating environment. Although not totally protected from flooding, the Frisians were able to secure people, goods, and livestock on the terpen during high waters. In return, the Wadden Sea, the estuaries, and the creeks offered rich fishing resources, and the Frisians learned to use tidal movements to maximize their catch. They used the wide coastal plain for extensive pasture, hay production, and for crop farming; the terpen provided fertile soil for intensive agriculture close to the house; the house itself had a limited life of a few decades, depending on the moisture of the ground and the type of wood, but could be recycled and rebuilt together with raising the height of the terp, when necessary (Boersma, 1972: 69, 87); these scattered terpen individually offered flood-proof, divisible, and expandable lots, and together formed a resilient decentralized spatial structure, maximizing accessibility by sea and by land.

Paradoxically, the Frisian tidal civilization was not destroyed by the sea but by Viking plunderers attracted by its wealth. During the 9th and 10th centuries, repeated attacks weakened Frisian society. In the second half of the 10th century, the first polders and dike rings announced the end of the terpen, and the progressive incorporation of the Frisian archipelago with the mainland (Ter Haar, 2004: 31). As the sea was progressively closed off, the utility of the terpen diminished – only to be recalled by dramatic floods that spared the highest villages – and their construction stopped with the progressive generalization of the levee. Farmhouses and barns moved to the lowlands, close to their farmland. As they come to stand on dry land, the function of the terpen, as described by Pliny the Elder almost two millennia ago, faded away, together with their cultural value. Many terpen were demolished in the 19th century, their rich soil excavated and sold by the ton to farmers willing to fertilize sandy lands (Boersma,1972: 100). Paradoxically, the interest in terpen was again awakened during the same period, and this, for various reasons: the abundance of objects found during the excavation and the transport of the terp's soil when sold as fertilizer; the rise of regionalism and nationalist movements, for which archaeology became a matter of identity; the dramatic 1825 flood, that hit large parts of Frisia and Holland, calling the national flood defense system into question; and the international interest in prehistoric archaeology, aroused by discovery of the pile dwellings in the Alps, that archaeologists wrongly associate with the Frisian terpen, together with the Italian "terramare" (id.: 93-94).

A renewed interest has been seen in the last few decades in Germany and in the Netherlands, partly driven by the increasing salinization of coastal farmland and by the need to create space for temporary flooding while keeping settlements secure, characteristics inherent in the ancient Frisian landscape. Experiments conducted in the 1960s by the University of Groningen showed that the plants found on the excavated "wierden" could survive a spring tide, whereas modern cultivated plants died. Archeobotanist Udelgard Körber-Grohne showed that these species could grow on brackish ground and produce satisfactory harvests if no inundation took place during the growing period (Boersma, 1972:33). In the Netherlands, where 125,000 m2 of coastal area is expected to be unsuitable for regular agriculture before 2020 due to salinization, farmers and research institutes have been testing the resistance of various vegetables, with "saline" potatoes commercially available nationwide since 2014. One of the most commented projects of the Room for the River program is the transformation of the Overdiepse polder into a temporary retention basin bordered by a series of elevated mounds connected by a dike – clearly inspired by the Frisian terpen and often presented as a return to ancient Dutch adaptive strategies – although no terpen were ever found in this part of the Netherlands. The long ignored and forgotten Frisian terp, a remarkable landscape built for flood-prone conditions, has now become a reference for new adaptation projects that seek to achieve gradual safety and flexible solutions.

Living with the flow

Examples of culture adapted to flood dynamics can be found not only along coastal areas but also along riverine floodplains. The Loire River, historically known for its overwhelming floods, was, however, inhabited and exploited long before the first levees were built at the end of the Middle Ages. Ancient settlements were carefully located on the riverbanks ("chantiers" in local dialect), on natural ridges or artificial mounds,whereas today about 300,000 people live in the river's natural expansion area (Guillou, Maurin, 2005: 37). The elevated mounds called tertres were rather similar in functionality to the mounds found around the North Sea, located just a few meters above flood levels, which were much lower when the river was able to spread over vast areas. Different from the burial tumuli found along the Rhine River, the tertres of the Loire Valley were places to live and work, large enough for families, small farming communities, and sometimes for a full abbey. As flexible as the Frisian terpen, these tertres could also be expanded and agglomerated into circular or linear ensembles, and eventually could grow into villages (Oudot,1989: 212). Such constructed topographies were found as well in the estuary of the Rhône river, and in the Camargue region, more limited in size but similar in function: During a flood, livestock and equipment could be brought there in the safety of the "recati," a small artificial knoll built close to the farm (Allard, Labeur, 2009: 180).



Inhabited mounds above flood level in the Loire Valley (Dion, Histoire des levées de la Loire, 1961:76)

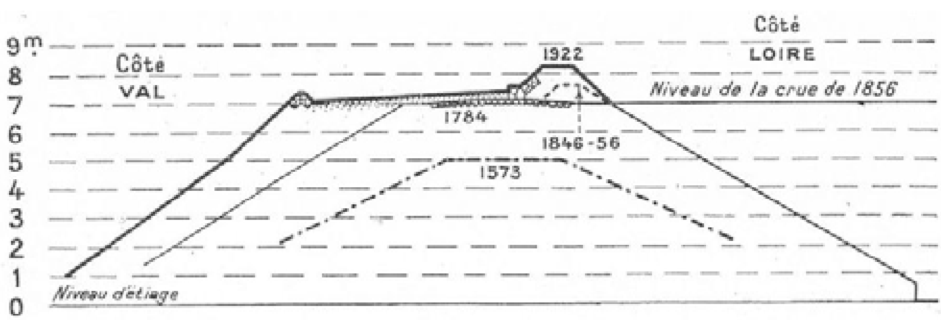
For the early inhabitants of the low Loire valley, directing and making use of floods was a better strategy than trying to block it off and lose the benefit of its rich alluvium. The first artisanal levees, called "turcies," were in use at least since the 8th century. They consisted of low and rudimentary ridges made of a mix of earth and faggots. They could be used to connect the inhabited tertres, to create continuous paths along the river arms, or to protect side areas of the floodplain from erosive floods. The turcies formed soft and submersible barriers against the Loire's powerful stream, which would not guarantee safe ground for habitation but could efficiently slow down the stream in times of high water and mitigate its effects. The energy of the flow could be thus attuned and used to catch and spread fertile sediments onto the inundated land (Fournier, 2008: 9).

Pressured by big landowners wanting to secure their farmland, King Henri II of England, Count of Anjou, organized the installation of permanent dwellers on the turcies. According to the 1160 Charter, the new inhabitants of the turcies were made responsible for their maintenance – for their own safety and that of the farmland behind. Strangers in the river's domain, the settlers were given no other choice than to fight against the flow and defend their land in order to survive, being, in exchange, exempted from certain military duties.

This forced colonization and the pioneers themselves were placed under the control of the Count's army officers, thus attesting to the coordinated and political character of the campaign. As maritime transport intensified on the Loire River, pressure grew on local authorities to regulate further the river's profile in order to control its level. The turcies were then progressively replaced by stronger, permanent, and continuous levees, and for two centuries this development was not challenged by major floods, possibly due to a mild hydrology and the mitigating effect of the tributaries' still open floodplains (Guillou, 2005: 31). The fixed and strong levee temporarily won the battle against the submersible turcie. But by allowing more floodplain to be exploited, and by raising the level of the river, the levee made every transgression more dramatic, and opened a "frantic chase for insubmersibility" that lasted until the Plan Comoy in the mid-19th century (Guillou et al., 2005: 67). Furthermore, the shift from submersible turcies to fixed levees is not so much the result of technical advancement but rather the consequence of economic developments that see the economic interests of traders and big landowners prevail over local interests and small-scale agriculture. Thanks to the levees, navigation intensified and enabled the empowerment of urban trade centers over local communities, which underwent the often negative consequences of the channelization implemented in and around cities (Fournier, 2008), and the downsides of an early globalization.

With the return of major floods in the 15th century, many dikes and goods were destroyed by the river, but following the paradox common to most modern Western European basins, the narrowed riverbed and high levees led to more dramatic floods that led, in turn, to raising the same levees further up, etc. No one then questioned the basic principle itself, and royal authorities, financially supported by the local trade bourgeoisie, carried on with the progressive canalization of the river, foremost in order to secure river shipping (Guilou, 2005: 32). Despite this priority given to canalization, mention is already made in 1584 of a first spillway thought to be able to release the pressure on the levee and so prevent dike breaches in Blois. A plan made by the royal council of Louis XIII in 1629 proposed the creation of six of these spillways, and even the destruction of existing levees. Local authorities however succeeded in hindering their implementation, and instead the levees were raised up again at the end of the century (id.).

After four catastrophic floods in the early 18th century, submersible levees were again suggested and this time implemented between Gien and Tours in the shape of lowered dike sections of 200 meters or longer, which were kept at the old level of 15 "feet" (4.88 meters) to allow local overspill (Guillou, 2005: 33). After the 1733 flood, these spillways, however, caused an outcry in the flooded areas and failed to prevent the breach of several higher levees, leading to another campaign of dike raising and extension. But the dramatic floods of 1846, 1856, and 1866 again showed the failure of ad hoc raising of the levees and the risks brought by the systematic channeling of the riverbed. More and more engineers estimated that finding space for expansion and mitigation was inevitable.



Ever-growing levees along the Loire: the Authion levee in Angers, evolution since the sixteenth century (R. Dion, 1934: 444)

This shift led to the creation of a commission headed by the engineer Comoy, explicitly tasked with studying the controlled flooding of side valleys in order to mitigate the effects of future flooding. Particularly interesting here is the role played by Emperor Napoleon III in the emergence of adaptive river management, in a century that saw most of Europe's rivers disappear behind levees. As imperial leader, Napoleon III favored order and reliability over chaos: ""I am honor bound that in France rivers like revolution shall return to their beds and rise no more," he declared in his opening speech at the 1957 parliamentary session, a few months after the 1956 floods. The Emperor, however, saw with his own eyes the destruction caused by the Loire and the Rhône Rivers, both corseted by high and continuous levees to secure shipping and trade. His personal commitment to territorial development and civil works went far beyond Paris, and his letters show a great concern and a wide perspective on the management of great French rivers. Like many of his engineers, Napoleon III was frustrated by the poor results of the massive investments made after the 1846 floods, mostly directed to the heightening of portions of the levees without any broader perspective, which "only made the effects of the last tragedy even more disastrous" (Bonaparte, 1956). The Emperor called for a scientific and systemic approach, and took a critical stance about the levee system, "merely a ruinous palliative." About the reservoir-dams planned in the upper Loire basin, Louis-Napoleon wrote: "Even if these dams were causing any wrong to the cultures of the valleys, one would have to come to terms with this, even if it implies compensating the owners, for one should accept giving water some space [faire la part de l'eau] just like one has to cut one's losses [faire la part du feu]" (id.).

Unfortunately, the areas designated to be used for preventive overspill were increasingly built upon and exploited, making it every year more difficult to implement the project of the Comoy Commission (Guillou: 2005); only seven out of the nineteen planned overspill sections were eventually built. Still the "Plan Comoy" remains known to this day as one of the earliest flood mitigation programs implemented on a grand scale, which tried to reconcile variability, safety, and navigability – prefiguring the contemporary Room for the River programs.

The vertical distribution of function and submersible flood defenses seen in Frisia and along the Loire could be found as well in the Elbe basin, in the Oderbruch region. Before its reclamation by the King of Prussia, the area "contained a scatter of villages built on higher sandy mounds." Historian David Blackbourn gives a description of the mores of this region that very much recalls what is known from the Frisian coastal plains and the Loire Valley: "Their inhabitants were amphibious. They lived primarily as fishermen, from the rich stocks of carp, perch, pike, (...)." "But they also produced hay and pastured animals when water-levels were lower, using animal dung mixed with mud and bundles of twigs to construct protective walls against floods, and on those walls they grew vegetables. For much of the year, except during lower water and winter ice, communication was by water." (Blackbourn, 2000).

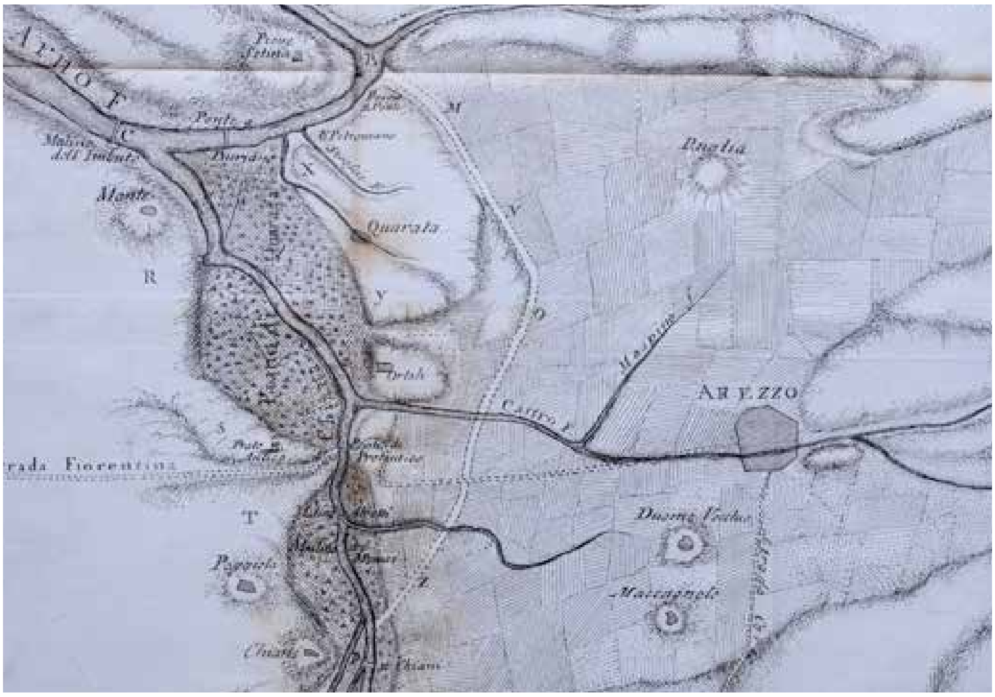
1856 flood in the Loire Valley: Carte cavalière des inondations de la Loire - Trélazé - Oudon - Richebourg - Cinqmars.
(Anonymous, L'Illustration, 28 (3 July 1856), 8)

Flood as land-maker

"From the flooding of the river abundant crops spring up," writes Appolonius in the 3rd century BCE about the benefits of the Nile inundations (Appolonius). Flood was always known to erode and destroy, but in many places and under certain conditions it was also welcome as a free and natural fertilizing agent, this, since the first agricultural societies developed along the great rivers of the Fertile Crescent. The quality of the soil found on river banks after a flood was also known along European rivers, as well as the value of the water that was brought by the flooding of the large rivers, accurately named "vetwater" in Dutch (Bink, 2011: 62) and "fat water" in English: "the Seyne, with it's fat and folt Waters, makes the Land fertile" reads the 1734 English translation of Varenius's Compleat System of General Geography. The origin of this fertility, however, remained obscure (Varenius, 1734 ed., 2: 344).

Spontaneous flooding had the disadvantage of being erratic in its distribution of material – a wild stream could bring more gravel or sand than fertile alluvium, or erode more than it would silt. Various attempts were thus made to guide and make use of this natural process, in order to heighten and fertilize unproductive land. Controlled flooding for fertilization was a practice seen in much of Europe from at least the thirteenth century (Cook et al., 2003), both in monastic domains and secular practices. These techniques could vary from artificially slowing down the stream to facilitate the accumulation of alluvium, practices seen in the Dutch Delta or along the Loire river, to deliberately rerouting these river waters towards poor land in order to raise their level and improve their soil, making use of gravity or tidal movements to redirect the rich waters.

Besides fertilization, flooding was also uased to *make* land through warping techniques, known in the 16th century in Tuscany under the name *colmata* (Girel, 2008: 84). *Colmata* techniques literally meaning "filled up," aroused international curiosity in the early 19th century, as booming European populations put pressure on the demand for arable land. In his Journey in Carniola, Italy and France published in Edinburgh in 1820, W.A. Cadell relates how "almost the whole of the Val di Chiana has been raised by the process of *colmata*." He describes the process of warping as it was applied in the 18th century to the marshlands surrounding the river, first transformed into a closed compartment: "The field is surrounded in an embankment to confine the water; the dike of the rivulet is broken down so as to admit the muddy water of the high floods." The Chiana River itself was too powerful to be allowed into the new compartment, thus only water from the tributaries was used. "This water is allowed to settle and deposit its mud on the field. The water is then let off into the river at the lower end of the field by a discharging course called *scolo*, and, in French, *canal d'écoulement*." Cadell estimated the duration of the process to take ten years for an impressive 1.7 to 2.30 meter land rise. He specified, however, that various factors could influence the thickness and the quality of the new soil: "If the dike is broken down to the bottom, the field will be raised the same height in seven years; but then, in this case, gravel is also carried in along with the mud. (...) The water which comes off cultivated land completes the process sooner than that at which it comes off hill and woodlands" (Cadell, 1820: 266).



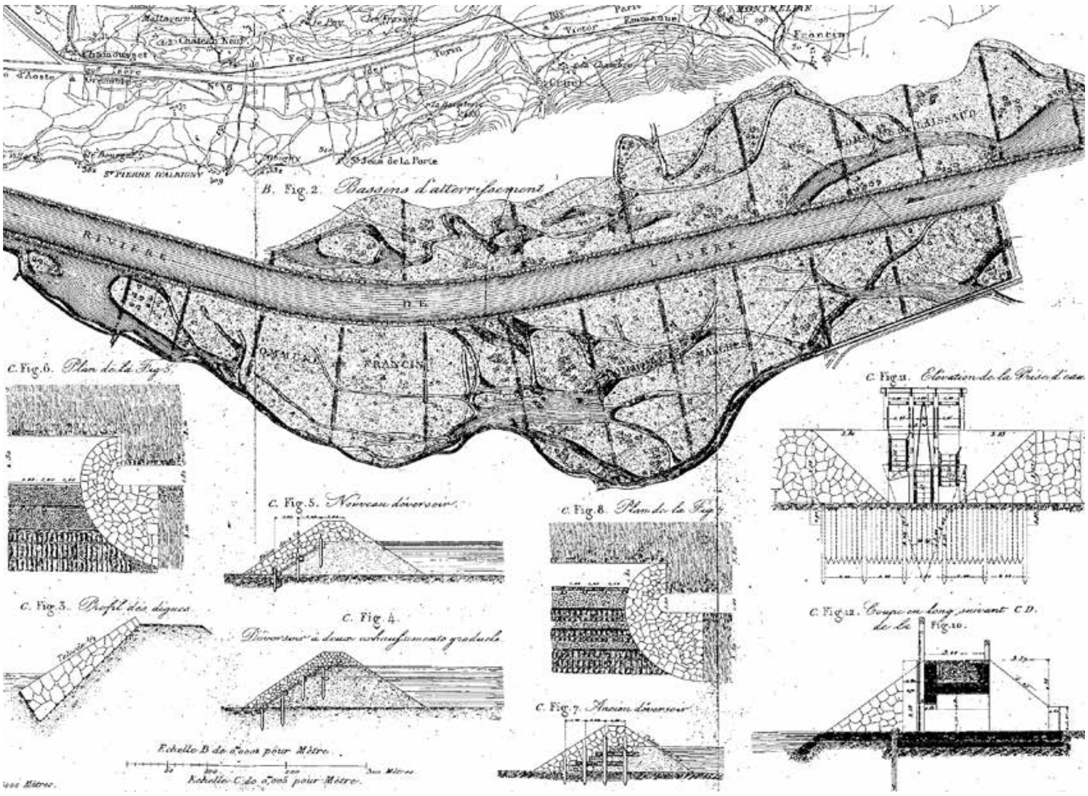
Warping in the Chiana Valley, Tuscany
(Vittorio Fossombroni: Memorie idraulico-storiche sopra la Valdi-Chiana, 1835)

The success booked in the Val-di-Chiana, after centuries of vain attempts to drain the wetlands, received a great deal of attention and influenced ensuing reclamation projects in Italy and elsewhere. "In 1817 laws were passed in Piedmont and Central Italy (under the respective titles of Regie patenti and motu proprio) for government-sponsored land reclamation (Enciclopedia Italiana, 1933-42), and in 1839 and 1855 in the Kingdom of Naples. Following Unification, the Piedmontese Regie patenti were adopted throughout Italy; the *colmata* principle was incorporated into new laws in 1873, and the period 1870-1912 involved much legislation dealing with river regulation, slope protection, and reforestation" (Alexander, 1984: 547). Following upon the Val di Chiana, the warping technique was further developed in Tuscany, on the coastal plain of Marremam, and in the neighboring Kingdom of Piedmont-Sardinia, which engaged in the late 18th century in a large program of land reclamation in the Isère Valley (today located in the French Departement de Savoie). In the mountainous regions of the Kingdom, arable land was scarce, and pasture had reached its maximum intensity, causing deforestation, erosion, and more frequent floods on hillsides and in valleys, where rivers regularly changed bed. These fluctuating floodplains, however, still provided the local population with wood for construction, brushwood, and grass used by farmers as feed and fertilizer (Girel, 2010: 42). They were also seen as the last opportunity to fix populations in a border area that needed to be in a fit state to resist possible military threats, a region where demographic and economic development was hindered by the lack of arable land. With the planned reclamation, the Sardinian government hoped to empower its borders and facilitate the integration of Savoy into a "united, organised and modern" Kingdom, with the transformed river symbolizing the power of Man over a wild and hostile Nature (id.). The channelling project, prepared by French engineers before the Revolution, was thus developed by the Sardinian government, and the channeling of the Isère river was completed between 1829 and 1854. The braided stream was confined to a single channel bordered by so-called insubmersible levees, and the vegetation of the floodplain, adapted to frequent fluctuations, lost about 90% of its habitat (id.: 52).

The land isolated from the river was ready for "bonification," drainage, and exploitation, an enterprise initiated by Sardinian but completed by French Engineers, since Savoy joined the French Empire again in 1860. Along the Isère River, 44 hectares of former riverbed were turned into farmland through *colmatage* (Choron, 1871: 359). Two warping techniques were actually used to turn the former floodplain into arable land: the "Italian system" that leads waters from the main bed directly into a succession of compartments, each one feeding the next until the water is sent back into the main bed; and the "French system," where waters are distributed into all the compartments by a single canal laid parallel to the river, and evacuated by a ditch dug on the opposite side of the reclaimed land. The "French system" ensures a homogeneous soil quality, while the Italian technique generates a big variety in soil composition. The warping operation lasts from 5 to 20 years, bringing even more variation in soil quality. The work was not yet finished when the Annales des Ponts et Chaussées, a yearly journal published by the French Corps of Engineers, published two essays on the warping experiment, in 1868 and 1871. Both articles praised the achievements of the engineers, Choron stating confidently in 1871 that the "insalubrious regions that are constitutive of state properties in our valley are not unproductive, and that with enough perseverance, the grains sowed onto these grounds will one day produce a rich harvest."

In neighboring Switzerland, engineer Ignace Venetz, who envisioned the channelization of the river Rhône in the Cantons of Vaud and Valais, also promoted the warping technique for the reclamation of the river delta upstream from Lake Geneva. Insufficiently drained by open ditches, the area consisted in 1840 of wetlands, pastures, and "flachères," wet meadow where farmers produced a forage mostly composed of sedge, locally called "flats" (Schoeneich, 2009: 152). In order to raise the plain and increase its productivity, the 1843 preliminary project included the creation of two "canaux de colmate" (warping canals) running parallel to the central drainage canal, meant to bring the fine sediments carried by the river onto the low parts of the delta. The principle of warping had already been known in the Rhône valley since the 15th century, when submersible levees made of wood and stones were built across secondary river arms to slow down the stream, accelerate silting, and create new farmland (Borgeat-Theler, 2011: 31). But eventually, only the drainage canal was built between 1852 and 1863, and soon proved insufficient to drain the whole plain.

The channeling of the Rhône worsened the problem, since the plain was then flooded by the Rhône's tributaries, which could not flow into the main river. While the warping might have heightened and fertilized the plain in a few years, it would take a century to make the area suitable for agriculture again, with the 1907 land re-parceling, the deepening of the canal in 1917-1922, and the development of systematic underground drainage until ca. 1950 (id.: 162-163). Fifteen years later, the municipalities of Riddes and Saxon decide to launch together a study on the drainage and warping of the plain between these two villages (Gazette du Valais, 16, 1859: 1-2). J.A. Raby, "ingénieur civil, membre correspondant de la société des sciences chimiques, physiques, arts agricoles et industriels de France, etc.," promoted the warping technique, over the construction of levees alone, in a series of articles published by the local newspaper. In his ambitious proposal for the transformation of the Rhône valley, Raby estimated that 19 millions toises (about 7600 hectares) could be protected from flooding and partly warped (Gazette du Valais, 1861: 1.3, and 7.2-3). He also proposed very symbolically to locate a new school for agronomy on the land that would be reclaimed through warping from the marshes of Conthey, "a good and useful example"; he admits that the first warping attempt in Granges had not been conclusive - but "one had applied the means of warping and diking adapted to the nature of the river and the land. Many similar enterprises have been made in other countries. All were totally successful, regarding the completed works as well as the profit obtained" (Courrier du Valais: 3 July 1856, 74.1).



Warping in the Isère Valley.
(From A. Drizard (1868), Mémoire sur le colmatage des terrains de la vallée de l'Isère)

The technique was not limited to alpine rivers but also received serious attention in England, where it was widely practiced from the 1730s to the 1880s. (Smith, 2012: 18). Warping was used onto several estuarine wetlands (Somerset Levels, Humber area, Gainsborough), and seemed common along the River Ouse according to Loudon's 1826 Encyclopedia of Agriculture (Loudon, 1926: 324). In later editions, Loudon used the description of the *colmata* given by Cadell in 1920 (Loudon, 1871: 330), adding however that "the Italian process called colmata is nothing more than a variety of the British process called warping" (Loudon, 1871: 330). Warping is for him an ancient and obvious technique that "has long been practised, and is an evident imitation of the overflowing of alluvial land, whether in meadow or aration" (id.). Initially, the warping implemented in England seems indeed not to be related to a specific tradition, but rather be an attempt to reproduce the benefits of spontaneous river floods, since "superior quality pastures that were regularly flooded pointed the way to controlled flooding or warpings" (Williams, 1963: 179). It is also sometimes combined with various techniques of soil improvement, such as burning and claying (id.).

A detailed description of the warping process as applied in Yorkshire was published in 1845 in the British Farmer's Magazine. In a detailed article, Ralph Creyke presented his warping technique and promoted his own experience with warping and draining the South Yorkshire peat bogs (Creyke, 1845). The company of Dutch engineer Cornelis Vermuyden (famous for introducing the land reclamation to England in the 17th century) had already been active in the area, building the well-named Dutch River, a diversion of the River Don, that allowed the drainage of 30,000 hectares of land. A century later, Ralph Creyke went further in land creation, and developed the warping techniques for use on the Yorkshire peat bogs. A landowner himself, Creyke closed a deal with three townships, offering to reclaim 648 hectares in an area known as Thorn Waste, a bog that had long been open to the tidal movements of the Humber estuary. The levees built along the Ouse River and the drains crossing the land had caused the peat bog to subside below high tide levels. Using the same warping process he had previously applied to raise his own land, Creyke tells how he created a channel to convey the rich waters of the Ouse River through cultivated land all the way to the bog, which had first been divided into three compartments through the construction of new embankments. These compartments were then progressively raised by the deposits brought in by spring tides, which were powerful enough to keep a sufficient flow in the channel and prevent it from being clogged with alluvium. Looking backward at the warping process completed from 1821 to 1826, Creyke estimated in 1845 that ten to twelve tidal movements can warp 4 to 6 hectares with a 30- to 90-centimeter thick layer of fertile alluvium, although the speed depended on many factors such as the distance to the river, the depth of the area, etc. (id.: 33). In total, only five years had been necessary to warp the initial area, and the process was so successful that an additional 800 hectares was eventually reclaimed with the same technique in the surrounding townships by the time Creyke wrote his article. More land followed after a second Act for the Improvement of Thorne Waste in 1861, but the central part of the area remained a peat bog, and some warped area was not reclaimed (Smart et al., 1986: 739). Ironically, the effort to create new land by raising the peat bogs were followed by a period of intensive peat extraction in the second half of the 19th century: After succeeding in creating large areas of land out of muddy waters, vast areas were excavated and returned to wetlands.

Reinventing flexible landscape

Coasts, rivers, and alpine valleys saw cultures of adaptation slowly built on experience and observation being overruled by widespread damming and channelization, starting in the Middle Ages and with the rise of navigation. Today's adaptation measures and mitigation plans, however, show that ancient strategies are again a source of inspiration, bridging centuries of technical and territorial transformations. From the construction of the first artificial mounds in Frisia to the "depoldering" of the Overdiepsepolder in Dutch Brabant, more than 2500 years have past. Five hundred years separate the first "déversoir" overspill in Blois from the "champs d'inondation contrôlés" currently built in the Isère Valley. Raising and stabilizing land through silting and plantation is still in use, 200 years after the warping of the Val di Chiana.

Without idealizing the existence of prehistoric and medieval European populations, the revival of these past practices considerably enlarges the range of possible landscape intervention and practices capable of restoring a balanced and dynamic relationship between human habitat and natural fluctuations. Furthermore, these past practices, motivated by the need to exploit and produce, show that mitigation does not necessarily rhyme with the creation of enclosed and unproductive green buffer zones: On the contrary, millenary experience has shown that flexible and resilient landscapes could also offer living and productive environments, provided that these landscapes were designed and inhabited in a way that allowed natural fluctuations to take place.

Dreams and achievements of the Great Reclamation works

"If the levees are now everywhere raised above previous flood levels, water will be forced to rise higher than ever before, and possibly flow down and inundate the land once more as a result: God protect us against such plagues!" (Vierlingh, 1579)

Although wetland reclamation or levees were built and implemented several millennia before the Enlightenment –various plains and marshes of Italy, England, and the Low Lands had already been reclaimed during the Middle Ages, as monasteries spread hydraulic technologies over Europe – from the 18th century onward, however, converging evolutions in technology, demography, agriculture, and politics lead to a strong acceleration in large canalization and reclamation projects, which together addressed flood risks, pandemics, food safety, the stabilization of local populations, and the empowerment of young nations. Economic development and political integration merged into river management and land-making that turned into national projects, sometimes personally orchestrated by King-Engineers such as Frederick the Great in Prussia and later Napoleon III in France. These vast landscape enterprises were supported by a new discourse of progress: Projects of bonification, Flusskorrection, Rektifizierung, correction, melioration, or assainissement all imply the promise of a better, safer, and wealthier future for all, and were often supported by the denigration of pre-existing landscapes and pre-industrial economies, and the downplaying of the corrections' downsides that already were arising during construction work. Opponents criticized the impoverishment of the landscape and also doubted the long-term efficiency of canalization measures. Economically profitable, the "taming of rivers" indeed soon appeared to be an endless task, as each canalized river allowed for more land to be reclaimed, yet also called for still more correction work in order to remedy its side-effects and in order to protect newly exposed assets. Two centuries later, the controversy has again been revived by the hydrological uncertainty brought about by global warming, making many historical arguments again relevant in order to envision possible futures.

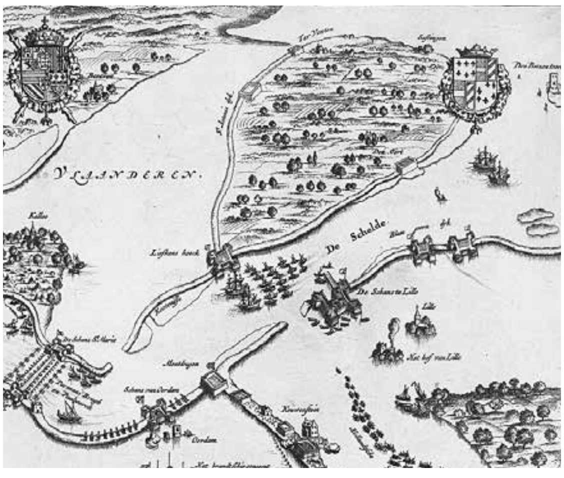
A European self-colonization

To a large extent, the origins of land reclamation techniques in Western Europe can be traced from the practices found in ancient Egypt, Greece, Etruria, and the Roman Empire. Contemporary landscapes, however, owe as much to the medieval development of feudal and ecclesiastical domains, and more particularly to the remarkable expansion of the Cistercian Order in the late

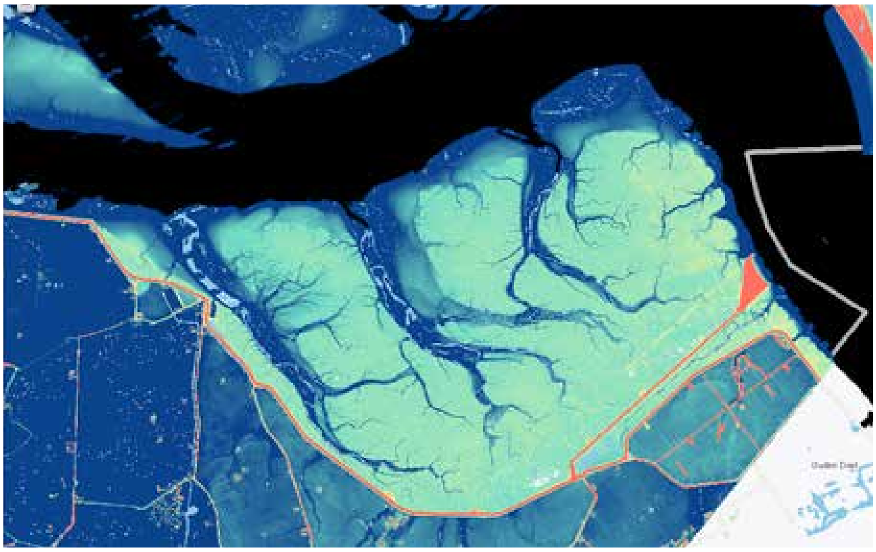
Opposite page: Raphaël Ritz, Ingénieurs dans la montagne
(c.1870, Musées cantonaux du Valais/Musée d'art du Valais, Sion)

Middle Ages, although the myth of a pioneer order colonizing new land from scratch has now been widely revised (Van Acker, 2014; Curtis and Campopiano, 2013). More than just a spiritual project, the Cistercians gave a new dimension to the Benedictine adage ora et labora (pray and work), laying more stress on the second term and including in their credo a full economic model based on individual poverty, collective productivity, and material autonomy. Each new abbey had to be self-sufficient but stay closely connected to the whole organization through the yearly gatherings in Citeaux; it was an organization particularly well adapted to the instability of medieval borders. The apparently contradictory combination of productivism, collective capitalization, and individual poverty, presaging the strict protestant ethics of work, wealth, and austerity, were soon shown to be successful as the new monastic order became expert in structuring and exploiting the land donated by local lords, including barren marshlands, remote valleys, or tidal mudflats.

The development of the first Cistercian Abbey in Citeaux was itself closely related not only to the great hydrological works undertaken to drain, irrigate, and power the domain but also to its central location within the European navigation network. Following the Rhône, Seine, Loire, and Rhine, the Cistercian Order became a master in the control of water and the exploitation of waterways, creating a wide spiritual and commercial network that expanded towards Flanders, to the East along Alpine valleys, and to the South in the Camargue, Spain, and Italy. Everywhere, the Cistercian developed specialized knowledge that could be put into practice on "wastes" made available in addition to the gifts of pious landowners. Thanks to the Cistercian centralism and to its expansionary drift, information and knowledge was regularly exchanged and spread again over Western Europe. Thanks to the autonomy of abbeys, to the flexible system of granges, and to the free labor of lay brothers, this knowledge was turned into profitable enterprises. The rapid expansion of the order from the 12th century on was largely fuelled by this unique strategy associating pioneer development of neglected land, diversified production, and international trading – all encouraged by the Christian authorities and supported by numerous land donations (Van Acker, 2014: 15). In 1129, thirty years after the foundation of the Citeaux Abbey, thirty-five monasteries were active, stretching from the Lucedio monastery in Piedmont through France and Switzerland to the Saxon monastery of Walkenwied (Cooke, 1893: 640), with these latter two domains having again been donated to the Order, to be reclaimed from wetlands and floodplains. In 1153, at the death of the Saint Bernard, founder of the Cistercian Order, 343 monasteries could be counted (id.: 639).



The Cistercian Saeftinghe Polder in the 16th century
(Het Belegh der Stad Antwerpen
in den jaeren 1584 en 1585, detail)

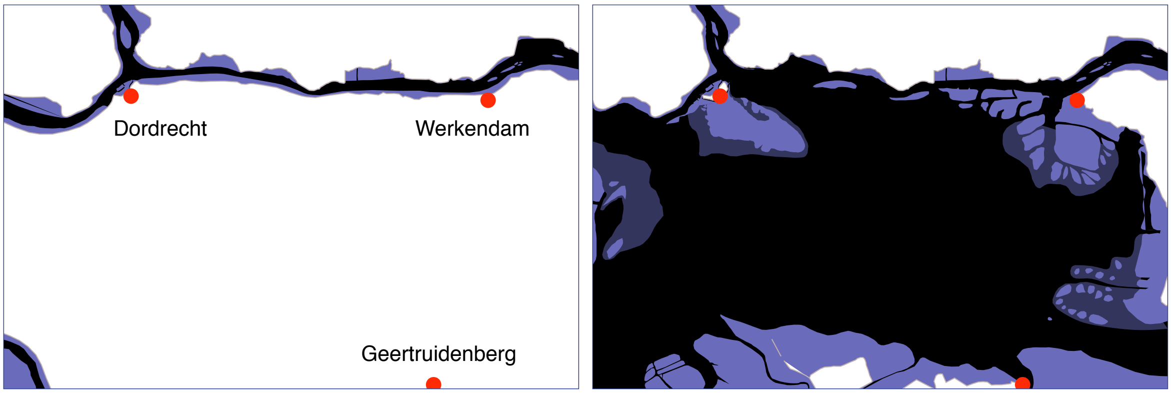


2013: Saeftinghe nature reserve, current terrain elevation (AHN/Rossano)

The Order spread rapidly towards the coasts of the North Sea, where it developed and expanded its large domains, not only thanks to rich donors but also through extensive land reclamation and drainage. Founded in the 12th century, the Flemish domain of the Abbey of Duinen in the year 1300 covered circa 10,000 hectares, becoming one of the largest landowners in the Low Lands (Lehouck and Van Acker: 2). Its filial abbey, Abbey Ter Doest, came to play a crucial role in the history of water management with the transformation of a brackish intertidal area into a fertile polder: the Land of Saeftinghe in Flemish Zeeland. Building dikes, draining and reclaiming new land, maintaining locks, and in some cases heading local water boards, the Cistercian abbeys expand their reputation further to the North, into Holland, Frisia, Northern Germany, and England (Rooiendijk: 51-2), where more abbeys were founded in coastal plains and estuarine areas. There the Cistercian order developed a model of land entrepreneurship that rapidly turned free land into highly productive ground, generating high capital gains on property and paving the way for future reclamation enterprises. Within the Cistercian context, land reclamation and exploitation became a deed of faith, with the monks in theory protected against greed by a ban on individual property; no limit was placed on productivity and the accumulation of capital.

Although the Cistercian enterprise appeared very successful and lasted several centuries, the great medieval colonization cannot be reduced to one single model. The techniques differed according to the local conditions: Tidal mud flats and continental marshes required different drainage and diking techniques. Furthermore, the social and economic schemes used for pioneering reclamations differed from country to country. The Cistercian expansion of monastic domains run by monks, and Granges supported by the labor of lay brothers, were successful, especially in France and Flanders. In Medieval Holland, aristocrats, lords, and clergy instead encouraged colonists by granting them full ownership and by setting them free from serfdom (Curtis, Campopiano, 2013: 6), thus involving the pioneers in the maintenance of the water system they depended on. As a result, their administrative territory and tax revenue increased.

But contrary to the ancient Nile fertilization systems, or to the later *colmata* techniques, the diking of the North Sea lowlands was not based on an open system but on a permanent isolation of the land from the surrounding waters. In Flanders and Zeeland, a new culture of fighting and containment competed with the adaptive mores developed by the Frisians. As the population grew and trade increased, the diking of new polders was followed by extensive peat extraction for salt and fuel. Peat mining and land subsidence caused by grazing and draining, however, rapidly worsened the position of the new lands in regard to sea and river levels, calling for more radical measures in order to keep waters out of profitable but fragile properties. In this increasingly dual system, floods turned into considerable threats against the very existence of the hard-won domains. The total disappearance of the Land of Seftinghe during the floods of the 16th century, together with many more Zeeland villages, offered a dramatic example of the fragility of the new system, protected on its perimeter but forever exposed in elevation, which created a land that appeared to be borrowed rather than won from the waters of the estuary. Another dramatic example of this vulnerable success was the completion of the Hollandsche Waard in 1283 and its relatively short life before it was swallowed by the 1421 Saint Elizabeth flood. This large area won from the floodplain of the Meuse River remained "one of the biggest waterworks in the Dutch History": 130 km of dikes, 540 square kilometers of land, which disappeared after less than 150 years of intensive drainage and peat mining (Bink et al., 2011: 14-16).



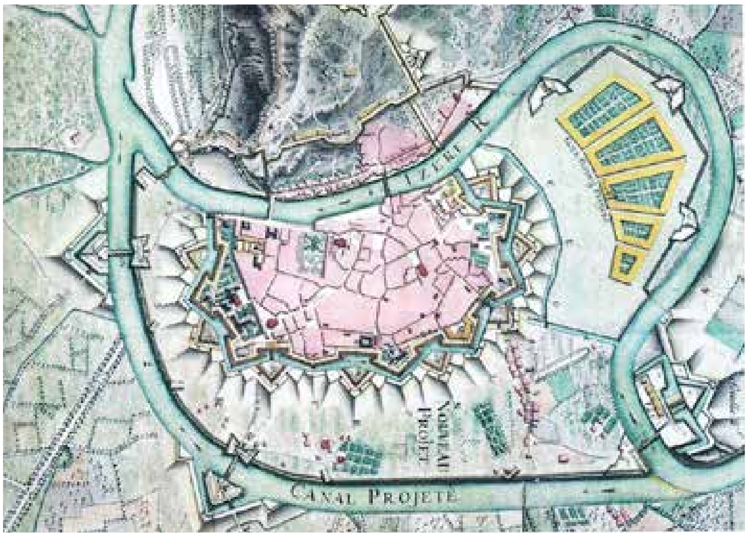
The Hollandsche Waard polder, in ca. 1300 and 1450 after the Saint Elizabeth Flood (Rossano)

Despite major losses, reclamation gained ground on sea, rivers, and lakes, and in 1577, Dike Master Andries Vierlingh sketched a time when dike-building had become a flourishing industry powered by the "polderjongens" who alternatively work on the levees and in the fields (Vierlingh, ca. 1577). He also criticized the downsides of a booming industry that lacked coherent vision, as Dike Masters sometimes "loosely go diking and damming at all cost, throwing someone else's money to keep the honour and the profit to themselves" (Vierlingh, 1920 ed.: XVIII). As Holland gained more and more territory over water but lost some again after each big flood, Vierlingh warned his contemporaries against the sea but also against division. "Your enemy the Ocean does not sleep or rest, days nor night, but like a roaring lion is searching for something to destroy hereabout." He insisted this enemy should be fought together: "In dike-making, the external enemy must be resisted with joined means [beurs] and joined capacity [macht]," as "this should be considered: give way to the sea, the more it will want to flow in" (id.: 396). Although unfinished and not published until the 20th century, the treatise reflects the successful interaction of technological, economic, and political developments that allowed for the reclamation of ever-larger territories, and the slow structuration of a "water-repellent" landscape. From an agglomeration of autonomous domains independently gained on marshes, lakes, or sea, where each local negligence could have dramatic consequences for all, the Low Lands evolved towards a more coherent organization, which Vierlingh wanted to further professionalize and detach from the local interests of the dike-builders and land owners, who tolerated division, corruption, and incompetence for the sake of individual and short-term profit.

The collectivization of flood defenses accelerated from the 17th century onward, and allowed for more massive and coherent reclamation projects to be planned by qualified engineers. The development and the communication of knowledge intensified throughout Europe, among countries but also among scientific disciplines that were not clearly differentiated. At the time Dutch water expert Cornelis Vermuyden was working in England, Swiss-born mathematician Leonard Euler, friend of Daniel Bernouilli, was called upon by King Frederick II to work on the transformation of the Oder in Prussia, together with German engineer Simon Leonhard von Haerlem, son of a Dutch dike master (Blackbourn, 2007). Before studying the Swiss Reuss and Linth, Jean-Samuel Guisan was chief Engineer for hydrology and farming in the French Cayenne. Army officer, engineer, and painter Jan-Pawel Lelewel fled from Warsaw to France before working in Switzerland, among various projects, on the correction of the Jura waters (Historisches Lexicon der Schweiz).

The up-scaling of European reclamations further followed upon the political empowering of European kingdoms, their economic development, and the progress made in the technologies essential to landscape architecture: surveying, mapping, and hydrology, along with mechanical engineering (Blackbourn, 2000). Large drainage works were undertaken, where the conditions were met for these enterprises: a strong demand for arable land, an abundant labor force, capitalistic entrepreneurship, and a strong support if not leadership from political authorities. The 17th and 18th centuries saw large areas diked and/or drained in Northwestern Europe: the Fens and Somerset Levels in England, the Watergraafsmeer and Beemster Polders (72km2) in the Netherlands, the more than 600 km2 Oderbruch in Prussia, the 30 km2 Moëres Polders in today's French Flanders, not to overlook a bog reclamation of modest size but of great symbolic power: the drainage of the Versailles marshes. More than flood defense, these large transformation were the materialization of a *Peuplierungspolitik* policy that increased population and food supply for the large urban centers (id.)

The power and imagination of the engineers for a while seemed limitless, as nature became increasingly considered as a meaningless entity that man was meant to shape and exploit. The design that was presented in 1747 by the "ingénieurs du Génie" to protect Grenoble from new inundations shows one of many examples of the Promethean dimension taken on by territorial engineering during the early industrial revolution.



Projet de Fortification de Grenoble,
avec canal de contournement de l'Isère, par les ingénieurs du Génie,
1747 (Archives du Génie, Vincennes)

Since the Isère was squeezed within the old city, threatening to destroy its bridges and flood its heart, the engineers proposed splitting the river into two branches, by creating a new channel encompassing the city on its southern border. Not only would this new channel double the river's discharge capacity and deviate a major part of the stream but it could also create a second ring of military defense, and allow for the construction of a new neighborhood sheltered against future attacks from the river or foreign armies. All-in-one – urban design, military defense project, and flood protection – the proposal showed a holistic but also mechanical vision of hydrology, and was received with both satisfaction and circumspection. The diversion, however, remained a project on paper: The Isère upstream from Grenoble would be more classically corseted in-between two levees a century later.

From the 19th to the late 20th centuris, flood and river management definitively shifted from local adaptive measures to centralized defense engineering, leaving for good the religious and emotional domain to enter the field of rational choices, whether technical or political. But as it soon appears, technical choices could be as dogmatic as religious beliefs. In 1812, Johann Gottfried Tulla, "the man who tamed the wild Rhine" (Blackbourn, 2007), concisely summed up the prevailing vision of river management: "Every river or stream needs only one bed, and if it has several arms, one should work towards a narrowed stream. It should be kept as straight as possible to facilitate a constant run-off by high waters in order to preserve the banks and so that the flow lowers its own bed and does not flood the surrounding area. The old river arms should be filled and the reclaimed land should be planted." Following Tulla's rigid prescription, almost all the principal Western European rivers were channeled between levees and their floodplains were subsequently drained to feed the ongoing industrial revolution: The French lower Rhône, the Saône, the Seine between Paris and Rouen, and the Isère; the German Rhine, the Elbe, the Emscher, and the Isar; and the Swiss Linth, the Reuss, the Jura, the Aare, the Upper-Rhône and Rhine rivers, to name only the largest canalized rivers.

These large and long-term projects also reflexively determined the new relationships established between local and national powers. The English reclamation was generally the result of private entrepreneurship supported by the monarchy. The reclamation of the Oderbruch in Prussia was largely the work of Frederick the Great, his personal views on territorial development, and the power of his army and administration. The French river corrections were also mostly orchestrated and financed by the central royal and later imperial authority, supported by its increasingly influential corps of engineer. In Switzerland, on the other hand, its federal structure implied a different balance of powers. The First Rhône Correction was, for example, initiated but also long disputed within the Valais Canton's borders, while the Federal Council took a clear stance on how the plain should evolve, setting strict conditions on its contribution. After the massive 1860 floods, the Federal Council refused to fund the reconstruction of the Canton, arguing that "we could not positively answer this demand, for its potential consequences and because the Federal Constitution does not allow such subsidies." The Council also feared that other cantons hit by the floods would soon follow with similar claims. A different answer would be made if only "the Valais Canton, in order to prevent similar catastrophes, would consider a correction of the Rhône through diking," a project that the Confederation offered to finance at least one third of, while expecting the railway company to fund about 40% of the total cost (Blotnitzki and Hartmann, 1863: 274-75, 280). To the Canton of Uri, also hit by severe floods, the Confederation "gives a similar answer by noting that we could only consider the request if it includes a correction project with plans and an estimate of the costs." (Rapport du conseil fédéral sur sa gestion en 1860, p. 316). In both cases direct support for the victims of flooding was ruled out by constitutional law, but massive funding was made available to finance the diking of rivers thought to solve the problem for good, and to be in the interest of the country as a whole, since the Upper Rhône Valley was a major transportation axis.

Not only was the Confederation a crucial supporter of marsh reclamation and river canalization but the corrections also needed to be radical, as recommended for the Rhine River in 1861: "The Confederation declares being prepared to support the correction of the Rhine (...). However, no subsidies will be granted to favour the enterprise unless a plan is adopted for the correction to be as complete as possible" (Dapples, et al., 1861: 51). The Federation offered financial support only when the country as a whole could benefit from the projects, and only when these projects followed a global plan fitting into the Federal vision. In return, the Federation covered a large part of the investment, offered a financial safety net that private companies often failed to secure in the long term, and let the Canton lead the construction works. Through this strict policy, the central authorities stimulated the systematic canalization of Swiss rivers all through the 19th century, propagating a unified vision of flood defense similar to Tulla's vision: Rivers should be totally channeled, and priority be given to the development of agriculture and infrastructure. The corrections and reclamation projects thus both revealed and shaped a conditional relationship between the Federal and Cantonal powers, made up of a careful balance of solidarity and self-interest, central control and local autonomy; this was a still relatively young relationship for the western Cantons that had joined the Confederation just a few decades earlier, after centuries of bouncing between autonomy and allegiance to Savoy, Prussia, and France.

The hygiene of drainage

With cholera, water was already long known as a vector of deadly diseases. Until the origin of malaria was found in the late 19th century, fresh water wetlands furthermore remained synonymous with dangerous fevers. People "located the origin of all medical evil in the swamps. Their smell was designated as 'mal'aria' [bad air], in which people figured a sickening substance" (Speich, 2002:13). The etymology of the word itself and its various translations all closely link the dangerous disease to wetlands, swamps, and their unpleasant smell, rather than to the long unknown parasite or its carrier, the mosquito. The Latin origin *mal'aria*, a contraction of *mala aria*, refers to the swamps' "bad air"; the Dutch *moeraskoorts* and the German *Sumpffieber* both mean literally swamp fever; the French *paludisme* originates from the Latin *paludis*, swamp. Stagnant waters were commonly seen as unhealthy, but this bad reputation did not necessarily extend to flooding. As Rousseau had noticed, flood was not the enemy as long as water remained in motion: "although the Areuse [river] crossing the glen frequently overflows, making its banks a sort of marshland, it does not smell like marsh, the air is not humid or unhealthy, as the vivacity generated by its elevation prevents filthy fumes to last, and fog, frequents in the morning, generally disappear as the sun rises" (Rousseau, 1763).

Malaria became a growing concern in 18th and 19th centuries, since it became endemic in many coastal and alpine plains (Pautou et al., 1995: 37). The Rhine and Rhône Rivers and their alpine tributaries (Limmat, Reuss, Arve, Isère...) saw the disease expand, favored by frequent inundations and anthropogenic disruptions that created new habitats for mosquitoes to develop. Malaria was eventually incorporated within the disaster genre thanks to Ernest Hébert, a painter born in the French Alps, whose work "La Mal'aria" composed in Italy depicts an afflicted family escaping the infected area on a boat. The painting brought him his first big success in the Salon of 1850, and was shortly thereafter bought by the state to be exhibited in the Musée du Luxembourg (musee-orsay.fr).

La Mal'aria. Ernest Hébert, 1848-49 (Musée d'Orsay, Paris)

With the knowledge of their time, the promoters of diking and reclamation could quite rightfully stress the health benefits that could be attained with the eradication of wetlands, as the recrudescence of epidemics after big floods seemed to confirm the assumption that water and humidity were at the origin of the plague. Officials did not hesitate to directly blame wetlands and the smell of decomposing organic materials for the spreading of the disease, occasionally to support their own ambitions. "The emanation from these inundated or desiccated wetlands are contrary to the human race," boldly states French Engineer and Deputy M.-A. Puvis (Puvis, 1844: 183). In the French Dombes region, "Everything we know about all countries and everything we learned out of this investigation converges to prove the ponds' insalubrity," write Puvis in a technical treatise on the drainage of ponds. The origin and the remedy are thus easily found: "In the Dombes region, the ponds are the main and almost unique source of insalubrity, but it will disappear with all the swamps when we release the waters."

Upstream in Switzerland, the State Commission for the Rhône Correction concludes that malaria is spread by the "noxious action of miasmas originating from the Rhône inundations" – another argument in favor of a full diking of the river, which is praised by both state and federal authorities (Schenk, et al., 1863: 38). Besides the legitimate fight against malaria, stagnant waters are accused of even more evil, especially when drainage has to be actively promoted. An official report from the same Commission sees one more argument for the Confederation to fund the costly river correction: the fight against "cretinism," a case of mental and physical debility later attributed to iodine deficiency. The reporters argue that "the Valais has, as we know, a large numbers of cretins, and according to various experts, this sad impairment is directly related to the immediate effects of the Rhône's floods" (id.: 38), another argument in favor of the Correction. It appears, however, that not only do floods bring malaria but also the construction of flood defense itself. The correlation between diking works and malaria is made by local alpine populations, and is soon used as an additional argument by the supporters of drainage and warping techniques, such as Antoine Chiron, Architect of the City of Chambéry in Savoy. Chiron notes in 1844 that the population of the valley blames the new dikes for the regular epidemics of "fever," this quite rightfully as the canalization of the river hinders natural drainage, and the marshlands became permanent. He recommends using warping technique to heighten the valley floor, so that "with cleverly and patiently completed works, vast areas will be cultivated and the initial cause of fevers will disappear" (Lortet, 1846: 732). A recent analysis of the history of alpine rivers in relation to the development of malaria confirms a direct correlation between the construction of new dikes and the recrudescence of the disease: The civil works proposed by engineers to eradicate the disease appeared to be "simultaneously responsible for the expansion and the regression of malaria" (Pautou et al., 1995: 45). Channelization hinders the drainage of the surrounding plains, creating larger areas of stagnant waters. Warping basins offer new breeding grounds for mosquitoes, since they remain wet for several years. Furthermore, these great civil works put even more individuals at risk: Besides residents and farm workers, state employees, ditch diggers, and levee builders are also exposed, increasing the total amount of victims of the "fevers" – that historically include Grand-Duke Ferdinand III of Tuscany, involved in the drainage of the Maremma plains, and later Engineer Tulla, famous for the diking of the Rhine between Basel and Worms. Everywhere malaria was already present, diking works appeared to be the temporary ally of the disease by hindering natural run-off towards the new channel and making the full drainage of the valley a matter of public health.

From river space to border river

As fluctuating space, the floodplain long resisted enclosure and land monetization. Its boundaries were vague, changing according to climatic shifts, seasonal floods, and variations in the ground water table, which could rapidly turn a pasture into marshland. The river itself often failed to provide steady borders between communities, and conflicts emerged, when a stream would change its bed and redistribute the land among neighboring municipalities or countries.

In the fluctuating Rhine-Meuse Delta, floodings regularly blurred political borders and user rights. In 1560, a commission was designated to find back the Meuse riverbed, covered after the inundation of the Grote Waard in 1421 and eroded by 140 years of tides and river flow. The issue: finding the border between the belongings of the Prince of Orange, south of the Meuse, and the Count of Holland to the North, with all implications on navigation and fishery rights. Using prods to test the resistance of the sunken land, the surveyors tryed to locate the old riverbed, but could find only two third of its old course. The rest was arbitrary drawn on the map and materialized with markers - that were maliciously displaced by fishermen from one or the other country, and ultimately had to be anquored by sunken mill stones (van Wijk, 2012: 14-15).

In the medieval Alps, with the first attempts to resist the flow with a turcie or a barrière, there also came the protest of those who suffered from the counter-effects. It was first as a border between village communities that the Rhône became a source of conflict. The plain became the platform for continuous negotiation and arbitrages requested of the feudal and religious authorities, which also varied in the 14th and 15th centuries as the Rhône formed a disputed border. As the population grew and agriculture flourished in the floodplain, conflicts among users and commoners from different communities emerged frequently. Milestones and crosses of larch wood were used to indicate reference points and delimit the different pastures, but the placement (and displacement) of these milestones could become a source of conflict as well. The topographical description found in a 1409 arbitrage shows the difficulty of agreeing on the borders and the location of pastures in a fluctuating landscape that lacked fixed elements, a difficulty that the arbitrators sometimes tried to resolve by using the surrounding relief and villages as landmarks in their descriptions (Borgeat-Theler, 2011: 9).

Stabilizing the Rhône thus becomes a question of flood defense, border protection, and social peacemaking together, a question that intensified when the hydrological activity became more intense. Increasing variations in the Rhône, combined with growing populations, could only exacerbate competing interests. Various devices were used to stabilize the borders and the riverbanks already in the Middle Ages, such as "barrières" (levees made of branches, stones, and gravel), "groins," "arches" (chests), or "fourrage," a coating of stone and branches anchored with wood stakes sunk into the riverbank, a technique already known in Provence. However, these techniques often had the effect of pushing the stream in the opposite direction, causing fear and anger on the opposite side of the river.

Among these techniques, medieval arbitrages tried to differentiate offensive and defensive installations. Longitudinal levees were generally seen as defensive, whereas transversal structures were considered as offensive, since they pushed the river flow in the opposite direction, threatening the land of neighbors. Elements placed inside the riverbed were also seen as a threat, since they restricted flow in the high water season. The right to install defense structures was a disputed privilege: No community was allowed to intervene with the river course beyond its territorial borders – a double challenge, since these borders were not all that clear and stable, and since it was then already understood that flood defense issues went far beyond administrative borders. In a trial that began in 1489 in Valais, the community of Fully accused the people of Martigny of setting their wooden levees on fire, exposing their territory to dangerous floods, to which the witnesses who were heard for Martigny replied that the levees were illegitimately built on their territory, while claiming to be ignorant of who set them on fire. (Borgeat-Theler, 2011: 45). The underlying motivation seemed, however, to be the orientation of the Rhône waters: By building the "barrière," Fouilly redirected flood risks towards its neighbors from Martigny, who saw this as a direct threat (id.: 46-47). The verdict, more than an arbitrage between right and wrong, clearly tried to reach a balance between what should be protected and what should remain open to flooding in order to protect valuable areas, thereby showing a global understanding of the river's dynamic and the need for a large and dynamic approach in order to share the plain with a fluctuating river. It also presaged the first coordinated plans for the Rhône in this region, plans that were made in the mid-16th century by the Diet and aimed at coordinating the different structures built along and within the riverbed, until then built without an overall picture in mind. It is only with the map of the Rhône made in 1768 that the border between the Vaud and Valais Cantons was agreed, a map that also represented the width, within which the river should be kept. The actual diking was only considered in the 1836 convention signed by the two cantons (De Torrenté, 1964: 114), showing that the evolution of the border, the planning of the canalization, and the actual shifts of the riverbed were not simultaneous – the river obviously resisting the fixity and the permanence desired by the human administrations.

At the same period, in Prussia, "reclamation and settlement 'secured' the border – for how could you protect or even define a frontier that was under water half the year?" (Blackbourn, 2000). Reclamation works not only aimed at stabilizing international borders but also at reinforcing them through a pro-active policy of population supported by new agricultural production and settlements, a policy also applied in the Isère Valley, the Alpine border of the Kingdom of Piedmont Sardinia (Coeur, 2008). Not only did the river's fluctuation hinder the stability of local borders but transnational dissensions also hindered water management. The management of the Rhine River in particular was a source of conflict and discussions during the great reclamation era, since it formed a sensitive border between Switzerland, Liechtenstein, Austria, Germany, France, and the Netherlands. In 1861, the Swiss Confederation reported having trouble implementing the correction of the river in the St.-Gall Canton, since negotiations with their Austrian neighbor had not made any progress in more than 40 years (Dapples, et al., 1861: 666). The Commission subsequently recommended dividing the works in two segments: an upstream segment fully located on Swiss territory, and a downstream segment shared between the two countries. The Rhine Commission further suggested that Switzerland could start with the diking of the upstream segment, and noted maliciously that "one can even anticipate that these works will wake the Austrian Empire from its current apathy, as when the river would be narrowed upstream its waters would run even more violently into the [Austrian] Vorarlberg territory." The proposal, addressed to the Federal Council by the state commission, was at the least undiplomatic, since it suggested no less than the deliberate flooding of foreign territories to force the neighboring country into joint river management. "One cannot deny there is something specious to this proposal," admitted the commission, but "not being able to do as good as we wish we could, is no excuse for doing nothing at all" (id.: 667). Despite the Swiss threat, it would take another thirty years to arrive at a treaty settling the status and the shape of the Rhine between Switzerland and Austria (Attinger, 1930: 473) – the river being eventually shortened by ten kilometers, and the border left unchanged.

From common good to real estate

Unlike Flemish land expansion, the reclamations made in Holland during the Middle Ages were generally carried out by colonists, granted broad autonomy by the religious, aristocratic, or feudal powers. The pioneers owned their land, were involved in the reclamation and in the maintenance of the water system through dike service, and the water boards generally corresponded to a specific reclaimed area, giving them local knowledge and legitimacy; Dutch water boards to this day are allowed to raise taxes and are run by elected administrators. Religious or secular authorities could, in return, expand the population and increase the production of their jurisdictions, generating higher tax revenues. This fairly egalitarian distribution of new land remained specific, however, to the early reclamation period of the Dutch Low Lands, and could not be extended to the whole of Western Europe, where land, including wasteland, was generally not "new" nor free of ownership or rights of use.

Alluvial pastures, woodlands, marshes, and peat bogs long remained "waste" or commons useful to local populations, their unstable nature protecting them from enclosure and appropriation other than collective and informal. Their transformation into permanent and arable land radically changed their status, from open land used by all with few restriction, to defined and eventually enclosed domains owned by religious orders or feudal lords, and later by urban investors. The egalitarian distribution of reclaimed land and water-related duties known in the barren marshes of medieval Holland seems to have been the exception in Western Europe; uncultivated lands elsewhere were generally burdened with various rights of use and property, applying to hunting preserves but also to commons (Curtis, Campopiano, 2013), and remained the property of abbeys, aristocrats, or lords after their reclamation.

In medieval Switzerland, alluvial commons generally belonged to feudal lords, who granted their use to the local community in exchange for goods or labor days; the land remained open, offering free access and transit. Only in the 18th century and after were agrarian communities progressively deprived of their right to use wild areas, as restrictions were applied to free pasture in woods and forests, and fishing rights became more and more restricted and codified (Walter, 1990: 31). With the corrections and reclamation works, the reduction of riverbeds to dammed channels further reduced the area of commons and "vaines pâtures" available to local communities, while the nineteenth-century campaign against deforestation diminished their access to wood. The intensification of land exploitation increased global production but intrinsically tended to reinforce inequality between owners and users.

Flood defense and land-making became increasingly connected, as the knowledge and money needed for large diking and reclamation works generally exceeded the means of local communities, which were often hit by floods at the time diking appeared necessary. Royal authorities were commonly called upon for help in order to implement new flood-defense infrastructure, occasionally associated with third parties in order to (co-)finance and carry out construction of the levees, this, in exchange for ownership or exclusive use of the land taken from the river. Frequently private investors on their own approached governments to propose a dike-for-land deal. In England, a Dutch-French group led by Comelius Vermuyden is reported to have "contracted with the Crown to drain certain lands south of Thorne and in the parishes of Epworth, Crowle, etc., (...), receiving for their labour and expense one-third of the land so drained" (Creyke, 1845: 29). A similar offer was made for the French Isère river by Lesdiguières, Governor of Grenoble, who at the end of the 16th century proposed diking and straightening the river in exchange for the drained areas; the consequences of the straightening for the city downstream seemed too uncertain, however, and Grenoble declined the proposal of its governor. The same offer was repeated in 1670 by a descendant of Lesdiguières, the Duke of Sault, and was again declined for the same reason (Agard, 1942: 711 and Champion, 1862: 76).

With the development of capitalism, new forms of funding were called upon to fuel flood defense and reclamation, which then become two closely connected domains, since private investors naturally expected a return on their investments. For the correction of the Upper Rhine in the Canton of Graubünden, following the dramatic 1807 floods, the engineer Richard La Nicca presented a project to the council and recommended the creation of a joint-stock company to finance the works meant to create 575 hectares of arable land. The company was created in 1832, but could not complete the work, which ended up taking half a century. In 1851 the Canton had to take over, followed by the Confederation in 1871 (Attinger, 1930: 473). Along the Rhône in Valais, the creation of the Simplon railway line and the simultaneous First Rhône Correction also were too much for the investment capacities of local authorities, which had to offer, free of charge, the land that was necessary for both civil works (Bender, 2004: 65). Already, when the idea of a general correction of the Rhône emerged, Franz Bernard Wild, commissioner for the Confederation, in 1800 suggested creating a joint-stock company that could finance the operation. His idea was this: "The whole plain is expropriated; councils of experts estimate its value before and after execution of the works; owners who wish to keep their land are authorized to do so, provided they pay the company for the added value realized on this land" (De Torrenté, 1964: 43). This was a system similar to the "Aktiengesellschaft" that was created for the Linth reclamation (1807-1823). Later on, with no correction yet decided, municipalities received various proposals from private companies, eventually backed by local notables: "Mr. Junod, chemical engineer living in Monthey, in the name of a company that has undertook large agricultural works in Switzerland, (...) has offered to take care of the drainage and warping of the marshlands spreading on both sides of the Rhône from Riddes to Martigny," reads la Gazette in 1859 (La Gazette du Valais, 16, 1859: 1-2). The company, which remains unnamed in the article, offered to build all infrastructure necessary in order to transform the land into an "arable state" and pay a rent equal to 10 years of average profit in exchange for 22 years of enjoyment and the perennial property of 5% of the reclaimed land. The municipalities declined the offer but immediately commissioned a reclamation study (Bender, 2004). A year later, with the great 1860 flood, the canalization of the river became the first priority for local and federal authorities, and put an end to piecemeal diking. Eventually, Confederation, canton, and the private railway company joined forces in a public-private enterprise meant to bring about a national transportation system as well as local agricultural development.

Potential conflicts between the common good and private interests are most visible in England, where capitalistic enterprises early clashed with local rural societies, as the "British Agricultural Revolution," characterized by enclosure and reclamation works, often implied the sale and/or the expropriation of users of the commons and small landowners. These transformations in land use and property were legitimatized by the global rise of arable land and production. John Locke theorized about this new relationship to land and nature in his Second Treatise of Government.

In Locke's perspective, the value of land is proportional to the amount of goods that are actually gained from it and useful for humankind; property rights can thus directly be derived from the exploitative capacity of the one who claims ownership, as "he who appropriates land to himself by his labour, does not lessen, but increase the common stock of mankind (...). And therefore he that incloses land, and has a greater plenty of the conveniencies of life from ten acres, than he could have from an hundred left to nature, may truly be said to give ninety acres to mankind: for his labour now supplies him with provisions out of ten acres, which were but the product of an hundred lying in common." (Locke, 1690) For Locke, nature in the sense of unexploited environment, can be assimilated as "waste" in the literal English meaning (the unused land) and moral meaning (the worthless, disposable), and nature should be valued according to what it produces, thus making inaccessible and untouched nature worthless, and intensively cultivated land the most valuable and legitimate. "I have here rated the improved land very low, in making its product but as ten to one, when it is much nearer an hundred to one: for I ask, whether in the wild woods and uncultivated waste of America, left to nature, without any improvement, tillage or husbandry, a thousand acres yield the needy and wretched inhabitants as many conveniencies of life, as ten acres of equally fertile land do in Devonshire, where they are well cultivated?" (Locke, 1690: 5.37). This utilitarian vision translates into capitalistic terms the new relationship constructed between nature as resource and humankind as the only legitimate ruler and beneficiary.

Draining and warping techniques greatly supported the "valorization" of England, and participated in the historical Enclosure movement spreading from the 16th to the 19th centuries. The draining of the Fenland around the borders of Norfolk, Cambridgeshire, and especially in Lincolnshire, was only possible thanks to a collusion between royal authorities and wealthy investors-entrepreneurs mandated by the Crown. "This was carried out by enterprising individuals or 'improvers' generally under Royal mandate, who with the help of workers and ideas from the Low Countries drained marshy areas, using straight canals, ditches and embankments. The improved landscape which resulted replaced an economy based on exploitation of the marshland, with one based on arable and pastoral farming." (Smith, 2012: 18-19). However, the "progress" brought by the "improvers" was not always welcome, and "Opposition took both legal and illegal forms, involving petitions to Parliament and full-scale riots" (id.). The reclamation agreements made between the developers and the Crown generally included a payment in land, and implied the loss of large parts of the commons on the part of the local communities in return for a smaller area of reclaimed land. In 1845, Creyke relates how, a century earlier, Dutchman Cornelius Vermuyden "and a few Frenchmen," in return for their financial and technical investment in the drainage of about 30,000 hectares of wetlands in South Yorkshire, had received one third of the land. The Crown of England, which had to agree to the transaction, received another third, with the remaining land going to "the commoners of the district" (Creyke, 1945: 29-30). Creyke, who was himself a land developer and competitor of the Dutch reclaimers, maliciously stressed that the deal was not welcomed by the locals and led to numerous conflicts. "The Dutch seem, by numerous lawsuits, and by a *marked* dislike of the inhabitants to those *innovators*, to have been finally driven out of the country, and their property to have been taken from them (although there are many bearing Dutch names living in the neighborhood to this day)" (id., emphasis in the original). Whether reclamation can be seen as a global improvement or as "class robbery" (a term used by historian Thompson to define enclosure) remains controversial, as the positive aspects of land reclamation and cultivation, which allowed for economic and demographic growth, went together with drastic changes in agricultural practices and land distribution, and implied a radical transformation of the landscape.

Tame or set free: nature and the Enlightenment

Two main ontological attitudes towards the rivers coexisted after the Enlightenment: that of acceptance and contemplation towards a living element to be enjoyed in its primary and unspoiled state, and that of contempt for a chaotic and pointless phenomenon that only becomes meaningful through its transformation and exploitation, with the latter eventually winning over the former, as "[t]he prevailing agromania abhors idleness and spatial disorder" (Walter 1990: 30). Through the lens of productivism emerged a new definition of good and evil, opposing the useless and formless to the productive and formalized. Projects of bonification, correction, Rektifizierung, melioration, or assainissement were opposed to the *waste*, the *prés pourris* and the *miasmatic swamps*. They all implied promises of a better, safer, and wealthier future for all. The philosophers of the Enlightenment blessed the civilizing enterprise of the great monarchs: "From the side of my marshland, I bless you for all the marshes that you have reclaimed: together with my ploughmen, I bless you for the many ploughmen that you have set free from slavery and changed into men," writes Voltaire to Frederick II to celebrate the King's achievement in reclaiming the Oderbruch marshes (Voltaire, Frederick II, 1889: 8.11.1773).

The advocates of reclamation often denigrated the local and the informal celebrated by the poet. Where J.G. Tulla sees efficiency and progress, J.-J. Rousseau, one of the few defenders of pre-industrial waterscapes along with Theodor Fontane later, saw foremost homogenization of the landscape and cultural impoverishment in the drainage of the valleys. The Architect, this Janus studying the past and envisioning the future, was split between the apostles of progress and the poets of nostalgia. For Rousseau, marshes became a place of retreat from the tumult of urban life, and he criticizes the "draining of marshes as one of the destructive interventions in nature that threatened to obliterate physical distinctions in the face of the land" (Blackbourn, 2007: 71). Furthermore, none of these great technical achievements could be justified by the happiness these works failed to bring to humankind. "When we consider, on the one hand, the immense labours of mankind, the many sciences brought to perfection, the arts invented, the powers employed, the deeps filled up, the mountains levelled, the rocks shattered, the rivers made navigable, the tracts of land cleared, the lakes emptied, the marshes drained, the enormous structures erected on land, and the teeming vessels that cover the sea; and, on the other hand, estimate with ever so little thought, the real advantages that have accrued from all these works to [the happiness of] mankind, we cannot help being amazed at the vast disproportion there is between these things, and deploring the infatuation of man, which, to gratify his silly pride and vain self-admiration, induces him eagerly to pursue all the miseries he is capable of feeling, though beneficent nature had kindly placed them out of his way." (Rousseau, 1754: appendix).

More specifically, Rousseau considered the reclamation of marshlands, just like deforestation, as an impoverishment of the landscape that was being standardized for the sake of cultivation. This poor landscape led in turn to a cultural impoverishment for populations, which no longer needed to adjust to specific conditions but shared a standardized environment. "This is why the ancient distinctions of race, the effect of soil and climate, made a greater difference between nation and nation in respect of temperament, looks, manners, and character than can be distinguished in our own time, when the fickleness of Europe leaves no time for natural causes to work, when the forests are cut down and the marshes drained, when the earth is more generally, though less thoroughly, tilled, so that the same differences between country and country can no longer be detected even in purely physical features" (Rousseau: 1762).

Raphael Ritz, Correction du Rhône à Rarogne, 1888 (Musée d'Art, Sion)

Furthermore, the forces of nature, whether expressed in terms of human beings, other creatures, or the elements, should not to be constrained but set free. Flood in particular is to rivers what passion is to youth: Restrained, it breaks free and destroys; set free, it expands and pulls back naturally. This parallel was drawn by Rousseau during an epistolary controversy opposing him in 1763 to Christophe de Beaumont, Archbishop of Paris, who fiercely condemned the book Emile, or on Education as a dangerous attempt to confuse good and evil in young minds. Beaumont asked: "Left to itself, into what errors, what excesses would youth not throw itself? It is a torrent that overflows despite the powerful dikes built to contain it. What would happen, then, if no obstacle stopped its flow and broke its force?" (Rousseau, 1763). To which Rousseau answered: "Youth never goes astray on its own. (...) It is a torrent that overflows despite the powerful dikes built to contain it. What would happen, then, if no obstacle stopped its flow and broke its force? I could say: it is a torrent that topples your impotent dikes and breaks everything. Broaden its bed and allow it to run without obstacle. It will never do harm" (id.: 33). Although the dispute concerned education rather than hydrology, it reveals both the opposition and the similarity between Rousseau's vision of nature and the prevailing technicism. The flood was for Rousseau a temporary manifestation that should be accepted as such; for the engineer it was a flaw that had to be corrected. Nature should either be set free and correct itself, or strictly educated and "corrected"; in both perspectives, it was a child in regard to its human counterpart.

For the scientist and technician of the Enlightenment, man's destiny was indeed to rule over nature and adapt the world to his need rather than to adapt himself to specific conditions. For Buffon, nature's faith and reason was to be helpful to humans, and useless plants or animals could doubtless be disposed of. Fortunately, there was no region where "human power has not supported nature's power, by attracting or redirecting waters, or destroy useless grasses and harmful or superfluous vegetation, or by conciliating and multiplying useful animals" (Buffon,1778: sup. 5: 246). Exploiting and transforming Nature into a productive system was for the naturalist an act of civilization: "The first feature of man starting to civilized is the domination he exert over animals, & this first sign of intelligence later becomes the greatest feature of his power over Nature; for it is only after having submitted them that he, with their support, changed the face of the Earth" (id. 248). For Walckenaer, one of the first "polytechniciens" educated to transform revolutionary France into a modern country, humankind was a species chosen from among all beings, for "among the multitude of living creatures spread over the earth by nature's generous hand, it is to man it gave prominence. Everything announces his superiority and proclaims him master and dominator of the planet he inhabits" (Walckenaer, 1798: 3, 6). Echoing this new self-consciousness, rivers were increasingly "improved" and objectified in writings and in arrangements, drifting further away with the Catholic tradition that saw nature as a divine creation (Boersema, 2011). The descriptions made of the Rhine civil works conducted in Germany in the first half of the 19th century are representative of the new paradigm, as they mostly show contempt towards the river's former natural course – for Tulla "a twisted snake through the German Landscape" (Blackbourn, 2007). The vocabulary used for the canalization of the river is far from innocent: The "Rektifikation des Rheins" (Tulla, 1825) related both to its geometry – the "snake" loosing 75km of its original curves – as well as its morals; the twisted, unproductive, and dangerous river was turned into a channel made "right," suitable for navigation from Mannheim up to Basel – losing en passant about 80% of its riverine eco-system (Blackbourn, 2007: 71-111). Besides the global movement of "disenchantment" that was spreading over Europe, could this objectification also be explained by the abundance of water in North-West Europe? The utilitarian protestant vision emerged in the wet plains of the Rhine and Elbe basins, where agrarian economy was not so much dependant on retention and irrigation but rather on drainage and containment – a precious resource here and a nuisance there. In this perspective, the Alps form a transitional stage that combines both perceptions, since water is there both a treasure and an enemy, depending on the season, the inclination of the land, and the quality of the soil. This duality can be read between the lines in a notable article from the Confédéré newspaper, which asked the architects of the first Correction to consider using the Rhône waters for irrigation before collecting them in a giant drain. An anonymous letter published on the front-page pleaded for a general warping and irrigation plan of the plain, stating that "the Rhône could be to Valais what the Nile is in Egypt" instead of "throwing all the waters of our torrents into the Geneva Lake" (Le Confédéré du Valais, 28.02.1864: 1).

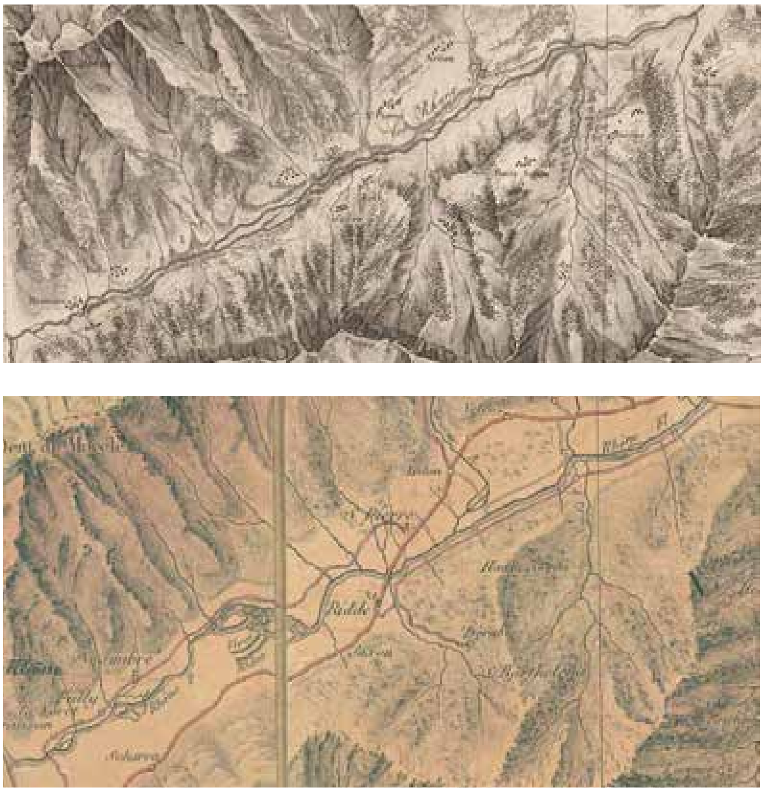
Rewriting history: the negation of pre-industrial economies and the apology of technology

For public authorities, landowners, engineers, or entrepreneurs promoting great reclamation works, it was crucial to convince local populations of the legitimacy of their enterprise and the radical landscape transformation it implied. The reclamation and subsequent privatization of large parts of the land thus needed to be understood as progress in terms of wealth and public health, before the work started but also retroactively. All arguments were welcome that could legitimize the enterprise and a fortiori prove it to be beneficial to all. The need to secure the land and protect the plain from disastrous floods was naturally emphasized as the first motivation for canalization rather than the profit expected from the operation. The eradication of diseases associated with wetlands was commonly used as well to promote drainage. Furthermore, the narratives developed to advocate these great enterprises often included a part of dramatization and frank optimism, which associated "unsubmersible" levees with absolute safety, drainage with productivity and health, on the one hand, and flood with disaster, and marshland with wasteland, on the other hand.

Since the winner gets to write history, few accounts are left of pre-correction river landscapes, whether textual or graphic, apart from the often-apocalyptic reports made by pro-correction engineers. The assumption that pre-correction floodplains intrinsically consisted of wetlands, and that only canalization and drainage could make them exploitable has a posteriori been proved partly wrong if not tendentious. Still it can be found until the current reports made for Third Correction: " Until the half of the nineteenth century, the Rhône valley looks like a vast swampy area, " write the authors of the first official synthesis report (HydroNat, 2000).

Yet commons and marshes hosted before the Rhône Correction an active economy reliant on the pasture of pigs, hunting, and fishing – and marshes were more than often than not hunting reserves for the nobility, some of whom opposed the reclamation works (Blackbourn, 2000). In the case of the Upper Rhône, the floodplain before correction was considered all but "waste." Medieval writings attest that the riverine space played a central role in the rural economy of alpine valleys. About the life of the inhabitants of the Upper-Rhône, historian Borgeat-Theler noted that "far from the stereotype of a swampy and unusable valley floor, far from the cliché of a frightening river one should avoid, their existence is punctuated by agro-pastoral practices that perfectly integrate the varied resources of the Rhône plain" (Borgeat-Theler, 2011: 7). The numerous conflicts that took place throughout the Middle Ages precisely reflect the importance of these resources for local populations. Medieval documentation sketches an image of the intense agricultural activity that took place in the plain already in the 15th century, with generalized pastoral and cultural practices indicating that the region was anything but an abandoned marsh. Areas that can produce grass are turned into pasture; straw and cereals are also produced, wood is cut from the riverbanks, while enough is left to stabilize the slopes. After a flood, inhabitants collected driftwood, sand, and stones, sometimes selling their findings to neighboring communities (id.: 10). Ancient documents sometimes name the plain between Sion and Martigny a "campagne" or "champagne," attesting to its open and fully exploited character (id.: 14, 16). Marshes were exploited as well, for pasture, forage, livestock bedding later used fertilizer, wicker, or for peat extraction.

Other than these declared practices, few general descriptions of the Valais are found before the mid-18th century, since scientists and tourists had eyes foremost for the spectacular mountains, waterfalls, and other "curiosités" (Bender, 2001: 88). The description made in 1800 by Franz S. Wild, federal commissioner in the Valais from 1798 until his death in 1802, evoked the opposite of a rich campagne: "Close to Naters, a large zone is totally devastated and occupied by the river during high waters season; downstream of the village, the land is marshy and produces bad hay. Between Brigue and Viège, the valley is very diverse; beneath the pleasant village of Glis are wide areas left marshy by laziness and inefficiency (...) In the summer, from Loèche to Sierre, the Rhône covers almost the whole plain, besides a few miserable coppices and a few Island of poor profit. From Sierre to Sion, the biggest part of the plain is barren, covered by stones and marshes. (...) From Sion to Saint-Pierre de Clages, the plain is absolutely marshy and belongs to the Rhône riverbed; from this last place, until the Branson bridge, almost the whole valley is flooded and the stream threatens to wash away more of the few areas that are protected by scarce and meaningless defence works" (Wild, 1800, quoted in Torrenté, 1964: 42-3). Wild's description can hardly be confirmed from historical maps, which were generally drawn for military purposes and were not too precise as to land use. The available maps from 1798 and 1820 tend, however, to confirm that the Rhône was more meandering at the time Wild described the valley, but none of these maps can attest to the general devastation he describes.



Upper Rhône between the Dranse and Borgne in 1798 and 1820

The objectivity of Wild's description can be doubted, not only because he omits to describe the parts of the valley that are profitably exploited but foremost because he is himself a passionate promoter of diking, promoting the correction of the Rhône by the Vaud and Valais Councils as well as in Bern, where he presented his "projet pour le diguement du Rhône" shortly after the Linth Korrection project was revealed in 1783. Wild considers taming the Upper Rhône to be a personal and sacred mission: "Which brave hearted man with the power to do so, would not try joyfully and with all his strength to withdraw the pitiable population of a large part of the Rhône Valley from the evil influence of the devastating river? Which friend of his fatherland and of humankind would refuse to contribute with all his heart to the let our fellow countrymen from Valais get a taste from the sweet fruits of fraternity after all the pain they endured?" (quoted in Le Confédéré, 13.09.1913: 1). Patriotic feelings, Christian charity, trust in progress and technology, Wild's vibrant appeal leaves no room for doubt; the correction is the best and only road to safety and prosperity, and the river, Valais' worst enemy, had to be channeled without delay.

The description of the valley made by Charles Lenthéric a century later in his monograph of the Rhône River expresses once again all the contempt of the nineteenth-century engineer for a stream unsuitable for navigation and unusable for industry: "In the long corridor of Valais (...), the Rhône is nothing more than a dangerous and violent torrent. Man can at best use it as driving force. But the region is essentially pastoral and not industrial at all. Everywhere meadows, woods, poor commons [vaine pâture]. Merely a few sawmills." Besides his contempt for the limited industrialization of the Canton, Lenthéric has no good word for the river itself: "Man nowhere feels the need to take possession of water; it overflows [metaphorically: elle abonde]. The river is an enemy more than a support" (Lentheric, 1892: 498-9).

In 1924, Walter Haenni again described a terrible pre-correction landscape before the audience of the third Rhône Congress, justifying the river correction retroactively. "The Rhône used to flow in countless meanders, causing terrible inundations and every year changing its bed," he writes, probably exaggerating the wilderness (and the freedom) of the river. But did the river change so radically between the late Middle Ages and the industrial Revolution? Most probably the European Little Ice Age did influence the regime of the Upper Rhône, as it did for the lower Rhône (Pichard, 1995) and for other alpine rivers (Girel, 2005). However, historian Evéquoz-Dayen notes that "the majority of publications dedicated to the Rhône upstream from Lake Geneva in the 19th and 20th centuries are marked by the negative perception that was used to convince of the necessity to correct the river" (Evéquoz-Dayen, 2009: 47). And indeed Haenni wants to celebrate the correction as a victory of the "Valaisan People that was able to tame the Rhône and keep it in its bed." (...) The horrific vision of past floods and chaos made place for an idyllic future: "Valais, thanks to the works we just described, is now protected from flooding and the plain is transformed into fertile gardens with a bright future" (Haenni, 1929: 43, 45).

A later retrospective depiction of the Rhône before diking is given by Charles de Torrenté in 1964, in his monograph dedicated to the Rhône Correction, and published by the Federal Department of Roads and Levees. Following Walckenaer's theory, De Torrenté sees the exploitation of natural resources as the destiny and the duty of humankind: "As the Rhône obeys immutable natural laws when he carries down his water and gravel and can contribute to this work only with his strength, it is up to man to use this energy in his best interests" (De Torrenté, 1964: 40). The dramatic description of the untamed Rhône made by F.S. Wild is for De Torrenté an indisputable reference: "To figure out the state of the Rhône before the correction, there is no better description than the one made in 1800 by M. Wild, director of the Salterns of Bex and Commissary for the Federal Government in a 'Proposal for the diking of the Rhône and its arrangement into a navigable river from its mouth in the Lake Geneva to upstream Brigue.'" To prevent any further doubt, De Torrenté adds: "The official mission of the author confers an indisputable veracity to this description" – an utterly doubtful statement as when Wild writes his own description, he also advocates his own correction project (see above), and does not seem to make use of various sources besides his own occasional observations. De Torrenté further enumerates the inundations that have been remembered by historical documents, mentions the conflicts between neighboring states over their fluctuating border, and describes the measures taken since the Middle Ages to stabilize the river before a global correction project emerged in the early 19th century. He, however, fully ignores the activities that for centuries had taken place in the floodplain before the correction, simply noting that "already [in 580] parts of the plain were cultivated." But "Man long remained very weak in front of the fieriness of the young Rhône," he notes, and this power play had finally been turned to man's advantage.

The pro and cons of containment

Despite regular floods and the prevailing pro-levee attitude of national authorities, the very principle of damming (alpine) rivers was occasionally doubted by a few experts already in the 18th century. Chevalier du Buat, a respected hydraulic engineer under Louis XVI, author of a treatise on "Principles of hydraulics verified by a large number of experiments made by order of the Government" (Du Buat, 1786), is one of them. Du Buat was asked to examine the damming project made in 1786-88 for the Isère river upstream from Grenoble, which included eighteen cuts in the river's course and the creation of a second river arm south of the city (Champion, 1858-64, 4: 77). His answer is an urgent warning against the channeling: "I would see myself as guilty of loosing this city if I would in any way seem to approve the straightening of the Isère river upstream

Grenoble (...) and the construction of levees supposed to contain its swollen waters" (Du Buat, 1789). "I thus absolutely believe that one should abandon the straightening, and make do with a widening of the former bed, without damming it, following the old meanders." He furthermore generally warned that one should address a whole river and not only isolated portions of it, and insisted on starting damming works from downstream – which would not be the case for the Isère, with disastrous consequences. In his treatise, Du Buat conceded that "there are several cases when nature seems to require the help of art, to moderate the course of rivers," but warns against overenthusiastic river diking, "as all excess is harmful, it could happen that through straightening a river excessively, this would cause accidents as damageable as the ones to be prevented; for the speed of the flow, accelerated by the increased slope, could excavate its own bed and erode its banks, which would cause various damages" (Du Buat, 1786, 2, notes: LXV, LXVI).

Circumspection if not frank opposition to river correction was not unusual in the 19th century, as the rural economy still greatly depended on the production of the floodplain (Pautou et al., 1995: 38). The results of completed river canalizations were being discussed among engineers, who had in mind the spectacular diking of the Po River "which, since his bed was narrowed between powerful levees, has raised so high that it now flows at the level of Ferrare's roofs" (Pigeon et al., 1845: 236). Permanent diking was not seen by all as the best and only response to flood risks, since it deprived the floodplain of valuable alluvium and made flood less frequent but potentially more damaging. Ignace Venetz, co-author of the Rhône Correction scheme, former Chief Engineer of Valais and inventor of a new warping technique, wrote in 1850 that "a weighty question is agitating flood-prone regions: That of knowing whether one should dike rivers and streams in the plain in order to prevent overflow even during high waters, or put no obstacle to this overflow" (Venetz, 1851: 1). He refers more particularly to the controversy generated in 1844 by a publication by Marc-Antoine Puvis: De l'endiguement des fleuves et des rivières (On river diking). Puvis, graduated from the prestigious École Polytechnique, was at the time a respected agronomist, Deputy, and President of the agriculture society of the French Department of Ain, close to Geneva. His work was also known outside France, translated into English (Puvis: 1836) and German (Puvis: 1847), and he was a correspondent for the agriculture societies of Turin and Geneva. In his essay, Puvis praised the fertilizing effect of seasonal floods, which for him largely made up for the their negative aspects, and denounced the longitudinal diking of rivers as "absolutely disastrous," for these dikes "tend to constantly raise riverbeds and leave pestilential wetlands behind" (in Venetz, 1851: 5). Puvis notes that he did not oppose levees in general, especially not those built to prevent erosion or secure the navigability of waterways, but he denounced levees "that aim at creating an artificial bed for the river's high waters, and deny them the basin that they themselves defined as an additional riverbed, especially for theses high waters" (id.: 2). He directly opposed the diking scheme made for the Saône River and indirectly criticized the general movement of river channelization that had spread across Europe, becoming an early supporter of mitigation strategies and "soft engineering" over strict and fixed correction schemes. Leaning from his own experience, he tried to generalize a hydro-dynamic model applicable to all rivers in all segments: Streams collect sediments from mountains, deforestation increases their volume, diking keeps the sediments inside the main bed, leading to its constantly rising above the surrounding land, portending more dramatic floods.

Published in a time of systematic canalization, including the Saône River in his own Département, Puvis' pamphlet generated vehement reactions. The Société Royale d'Agriculture de Lyon published a fierce letter from chief-engineer Laval, who was in charge of the correction of the Saône River, and a report of a review commission composed of no less than five members of the society. In a tone that leaves few doubts about his feelings, Laval first acknowledges "the author's excellent intentions" and agrees on his general considerations, to further denounce Puvis' arguments against the diking of the Saône, which he considers misleading and based on fantasy calculations when it comes to its effect on water levels. Laval remarks that when the river threatens to flood the land during summer, inhabitants build improvised dikes on the riverbanks, which are naturally heightened by the river's deposits. "The levees I propose are thus, so to speak, just the regularization of a system already adopted by the inhabitants" (Laval, 1845: 225). He then refuted each argument brought by Puvis against his project: Pavus' calculations are wrong and the planned submersible dikes would still allow the fertilizing winter floods to overflow onto the fields; erosion during flooding would be avoided by letting the water flow from downstream into compartments; openings in the dike could also let alluvium in, if the dike blocks them out; drainage ditches should finally make sure that no swamp was left behind after the flood. In conclusion, Laval deplored the effects of Puvis' essay on local opinion: "It is unfortunate that his conviction was based on an exclusive system, or on incorrect observation, as if it had been better informed of the facts, his text could have been of powerful support to the measures demanded by three Départements bordered by this river, instead of spreading suspicion and discouragement among the local population most concerned by their implementation."

The review commission was more nuanced in its comments but ultimately supported Laval's scheme. After a brief summary, the reviewers refuted Puvis' assumption that diking leads to the rising of riverbeds, "a rare phenomenon only seen close to the estuaries" (Pigeon et al., 1845: 236). The constant threat formed by raised riverbeds such as the Pô could be averted by "a tireless vigilance and well directed efforts," the commission argued. Wetlands left behind the levees constructed were similar to those naturally generated by riverbanks raised by spontaneous deposits, and could be improved by warping techniques. Spontaneous floods were often welcomed for their fertilizing virtues but might also cover rich fields with a bed of gravel, ruin a harvest when occurring at the wrong season, or change the riverbed, making permanent land use impossible: In these cases, the authors would favor non-submersible levees. Confident that the range of technique available could compensate for the downsides of diking, the commission supported Laval's project and believed in its success – if "the construction [of the dikes] is conscientious," if "the repair work is done timely," if the warping and drainage works are sufficiently funded and if the locks are used "with intelligence and coordination" – a combination that would rarely be achieved.

The proceedings of the special session held to discuss Puvis' book and its review especially reveal the lack of global and dynamic vision that then hindered a full understanding of the river. Various arguments were exchanged, which above all showed the difficulty of drawing general conclusions from fragmentary information. The total volume of carried sediments might increase with deforestation and channeling, but the straightening of rivers actually speeds up the streams and accelerates erosion, some answered. Puvis himself, in his attempt to defend floodplains and rivers against full channeling, failed to find a universal hydrological model that could apply to all rivers. But, despite his errors, what makes Puvis' text visionary is his description of an irresistible chain of decisions, events, and reactions that inevitably lead to full and permanent diking: "One will start with a combined system of submersible dikes, but will soon be forced to raise them, seeing the fields badly preserved and loosing their fertility; waters filtrating through the locks will rust the hay and spoil the harvest; these locks will be removed and one will make the dikes unsubmersible, then raise them again as the riverbed will rise continuously, like in Italy or on the Rhône River" (Puvis: 1844: 36). Although Puvis' theory of sediment transport indeed proved to be too general and wrong in many situations, his scenario came true in the long term for most European rivers: Building barriers to isolate rivers from their natural floodplain and protect the plain from seasonal damage only led to greater exposure and to the construction of ever stronger barriers. His message was lost, however, in the collective fear of floods and faith in technological infallibility.

Ten years later, the French central government, obviously a supporter of its own engineers, did not always appear so univocal, especially after inundations washed away the levees that had just been heightened or repaired. In a public letter to his Minister for Public Works, Emperor Napoleon III appeared very critical of the levee systems pretending to prevent all floods and that ultimately lead to more damage, as seen along the Loire and the Rhône in a series of major inundations (Bonaparte, 1856). However, four years later, the same Louis-Napoléon Bonaparte encouraged the reclamation, land clearing, and irrigation of the French plains in a letter to his State Minister Achille Fould. In what appears to be a declaration of economic policy based on free trade and massive public investment, fuelled by the "considerable amount of money" left unused at the end of the Italian campaign, he wrote: "Concerning agriculture, it should benefit from the credit institutions: clear forest located in the plains and reforest the mountains, dedicate each year considerable sums to great works of reclamation [déssèchement], irrigation and forest clearance. These works, turning uncultivated commons into cultivated land, would enrich municipalities without impoverishing the State, which will recover its advances by selling part of these land returned to agriculture" (Bonaparte, 1860: 46). The Journal de l'Agriculture Pratique, one of the many that published the letter, reacted enthusiastically to the Emperor's program: "The cities will no longer be the only ones to benefit from great public works, life will flow through the countryside. France's destiny shall be fulfilled."

Sion et la vallée du Rhône

After the Correction

"I am honor bound that in France rivers like revolution shall return to their beds and rise no more." (Discours de S. M. Napoléon III à l'ouverture de la session législative, le 17 février 1857)

Correcting the correction: illusion of progress and never-ending adjustment

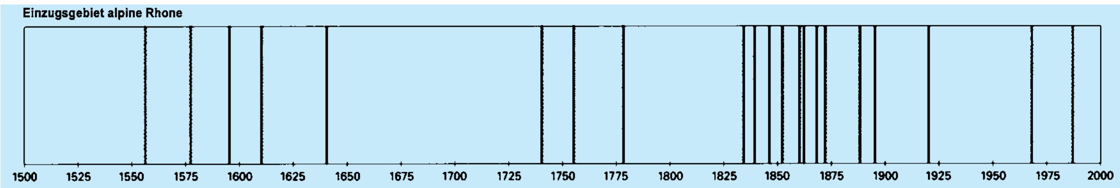
Commenting on the optimism and the self-confidence of reclamation defenders, David Blackbourn remarks that "the reality was that (taking the Oderbruch once again as an example) none of these supposedly definitive solutions (...) was able to prevent floods that were now a threat to the work-cycle rather than a part of it" (Blackbourn, 2000). This statement could be extended to just about all reclamation works and river canalizations, which did not all succeed or fail, but all led to an endless chain of adjustments and further land transformations that were generally neither announced nor foreseen.

One of the most resounding failures is with no doubt the attempt on the part of the Swiss Federation to divert the Kander river in the Berner Oberland region in 1713-14. In order to protect the Allmend (commons) of Thun from regular flooding, a tunnel was dug to divert the waters of the waterfall towards the Lake Thun. The tunnel collapsed soon after completion; instead of regulating the river's discharge, the diversion led most of the river flow into the lake, rapidly raising its level. The road to Spitz was closed, the city of Thun was flooded several times, and it would take decades and massive defense works to protect the city and the lake area against the irreversible consequences of this failed attempt to correct nature (Walter, 1990: 34).

Opposite page: The Rhône valley after the correction.
Sion et la vallée du Rhône depuis le Sud-Ouest. (Postcard, detail, date unknown, collection of the author)

Plan for a diversion tunnel between the Kander River to the Lake Thun,
Samuel Bodmer, 1710, detail (OFEG, 2003)

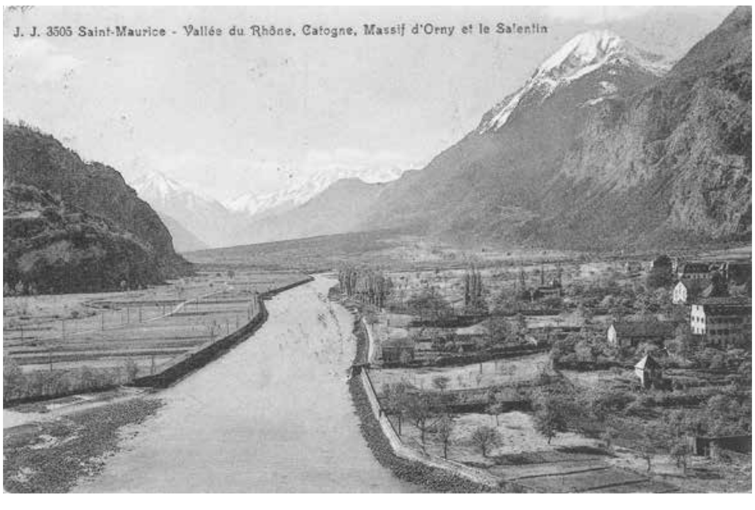
Even for those correction works that seemed to go as planned, not all their goals were achieved nor all consequences foreseen. A posteriori, it appeared that the global surface of wetlands did not necessary diminish after the channelization of the river, as tributaries had trouble finding their way towards the "corrected" river, which would lead locally to rising ground water, growing marshes, and sometimes to increased flooding along these tributaries and behind the dikes. The correction of the Linth, envisioned by German engineer Tulla and completed by Swiss geologist Hans Konrad Escher, did not improve production at the expected rate, and "in fact, to achieve this objective, several additional projects of land drainage had to be carried out, the last of which was not completed until 1964" (Speich, 2002: 434). The inhabitants of the Isère Valley in Savoy, and those of the Rhône Valley in Switzerland, locally saw marshland expand and malaria spread during and after the diking works meant to achieve the opposite result (Staüble, 2009: 172-174 and Puvis, 1845). Around the Jura lakes, the productivity of meadows decreased after the first correction, completed in 1891, and drainage caused the land to sink rapidly, more than a meter in some places (Walter, 1990: 73). Retrospectively there is nothing surprising in these unforeseen consequences, considering the scale and complexity of these enterprises and the limited knowledge and modeling possibilities available at the time. More intriguing are the promises of eradicating flood risks and fluctuations that could never and would nowhere be made true, since the assumption that a landscape and a hydrological system could be stabilized, if not petrified, later proved to be totally wrong.



A high frequency of extreme flooding in the Rhône basin before and after the river correction
(Summermatter, 2006)

Officially, the canalization of rivers was still celebrated, however, as a triumph of man's technology over nature's needless fluctuations, the achievement of a whole people and its engineers such as Hans Konrad Escher who became a "Swiss national hero who achieved national unity through a concrete task" (Speich, 2002: 434). Historian David Blackbourn notes, however, that the "great illusion of the 'improvers' was the belief that they had found a once-and-for-all technical solution" (Blackbourn, 2007: 74). Despite the progress of cartography and civil engineering techniques, engineers still lacked the knowledge of hydrodynamics and hydro-morphology that could help them predict the long-term and large-scale consequences of their interventions. In their enthusiasm and faith in the superiority of man's rationality vis-à-vis nature's purposelessness, engineers often failed to predict these consequences and soon new symptoms arose. Often, the canalization of an isolated segment exposed the downstream regions to greater and faster floods. The concentration of deposits in a narrowed profile led to the rise of the river, silting its own bed above the surrounding land, making every dike breach even more devastating. Catching materials upstream in weirs, dams, or retention lakes led downstream to accelerated erosion and, eventually, to the sinking of the riverbed, and the subsequent weakening of the levees. So, each wetland reclamation and river correction rapidly created the problems that would lead to the next correction, a correction of a correction, initiating the spiral of technical intervention feared by Puvis. However, despite the dramatic shortcomings of systematic channeling, the legitimacy of the engineering as such has, until recently, seldom been questioned. "How people reacted to these reverses has changed over the 250 years. But for most of that time it was the specific remedies that changed, not the underlying assumptions" (Blackbourn, 2007: 68). For despite the successive adaptations and corrections, the belief that a battle between rivers and technology was going on, and that technology would eventually triumph, could still be found until just recently.

In 1929, Swiss Engineer Haenni was still praising the First Rhône correction, quoting an anonymous expert: "The success of the (Rhône) Correction is resounding and the speciality of the system has proved itself." Although he went on to acknowledge the multiple negative consequences of the river's channeling and shortening, that simply "demonstrated that the Rhône Correction had to be completed with the Correction of the (tributary) streams" (Haenni, 1929: 41-42). Thirty-nine years later, on the French side of Mont Blanc, the local newspaper Dauphiné Libéré used similar words to praise the opening of a new straight channel cutting off a three kilometer-long meander of the Isère River, as another final victory over the river's wilderness character: "There was a time when the Isère would go its own way and be a headache for the agglomeration of Grenoble. Today the hand of man dictates the way, and she surrenders" (Dauphiné Libéré, 1968). Despite the successive cycle of disasters and corrections (that to a large extent still goes on today), the belief that a holy battle between rivers and technology was going on, and that technology would eventually triumph, could still be found until just recently.



Canalized Rhône in Saint-Maurice, Valais (1922)

1968: opening of a by-pass in the course of the Isère River
(Dauphiné Libéré, 02.02.1968)

Water, the most malleable of all elements, allows man to measure his power against the creator's. "God created Valais, but the Valaisans made it inhabitable by creating the aqueducts [bisses] that carry the sacred waters," states Professor Schöter from the Société Valaisanne des Sciences Naturelles (quoted in Haenni, 1929: 42). The name "Third Correction," recently chosen to designate the program currently applied to the Rhône river in Swiss Valais ironically enough, stresses that not only Nature's oeuvre but also man's work needs correction, since this new enterprise also involves not only a correction of nature but also a correction of the two previous corrections. The term also shows the difficulty of breaking with centuries of technological triumphalism, despite the adaptive and integrated character of the new project.

A perspective brought to a paroxysm by the Dutch with the often heard saying "God created Earth but the Dutch created Holland," regularly used by Dutch landscape architects to promote and export their collective skills. The world-famous Delta Works completed in Holland in the 1980s and sanctified as one of the "seven wonders of the modern world" by the American Society of Engineers, fit in the tradition of massive infrastructures meant to provide a final answer to flood risk but rapidly criticized for their lack of flexibility and their underestimated side effects. Yet this Promethean vision of flood defense, still widely supported by contemporary media, is today in contradiction with a growing uncertainty about future hydrological conditions, which should inspire flexible and cautious interventions rather than heroic infrastructures.

Environmental groups and the engineered landscape

As mentioned above, river correction projects were in their time criticized on technical grounds and for aesthetic reasons: They could fail to achieve their goals, and they turned diverse and fluctuating environments into fixed and uniform landscapes. The environmental aspect, however, did not seem to play a significant role in the discussion until recent times. In Switzerland, the first example of a collective consciousness of destruction of nature was provided by the fight against deforestation, begun in the mid-19th century. The erosion, the increased run-off, landslides, and plain flooding were then identified as the direct consequences of the deforestation of the rivers' catchment areas. But the strong mobilization that followed in Switzerland as well as in France with the Restauration des Terrains de Montagnes above all indicated a well understood self-interest: The massive reforestation campaigns were not begun in order to restore natural habitats but primarily to prevent flooding, the most feared hazard in the Alps, and to secure wood production in fear of the exhaustion of a crucial resource (Walter, 1990: 67, 77).

The Heimatschutz and Naturschutz movements later emerged in Switzerland as political forces in the first decade of the 20th century, almost simultaneously with the German Bund Heimatschutz, the French Société pour la protection des Paysages, and the British National Trust for Places of Historic Interest or Natural Beauty (Walter, 1990: 115). The nature these movements defended was, however, still fundamentally different from contemporary concepts and also differed among countries, as each nation tried to define and differentiate its singular identity. History, archaeology, and geography became political sciences, often manipulated to build or confirm national myths, and bind the populations around a reconstructed common past, generating a new interest for the history of the Frisian "werd" in Holland or for the Alpine lacustrine settlements.

At a time of rapid urbanization, the Swiss Federation paradoxically defined its own identity around the alpine pastoral figure, through an image of cultivation and humanization of a beautiful but fundamentally inhospitable landscape (id.: 72). Two main categories of nature remained: iconographic and utilitarian nature. On the one hand, the nature man should protect and venerate, the pristine and the overwhelming, only accessible by alpine heroes (and later cable cars), emerged. On the other, there was the nature humans were collectively entitled to tame and transform, ameliorate and exploit for their own survival, displaying their genius and technical skills through the excavation of tunnels, the damming of rivers and the reclamation of wetlands – each dike breach or devastating avalanche being a lost battle in the long war against the wild.

In these turbulent times, the Heimatschutz fought to protect that first concept of nature from the zeal of the conquerors, since the picturesque Swiss landscape should be spared the trivialization imposed by new infrastructures (a criticism already made by Rousseau a century earlier) and commerce (with the development of road advertising), engaging in a definition of what should be considered as valuable. This perspective led naturally to the sacredization of identifiable and spectacular landscape features, such as waterfalls, glaciers, peaks and rocks. The first successful campaign of the Heimatschutz movement came with the preservation of an erratic block in Monthey in 1905, which was saved from splitting and sale as construction material after a fierce campaign (Walter, 1990: 120). Eventually, authorities at all levels joined forces to buy the erratic rock: Federation, municipality, and the canton of Valais, the same canton that in 1907 "in the name of God Almighty!" engraved the funding of the Rhône and river corrections in its new constitution, still valid today (State of Valais, 8.03.1907). Erratic blocks and erratic rivers obviously belonged in two opposite categories. Not picturesque enough in its liquid form, and not suitable for navigation, the Rhône fell between the gaps of emerging cultural concepts, and long remained an insignificant element in the Valaisan landscape.

Corrected river and railway running parallel through
an ideal pastoral landscape (Hugo d'Alési,
poster for the Chemins de Fer Jura-Simplon, 1895)

The interwar period constitutes a particular period in the cultural history of landscape. The sacredization of national items was stronger than ever, but the objectification of nature was simultaneously being reinforced by economic depression. In 1914-18, European countries underwent the painful experience that, just as globalization could accelerate things, it could also rapidly crumble, returning countries to their former isolation, making food and energetic autonomy a central item in national policies. In Germany and Switzerland, various initiatives called for an "interior colonization," which included the planning, the definition, and the expansion of arable lands (Walter 1990: 155-159), and which in the Alps could mostly be made at the cost of remaining wetlands and floodplains.

In this political context, patriotism justified damming and reclamation, and opposing productivism came close to homeland treason, advocating dependency and surrender instead of securing national autonomy – an argument still heard today in the discourse of the movements opposing the widening of the Rhône. The ideals concerning nature of environmentalists and ago-productivists occasionally joined to oppose hydroelectric dam projects, accused of destroying precious farmland and disfiguring the alpine pastoral landscape for the sake of the foreign energy market. However, this particular case aside, the transformation of almost all Swiss rivers and the subsequent quasi-disappearance of wetlands has long remained barely mentioned by conservationists, as well as the diking, dredging, and the extraction of river materials that fueled a century of urban sprawl.

Not all Western European countries obviously shared the Swiss representation of river, wetlands, and nature in general. The sacredization of landscape features above landscape structures and the objectification of productive nature, however, was commonplace throughout the 19th and 20th centuries. Everywhere protection movements have not only concentrated on mounts, mountains, and cliffs but also on coasts and islands, for instance, with the case of the Wadden Islands in the Netherlands and Germany, or the coast of Normandy in France (Corbin, 1990). Plains and valleys, in contrast, comprise domestic space, where safety and functionality prevail over cultural and esthetic value.

The rehabilitation of the river shore and floodplain

The revaluation of rivers and floodplains at the end of the twentieth century seems, furthermore, to be concomitant with urban sprawl and the progressive disappearance of large open spaces and natural fluctuations within metropolitan areas. Digging their way through frozen urban landscapes, insignificant rivers become again particular and potential environments of ecological value, visual enjoyment, recreation, and identity-building. The case of the Isar River in Munich is illustrative of this late evolution, as the river's status evolved from water machine to ecological corridor in the late 1970s and early 1980s, while environmental concerns also grow in the state's capital. Not yet a public space, the Isar became acknowledged as a key space for the city's environmental quality and quality of life, a movement that generated the first discussions about the potential redevelopment of the engineered floodplain into a space of nature and recreation, a project that would be only achieved in the first decade of the 21st century, along with the transformation of numerous European river banks.

Paradoxically, it is thus in cities that environmental groups first advocated renaturation, often to be disillusioned by the difficulty in restoring free flow in an urban environment. New conflicts surfaced at the end of the 20th century, as flood defense infrastructure is increasingly opposed as destructive, and renaturation ambitions stumble over the intrinsic variability of river landscapes and the risk this implies for vital urban infrastructures. Against the faith in absolute safety by technical know-how, "[t]he opposite snare of the green-minded is the belief in a one-and-for-all state of nature." (Blackbourn, 2007: 74) Between contradictory demands of secure flood defense and "free" streams, new ambitions of balanced and integrated flood policy arise that change again the perspective onto riverine landscape and natural risks.


Meerstad
Room for the River
Noordwaard
Overdiepsepolder
Isar Plan
Third Rhône Correction
Sion-
sur-Rhône
Isère Amont

II. New European floodscapes

"Uncertainty is ineradicable, and there is every reason to see it not as a limitation but to approach it positively as a challenging fact that is inherent to social action". D. Sijmons. (Hajer, Maarten, et al.: 37)

The title of this dissertation could be seen as a "contradiction in terms": Flood spreads wherever gravity leads it, covering the familiar topography with a dark, gray, and uniform blanket. In that regard, flood is amorphous, as it can distort and temporarily erase forms and features from the visible landscape – nothing that could be described as a "scape" in a sense of articulated and meaningful scenery. But when the boundaries of a flood are not just defined by the quantity or the velocity of water but also by land forms and structures carefully designed and placed to influence and shape the "disaster," the result can be considered as a flood-defined landscape, physically and culturally defined.

As seen in the first part, flood risks have long been present in landscape architecture, not only as a threat but also as agents of creation, as forces that could be shaped, diverted, captured, used, filtered, or spread. Still to a large extent, today's Western European landscapes materialize the implementation of the "modern" dream, modernity here being understood as the subordination and the organization of natural elements and forces into a permanently productive state, a state benefiting humans or at the very least harmless. To reach permanence and safety, most European waters have been constrained and kept within constructed borders, conceived as establishing a stable optimum condition between known fluctuation and maximized land use. In this process, most Western European streams and estuaries have been turned into sterile and petrified waterways.

As the myth of absolute protection fades away, contemporary river design tends more and more to facilitate and control inundation instead of excluding it, and, in this way, has reintroduced flooding as an agent of territorial structuring and perception. Among the projects investigated, two rural areas, "Noordwaard" and "Overdiepse Polder" in the Netherlands, have been partially transformed into floodable areas, and shaped in order to widen the riverbeds and lower the water

Opposite page: location of the investigated projects in the Western Alps and the Dutch Deltas.

level, when it becomes a threat for neighboring cities, all while still guaranteeing the safety of inhabitants and livestock. The Meerstad project merges urban extension and creation of a 600-hectare retention lake into one combined development. The project Isère Amont in the French Alps creates a ribbon of controlled flood fields along the river, which gives it an extra 3000 hectares to expand into, in case of extreme high water. The canalized Isar River in Munich has been transformed by removing a large part of the straight embankment and restoring the accessibility of its floodplain to the population of the city, while improving its functionality in case of high water. And, finally, the Third Correction of the Rhône River in the Swiss Canton of Valais is preparing a reconfiguration and an enlargement of 160 km of the canalized river in order to reduce flood risks and improve the river's social and environmental value.

In all these projects, water dynamics have become an element of design instead of a problem to solve, echoing the words of landscape architect Jandirk Hoekstra about the future of the Dutch Delta: "The overall solution for the Southwestern Delta lies in the step-by-step restoration of the conditions for dynamics (...) and continuity (...): a transition from fixing the Delta to floating on the dynamics of the Delta." (Bax et al. 2012)

All six projects no longer rely only on vertical solutions (dams, levees, pumps) to address flood risks but rather on horizontal solutions (widening, deviation, temporary storage). This approach is not totally new: Restoration of floodplains and integrated water management were already discussed before. As the Emperor Napoleon the Third noted in the letter on flood prevention he addressed in 1856 to his Minister, there is "nothing easier then erecting civil works that temporarily protect cities like Lyon, Valence, Avignon, Tarascon, Orléans, Blois, and Tours from such floods. But as for the global system needed in the future to keep our rich valleys crossed by these great rivers safe from such curses, that is still missing and that we need to find promptly." This open critique of traditional flood protection eventually led to an early "room for the river" program: the Comoy Plan presented in 1867 that restored overflow areas along the Loire to protect cities from high waters.

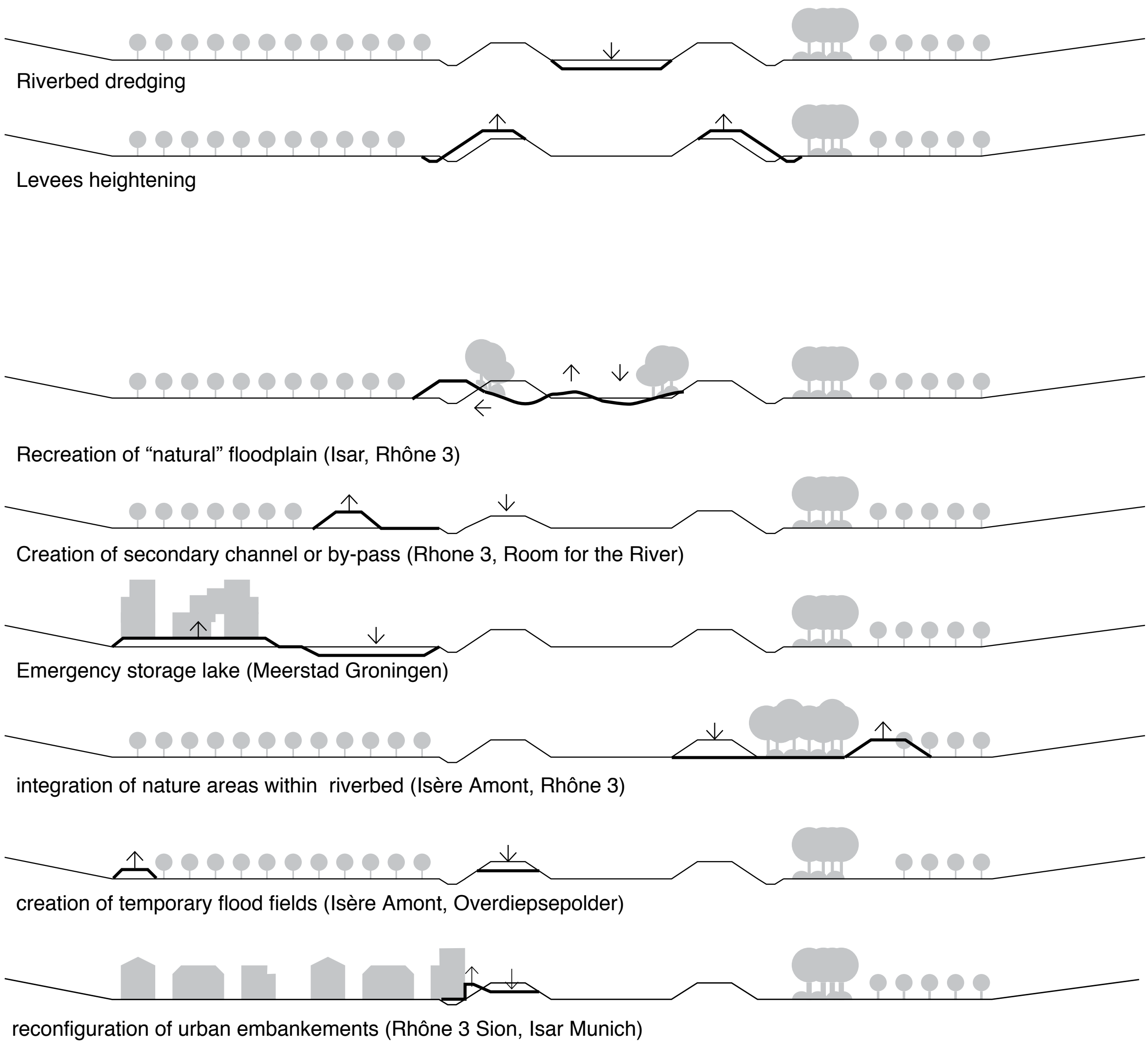
The Loire remains today a rare example of such strategy being implemented on a grand scale and still inspires contemporary design, including the visionary "Stork Plan" that prefigured the Dutch "Space for the River" program. Some of the principles applied today for this program are indeed, for Holland, "a rediscovery of time-honed practices that deserve the 'traditional' label even more than dike all new." (Warner et al., 2013) However, integrated water management only became the norm at the turn of the twenty-first century and is nowadays central to big-scale river projects. For Michel Pinhas, chairman of the Isère Water Board, who actively participated in the Isère Amont river project and who is a supporter of integrated water management, this is a synonym for good management rather then a new concept: "Integrated means we tried to bring in more parameters then just the Isère River and 3 meters on each side, [but also] the morpho-dynamic, economic, functional, security aspects, the mid- and long-term evolution, the maintenance, etc. (...) It sounds obvious, but numerous colossal projects are conceived contrary to all common sense and go off course after fifteen years; these are bad projects. Good projects are necessarily integrated" (Pinhas, 2013).

What is new, however, is the fact that these projects bring natural fluctuation back into areas that have been petrified by centuries of civil construction oriented towards rigid infrastructures – very far from integrated management and flexible river space. Creating spaces for temporary flood within urbanized regions once again creates the opportunity for the urban population to experience the reality of natural processes – provided these spaces are designed to actually be visible and accessible. Within an urbanization process based on drainage and containment of water dynamics, contemporary answers to inundation threats reintroduce physicality and positivism, and open up perspectives for integrated living environments, combining technology with a renewed perception of natural phenomena.

Title (Country)	river	planning studies/ construction	main goals	main measures
PROGRAMS				
Third Rhône Correction (CH)	Rhône	1995-2008 2006-2030/ 2050	flood safety restoration / consolidation of ecological, social and economc functions of the river	widening of of river segments and confluences reinforcement levees dredging of riverbed creation of emergency flood corridor creation of recreational routes
Room for the River (NL)	Rhine and Meuse branches	2000-2006 2007-2016	making space for river increase spatial quality	dike relocation flood bypasses lowering floodplain green rivers lowering of groynes removal of obstacles reinforcement levees dredging of riverbed
PROJECTS				
Sion-sur-Rhône (CH)	Rhône	2011-... (unknown)	increase flood safety urban renewal public space developement	reinforcement of levees dredging riverbed creation of new park & promenade building of urban riverfront
Isar Plan (DE)	Isar	1998-2006 2006-2010	increase flood safety development recreational uses ecological restoration	reinforcement of levees softening of river embankements restructuration of floodplain
Isère Amont (FR)	Isère	2004-2009 2012-2016	lower river level at high discharge ecological restoration development recreational uses	reinforcement of levees local widening river channel creation of emergency flood fields creation of recreational routes
Ontpoldering Noordwaard (NL)	Waal and Merwede	2003-2011 2012-2016	lower river level at high discharge increase spatial quality ecological restoration development recreational uses	high-water diversion channel lowering of levees for emergency flood mitigation creation of wetland creation of recreational routes farms displaced onto elevated mounds
Overdiepse Polder (NL)	Bergsche Maas	2000-2010 2010-2015	lower river level at high discharge increase spatial quality	lowering of levees for emergency flood mitigation farms displaced onto elevated mounds
Meerstad Groningen (NL)	Eemskanaal	2002-2011 2006-(...)	urban extension nature developmement creation of water storage capacity for flood situations	creation of lake for recreation and water retention housing development creation of new nature areas creation of recreational routes

Case studies overview

At the end of the twentieth century, the large floods seen in Western Europe (1993 and 1998 in the Netherlands, 2000 in Switzerland, 2005 and 2013 in Central Germany, 2013 in Southwest France, 2014 in England...); Combined with the increasing threat posed by climate change, this flood series eventually challenges the capacity of engineering knowledge to tame natural fluctuations and to keep rivers within the beds defined by traditional, coercive infrastructures. Horizontal approaches irresistibly emerged in several countries and in various geographical contexts in order to replace or supplement traditional flood defense.



Typology of interventions found in the case studies: Conventional vertical interventions and horizontal adaptive measures

River widening has become a more common approach, as well as the design of areas dedicated to emergency flooding, possibly combined with other land use. In a post-modern and post-environmentalist era, the faith in final technological solutions to natural hazards and the myths of a permanent harmony with natural forces have lost ground: Landscape architecture today faces the challenge of reintegrating uncertainty into carefully designed living environments, in a perspective that includes possible short and dramatic events (floods, storms, landslide), as well as slow but potentially distressful processes (rise of sea level, salinization, increasing amplitude of river discharge, decrease of winter ice storage, drought). From this perspective, the physical, aesthetic and philosophical definition of a "healthy landscape" should today be reconsidered in a systematic way, in addition to those questions of how to adapt the living environment so as to reach such a flexible and dynamic state, and how to make these qualities last and still remain adaptable to change.

The six river transformations investigated in this second part take an active stance in the integration of flood dynamics into landscape design, in various ways and for various purposes. After three hundred years of a relentless battle against natural dynamics, they clearly announce a re-balancing in goals and strategies; their combinatory character also suggests a new attitude towards risk that dares to integrate flood management with the various structures and processes that shape our complex living environments. Through the investigation of six contemporary projects where "space for flood" is a central theme, the topics of framing, spatiality, and ethics/aesthetics appear to be crucial conditions for their development.

Framing

Even before projects are envisioned and drawn, ambitions, means, goals, and role distribution are set to compose a specific framework, that greatly defines the design to come, its development, and its morphology. The base of this framework can be interpreted through the notion of (de-) synchronization: Each project is an attempt to address processes that take place on various timescales (seasonal, political, generational, geological), and more than any other, riverine landscapes call for time-based, dynamic, and far-reaching approaches. The current uncertainty about the speed and the effects of climate change not only calls for rapid interventions but also for "no-regrets" decisions that leave space for future adaptation. Each project further evolves within a specific time frame that seems more defined by financial means and cultural specificities than by objective knowledge – equivalent climatological knowledge being found across all Western European countries.

The role distribution among the various disciplines varies greatly: Although hydraulic engineers direct most projects, landscape architects play a leading role as well (Isar, Meerstad), and inhabitants sometimes define the final choice (Overdiepse Polder). On the institutional side, the quantity of commissioners also influences the project's complexity and therefore the chances to arrive at a successful completion vis-à-vis the ambitions of the schedule. Although flood protection – the core of all projects – can generally count on public support, motivated as it is by the seriousness of the threat, this in no way implies an absence of debate or immediate consensus on the chosen strategy and its application. In many cases, design functions not only as a propositional tool but also as a negotiation platform, showing variable degrees of flexibility and precision.

Spatialization

Next to framing, spatialization appears as the second field where projects evolve and find their legitimation. It is in space that the most fundamental changes take place. Floodscapes affect land use (maintained or adapted, mono-functional or combinatory) and accessibility (restored for the Isar floodplain, hindered in Noordwaard); they affect the morphology of landscapes, and thereby the ethics and aesthetics of their inhabitants (see the fierce opposition between proponents of renaturation and defenders of agricultural landscapes); finally, the permanence of these landscapes evolves, since adaptive strategies intrinsically involve extended transformability in order to create resilience.

The combination of land use, morphology, and transformability eventually define the capacity of the "Room for the River" projects to create "room for landscape" and ultimately "room for people" – whose presence in floodplains, whether used as farmland, nature reserves, or hydraulic channels, is all but self-evident. Binding the local populations to "their" riverine landscapes – through participatory design, shared used, or simply public openness, however, offers the best perspective for successful and lasting transformations.

Ethics and Aesthetics

As engineering peaked, Environmentalism arose as a counterforce, encouraging a policy of landscape restoration that returned to a state of pre-cultivation. Renaturation works, implemented along numerous rivers, have, however, only partially resolved the lack of flexibility of engineered structures ("renatured" rivers are not by definition wider or safer for their environment) and have often failed the populations that believed in the illusions of a friendly, inhabitable state of nature that could be restored even within the borders of a city turned "limitless." The story of the Isar River in Munich, from channeling to renaturation, illustrates the new beliefs – and the new myths – that accompany the transformation of streams, as currently conducted.

Climate change expectations and narratives

"Nothing seems more difficult, or even impossible, than to resist the Earth cooling and to warm up a climate; and still Man can do it and did it."
(Buffon, 1779, 5. Septième et dernière Époque*: 240)*

A young idea for an old process

A major threat for coastal cities, for global food and water supply, and a key item in global politics, climate change has focused worldwide attention since the 1990s. Most news magazines have since then devoted a cover to the issue – "Die klima-Katastrophe," announces the German Spiegel in 1986, while the American magazine Time warns of "The big dry" already in 1988. But how new and how unique is the current phenomenon? Only since the nineteenth century has climate's changing nature been known as a fact, and it is now known as well that humankind has survived several episodes of glaciation and warming. But still, in relation to the climatic time scale, this knowledge is relatively new, and it remains difficult for today's societies to relate to a threat that seems at the same time near and yet abstract.

Consciousness of a geological time scale is not totally absent from pre-modern history, albeit mentioned only incidentally. Until the first glaciation hypothesis was made in the early nineteenth century, the Flood remained in Europe the main and most discussed episode in the field of climatology. Where it happened, which creatures survived it, how it changed the world: Arguments were exchanged over the centuries, discussed in sacred and profane terms, involving philosophy, theology, and geography in an endless quest for answers and meaning. In ancient Mesopotamian, Greek, Hebrew, or Christian traditions, the Flood remained, however, a short single episode, however destructive or widespread. Only in the twentieth century would archaeologists and geologists suggest that the ancient Flood tale could be a reminiscence of some slow climatic transition characterized by several floods at large. In this perspective, the Flood tale could be seen as a window on the Earth's geological history, a first contact between human consciousness and geological times, long before climate was measured, registered, or fully understood.

Before the development of climatology, the presence of fossilized seashells in mountainous areas already suggested that the Earth's climate and morphology was not all that fixed and stable. Already in the sixth century BCE, Xenophanes suggests that their presence attests that vast parts of the Earth had been submerged by the sea. Xenophanes is credited by Hippolytus "with a theory of alternating periods of world-wide flood and drought that was inspired, at least in part, by the discovery of fossilized remains of sea creatures at inland locations" (Lesher, 2014). The hypothesis is transmitted by various Pre-Socratic thinkers who tried to envision the hydrological mechanism that could explain such findings – with Anaximender and Diogenes of Apollonia suggesting that the Earth's waters were gradually sinking and disappearing, while others such as Herodotus believed that sea levels fluctuated whenever one sea would communicate with another (Duhem, 1913, 9: 247) – a hypothesis partly similar to those that today link the biblical Flood to great marine transgressions in the seas of the Near East and the Caucasian region, which would have taken place during de-glaciation episodes around the eighth millennium BCE (see part 1).

In the fourth century BCE Aristotle, however, refuted the theory of a flood of geological amplitude. In Aristotle's Meteorology, Deucalion's flood is downplayed to a local event rather than a global disaster of divine origin similar to the flood known from the Mesopotamian tale of Atrahasis, from the Hebraic Genesis, or as later found in Ovid's Metamorphoses. Aristotle states that large hydrological transformations related by humans are in reality merely local phenomena. He further suggests that the Earth undergoes constant changes, but at such a slow pace that they barely affect human life and are overshadowed by wars, epidemics, or famines. "But the whole vital process of the earth takes place so gradually and in periods of time which are so immense compared with the length of our life, that these changes are not observed, and before their course can be recorded from beginning to end whole nations perish and are destroyed" (Aristotle, Meteorology, 2.14). To illustrate the Earth's variability, Aristotle cites Egypt, which "has evidently gradually come into existence and been produced by the river" and Libya, which is "strangely enough, lower and hollower than the land to the seaward of it," and which thus must have once been covered with water.

Envisioning fluctuating continuity rather than linear evolution, Aristotle describes natural conditions as permanently changing, and permanently re-balancing: "The same parts of the earth are not always moist or dry, but they change according as rivers come into existence and dry up. And so the relation of land to sea changes too and a place does not always remain land or sea throughout all time, but where there was dry land there comes to be sea, and where there is now sea, there one day comes to be dry land" (id.). He thus suggests a dual reading of the Earth's history, consisting of a perceptible history, made up of dramatic and abrupt events, and a hidden history, made up of mighty but gradual processes, which cannot be observed but only known by reasoning, based on the signs they leave behind. History according to Aristotle is intrinsically asynchronous: The Earth's history and human history follow their own pace and partition, and neither humans nor nations are capable of relating to this parallel history. "In the same way a nation must be supposed to lose account of the time when it first settled in a land that was changing from a marshy and watery state and becoming dry. Here, too, the change is gradual and lasts a long time and men do not remember who came first, or when, or what the land was like when they came." Without noticing, humankind adapts to varying conditions, countries grow rich and mighty on rich land, and later decay when the same land dries up; poor communities flourish in their turn, as their land slowly turns fertile and hospitable.

Furthermore, while human history involves development and destruction, the Earth's history is for Aristotle fundamentally cyclical, and no phenomenon can be observed that is not compensated by its opposite. There is thus no reason to fear the end of the world, "since there is necessarily some change in the whole world, but not in the way of coming into existence or perishing (for the universe is permanent)." In the light of contemporary knowledge on geological history, Aristotle's theory might sound outdated: Today's societies are in a state of figuring out their own origins and reconstructing the formation of their habitats, if not yet the full history of the planet. Still with the limited knowledge of his time, Aristotle raises two existential questions that remain unresolved in today's context: the human (in)capacity to relate simultaneously to its lifetime and to geological times, and the (dis)belief as to the world's origin and end.

Aristotle's successor Theophrastus also studied climatic phenomena and refered to what could be a manifestation of climate variability – without, however, drawing further hypotheses nor conclusions. In his treaty "On winds," Theophrastus reports the case of elevated regions of Crete that used to be cultivated and populated and were later abandoned as a consequence of a general cooling: "If, then, it is true (as some and particularly the dwellers in Crete say) that the winters are more severe, and more snow falls than formerly – (as proof of which they allege that formerly the hills were inhabited and produced both corn and fruit, the land having been planted and cultivated for that purpose; that there are in fact on the hills of the Ida range and on others, plateaus of considerable extent of which now-a-days they cultivate not one, because they are unproductive; while formerly as has been said they not only cultivated them, but also dwelt upon them so that the Island had a large population; and that at that time showers occurred, but much snow and storm did not) – if, I repeat, this is true which they allege, it follows that the monsoon also has greater duration [now than formerly]" (Theophrastus, 1894 ed.: 26). This story – whose veracity is not established by Theophrastus – remains merely an anecdote in the treatise, and an uncertain and unremarked trace of climate variability.

For centuries, only the presence of seashells on land suggested that the Earth had seen various stages, with this intriguing phenomenon being for centuries explained by a past planetary flood – although the idea that fossils grew in place was also common place, since it better explained the fact that shells are found not just on the surface but also inside the rock. Ovid summaried the common belief: "what once was solid earth changed into sea, and lands created out of what once was ocean. Seashells lie far away from ocean's waves, and ancient anchors have been found on mountain tops" (Ovid, Metamorphoses, XV).

It is only in the late Middle Ages that the oldest observed and documented climate change begins: the Little Ice Age, currently considered as lasting from the end of the thirteenth century to the mid-nineteenth century, with a high point reached during the fourteenth century (Holzhauser et al., 1999: 223-4). The 2002 report of the IPCC questions its planetary importance, describing it as "a modest cooling of the Northern Hemisphere during this period of less than 1° Celsius," which however had locally significant effects, bringing, among other things, "unusually cold, dry winters in central Europe" (Folland et al., 135). During this period, an increased variability and extreme weather events put European communities and organization under stress (Behringer, 2010: 85-86).

Even though the Little Ice Age was only identified in the 1930s, its effects were widely noted and documented by its contemporaries. Around the North Sea, in Germany, and in France down to Marseilles, canals and rivers remained frozen in the winter, inspiring the famous images of icy landscapes left by Averkamp and Brueghel the Younger in the seventeenth century and Van Hove in the eighteenth. Borders are challenged both by the sea and by the rivers, resulting in major transformations such as the drowning of the Biesbosch between Holland and Brabant, and the drowning of the Dollard region between Frisia and Saxony (Meyer, 2010: 16). The newly colonized Greenland had to be abandoned again by its Scandinavian settlers. Alpine populations saw glaciers irresistibly grow and expand, as attested by written documents dating from the beginning of the sixteenth century.

These glaciers sometimes obstructed valleys and created new glacial lakes, which could suddenly empty and flood entire valleys. Such outbursts were attested in the Swiss Valais region already from the late sixthteenth century, and lasted until the nineteenth century (Holzhauser et al., 1999: 226), when Ignace Venetz tried to release the waters captured by a dam of ice that eventually flooded the Val de Bagnes in 1818, killing 44 inhabitants.

The Gietro glacier and the remains of the glacial lake
that flooded the Val de Bagnes,
H. C. Escher, 1818 (ETH Zürich, Graphische Sammlung)

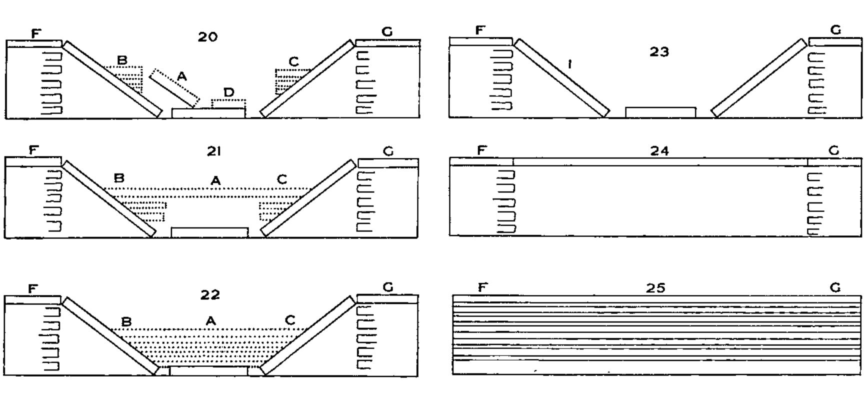
In the Christian Middle Ages, the debates around floods, late frosts, and poor harvests however long focuses on finding in them a moral explanation – God's punishment or witches' curses – rather than on understanding of their physical origins. The Earth's permanence is still not questioned in the long term, and seashell fossils found on high land are still interpreted as a proof of the biblical Flood, a thesis defended by, among others, the Catholic monk Restoro d'Arezzo (Duhem, 1958: 281), basing himself on Aristotle's Meteorology. Any measurement of the climate that would make a long-term perspective possible was still lacking. Furthermore, investigating the origins and the transformation of the Earth could quickly lead to questioning Genesis itself, a dangerous exercise until the Renaissance, even though the "Little Ice Age" offered a living example of climate variability.

With the Enlightenment new perspectives emerged concerning the Earth's history. Along with scientific emancipation from the Christian canon, geology becomes a full-fledged discipline, and the formation and evolution of the planet received attention from various scientists. In the 17th century, geographers dared to question the hypothesis of a flood covering the whole planet. Scholar and geographer Bernhardus Varenius shared his doubts about belief in the Great Flood: "But to that question, whether there may be a Deluge that shall cover the whole, even the very Islands: we answer the way how such a thing may happen, may be conceived and explained, yet can scarce ever happen, the Earth being to compactly joined and the Mountains too high" (Varenius, 1650, 1734 ed., 2: 416). Nicholas Steno was the first to envision the process of stratification and the formation of mountains – still without questioning the biblical account of the creation. Putting "Scripture" and "Nature" in dialogue, he argued that "Nature proves that unevenness was great, while Scripture makes mention of mountains at the time of the flood. But when those mountains, of which Scripture in this connection makes mention, were formed, whether they were identical to the mountains of the present days, whether at the beginning of the Deluge there was the same depths of valleys as there is to-day, or whether new strata opened new chasm to lower the surface of the rising waters, neither Scripture nor Nature declares" (Steno, 1669: 264-65). Steno succeeded in creating a new perspective on the planet's history and morphology, one which was no longer reduced to a dramatic founding episode but instead was the result of mighty geological movements attested to by the visible stratification of mountains. Whether due to incoherency or diplomacy, Steno, who converted to Catholicism when he published his "Prodromus" in Florence, accepted however the birth date of the Earth as proposed by Archbishop Usher, that is, 4004 BCE.

In the eighteenth century, Buffon furthered emancipation from the religious canon, by stating that the Earth had to be older than the Great Flood, and "the times when continents split and even the times when barriers broke that separated the ocean from the Black Sea, seem much older than the deluges remembered by men." These floods are thus products of a "particular cause" such as an earthquake. Even the "deluge of Armenia and Egypt, which tradition was kept by Egyptians and Hebrews, (...) is still very recent compared to the events we evoke, as one counts only four thousand years since this first deluge" (Buffon, 1778: V, 203). In a few sentences, Buffon freed geology from belief: All antique floods should be seen as temporary inundations that have not changed the face of the Earth (id.).

The biblical Flood should furthermore be considered as a miracle: Scientists should not look for explanations for the Earth's history there, for "Earth was before the Deluge just about as it is today; and this enormous quantity of water thrown down by divine Justice to punish guilty man, indeed killed all creatures, but did not bring any change to the Earth's surface, it did not even destroy plants, as the dove brought back a branch of olive tree. Why then imagine, just as most of our Naturalists do, that this water totally changed the surface of the globe from one or a thousand feet in depth?" (id.: I, 200)

Despite this new freedom, the biblical Flood story still hindered the development of climatology, since water was still seen by most as the main agent of the Earth's formation, a belief that can be found again in George Cuvier's Catastrophism in the early nineteenth century, which considered local floods to be the main factors for biological evolution and migrations. It is around this period, however, that the hypothesis surfaced that not water but ice transported rocks and sediments over vast distances and shaped the Earth's surface, thus attesting to past ice ages and thereby climatic variability. A climatic event that took place in 1816 is actually at the origin of this discovery: Five years after the "year without summer" that had raised fear of a climate cooling, the Swiss Society of Natural Sciences rewarded an essay written by Ignace Venetz entitled "Mémoire sur les Variations de la température dans les Alpes de la Suisse."

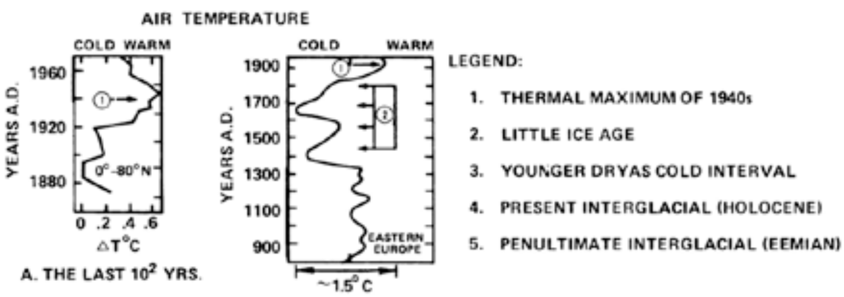


Steno, Prodromus, plate XI showing "in what way we infer the six distinct aspects of Tuscany from its present appearance" (from Steno, 1734)

The year 1816 had seen an abnormal cold spread over the Northern hemisphere, an episode then unexplained and later found to be related to the eruption of Mount Tambora in the Dutch Indies, today's Indonesia (Oppenheimer, 2003). Two years of famine followed the eruption in Western Europe and Switzerland, as the unusual cold dramatically slowed down the vegetation growth, slashed the harvest, and damaged most of the grapes – with winemakers being advised to add sugar to the must and to heat their cellars (see, i.a., Gazette de Lausanne, Oct. 29, 1816, and the Nouvelliste Vaudois, Nov. 4, 1825, for local reports in Western Switzerland). Investigating these disturbing events, Venetz tried to relate known climatic indicators, such as the cultivation of wine, the evolution of pasture, or the practicability of alpine routes, to the movements of glaciers made visible by geomorphological features and recorded in historical documentation. He concluded from his observations that glaciers had undergone gigantic variations in size and had transformed the topography of the Alps, therefore revealing major changes in the Earth's climate, some of which were "lost in the distant past." "We do not doubt the fact that several epochs existed when climate was much colder than it is today; we do not doubt either that in other [epochs] the climate was significantly warmer, and that temperature rises and decreases periodically."

About the cooling seen in the recent years, a worrying phenomenon for the Alpine state, Venetz writes comfortingly that "glaciers will hardly reach the gigantic heights that left so many traces, and we can put our minds at rest about the presumed extension of icy regions in general" (Venetz, 1821: 38). With this essay, Venetz and a few others opened the way for the study of climate history, and created space for future climate change hypotheses.

More than a hundred and fifty years after the "year without a summer" that triggered Ignace Venetz's discoveries, an episode of climate angst occurred again in the 1960s, with a temperature decrease observed after the mid 1940s. Considering the last warm period as abnormally long, several scientists saw in this cool decades the dawn of a new glaciation, urging humankind to prepare for the end of the Holocene (Beringher, 2010: 186-188). Human factors were also analyzed to explain what seemed to be a dangerous and rapid evolution, but the cooling and warming effects of atmospheric pollution appeared difficult to balance. Despite the fact that a minority of scientists supported the global cooling hypothesis (Peterson et al., 2008), various radical plans were made to counterbalance the threat: altering oceanic streams by closing the Bering strait or bombing undersea mountains, covering ice caps or melting them with hydrogen bombs in order to reduce sunlight reflection, and still wilder dreams of geo-engineering (Beringher, 2010: 189), which fortunately were not put into practice. Yet developing climate studies then allowed for the realization "that climate could change on time scales with the potential for significant effects on human societies, and that human activities could trigger such changes." (Peterson et al., 2008)



The "thermal maximum of the 1940s" and the fears of global cooling:
A colder future seen from 1974
(From Report of the Ad Hoc Panel on the Present Interglacial,
Interdepartmental Committee for Atmospheric Sciences)

Man as master of climate

A positive consequence of this second wave of climatological awareness was the creation of a Global Environment Monitoring System by the United Nations, following upon the recommendations of the UN conference on the Human Environment held in 1972 in Stockholm. In the US, a Subcommittee on Climate Change was created in 1974 "in order to assess the problem and to determine what concerted action ought to be undertaken" (Morton, quoted in Reeves, ,2004), followed by a successful effort to establish global cooperation on the subject. The report published in 1977 by the US National Research Council cautiously asks: "How long the current worldwide cooling trend will continue is now the subject of much speculation" (64), already acknowledging that "it appears unlikely that man can inject such large amounts of such an important component as carbon dioxide into the atmosphere without inducing some sort of environmental change," (Benton et al.,1977: 14) an assumption that will be comforted in the following decades.

The year 1988 saw the first World Climate Conference in Toronto send a clear warning on the warming effects of CO2 and other greenhouse gases, and, in the same year, the International Panel on Climate Change (IPCC) was created in Geneva, commissioned to coordinate climate research and issue a global report every five years, with the first report being issued in 1990. The 2007, IPCC reports confirmed again the dominant role of an anthropogenic influence in global warming, observing a CO2 level of 359 ppm, the highest know level in 650,000 years, without however establishing a full correlation between CO2 and global temperatures (Beringher, 2010: 198).

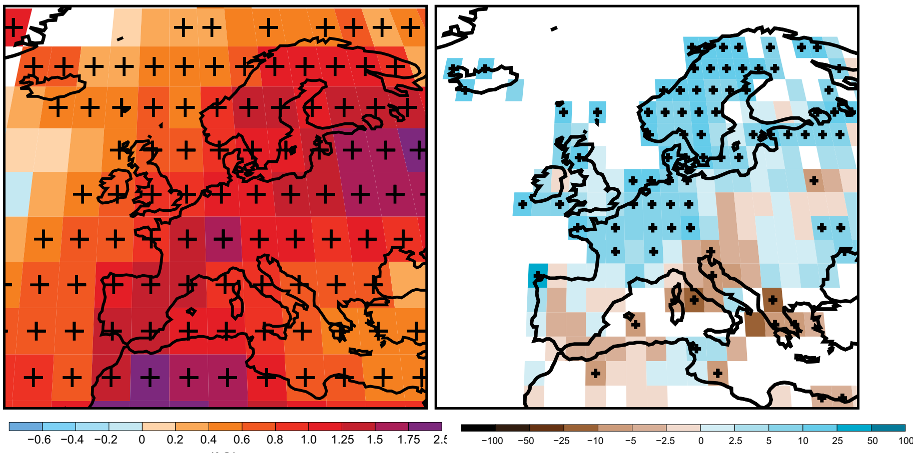
Anthropogenic influence on climate variation was not a totally new idea either. Already in the seventeenth century, Buffon added human factors to natural causes that could influence surface temperatures. He mentioned the then dominant climate cooling hypothesis, which he considered as correct but contradicted by a competing process: regional warming caused by human influence. Buffon arrived at a strikingly visionary statement, 200 years before the first IPCC report: "Nothing seems more difficult, if not impossible, than to oppose the gradual cooling of the Earth and warm up a climate; however, man can do it and did it." (Buffon, 1778: sup. 5, 240). However basing himself on fanciful reasoning, he drew his conclusion from the observation that two cities located at the same latitude, namely Paris and Montreal, showed a difference in temperature proportional to their difference in population: more people, Buffon concluded, generated more heat. Looking for an explanation for this correlation, Buffon more especially related climate warming to human activity as opposed to a vegetation cooling effect: "Drain, clear and populate a country, is giving it warmth for several thousands of years" (id.), since humans and animals produced heat but vegetation only "cold humidity." With striking accuracy, Buffon imagines the powerful effects of human activity upon climate, and the difficulty to control this power. It is singular, he notices, that it is easier for humans to heat the Earth up than to cool it down, "for the principle of cold is not even a real substance but the an absence, or rather a diminution of heat" (id.: 244), "and it is much easier to clear a forest in Guyana than plant one in Arabia to refresh arid sands." Buffon, however, does not lament climate warming nor does he plead for a form of conservation: In this perspective, humankind is bound to explore and exploit nature, and its power over the climate, although so far used unintentionally, should be exercised as well to make nature even more productive and hospitable.

Buffon's optimism, typical of the Enlightenment, has disappeared, however, from today's concerns, as the speed and implications of global warming become better known and quantified from year to year. Since the creation of the IPCC, climate change has remained a global issue for scientists, governments, and citizens. From the flow of climate data gathered and interpreted for the first time on a worldwide scale, various hypotheses can now be made by the IPCC and by each country to anticipate future climate change and its effect on human life. For the first time, humankind as a whole now has a global and dynamic picture of the planet's climate and sea-level evolution – but only precisely since the first continuous records were made, which represents a rather short period when seen in climatic terms. Yet for the 1901-2000 period, the Fifth IPCC Report showed a significant temperature increase in the whole of Europe, with a clear increase in precipitation in Northwestern Europe and a decrease around the Mediterranean basin.

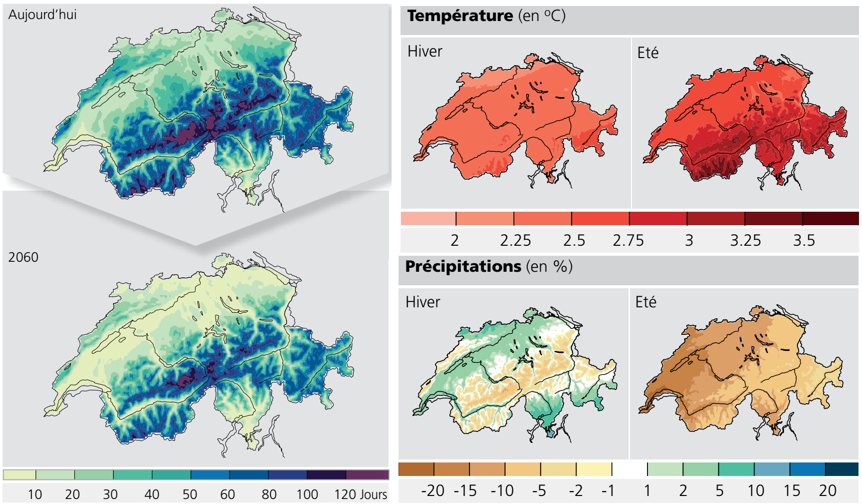
Temperatures in Switzerland are now expected to rise between 0.5 to 3.6 degrees Celsius in 2060, possibly much more than the global world expectation (1 to 2 degrees in 2060). More frequent heat waves and heavy rain episodes are expected. The Alpine region (corresponding approximately to Valais, Berner Oberland, Uri, Glarus, and Graubünden) should see their temperatures rise even more than the national average. Precipitation is expected to be stable or slightly lower in the summer, but to undergo a drastic diminution in snow days, with a decrease of about 30 days per year (Meteosuisse, Rapport technique n° 243, 2014). With less snow stored in upper altitudes, along with earlier and rapid snow melt, more frequent torrential rains, and longer hot periods, Alpine rivers should also be under stress, and their regime should evolve significantly in the coming century.

The Fifth IPCC Report has compiled records that forecast a global average sea rise of 15 centimeters in the twentieth century, accelerating from the 1990s onward, a global value comparable to what was measured at the North Sea coast by the Dutch Royal Meteorological Institute (KNMI, 2014). In its 2014 report, the KNMI drew various climate scenarios, forecasting a sea level rise of 20 to 90 centimeters in 2100, as well as an increase in extreme precipitation in summer and winter. Both aspects, sea levels and precipitation, would exert growing pressure on the country's water networks and flood defense system, at sea, river, and ground level.

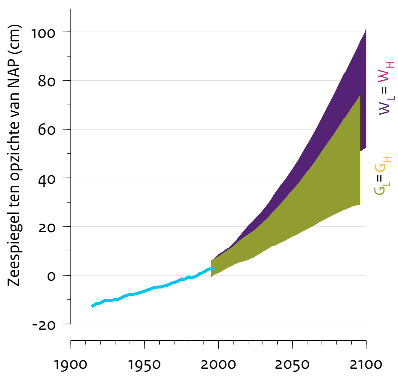
According to the KNMI, sea level by 2300 could well be fifty centimeters to several meters higher than it is today, a worrying scenario for a population living for the most part below the current sea level, but also alarming for all European coastal and estuarine regions that anticipate increasing flood risks. This forecast is made difficult, however, because of the uncertain future of CO2 atmospheric levels, since no international agreement on emissions reduction has so far been successfully implemented. These regions are today forced to "navigate by sight," since future scenarios beyond half a century diverge too much to provide any solid ground for long-term investment. Tendencies are known, however, and they everywhere suggest that a wider margin for fluctuation will be needed in order to withstand increasing variations in water levels and more frequent extremes in heat and rainfall.

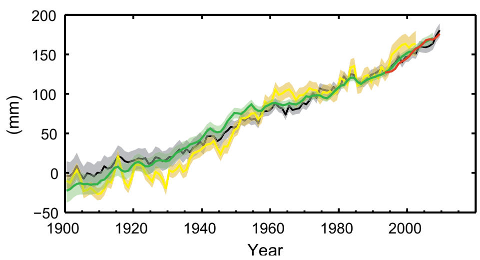


1901-2010: a warmer and wetter Northwestern Europe. Observed change in temperature and annual precipitation (5th IPPC Report, 2013, Summary, p.6, 8).



Present and expected days of snow per year and expected temperature and precipitation variation in 2060 for "moderate" scenario A1B
(from: Meteosuisse, 2014)





Sea-level rise on the Dutch coast measured since 1910 and projected until 2100 for two future scenarios
(from: KNMI, 2014)

Ca. 20 cm global average sea rise in the period 1900-2010
(IPPC, 2014: 6)

Panic and circumspection

From full denial to apocalyptic visions, the news regularly echoes the ongoing controversies about the amplitude of future climate change. Warm winters are welcomed in Northern and Central Europe with a mixture of fear and delight, while actual events such as the 2005 flood in New Orleans and Hurricane Sandy in 2012 play an influential role in the representation of climate dynamics and flood risk. For obvious reasons, popular cultural exploits the panic and fear around climate change, and reanimates the latent angst for a global flood, so well anchored in the Western psyche. Within the genre of climate catastrophe movies, two recent and successful features have exploited the theme of massive inundation, using very similar narratives, in order to exaggerate the dramatic and extraordinary nature of flood rather than its practical and predictable aspects: a Japanese movie "Japan sinks" (Shinji Higuchi, 2006) and an American one "2012" (Roland Emmerich, 2009).

In both movies, continents are about to collapse and drown due to sudden geological shifts: A lone scientist tries to warn authorities but is perceived as a dangerous fool. An ordinary individual becomes involved by chance, courageously decides to join the fight, and manages to raise concern and engage his country in a global fight. In both stories, the flood originates from destructive natural processes, and nature's power is eventually overcome by a combination of cutting-edge science and individual courage inspired by noble emotions. The overwhelming scale and the nature of the dangers depicted by both films does not shy away from reminding the viewer of the representations of Noah's Flood, combined with the real challenge raised by actual climate change. However, neither film evokes the human origins for the catastrophe; rather, they offer a simplified vision of what climate change most inspires: a diffuse fight with no clear opponent, a frightening uncertainty with little hope of reliable predictions, and a collective guilt without rapid possibility of reparation or redemption. Worse, by staging flood as a collective enemy of graspable origins and one ultimately beaten by coordinated action, both films sustain the dichotomous relationship between man's constructive rationality and nature's pointless violence that has dominated the field of water management since the Enlightenment.

When information meets fiction. Cover of the German news magazine Der Spiegel (11 August 1986) and poster for the film "2012" : "We were warned" (2009, Roland Emmerich, USA)

Heads of State inspect the devastated areas and comfort the victims:
Emperor Napoleon III (1856), Queen Juliana of the Netherlands (1953), Queen Beatrix (1998), President G.W. Bush (2005), President B. Obama (2012), President F. Hollande (2013), Chancellor A. Merkel (2013), Prince Charles (2014).

Information channels tend as well to stress the devastating effects of flood and their spectacular and exceptional nature, rather than their inscription into a predictable chain of events and actions. With each flood, authorities are expected to play their part, first of all in the emotional field. Carefully staged compassionate journeys remain a central element in information narratives, as they offer a public demonstration of national concern and personal commitment from the highest state representatives. From Emperor Napoleon III inspecting the flooded Rhône Valley on a boat in 1856, to Prince Charles visiting the devastated Somerset Levels in 2014, the official visit not only shows symbolically that the central power empathizes with the fate of the victims but also gives politicians the opportunity to show their personal qualities such as concern and compassion.

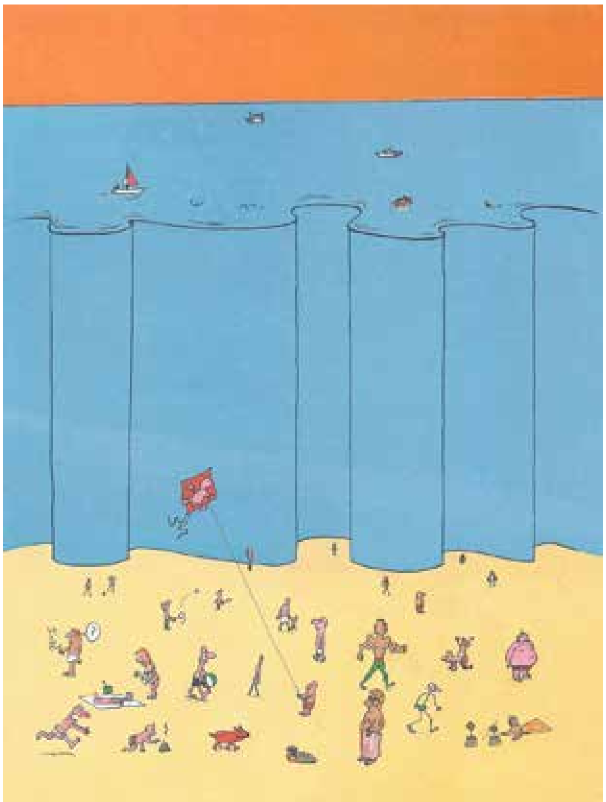
George W. Bush's failure to show that very empathy, as he comfortably flew over the devastated city of New Orleans in August 2005, was widely commented upon by the US media and used by his political opponents to contest his credibility as head of state – more efficiently than the criticism over his actual response to soaring carbon emissions. Omnipresent, mighty, and paralyzing, flood, more than any other catastrophe, calls for cohesion in suffering and solidarity in reconstruction, the only remedies against the millenary ghosts of divine punishment and total annihilation. Unlike other natural catastrophes, flood is a long-lasting event that should be experienced by leaders, and not just examined or contemplated, and, since G.W. Bush's crucial mistake, no leader has skipped a dutiful visit to a damaged area, a visit in which every detail counts, and cultural specificities are fully revealed. While President Barack Obama was photographed warmly hugging the victims of hurricane Katrina, Chancellor Angela Merkel kept her visits to Passau at a dignified distance, avoiding any drama: "Instead of rubber boots and oilskins, she was wearing solid shoes and a robust blue jacket," reported Germany's biggest tabloid (Bild, 05.06.2013).

In view of the amplitude and the ongoing nature of climate change, old promises of a final victory of technology over nature do not sound convincing anymore, although adaptation alone suggests a capitulation to a man-made evil. In this contradictory context, public communication around flood prevention has become particularly delicate. Raising awareness for flood risk appears difficult even in Holland, as "studying the debate on flood safety at the beginning of the 21st century made clear that most citizens showed little interest in becoming informed about flood safety nor in changing their behavior" (Heems and Kothuis, 2012: 448). Analyzing Dutch communication on the subject, researchers concluded that "the discourses in the flood safety debate that have been used until now (the discourses of fight, victory, and threat) are, all three, based on risk control," a perspective that shows its limits in times of great uncertainty. They suggest instead a discourse of care "based on the acceptance of vulnerability." (id.: 457)

Considering the ongoing nature of human interventions on coastal and river shores that were constructed, destroyed, and adapted for millennia, notions of care and adaptation would definitely be closer to the real scope of available strategies. And, indeed, navigating between mobilization and reassuring discourse, today's official message seeks to create space for anticipation, adaptation, of mitigation. Evacuation exercises are no longer taboo in the Rhône Valley, and the Canton's capital informs its inhabitants about the closest dry shelter reachable in case of a dam-breach alert. Beyond the myth of full safety, the Netherlands progressively elaborate evacuation strategies for its densely populated polders, and the local Red Cross has since 2015 become involved in exercises for flood rescue using a network of civilian volunteers. By high water, the municipality of Munich has set up a seven-step scheme of action in order to progressively restrain access to the Isar floodplain. Examples are numerous, but beyond the flood safety plans made by local authorities and the universal long-term warnings of the IPCC, the question of territorial adaptation to future climate and hydrology remains somehow hindered by denial, catastrophism, and, foremost, by uncertainty.

In his Cultural History of Climate, Wolfgang Behringer pleads for more relativism towards an ongoing change that has until now been no more extreme than the previous climate episodes survived by humankind, with each one of these episodes bringing good and bad news. "The Neolithic revolution and the rise of ancient civilization became possible in periods when it was somewhat warmer than it is today. If the IPCC's latest predictions are accurate, those levels will be reached again somewhere in the twenty-first century" (Behringer, 2010: 216). In the eyes of the historian, climate has no morality, and past glaciations have been a blessing for some regions, a drama for others. The Sahara was a rich and fertile region before it turned into a desert, and the Little Ice Age chased the first Scandinavian inhabitants out of Greenland. A relativism that could be shared by Prof. Richard Tol, who left the IPCC in 2014, accusing other authors of systematically anticipating the worst and missing the chance to stress that "through adaptation and clever development these were manageable risks." (McGrath, BBC, 25.03.2014; Volkskrant, 14.04.2014). This relativism can be found back in the ambivalent message issued in 2014 by the Dutch Royal Institute of Meteorology: According to the most recent projection, Dutch winters around 2050 should turn warmer and stormier, resembling those known in Bordeaux. The warning/good news was echoed by cheerful articles in national newspapers: "Dutch winters will look like Bordeaux's winters," which in the gray lowlands sounded like free holidays for all (Volkskrant, 26.05.26).

Climate change is indeed a contradiction in petto: Climate is a made up of moving matter and variable phenomena, and the patterns found in climatic fluctuations are still not enough to predict the near future. The future local effects due to global tendencies remain widely unknown, since they may differ from coast to coast or from valley to valley. And indeed the 1960s fear of "global cooling" should put our limited knowledge into perspective, showing if necessary that tendencies measured over decades do not necessarily hold for centuries. Behringer's relativism might, however, downplay key differences between the past episodes of climate change and today's challenges. Compared to the hundreds or thousands of Scandinavians who escaped a cooling Greenland, today's climate change would effect billions of people living in coastal cities and in regions threatened by desertification. Contrary to Neolithic settlements, contemporary cities are nor transportable nor disposable, and adaptation measures will have to be found on the spot, along the coasts and the river banks that border our living environments, as well as within those environments that were naively built for stable conditions. Considering not only the rapidity of current climate evolution but also the uncertainty of its effects beyond half a century, adaptation can only focus on restoring margins for future fluctuations rather than on finding new "unsubmersible" solutions to yet unknown problems, or one can set waters free and wait for a hypothetical natural balance. A reasonable mix of Mesopotamian fatalism, biblical fear, Promethean ambition, Frisian adaptability, and enlightened optimism might inspire the fresh ideas and flexible designs needed to engage in the necessary transitions.



High Waters in Middelkerke, Kamagurka
(Lava 2, 1987, Loempia uitegeverij)

Framing a new flood management policy

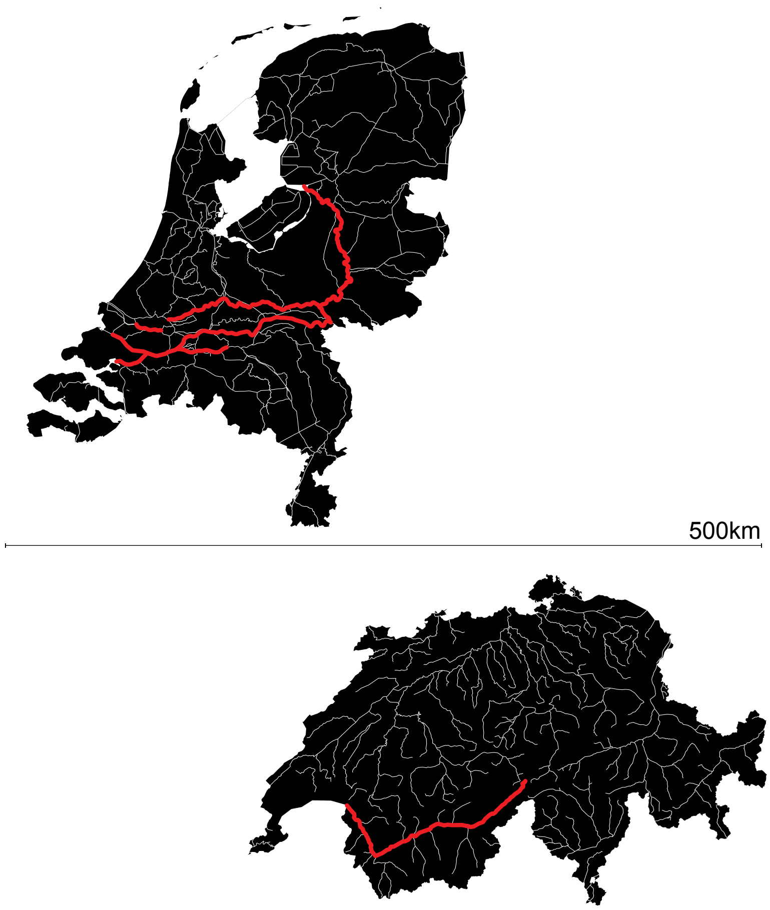
As seen in the first part of this thesis, living with riverine and marine fluctuations rather than fighting them is rather an old idea, as adaptive mores are most probably older than the invention of levees. Actively returning space or making "room for the river" is, however, a relatively modern idea, that implies that the space made available is created by removing preexisting elements or functions, a perspective that implicitly integrates various contemporary concepts. Indeed in order to be (re)distributed, space must be first quantified and divided among various agents, users and/or owners, a situation posterior to the uncertain and fluctuating state that characterized most Western European floodplains before damming, reclamation, and enclosure. Furthermore, the expression and the concept of "room for the river" identify the river as a legitimate negotiation partner that is entitled to have a reasonable share of territory.

There again the subjectification of a natural element is not new: Earlier example of virtual dialogue between local communities and fluctuating waters are numerous, attributing magical powers or bestial instincts and an autonomous will to seas and streams. The North Sea "like a roaring lion is searching for something to destroy hereabout," warns Vierlingh in Holland (Vierlingh, 1579,1920 ed: 396). "Isère, everywhere your fury appears," writes French poet François Blanc, describing an infuriate beast. "The Isère refuses to subside it seems/ However, reluctant, piqued and shameful/ she retreats growling into her muddy bed. (Blanc, 1760, X and XIV). "Der Rotti will Wiiti ha!," "the Rhône wants space," reports Grichting in Switzerland (Grichting, quoted in Vischer, 2003: 98). Similar narratives carry through the centuries the tales of territorial fights between humans and waters depicted as savage but primitive competitors that need to be tamed and contained.

Failed damming enterprises sporadically raise the idea that the coercion of waters has limits that can be reached and exceeded, as it appeared for the Loire in the nineteenth century. The Comoy plan in France offers an early example of voluntary creation of flood space (Rode, 2012), but later examples, such as the failed creation of dedicated flood fields along the French Isère in the 1970s, or the redefinition of river space in the Dutch Stork Plan in the 1980s, remain scarce, although the idea has already been discussed within the various water boards. The identification of the river as a legitimate agent within the public planning debate only became a widely shared concept at the end of the twentieth century, at the peak of damming history, when returning floods and threatening climate change exacerbated public concerns about flood defense. A cultural framework has been provided by the environmental movement, developed since the post-WW2 period, accelerating the cultural shift from a competitive fight against nature towards a discourse of harmonic relationships (when not guilt-creating, nostalgic, or fusional). A necessary discussion eventually started to take place simultaneously in several countries: How much space should the river dispose of in order to keep human space safe, or at least resilient.

The Swiss Third Rhône Correction and the Dutch Room for the River programs show a striking resemblance: Both programs planned to make space for rivers to ensure lasting flood control; In terms of scale, these billion euro/franc projects both addressed more than a hundred kilometers of rivers; Both programs were initiated in the last decade twentieth century and launched in the first decade of the twenty-first century. Both programs faced a similar challenge: gaining support for a long and costly program, by communicating a clear general idea, but without locking the project into a strict framework that would hinder local applications and future negotiations.

The Swiss Third Rhône Correction and the Dutch Room for the River programs might be comparable in goals, scale and budget; they however differ greatly in timescale and cultural context. The Room for the River program elaborated in the nineties concerns the Rhine Delta and its various branches (Meuse, Lek, Ijssel, Waal), a total of about 745 kilometers. A budget of 2.1 billion euros has been set aside for its implementation (Min. van Verkeer en Waterstaat, 2006). Room for the River is expected to bring safety to four million people living in the Dutch river region (www.roomfortheriver.com/). Validated in 2006 by the governmental "Key Decision," the program is meant to be implemented in 2015 – although some projects are expected to be delivered in subsequent years.



Rivers addressed in the Room for the River program in the Netherlands and the Third Rhône Correction in Switzerland
(map Rossano, data Eurogeographics)

The Third Rhône Correction encompasses 160 kilometers of stream to be enlarged by a factor of about 1.6. The project is meant to protect a 14,000ha flood prone area – 11,000ha in Valais and 3000ha in the Vaud canton, and "only" 100,000 people, among which are 40,000 inhabitants (Zones de danger d'inondation du Rhône, Rapport technique, 2011: 2). In contrast its budget is estimated at 2.5 billion Swiss Francs (Projet Rhône, 2008: 66).

The Third Rhône Correction is for the Canton of Valais only comparable to the previous correction works that channeled the Rhine River in the late nineteenth century (1863-1894) and secured its floodplain in the mid-twentieth century (1930-1960). The Third Correction can thus rightly be seen as the Great Work of the twenty-first century for a region that has willingly transformed its landscape only on a few historical occasions. The program furthermore addresses the full length of the Upper Rhône: from the village of Oberwald located only five kilometers away from the Rhône Glacier down to the Rhône estuary in Lake Geneva, a hundred-and-fifty kilometers further along the Rhône, and a thousand meters lower in altitude. The Swiss program thus aims logically at long-term and permanent safety, with the word sustainable ("durable") and its derivatives appearing twenty-one times in the 2006 master document (Projet Rhône, 2006) and thirty-seven times in the 2008 project report (Projet Rhône: 2008).

More than a trend in regional planning, sustainability is here also used in its literal meaning: long-lasting. A substantial investment responds to the project's ambition: with an estimated budget of 2.5 billion Swiss Francs for the full implementation of the project (Projet Rhône, 2008: 66), equivalent to 2.3 billion euros in october 2015, "Rhône III" can compete with the Room for the River program. The "Rhône III" budget is equivalent to 15% of the GDP of Valais Canton, 17 billions in 2012 (OFS: 2013), and corresponds to an investment of 25.000 Swiss Franc per inhabitant living in the risk area. Needless to say, the threat is not limited to the population physically domiciled within the Rhône floodplain: with 77% of its territory covered by steep forests or considered unworkable, the Valais sees securing the Rhône Valley as a vital issue for the whole Canton.

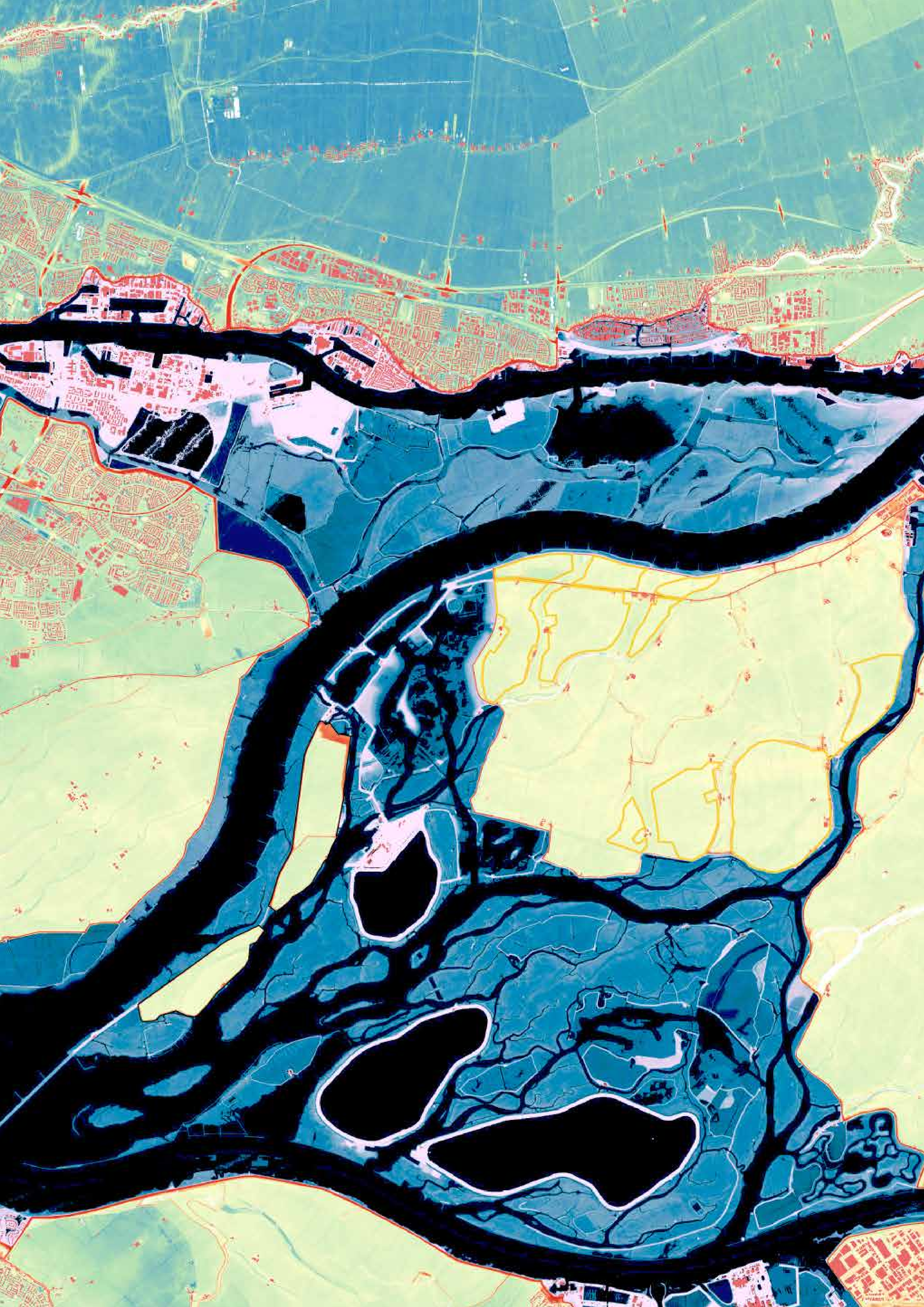
On the other hand, the identification of "Room for the River" as a specific program with a planned completion in 2015 might be misleading: Water management in the Netherlands is a continuous process rather than a succession of specific interventions, and associates local maintenance works with genuine transformations (such as the "de-poldering" of Noordwaard in Northern Brabant or the new river arm created in Nijmegen). The program's relatively short completion period – nine years from the 2006 governmental bill to completion planned in 2016 – "does not mean that it ends there: we still have plans for the rivers after that, and we are working on what will happen in 2050," reveal the planners from the National Water Agency (Van der Grift and Der Nederlanden, interview, 2013).

The Dutch Room for the River acknowledges the impermanent character of the Delta, revealing a major difference in geography and culture – "I find this typically Dutch," outlines Rijkswaterstaat engineer Jan Van der Grift, "once in a few decades each region is again addressed and remodeled (opgepakt en opnieuw gekleid)" (id.). The morphology of the Dutch program is also more adapted to this time continuum: Where the Swiss program addresses the Upper Rhône in its full length of a 150 kilometers, the "Room for the River" concerns 39 distinct projects scattered along about 750 kilometers of rivers and channels that remain generally untouched in between the project areas. Combined, this string of interventions has a systemic effect on the whole river network of the region – combinatory effects that could be measured already during the investigation phase thanks to the "construction box" (blokkendoos) hydrological modeling program.

Comparable in size, ambitions and type of measures, "Rhône 3" and "Room for the River" choose two opposite approaches, one aiming for a lasting balance though a historical transformation, the other aiming at reintroducing flexibility in an ongoing and unlimited adaption process. An in-depth analysis of cultural motives and planning strategies shows nuances in this basic opposition and reveals a set of combinatory tools applied in various geographical contexts, some within the frame of large programs, others on a more regional scale. The following essays thus focus on six contemporary projects that have in common the reintroduction of flood within territorial process and spatial planning through a specific combination. Flood scape as ecological restoration, cultural statement, urban development, integral makeover, or discreet adaptation: this overview unravels the vast scope of possible approaches and combinations, providing tools and reflection for future landscape transformations.

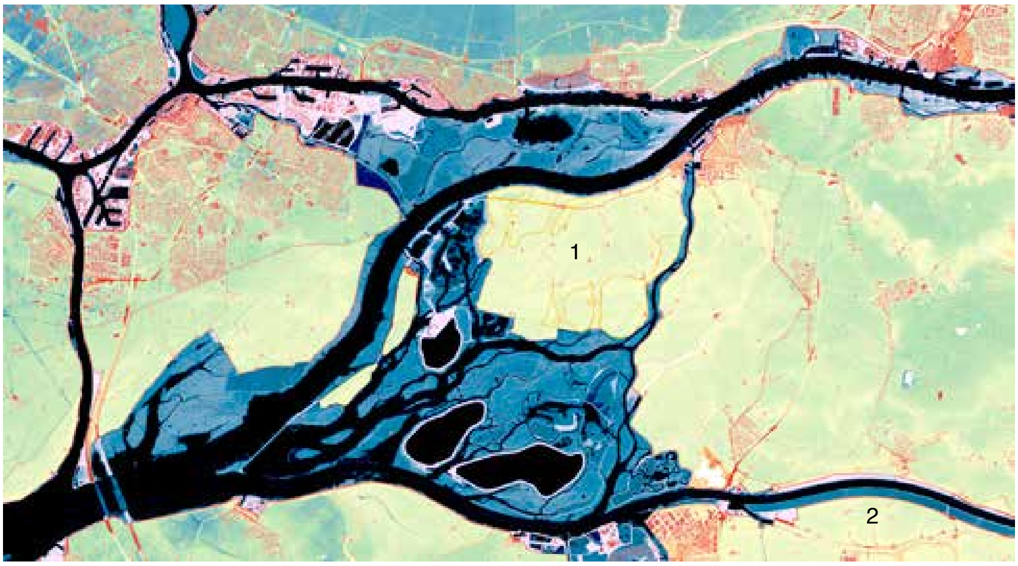
Program	risk area (hectares)	amount projects	stream lenght (km)	total building costs (millions)	project validation	planned completion	population protected
Room for the River (NL)*	unknown	39	745	€2.300	2006 (PKB)	2007-2015 (2013-2019)	4.000.000
3d Rhône Correction (CH)**	13.000 (risk area)	5 priority projects (tot. 30km)	150	SF1.500 2006-2030 - SF2.500 total estim.	2006 (Plan Sectoriel)	2006-2020 -priority measures 2030-phase 2 2050-phase 3	42.000 inh./ 100.000

Key facts for the Third Rhône Correction and the Room for the River programs
(Source: *Ruimte voor de Rivier, 2011: 4, 6; **Projet Rhône, 2008: iii, 9, 19, 66., Projet Rhône 2011: 2)



Room for the River: reversible landscapes in the Rhine-Meuse Delta

The Dutch Rhine-Meuse Delta is famous for its tumultuous history of reclamation and dramatic floods. The current "Room for the River" program, due to be completed in 2016, should be thus seen in the context of a intrinsically malleable geography, shaped by slow natural processes and rapid human transformations. This is for example particularly visible in the Biesbosch region and its succession of dramatic turnarounds up until today's de-poldering, a region therefore investigated here in greater detail.



The Biesbosch region in the Dutch Southern Delta, with the recently reopened Noordwaard (1) and Overdiepse polders (2) (ill. Rossano, data AHN 2010)

In Roman times, the Southern delta formed a vast peat bog, covered by a meters-thick peat layer, and isolated from the North Sea by a narrow dune ridge (Leenders, 1999). The coastal ridge then runs almost from the Strait of Dover until the Wadden Sea, interrupted only by the outlet of the main rivers. The Meuse River flows from Geertruidenberg to Dordrecht through the Biesbosch, a river segment later displaced and reclaimed, invisible in today's landscape. The Southern Delta was at this time not reclaimed by man but was gradually extended by spontaneous peat formation (Nienhuis, 2008: 74). The region was under the permanent influence of river streams and sea tides, spreading over vast areas: "The submersion of the riverbank by a flood was not considered a disaster" (idem) as no continuous dikes had been built as yet. Known human settlements were then concentrated in the area heightened by river deposits between the Maas, Waal, and Rhine rivers, west of today's Biesbosch, and along the Rhine itself, then the northern border of the

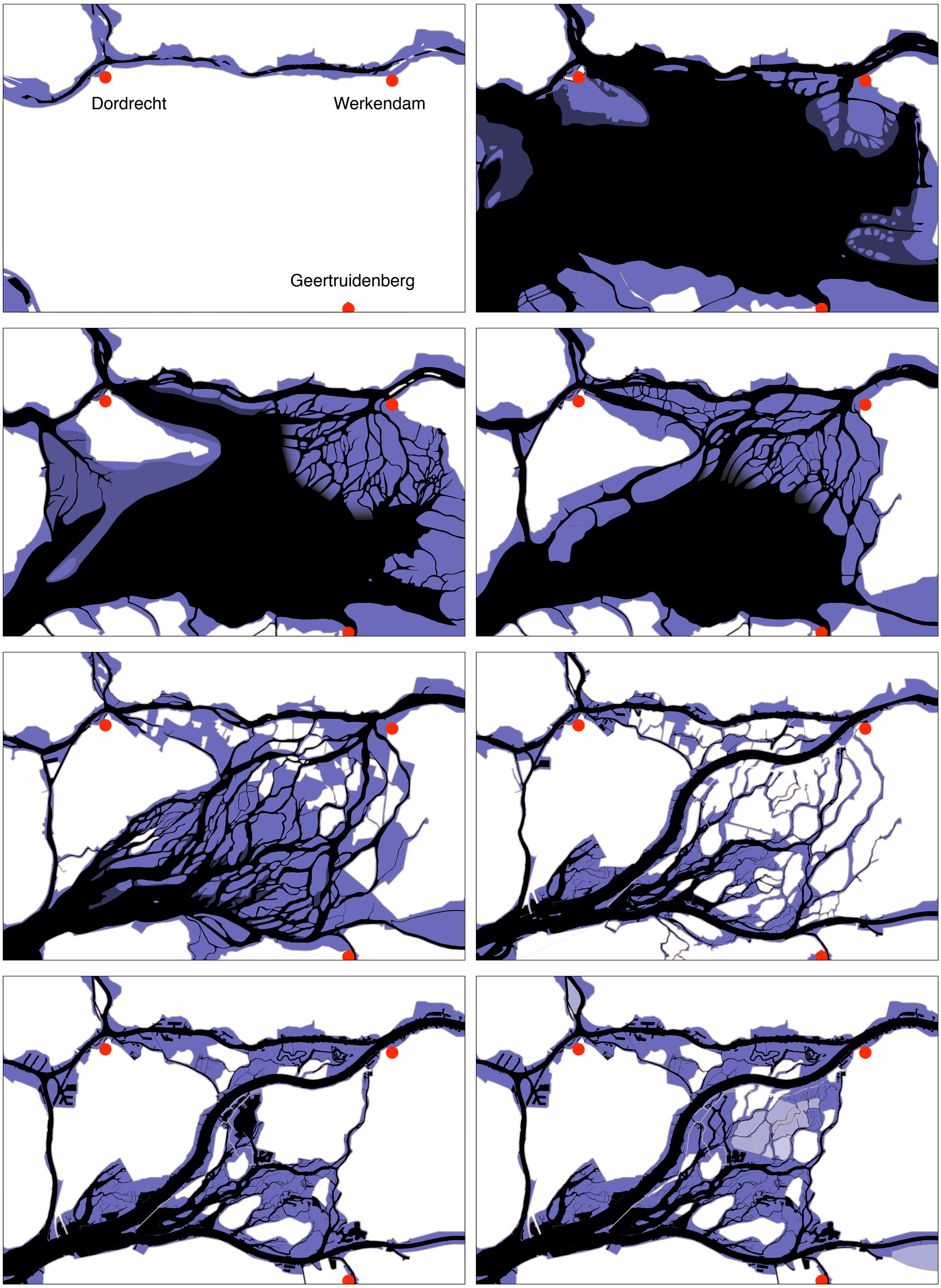
Roman Empire (Nienhuis, 2008: 30, 33). Without stable and permanent drainage, the lower delta region was, however, barely habitable and exploitable. The first traces of drainage there date from 75 and 125 CE, with the oldest known levees and tidal gates built close to the Meuse, near Rotterdam, to drain the land at low tide and defend it against rising waters at high tide. There are archaeological indications as well that large areas of high peat lands were also exploited between the mouth of the Meuse and the Rhine (Nienhuis, 2008: 37).

This first reclamation period stretches across the Middle Ages, a long period where hydraulic infrastructure developed and spread around the North Sea, and land exploitation slowly gained in scale and intensity. Behind the dikes that increasingly isolated land from water, peat was extracted as fuel and for the sea salt it contained. This intensifying exploitation, mining, and drainage of the soil led to land subsidence, which in its turn made it easier for the sea to cover the land again, causing "one of the best known examples of massive ecological damage at the countryside induced by man in the early modern times.' (id.: 58). Human exploitation caused the breach of the dune barrier (id.: 40) and the loss of large land areas. The wide opening of today's Haringvliet brought seawater closer to the river area and to the future Biesbosch, and the Southwest delta progressively took the contours that we still know today.

The period between 800 and 1200 saw the sea retreat again; a relatively mild climate and bog reclamation expanded again on a broader scale, later through planned operations. Between 800 and 1250, the population of the Netherlands grew from 100,000 to 800,000, consuming more and more ground for its subsistence and for the lucrative extraction of peat salt. In the centuries that followed, perpendicular flood-mitigation dikes were replaced by longitudinal defensive levees, progressively joined to form ever-larger enclosed areas. With the damming of the Meuse River in 1283, the Grote Waard or Hollandsche Waard polder was enclosed and became the greatest achievement of the Middle Ages, stretching over four hundred square kilometers from Heusden to Dordrecht (id.: 77).

This permanent enclosure by dike-rings, however, considerably reduced the space available for rivers to fluctuate and water levels to rise within the narrowed channels. Combined with land subsidence, rising waters made gravity-fed drainage obsolete and weakened the levees, making the new reclaimed land even more dependant on damming and drainage infrastructure and on continuous maintenance, thus increasing risk and exposure. A victim of the weakening of natural coastal defenses, of the side-effects of its own reclamation, and of maintenance failure, the Grote Waard was inundated during the famous Saint Elisabeth Flood in 1421, which drowned numerous villages and most of the polder between Dordrecht, Werkendam, and Geertruidenberg. The three cities, once part of the same territory, were suddenly isolated by a vast and shallow tidal lake, with Dordrecht remaining isolated on a tiny island.

Despite uncoordinated efforts made to rescue the lost land, the western part of the Zuid-Hollandse Waard was largely abandoned to the waters after a series of disastrous storms, less than 150 years after its completion. This dramatic episode became a national trauma for the man-made lowlands, a constant reminder of Holland's vulnerability and dependency on permanent and coordinated water management; with the emergence of environmental history, it will later also be seen as a "classic example of the devastating effects of human greed" (Nienhuis, 2008: 76).



Reclamation history of the Biesbosch area, in the early 15th, mid-16th, mid-17th, mid-18th, mid-19th, mid-20th centuries, and in 2010 and 2015, before and after the completion of the “Room for the River”program (ill. Rossano based on various historical maps, Top25 raster, Kadaster, 2010 and Inrichtingsplan Ontpoldering Noordwaard, Ruimte voor de Rivier, 2009)

The Biesbosch, from land to water to land

In the centuries following the flood, the lost region appeared on maps under the name of "Drowned South-Holland Polder" ("Verdronken Zuid-Hollandsche Waard" or "Waert," see Van Wijk, 2012: 15, 67). It formed a large inner lake at the eastern end of the Hollands Diep inlet. The new lake had extended the maritime influence further land inwards, up to Brabant's capital city 's-Hertogenbosch (id.:125), and had radically upset the local geography – in land use but also in navigability, the economy, and politics. The name "Bergsche Veld" appeared to designate the area that slowly emerged. As the lake started silting on its periphery, the lost land became progressively covered with wetlands and woods; the name Biesbosch, known before the flood as a small area east of Dordrecht (Van Wijk, 2012: 12) appeared as well to designate what slowly became a vast wetland – Biesbosch meaning literally "bulrush wood," bulrush having the double advantage of being dried and sold for the handicraft industry and to accelerate natural sedimentation. Rivers and streams, tidal movements, seasonal floods, vegetation growth, silting, and erosion finished erasing the medieval agrarian landscape, and replaced it with a new, fluctuating archipelago of islands and mudflats, out of which old church towers still emerged here and there (Chrysotomus Neapolitanus, 1514, quoted in Van Wijk, 2012, 12).

From the mid-fifteenth century, it took about 400 years of sedimentation to raise the land again above water level, as shown by a cartographic study. The first areas that were diked and reclaimed again were the flats west and south of Dordrecht, today located about one meter below sea level. Taking advantage of natural silting, side creeks were dammed and small pieces of land were again enclosed by small levees and aggregated. The reclamation works accelerated from the seventeenth century on – although the fear remained that narrowing the river could again cause a catastrophe (van Wijk, 2012).

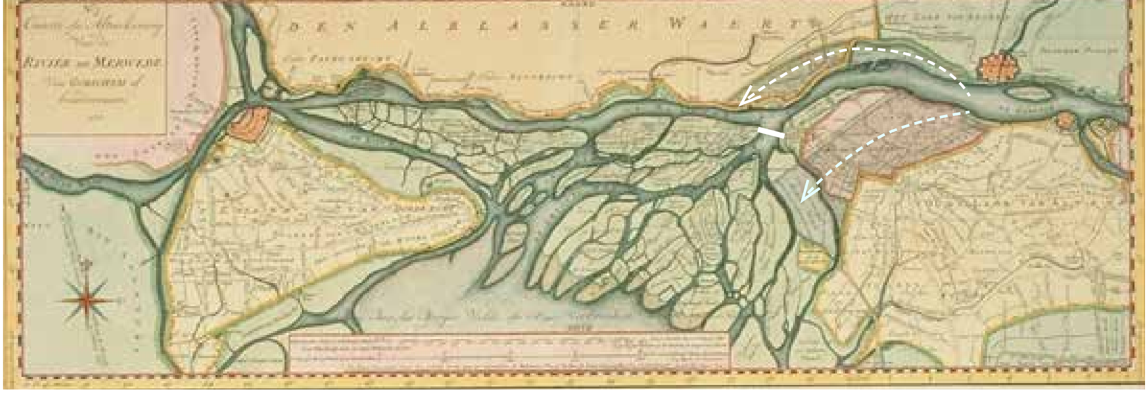
First regulation and first mitigation project

In the eighteenth century, the eastern part of the Biesbosch, south of Werkendam, was recovered as well and incorporated into the Land of Heusden and Altena. Rapid sedimentation, often "helped" with adequate plantations, allowed new land to arise everywhere and be exploited. Sedimentation, however, caused headaches for the municipalities around the Biesbosch. The narrow pass downstream from Gorinchem, where the Meuse and Waal waters join the Merwede, formed a dangerous bottleneck. Further downstream, the many branches let the river spread and slow down; waters were so shallow there that navigation between the Western harbors of Rotterdam and Dordrecht, and the Rhine and Meuse watersheds became difficult. During harsh winters, the shallow waters occasionally blocked the ice floating on the river, creating ice dams that hindered the flow, leading to dike breaches and inundations upstream.

Facing this recurring problem, the States of Holland create a commission to investigate ways to remediate these multiple problems. The resulting plan drawn up by Nicolas Samuel Cruquius, a surveyor and member of the commission, envisioned the first engineering intervention and flood mitigation on the Merwede. The Commission proposed the construction of a submersible dam across the Oude Wiel (white dash on the map), a solution designed to keep the northern route clear and navigable at all times, and let water overspill into the Biesbosch only when necessary. The commission also advised the construction of a bypass for the Merwede to expand when high waters threatened to inundate the neighboring polders. Two options were drawn up by Cruquius: the northern bypass located parallel to the river and temporarily isolating the village of Hardinxveld, and the southern bypass creating a large short-cut for the Merwede to flow into the Biesbosch through the Old Land of Altena and occasionally turning Werkendam into an island (white arrows). To implement these spillways, the river levees had to be lowered where indicated on the map, and new levees had to be erected further back inland.

The use of spillways and bypasses, or "overlaat" in Dutch, was not radically new at the time and known by the fact that rivers could spontaneously use former riverbeds during high floods, but it was not yet developed as a strategy for flood defense as it would be after Cruquius (Kappers, 2000). Old river branches and lower forelands regularly flooded there at high waters, a natural process sometimes instrumentalized as part of a flood mitigation or military defense strategy. The "Cruquius" plan was welcomed by the western harbor cities, from Rotterdam to Gorinchem, all eager to secure their access to the hinterland. However, it raised worries and opposition from the dike masters responsible for the large polders boarding the Merwede, who feared that the planned dam would increase flood risks upstream (Van Wijk, 2012: 137). Due to persisting disagreement, the project was not built. However, after the 1757 flood in the lower river region caused again by the formation of ice dams, state engineer Jacob Pierlinck published a book, in which he examined the circumstances of the catastrophe and advocated the use of "green rivers." Several spillways were later built, often using old river branches. Along the Meuse and Waal Rivers came the Baartwijkse Overlaat in 1767 and the Beerse Overlaat in 1828 (Vandersmissen, 1998: 61-62). The Lobith-Tolkamer Overlaat was successfully used as recently as 1995 to mitigate the effects of exceptional discharge in the Rhine River.

The "Cruquius Plan" has therefore remained to this day an inspiring attempt to address a major hydraulic challenge through "soft power" and controlled flooding, as a necessary complement to dikes and dams. Furthermore, its visionary mix of discharge repartition and disaster mitigation through submersible levees shows a striking resemblance with the current transformation of the area by the "Room for the River" program implemented 350 years later.

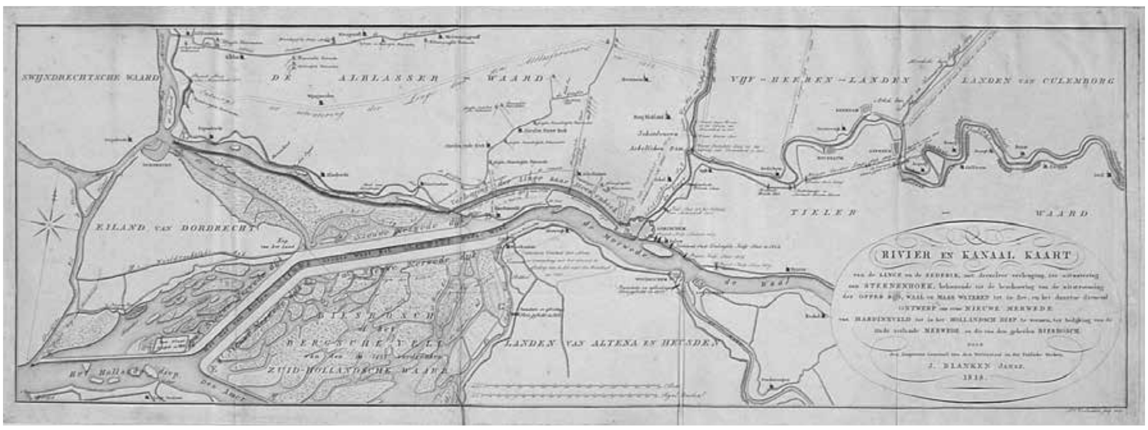


Caarte ofte Afteeckening van de rivier de Merwede van Gorichem af benedenwaarts, N. S. Cruquius, 1730 (Regionaal archief Dordrecht, 551_40141, white dash and arrows added by the author)

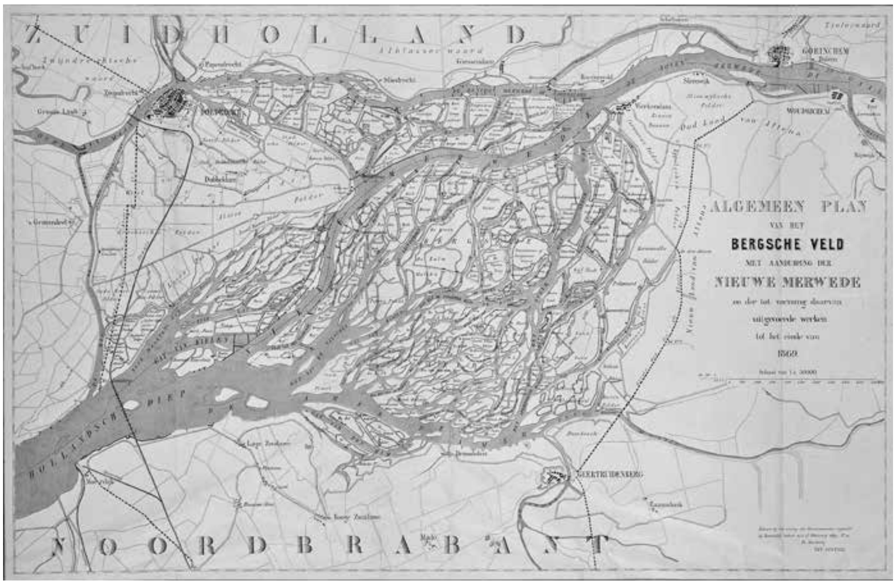
In the mid-nineteenth century, the whole area lost in the fifteenth century had turned into a complex and fluctuating archipelago of flats and islands, separated by numerous river branches and tidal creeks. Most islands were not yet enclosed by levees and were still regularly submerged by tidal and river floods. Although not very suitable for field agriculture, the Biesbosch hosts then an intensive activity: reed is used for construction; bulrush is harvested for handicrafts but also planted to accelerate silting and land creation; willow coppice is exploited along the streams; and fishing is carried out everywhere. This period might be considered as the ecological climax for the Biesbosch in terms of diversity of habitats and species, just as it is generally considered for the countryside of the river region, then still partly open to seasonal floods and not yet "shaved" from its extensive network of hawthorn hedges by massive re-allotment programs.

The plans made in the nineteenth and early twentieth centuries, however, changed this situation, with the implementation of two major "river improvement" projects: the Nieuwe Merwede and the Bergsche Maas. In Holland, as in the rest of Western Europe, the population was growing and with it the need for arable land, trade, and navigation; agricultural production intensified, putting more pressure on the rivers and their floodplains. As the floodplains were increasingly reduced upstream, lower rivers silted up, filling their own bed and rising over the surrounding lands. As the Biesbosch rose against thanks to river and tidal sedimentation, its shallow wetlands carried two major disadvantages lamented already since the seventeenth century (Van Wijk, 2012: 136): poor navigability due to changing, narrow and shallow streams; and the above-mentioned formation of ice dams on the sand flats and shallow river bottom, blocking the river's course and increasing flood risks in the area. In order to ameliorate both the navigability and the discharge capacity of the lower rivers, two new river channels were created along the Waal (Southern branch of the Dutch Rhine) and the Meuse Rivers before they joined the waters into the Biesbosch, radically changing the landscape of the area.

On the north side of the Biesbosch, various options were investigated to create a navigable channel through the shallow swamps, and facilitate the discharge of the Waal River into the estuary. A radical plan drawn in 1818 by the Governmental Water Agency Waterstaat and presented by General Inspector Jan Blanken, envisioned a cornered canal dug through the Biesbosch that would not only fully channel the Waal's southern branch but also redirect most of its waters into the Hollands Diep inlet and split the Biesbosch into two areas ready to be drained and exploited.



Design for the construction of a new Merwede from Hardinxveld to the Hollandsch Diep
by Inspecteur-Generaal van de Waterstaat J. Blanken Jansz, 1818 (unbuilt).
(Regionaal Archief Dordrecht, 551_20086)



General Plan of the Bergsche Veld with indication of the New Merwede and the construction works until the end of 1869, Staatscommissie, van Opstall, 13.02.1869 (University of Groningen, krt-1870-zho-nbr)

The plan that was eventually implemented half a century later fortunately showed a bit more concern for the preexisting landscape: The Nieuw Merwede, dug between 1861 and 1874, basically connects and enlarges existing streams into a regular curved channel with a standard width of 325 meters and a 18.2 kilometers length, which is ironically described today by Rijkwaterstaat as the "natural border between [the Provinces of] South Holland and North Brabant" (www.rijkswaterstaat.nl). The chosen track might indeed be more adapted to the initial morphology of the Biesbosch, but still mercilessly slices the vast Biesbosch into three isolated patches: the Sliedrechtse Biesbosch (Northeast), the Dordtse Biesbosch (Southwest) and Brabantse Biesbosch (Southeast).

Following the completion of the New Merwede, a new polder was dammed in 1926 on its left bank, along the Island of Dordrecht. The "Biesbosch Polder" redraws another 1100 hectares from the Merwede floodplain, allowing Dordrecht to expand its surface by 40% in a few years (area within the primary dike, Vis, 1936: 11). Fears of higher flood risks were quelled by the provincial Water and Infrastructure authorities: the new polder "would not change the situation of the river," stated chief-engineer Van Elzelingen (id.: 24), although the area before damming was covered with 20 centimeters of water at high tide. Fighting the post-WW1 economic crisis was then the first priority: in 1923, the municipality spent half of its tax income on unemployment allowance (id. 17), a situation seen as critical and unsustainable. All over the Netherlands, large urban civil works were undertaken during the inter-bellum period to put unemployed workers to work, in exchange for a modest salary or allowance, resulting in new large city parks (the Amsterdamse Bos in Amsterdam and the Kralingse Bos in Rotterdam, among others). For the Biesbosch polder project, 1316 unemployed Dordtenaars worked at damming, clearing, and draining of the new land. The polder was opened for farming by 1927, and the reclamation was celebrated as a final victory: "a work like the reclamation of the Biesbosch Polder will honor the city of Dordrecht until the end of time (id.: 111).

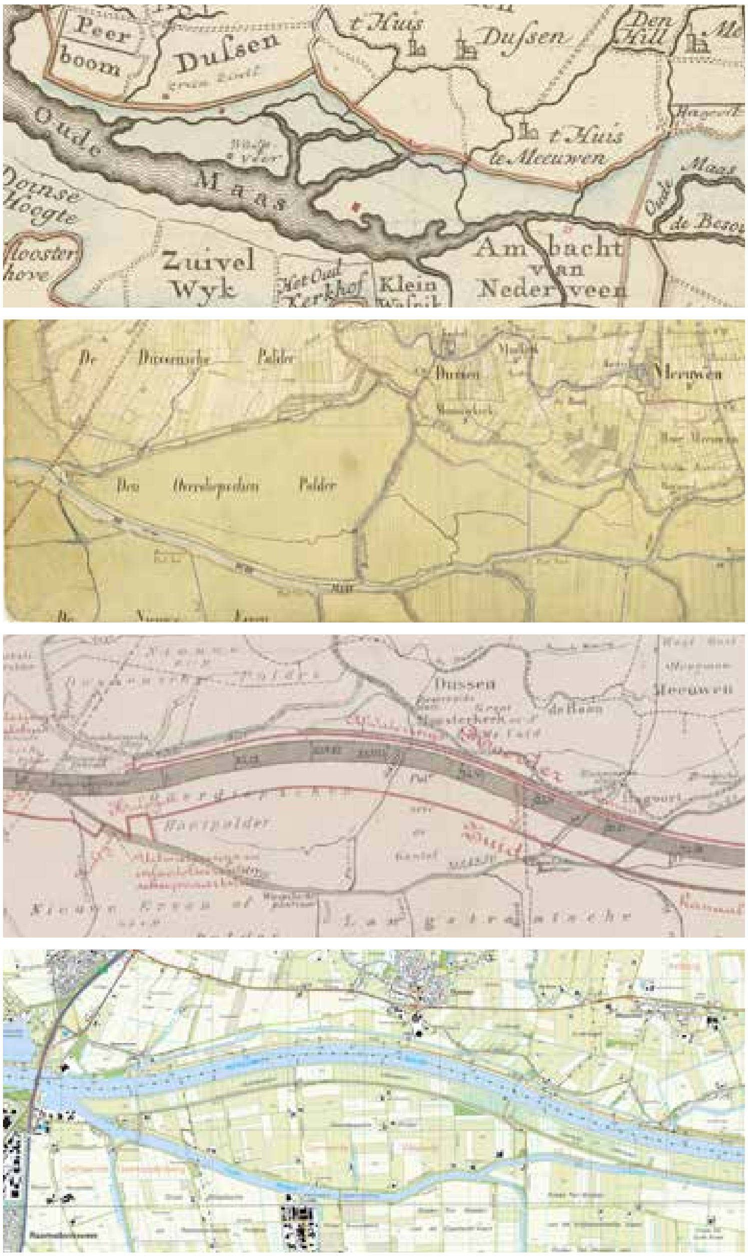
In the meantime on the left bank, south of the Merwede, many inlets were obstructed by the construction of a winter dike (Bandijk) alongside the new channel, hindering the connections to the Biesbosch, and closing many stream branches off at their upstream end. A full reconquest of the Great Hollandse Waard seemed nearer.

A similar scenario developed south of the Biesbosch. A crucial factor for the overload of the Merwede River was long identified: the confluence of the Maas and Rhine Rivers into a bottleneck in Gorinchem. Meuse and Rhine waters used to flow in separate beds to the estuary, until the Maas was dammed from Hedikhuizen in the thirteenth century, directing its waters to the north. From the old Meuse there remained a few branches and tidal channels of small importance, with most being dammed during the reclamation of the Hollandsche Waard, although some were later reopened to tidal influence by the Saint Elizabeth Flood. The main track remaining from the former river was later named the Oud Maasje (the "Little Old Meuse"), a silted tidal channel used to drain and fertilize the surrounding hay meadows – and after 1766 occasionally used as a temporary spillway to offload the "real" Meuse through the Baardwijkse Overlaat (Bink et al., 2011:54-56). The Overdiepse polder was progressively diked and gained upon the river banks of the Oud Maasje In the early years of the eighteenth century, although it was still flooded in the winter to benefit from the so-called "fat water" (vet water) used to fertilize the "flow meadow" (vloeiweide), a technique known since the early Middle Ages (see "Flood as land-maker" on page 54).

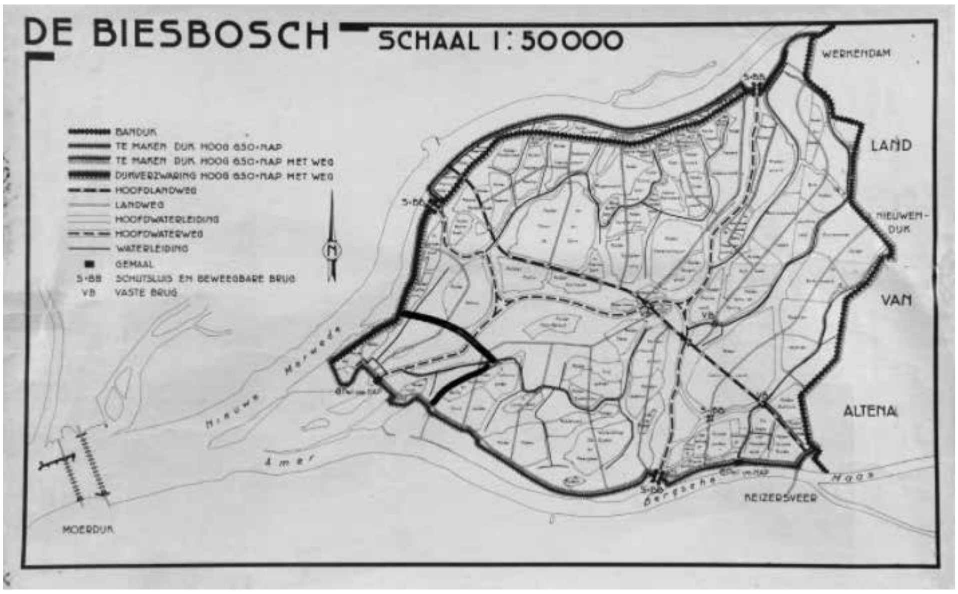
This situation changed again radically in the nineteenth century. Due to persisting floods along the Rhine, Meuse, and in their overloaded common branches, the Waal and Merwede, plans were made to redirect the Meuse towards its former route – the Oud Maasje. The first serious attempt was made in 1823, with Lieutenant Generaal Baron Krayenhoff's test design ("Proeve van een onwerp") for a new river channel from Herrewaarden towards the "Bergsche Veld," another name for the Biesbosch (Vorstenbosch, 2011). Several plans followed, and the creation of the Bergsche Maas was eventually decided by the Dutch Government in 1883. The 24 kilometer-long channel was dug and bordered by new levees between 1888 and 1904 under the aegis of Cornelius Lely, civil engineer and Minister of Waterstaat. Although the new riverbed mostly followed the old bed of the pre-medieval Meuse, it curved to the north around the Overdiepse polder to comply with the municipal borders and the existing drainage system. A new channel was dug through the meadows for the Bergsche Maas, boarded by heavy levees – the same levees that have today been lowered again to allow floodwaters to flow over the Overdiepsepolder. Today a fertile farmland, the Overdiepse Polder was first exploited for peat extraction in the Middle Ages, before disappearing under the waters of the Saint Elizabeth Floods (in 1421, 1422, and 1424). Covered and fertilized by the mud of the inundation, the area was progressively exploited and reclaimed again from the Oude Meuse River, and divided by a typical long and narrow parceling, still visible along the river. The polder only assumed its current shape with the creation of the Bergsche Maas.

The delta enclosed: nearly the end of the Biesbosch?

The twentieth century saw the Biesbosch come close to disappearing. In 1927, the area was still under the strong influence of tides and river dynamics, but its water network was diminished, amputated from many branches by damming works, and compartmented by rigid borders. With the construction of the Biesbosch polder in Dordrecht, and of the Nieuwe Merwede and its winter dike, a northern limit had been set for the wetland archipelago. To the south, the new Bergsche Maas channel already marked a possible edge, although not yet materialized by a continuous levee. In between was left a reduced Biesbosch, where many tidal creeks and silted channels were dammed, and where small polders were progressively assembled to form larger arable areas.



The Meuse River upstream from the Biesbosch:
The Oude Maas before embankments were build
(Kaart van de situatie van Hollands Brabant..., Nationaal Archief, The Hague, 1789, detail),
Oude Maas after the reclamation of the Overdiepse Polder
(Nationaal Archief, The Hague, first half of nineteenth century, detail)
Governmental project for the Bergsche Maas
(Verlegging van de uitmonding der rivier de Maas, A.J. Boagerts, ca. 1900, Brabants HIstorisch Informatiecentrum, 343.1831, s'Hertogenbosch)
Situation in 2010 (Top25, Kadaster)



Plan for the reclamation of the Brabantse Biesbosch (Biesbosch Museum, ca.1940)

However, contradictory events and concerns were at play. A research department for sea inlets, lower rivers and coast (Studiedienst van de Zeearmen, Benedenrivieren en Kusten) was founded in 1929 within the Rijswaterstaat Governmental Water Agency, initially to study and ameliorate the navigation network. It, however, soon also investigated the flood safety of the lower rivers and coastal regions. Initially asked to study the effects of the young Biesbosch Polder on flood risks, the department drew an alarming conclusion for the safety of the whole region, as the levees appeared to be too low to resist a major flood (Sanderse et al., 2004). As a result, the city became reluctant to see more land being reclaimed in its surroundings, but its reserve did not discourage the supporters of further drainage in the Brabantse Biesbosch. Plans were made to finalize its piecemeal reclamation with one great gesture embracing the whole area from Merwede to the Bergsche Maas. In 1940, one large polder was drawn that would achieve the final reconquest – and the end of the "Bulrush Wood" as such. The "grand projet" was, however, soon frustrated by the Second World War, which turned the Biesbosch into a battlefield between the German Occupiers and Dutch resistance fighters, and was further delayed by the reconstruction period that drew all energy towards the cities and the Ijsselmeer polders.

The 1953 storm surge and giant flood, although feared by the Rijkswaterstaat Research Department, paradoxically hit a poorly prepared country. The poor state of the levees and the need to better protect the land against combined sea and river floods had been identified before the war, but no action was taken due to the economic crisis, the occupation, and the reconstruction that followed. The loss in human lives, cattle, and land abruptly redirected the Nation's attention towards the southern Delta, leading to the construction of the world-famous Delta Works, a series of Herculean sluices built to protect the Netherlands from more sea surges and storms. The combination of dams and storm-surge barriers drastically lowered the chance of sea flood for the coastal provinces, by reducing about 700 kilometers of coastline. The closing of the Delta and the reclamation of the Ijsselmeer culminated in the 1970s marked the culmination of the "Art of a Nation: Dredge, Drain, Reclaim" (Van Veen, 1948).

As a result, the former sea inlet formed by Biesbosch, Hollands Diep, and Haringvliet became the downstream chemical depot for the Rhine and Meuse rivers, receiving more than 150 million cubic meters of polluted mud, the worse quality being the 90 million deposited from 1970 to 1989

(Nienhuis, 2008: 288). This process persists today, although with reduced pollution levels and at a slower rate of 5 million cubic meters per year.

The drainage of the Biesbosch was on hold, but the Haringvliet tidal gates built in 1970 brought another blow to the area: the Biesbosch largely lost its connection to the sea and its tidal influence, which only subsisted through the distant Rotterdam harbor channels. Environmental concerns would only become decisive with the construction of the last Delta Work, the Eastern Scheldt storm-surge barrier, six years after the Haringvliet dam was completed. Under pressure from environmental groups, this last work included an opened part to maintain tidal exchanges between sea and estuary. Unfortunately for the Biesbosch, environmental concerns came too late to save the Haringvliet/Hollands Diep inlet from enclosure, and the threat of sea salinization has so far carried more weight than the repeated calls to let sea water in again.

Henk Saeijs, biologist and former Chief Engineer Director of the Directorate Rijkswaterstaat Zeeland, noted in 1999 that "hydraulic works like the Delta Works in Zeeland are partly motivated by costs and benefits consideration. (...) The question is whether the benefits are correctly identified. Generally, few attention is payed to the ecological meaning and potential of existing or new systems, nor for its economic translation." (Saeijk, 1999). This impression was attested by scientific surveys already in the 1990's, showing that the Rhine-Meuse Delta had "developed toward a system with generally low natural ecological values" after it was closed (Smit, et al. 1997). Rijkswaterstaat experts today concede that "if it was today, we would not do it at all," regretting the formation of a "bit of a dead sea" in the estuary (Van der Grift, Der Nederlanden, interview, 2013).

With the construction of the Delta Works, the blind belief that dams, levees, and pumps could provide Holland with a safe and sustainable living environment started showing cracks, as the risks brought about through the "hard" approach and its the ecological consequences became visible. Yet the channeling of the Bergsche Maas and the Merwede Rivers that considerably reduced their floodplain and subsequent flood mitigation capacity is still occasionally referred to as a "river improvement" ("rivierverbetering") in governmental documents (Ruimte voor de Rivier, 2005: B, 33).

From raising dikes to making 'room for the river'

During the hydrologically quiet decades that followed the 1953 tragedy, flood protection along the rivers remained in the background. However, in the Netherlands, as in the rest of the Western European countries, concerns grew about the environmental and living quality of the river areas, challenged by intensifying agriculture, urban sprawl, and the progressive reinforcement of old river levees. In 1986, the today prestigious Eo Wijers competion for regional planning was organized on the theme "Netherlands Land of Rivers" ("Nederland Rivierenland"). Out of 34 designs, the jury gave the first prize to the "Stork Plan" ("Plan Ooievaar"). The Stork Plan proposes a stronger differentiation between intensified agricultural areas behind the levees, adapted to the rapid pace of a changing economy, and the river's floodplain where slow processes should be granted space and time to recompose a rich, diverse, and dynamic environment – one not necessarily free from human intervention, in the eyes of the authors. Within this differentiated landscape, "competing functions are isolated, while activities that can take place in the same areas and even reinforce each other, are combined" (Rijksplanologische Dienst, 1986: 14). To give the floodplain more legitimacy, the author proposed to create a new territorial status, the "waardschap" going "from dike to dike," that could turn the river space from "administrative border and backside to an administrative backbone."

The Stork Plan attracted the attention of several non-governmental organizations, which saw the plan "as a challenge and an opportunity to change their policy from a defensive to a more offensive and developmental strategy" (De Jonge, 2009: 187). The plan avoided the common opposition among production activity and nature protection – with the clay mining industry being, among others, "positive about cooperation as they were part of the win-win strategy of clay extraction and natural habitat development." Another original element is the interdisciplinary composition of the team that included ecologist Frans Vera and river expert Dick De Bruin, along with four landscape architects then working together at the Forestry and Nature Agency Staatsbosbeheer. One of them was Dirk Sijmons (co-supervisor of the present thesis), then head of the Landscape Department, who later investigated with his team the construction of new, reinforced dikes in the Maas and Waal area from the point of view of a landscape architect. With Yttje Feddes and Frans Halenbeek, the landscape architects from Staatsbosbeheer already set out alternative principles for dike reinforcement.

At the time, environmental aspect were integrated into Dutch planning procedures, in particular with the MER assessment report MER ("Milieueffectrapportage"), compulsory for large projects and civil works, including flood defense. The concept of "L.N.C. assets," the abbreviation then used for Landscape-natural and Culture-historical Assets ("landschappelijke-, natuurlijk een cultuur-historische waarden"), was then commonly used to summarize and evaluate environmental aspects, and had dominated the planning discourse since the 1960s (De Jonge, 2009). Established to provide assessors with objective criteria, the "LNC" system left little room for an in-depth, integrated analysis and project-oriented choices, forming for Sijmons an "accounting system" rather then a concept useful to a designer. Engineers focused on the preservation of 'LNC-assets' rather than on global quality and transformation potentials: in the 1990s, ' it was always about the integration of LNC assets (...) as a generic term: as long as it is well integrated' (Van der Grift, 2013). As a result, new 'enormous levees swirled from one compromise to the next', a situation Sijmons decides to address through an alternative approach.

In their new design guidelines (De scherpe Grens, 1988), Sijmons, Feddes, and Halenbeek contested this defensive and opportunistic method: "Our advise was: you forget your most important task, your cultural assignment, and that is building beautiful levees" (Sijmons, 2015). While "the proposed profile was a nondescript plum pudding," the designers stated that a good levee should form a clear border between the protected and open areas and enhance the experience of "floating over the landscape" that characterized the old narrow levees, both of them goals that could be achieved by giving the new dike a smooth trajectory, a clear, legible footprint and a narrow top. More generally, the landscape architects rejected a pure protective attitude regarding supposedly permanent natural elements: "cultural history should take precedence over nature – nature is a dynamic system; you can 'make' it" (id.). Yet a proactive and integrated design-oriented approach within the Forestry and Nature Agency was not welcomed by its directors, although the Dutch landscape was "exhausted by a series of re-allotment programs," and in need of a vision for its future (Sijmons, 2015).

With the start of the plan "Living Rivers" launched in 1992 by World Wide Fund for Nature and largely inspired by the Stork Plan, the idea was also growing stronger that riverine nature did not consist of permanent and fixed habitats to be defended at all costs, but rather of dynamic processes that could also be created and enhanced by human intervention. Nature development was then already practiced by the Stadsbosbeheer Agency, next to traditional nature conservation, "the only difference between the strategies [being] the length of time during which human interference is accepted in the system after the initial management measures" (de Hullu, 1995). In the world of water management, attention had slowly shifted from purely defensive strategies, based on "Pavlovian" reactions (Sijmons, 2015) – more water call for higher levees – towards more dynamic visions, integrating alluvial nature as an important and malleable component of the river landscape.

After four quiet decades that had seen Holland remain safe behind its new sea dams, the country endured a major flood event in 1993, this time from the Meuse River that flooded 6000 dwellings and about seven percent of South Limburg province, generating damage estimated at 250 million guilders (Heezik, 2007). Although the inundations claimed no human victims, the disaster created the "same shock-effect as in 1953" (Nienhuis, 2008: 548), laying bare the limited capacity of man-made channels, the crucial role of the river levees, and the exposure of the densely built river regions. The Dutch Government quickly created the Maas Flood Committee to investigate possible flood defense in the Meuse basin (the "Maas Watersnood Commissie," known as "Commissie Boertien II" after its chairman). In its final report, "The Meuse Back" (De Maas terug, 1994), the committee made a recommendation largely inspired by the Stork Plan and by the plan Living Rivers: combine material exploitation and nature development – already planned in the region – in order to restore the discharge capacity of the floodplain; raise the dikes only where necessary; prevent further construction in flood-prone areas (Heezik, 2007: 100).

Areas evacuated during the 1995 high waters. (Ill. Rossano, from: De Gast. 2004)

Before the Meuse could be widened and secured, water rose again in the Rhine and Meuse Rivers in January 1995, after days of heavy rain in both catchment areas. Low parts of the Dutch Limburg region were again inundated. With the 1993 flood still in mind, 250,000 people were evacuated from the downstream River Region out of fear for a larger catastrophe. The situation eventually remained safe and people returned home again after less than a week, but the massive evacuation left the country in shock. After that second, traumatic event, levee strengthening was seen by the public as an absolute priority, far above "LNC assets" and environmental concerns, held responsible for delays in maintenance works. Previous environmental protests against levee reinforcement were made null and void, as "people who had previously opposed the reinforcement [were] given the cold shoulder and treated like wartime collaborators, so to speak" (Sijmons, 2015). The public fear and uproar led to a massive increase in public funding for flood defense, channeled through the Delta Plan Large Rivers and validated by the Parliament in April 1995, only three months after the events.

The plan created the financial and procedural conditions for the accelerated implementation of maintenance and reinforcement works. This acceleration was made possible through "the shortening of delays and neutralization of dozens of laws" (Ministerie van Verkeer en Waterstaat

1997b: 2). Another accelerating factor was the Flood Defense Act of January 15, 1996 that made it possible to proceed with legal validation procedures before the necessary environmental assessment reports (MER) were finalized. The Flood Defense Act also shortened expropriation delays from fourteen down to three months (id.). Besides being procedural, this mobilization was also financial: For the year 1996 alone, the State spent 225 million guilders on the Delta Plan Large Rivers, and in 1997, all emergency measures were implemented. Hundreds of kilometers of levees were restored and reinforced during large infrastructural works stretching from 1996 to 2000. Unlike the earlier Delta Works, landscape and ecological concerns were integrated into the new campaign, but remained limited to general principles, such as "the limitation, as far as possible, of the degradation of Landscape, Nature and Cultural (historical) values" (Ministerie van Verkeer en Waterstaat, 1996).

Deeper reflection on territorial issues, however, were sustained, fueled by growing concerns about the future effects of climate change, in particular rising sea levels and more erratic regimes in the large rivers. Furthermore, the surge in financial resources allocated following the 1993 and 1995 high waters indirectly benefitted to landscape redevelopment: "Although there was haste and less participation, there was also more money, which made it more easy for the proponents of stronger levees to respect the 'LNV assets' (...)." This was also expressed in a growing interest for an alternative, more "natural approach to flood defense" (Heezik, 2007). The shift from coercive measures towards spatial strategies that had been brewing since the 1980s reached the political foreground, nationally and internationally. Agreements were made soon after the 1995 floods to promote a transnational approach that would integrate flood protection, land use, and environment policies: The Declaration of Strasbourg, made in March 1995 by Ministers of Spatial Planning from the Rhine and Meuse Countries; the 1995 Arles Declaration, by which EU and Swiss environment ministers agree on spatial prevention policy and floodplain restoration; the recommendations made by the International Commission for the Protection of the Rhine, created in 1950 by all countries crossed by the Rhine river; and the Werkgroep Hoogwater Maas, created in 1995, that associated France, Belgium and the Netherlands into a better flood prevention for the whole Meuse watershed (id.: 103).

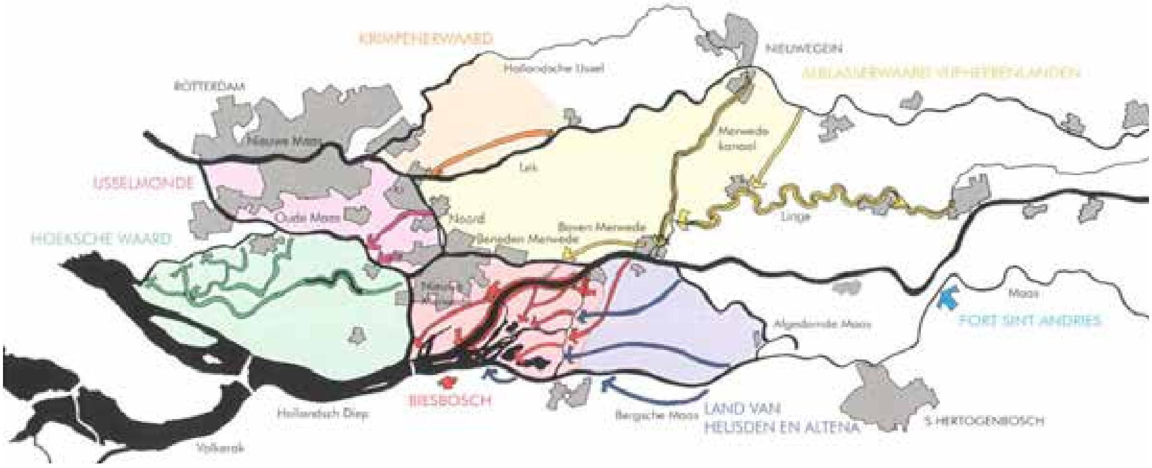
Eventually, Dirk Sijmons' private office for landscape architecture HNS was commissioned together with DHV engineering firm to apply the principles previously developed along the Waal and the Meuse Rivers in 1995. Between Afferden and Dreumel, fifty kilometers of levees were transformed according to new design principles, which for Sijmons, marked "one of the moments when technicians and designers learned to work together"; it also announced the return of spatial quality within the scope of flood management, a dimension that would gain importance in the "Room for the River" program.

From policy to proposal: Opening the scope of possible measures

The "Room for the River" concept was progressively engraved into governmental reports and policy documents, as the emphasis shifted further from flood defense infrastructure to long-term spatial measures. The 1996 governmental "Room for the River" Policy Guideline drew new conclusions from the 1993/1995 floods and expected sea level rise, a phenomenon already established in the 1980s. It set the tone for the future decades in a document eloquently signed by both the Minister of Water and Transport and the Minister of Housing, Spatial Planning and Environment. The document states: "For the short term, the Delta Plan Large Rivers allows for the accelerated reinforcement of levees and the construction of riverbanks along the undiked Meuse. In the long term, sustainable protection will not come as a result of continuous heightening of the levees, but much more from measures intended to give more space to the river in order to accommodate higher river discharges" (Min. van Verkeer en Waterstaat et al., 1996: 9). The document is particularly critical of past diking and compensation policy that permitted narrowing or occupying the river's winter beds and floodplain. Despite compensating measures, "we still must admit that the possibility of accommodating future higher river discharges was in fact diminished over time. With each activity [taking place in the floodplain] and its related compensation, a piece of spare space for the river was eliminated." This observation led to practical applications: Floodplains should be preserved in order to accommodate future water discharge levels and should only be used for activity directly related to the river; extra discharge capacity should be created through the extension and lowering of the floodplains; and exposure should be limited in the areas along the Meuse that are outside the primary levees (id.).

From then on, governmental reports consequently presented river widening as preferable, if not inevitable. Furthermore, a close link was made between river management and spatial planning, that broke with centuries of land expansion at the cost of water bodies: "The near-floods in the Rhine branches and the floods in the Meuse basin make it clear that rivers should get more space. To achieve this goal, more coherency is needed among water, spatial, and environmental policies" (Min. van Verkeer en Waterstaat , 1997: 3). The Governmental Statement of 2000 (Min. van Verkeer en Waterstaat, 2000) again confirmed the new strategy and launched the planning process that would lead to operational "Room for the River" proposals for the different river branches and regions.

The Dutch Government addressed regional situations with a series of specific reports at the turn of the century. Following the 1995 Delta Plan Large Rivers, a broad preliminary investigation involving various disciplines was engaged in 1997 by the Rijkswaterstaat agency vis-à-vis possible interventions along the lower rivers, including one specific study dedicated to the Biesbosch region. The general report, entitled "Integral Foresight Lower Rivers" (Integrale Verkenning Benedenrivieren, 2000), was compiled by the Rijkswaterstaat's South Holland Direction, under the supervision of representatives from the Provinces of South Holland and North Brabant, from the Union of River Municipalities, and from the Union of Water Boards. It explored various ways to increase the discharge capacity on the lower branches of the Rhine and Meuse Delta (Lek, Waal-Merwede, Bergsche Maas-Amer, Old Meuse, and New Meuse) that all flow through densely populated regions, including the scattered Rotterdam-Rijnmond agglomeration. Here again, the report stressed the necessity of a new approach: "While it was a common idea in the past century, to add a bit more on top of the dike to keep water out, future solutions will be sought after in terms of width" (Min. van Verkeer en Waterstaat, 2000b: Samenvatting). Thirty-one possible measures were sketched and regrouped into three scenarios: In between the dikes; Flow through the Biesbosch; and Green rivers (id.: 10-11). A cost-benefit analysis study commissioned that same year concluded that, in many cases, "room for water" measures appeared beneficial compared to heightening the levees or no intervention (Stolwaijk et al.: 2000).



Possible measures investigated for the lower rivers
(RIZA et al.: 2000)

Three combinations based on 31 possible measures for the lower rivers
(Min. van Verkeer en Waterstaat, 2000b: Samenvatting)

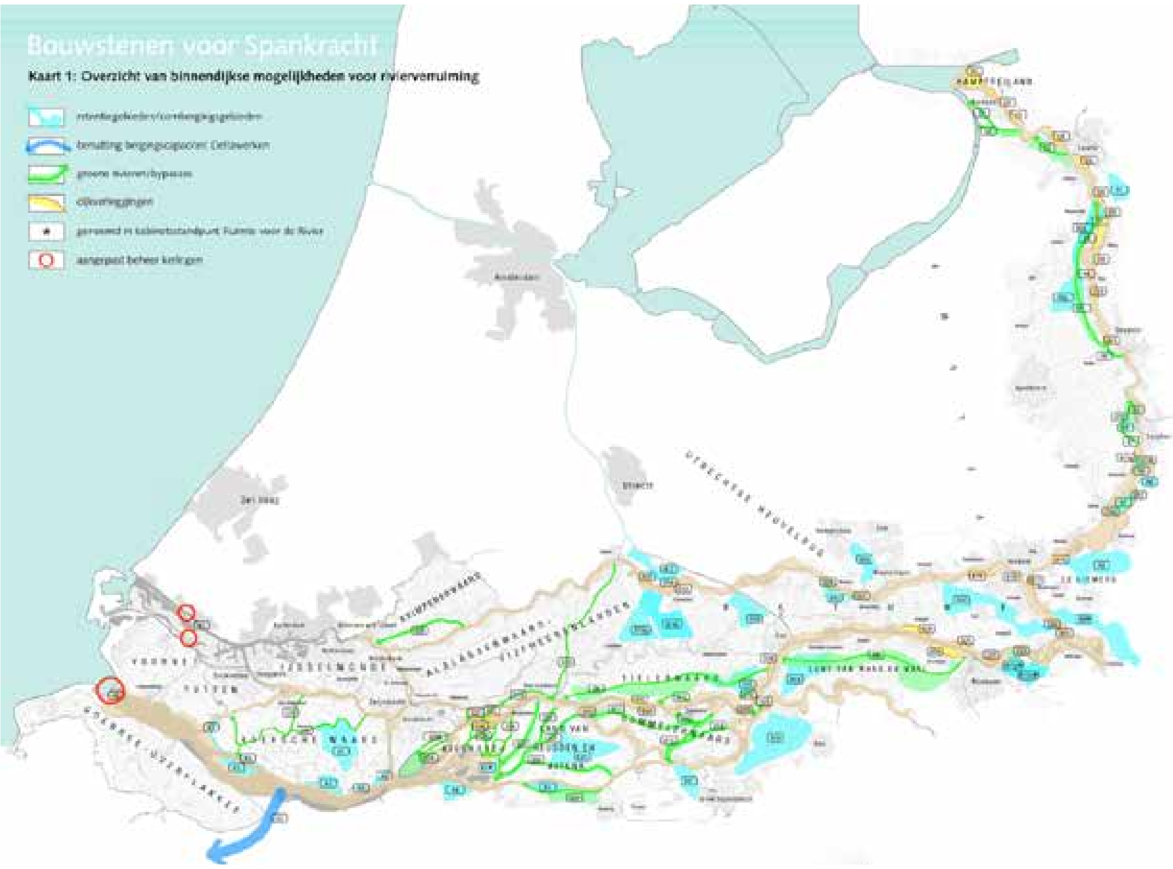
In 2001, the official discharge reference for the Rhine was heightened from 15,000 m3/s to 16,000m3/s (maximum peak discharge at the Dutch-German border), and for the Meuse from 3650 to 3800 m3/s as "a result of the integration of the 1993 and 1995 high river discharges" (Projectorganisatie Ruimte voor de Rivier, 2005: B, 35). This significant step had immediate implications for the whole Dutch dike network. Dutch law indeed guarantees the safety of each hydrological region (or "dike ring") up to a certain flood probability. This probability is itself calculated on the base of a reference peak discharge, and, with the rise of this reference for the Rhine and the Meuse Rivers, the government committed itself to take the necessary measures to maintain the same safety level. The reference level was thus significantly increased, but this time with the new "Room for the River" Policy Guideline: the new safety goal should, as far as possible, be achieved through spatial measures.

At the end of 2002, a synthesis for the whole river system was published by Rijkswaterstaat in association with ministries, provincial authorities, and water boards, entitled "Elasticity of the Rivers Region" (Spankrachtstudie Rivierengebied). The report explores and combines various options available to reach the new discharge reference. The study foresees a growing role for the Waal/Merwede channel as "long-term navigation and discharge route," where the "intensification of river-related economy and the maintenance of navigation depth can be perfectly combined with the development of highly dynamic nature" (RIZA, 2002: 8). It sets as a general goal "the realization of a large-scale nature area from the banks of the Waal River through the Biesbosch, the Island of Dordrecht, the Hollands Diep, and Haringvliet down to the fore-delta." The nature area envisioned "can form a robust spatial buffer between the Brabant sandy lands and the Randstad." Anticipating a possible reopening of the Haringvliet dam, the report adds:

"The long-term perspective is the realization of a fresh-salt water transition, and to give space to the tidal and river dynamics" (id.: 24). For the southern delta, the report thus clearly hints at a combination of intense river economy on the Rhine-Waal axis, and a greener and more dynamic future for the Biesbosch and Hollands Diep to the south.

Still a preliminary step on the way to a concrete program, the "Elasticity Study" does not, however, deliver a plan. Instead, various possible measures and combinations are listed, evaluated, and shared through an ad hoc computer program: the so-called "construction box" (blokkendoos), distributed on a compact disc by Rijkswaterstaat. The software allows its user to choose and combine various measures, and check in real time the efficiency and the financial implications of the chosen combination. This tool used during the discussion, allows the participants to elaborate various scenarios to answer the global goals set by the initial inquiry on regional water safety, and especially to discuss various options on a common and neutral basis. Although the Water and Public Works Agency was then leading the planning process, the "construction box" allowed the technicians and engineers to outline the goals and the scope of possible interventions, yet remain in a detached position when it comes to spatial policy: "It is very important that Rijkswaterstaat clarifies the safety task within the Key Decision, something that the society can not just make up, and says clearly: If you do not act here, we will have to heighten the levee there, and we do not want that" (Der Nederlanden, 2013).

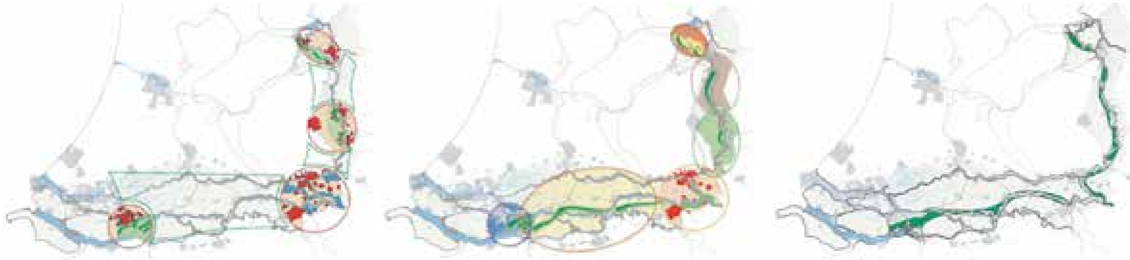
The "construction box" made legible for provinces and municipalities that various options are then still open and combinable – and Dirk Sijmons would later stress that all projects eventually integrated in the "Room for the River" program would indeed be a combination of several types of measures. Furthermore, the "construction box" also allowed Rijkswaterstaat to "involve various parties in the exploration phase," although progressively, as "there are so many different interests and priorities that one has to stay in control of this phase of generating support" (Sijmons, 2015). The chosen strategy is indeed not fully "bottom-up": the "Room for the River" team opened the discussion at a preliminary stage, but kept a firm hand on the sequencing of the planning process to avoid stranding the plan in endless discussions, a concern shared by Rijkswaterstaat (Der Nederlanden, interview, 2013; Sijmons, interview, 2015). As it would be stressed retrospectively, "there is strong evidence that collaborative approaches can be only successful when they are complemented by more hierarchical, top-down arrangements" (Warner et al., 2013).



Overview of possible river enlargement measures within reclaimed areas. In green: spillways/bypasses, light blue: retention areas, dark blue: retention potential offered by the Delta Works, red: adapted use of existing barriers (From: RIZA, 2002: eindrapport, 32, Detail)

The project as tool of involvment

Rather than elaborating a global program to be later submitted to national and local representatives, the "Room for the River" agency tried to facilitate the planning process by involving local parties in the preliminary design, years before the program was actually made official in 2006. Possible measures were exposed, discussed, and adapted during a large "consultation tour" across Water Boards, municipalities, and provinces of the two river regions (Upper and Lower Rivers). In terms of spatial strategy, the 600 potential measures resulting from all the preliminary investigations were grouped into three thematic approaches as to how the river landscape could be adapted in a coherent way: 1) Solve the problem in combination with landscape redevelopment in urbanized regions, 2) create new bypasses (or "green rivers") in low areas, and 3) structurally relocate the river levees to create a wide and continuous river zone. All options appeared feasible, but the second and third options implied a major loss of farmland. The first option thus received the most attention and governmental preference, since it identified areas offering "opportunities to combine urban development with robust nature cores and recreation possibilities" (Projectorganisatie Ruimte voor de Rivier, 2007, 27). The combinatory approach also implicitly suggested possible advantages for the Dutch Treasury: "The Water and Public Works Agency had limited financial means (...) and maybe the measures could be combined with local developments and so turn out to be much cheaper, this at a time when real estate development was a profitable national 'hobby'" (Sijmons, interview, 2015).



"Pearls on a string," "Old and new rivers courses," "Widened river ribbon":
Three landscape strategies to increase the global discharge capacity of the main rivers
(From Projectorganisatie Ruimte voor de Rivier, 2007, 1.2: 26-28)

During the consultation round, possible measures were exposed and various combinations were discussed, a discussion that generated local willingness and interest for the national program. Out of the six hundred possible measures, thirty-nine projects eventually emerged, often combining different measures that could count on local support and allow for a good distribution of the measures over the River Region – as "concentration of all measures along one river branch, for instance, was not an option" (id.). On the other hand, proposals that were not positively perceived by local authorities, such as a partial de-poldering of the Island of Dordrecht, were soon dropped in favor of less conflictual options – in that case a shift towards the reopening of the Noordwaard polder, a measure that appeared to be extremely effective in reaching the hydraulic targets. Above all else, this informal consultation process allowed projects to emerge that were "welcome in my backyard" and seemed "ready to start as they were already granted the green light at the local level" (id.). Although more detailed and complex negotiations with inhabitants were still to come, this first round with local representatives and managers later proved to be "one of the extraordinary success factors for the 'Room for the River' program" (id.).

Next to this first consultative approach, the "Room for the River" Agency imagined a second way to generate willingness among local parties: the so-called exchange rule ("omwisselbesluit"). This rule gave local authorities the possibility to propose alternative measures, as long as these measures could reach equivalent results and would not lead to higher costs for the government's budget. Kampen's bypass and the "terpenplan" in the Overdiepse Polder are examples of locally initiated plans that are now being implemented. For Kampen, a large lowering of the river floodplain was first proposed, but the city envisioned a new by-pass between the River Ijssel and the lakes south of Flevoland, which could be combined with future urban extension. The Overdiepse polder was initially planned to lose its agricultural function, in part or in totality, in order to expand the Bergsche Maas floodplain, but farmers appeared attached to their land and ready to exploit a polder that could be flooded at high water level, as long as the farms could be settled on safe grounds. A third spectacular "exchange-project" would be the Waal river in Nijmegen, which saw the creation of a second river branch, a new island, and waterfronts, to the benefit of the city's urban ambition. In all three cases, the Water and Public Works Agency studied the proposed alternatives and engaged in an open discussion with their promoters, sharing its knowledge rather than following traditional authoritarian strategies based on exclusive expertise.

Finally, the implementation of the projects, funded by the central government, was largely decentralized to local authorities, provinces, water boards and municipalities, who could better balance local interests and opportunities in contact with the stake holders directly concerned by the various projects, developed under the aegis of Rijkswaterstaat and the direction of the Room for the River program.

“Room for the River,” location of the 39 planned interventions, Biesbosch area marked in red. (2006: PKB Room for the River, summary: 5)

Embedding spatial quality into flood prevention

Considering the expected rise in reference discharge levels, the government chose to promote measures that prevented reference peak levels from rising further, meaning that the emphasis shifted from levee improvement to river widening, in addition to measures outside river channels that would also expand the actual floodplain. Furthermore, it was decided that "levee improvement should be implemented only on segments where other measures are inappropriate or impossible to finance" (PKB Ruimte voor de Rivier, Kabinetsstandpunt, Nota van Toelichting: 7). Far from being presented as an ultimate solution, the program was seen as a first step in an ongoing adaptation process: "Because of climate change, the safety of the rivers region will need ongoing investment. This is anticipated in this Spatial Key Decision, through the reservation of a limited number of areas for the river-widening measures that will be necessary after 2015" (id.). And indeed, in accordance with future climate projections, it was thought that the Rhine peak discharge would already possibly increase further to 18,000m3/s after 2050 (RIZA 2002: 15).

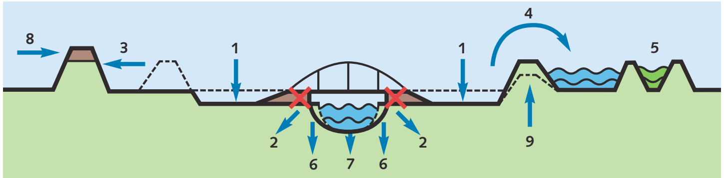
Discharge capacity was, however, not the only criterion: Differing from the previous programs implemented in a long history of flood defense, "Room for the River" set itself a second ambition: spatial quality, a criterion introduced in the Dutch spatial policy during the 1980's, i. a. in the Fourth Memorandum on Spatial Planning (Dauvellier, 1991). Although priority in Room for the River was given to flood prevention, its relationship with spatial quality was clearly articulated by the governmental documents. With this second goal, the River Region would "be made more attractive and more livable." The relationship between flood prevention and spatial quality was a subsidiary one, but spatial quality was a decisive element: "Achieving quantitative safety objectives will remain compulsory. This does not mean that safety objectives are the only [criterion] to choose from in the areas where "room for the river" will be created. It is rather both objectives that will determine where room should be found and how measures should be implemented" (Projectorganisatie Ruimte voor de Rivier, 2003).

With the Planning Key Decision "Room for the River" (PKB), first published in April 2005, adapted and validated in December 2006 and widely communicated, this change of philosophy within the Dutch Flood management turned into a program and the program into law. Without explicitly criticizing past policies, the government clearly acknowledged the shortcomings of containment measures that had characterized the Dutch water management for centuries. In its introduction, the document depicts in clear terms the growing exposure of the river region: "In past years, rivers were deprived of a lot of space; as a result, rivers were confined between levees that were heightened again and again over the past decades. In many places, the land behind the levees had sunk. Due to demographic development and economic growth, the assets to be protected have increased significantly. A flood would have huge consequences" (PKB, 3, 2006: 7).

With this (in the Dutch context) revolutionary statement, the government took a clear stance for horizontal solutions to fight increasing flood exposure, aiming at a long-term and sustainable approach: "The government has decided to raise flood protections to legal reference level no later than 2015, and to improve the spatial quality of the rivers region" (idem.). Replacing the old "LNC-waarden" (Landscape, Nature and Cultural-historical assets), the new concept of "spatial quality" was brought forward as a main requisite that incorporated various criteria, thus committing the state to qualitative results but leaving space for interpretation and local variations. As made explicit in the official program validated in 2006, "Room for the River" should "contribute to the improvement of the river region's spatial quality and simultaneously strengthen its economy, ecology and landscape," it should pay attention to the "preservation and the development of protected natural assets," and it should make the region altogether "more attractive and more livable" (PKB 4, 3: 2006: 9).

Rather than a systematic and uniform river widening, the program "Room for the River" presented itself from the beginning as a "tool box" consisting of various measures that could be taken and combined locally, and identified thirty-nine locations where these measures were thought to be feasible and effective, adding a few locations where spatial reservations should be made for future adaptation measures. Furthermore, the program should seek to combine water-related measures with other functions, making it clear that the governmental decision was no carte blanche for unlimited wetland creation and floodplain restoration, but rather should associate the retention function with other profitable land use – whether new or preexisting.

Practically speaking, the program largely communicated the types of measures that might be used to reach the general goals. The first list included six literal ways to give rivers more space: Removing obstacles from the riverbed, lowering floodplains or winter beds, lowering groins, creating high water channels, displacing and relocation river dikes, temporarily storing water in existing lakes, and temporarily storing water on farmland. However, the original toolbox, entitled "six new ways to safety" and nicknamed the "six-pack of spacemakers" (Sijmons, 2009), eventually expanded. "People found that it might be too dogmatic to put only measures that were literally making space (...). 'Strengthening dikes' was added, and it did play a role in the implementation. 'Water storage' and 'summer bed deepening' came along, and the toolbox got extended in terms of its initial definition" (Sijmons, 2015).



Nine types of possible measures
(Projectorganisatie Ruimte voor de Rivier, 2006: 38)

As it appeared, the notion of "room" in this context could be ambivalent. For the advocates of a radical change from containment to spatial flood management, the concept implied that more space and more land had to be made available for river fluctuation. Partisans of traditional flood defense technique preferred to interpret "room" as a general quantitative concept including any measures that can increase the discharge capacity of river channels and floodplains. Dirk Sijmons retrospectively perceives these additions as an attempt on the part of the promoters of containment strategies to reintroduce exactly the sort of measures that were meant to be avoided by the program, a reaction he considers "Pavlovian" within the context of Dutch water management (id.)

A key tool in the promotion of spatial quality and the safeguarding of the "Room for the River" approach was the creation of the "Quality-Team," or Q-Team, initially composed of Dirk Sijmons (chairman), Frans Klijn, Maurits de Hoog, Dick de Bruin, and Sjef Jansen. Respectively landscape architect, geographer, urban planner, river expert, and ecologist, they together composed a multidisciplinary team that over several years would supervise the elaboration and the implementation of the various projects. The Q-team however faced the difficult task to evaluate the project's "spatial quality", a relative concept. Former Governmental advisor for Architecture Tjeerd Dijkstra had in the 1980's introduced Vitruvius' principles for good architectural design, *utilitas*, *firmitas* and *venustas*, as an evaluation tool (Sijmons, 2006). The Q-team translated this triple criterion within the context of the Room for the River program: projects should meet and combine hydraulic effectiveness, ecological robustness, and cultural meaning and aesthetics (id.), with a special attention given to the relations among the criteria. Hydraulic effectiveness was obviously already assessed at the time the projects were to be detailed and built, but the Q-Team chose to consider "the relationship between hydraulic effectiveness and form, as well as about all other functionalities of the site", that most impacted the life of inhabitants (Klijn et al., 2013).

Being unable to judge the result of projects involving long-term processes, the Q-Team decided to also "assess the planning and design process as such, so that we could give useful recommendations in early stages and thus influence the designs when still possible" (id.): more than a fixed preliminary framework or a subsequent judgment, the aim was to provide active and continuous guidance to the authors and to the authorities in charge of the projects.

Flooding the Biesbosch (again)

During the years of planning investigations, it appeared preferable to concentrate the measures on the Meuse and Waal branches rather than on the Lek River. The latter had the disadvantage of streaming through densely populated areas, offering less space for widening and a narrow outlet channel through Rotterdam. On the contrary, the Meuse and Waal branches offered a long-term opportunity for spatial measures. They could also divert future additional discharge towards the wider Delta inlets, including the Volkerak, where extra capacity could be made for emergency retention whenever sea dams had to remain closed. At the crossroad of the Meuse, Waal, and sea inlets axis was the Biesbosch region. With its significant nature areas, its low building density, and its long history of frequent conversions from land to water and water to land, the Biesbosch was naturally seen as a place of opportunities for "Room for the River" measures.

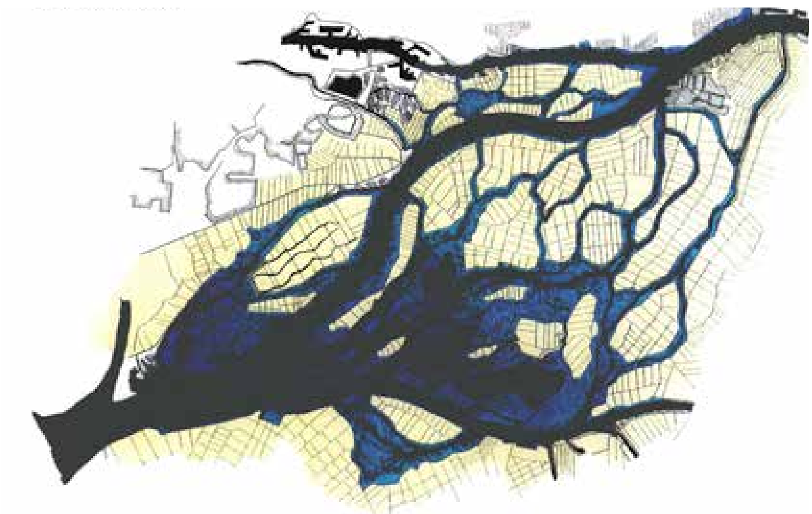
The "construction box" software made it possible to model the hydraulic effect of various possible measures – among others, the diversion of the Merwede waters to the south through the existing Steurgat stream, to the north through Dordrecht's Biesbosch Polder, and to the southwest by lowering the Merwede levees. The first one appeared to be the most effective to reach hydraulic and spatial quality goals, followed by the second and third measures, classified as average (RIZA, 2002: 125).

In the following design session, the creation of a large flow corridor through the Noordwaard polder appeared to have a strong short-term and long-term effect on the peak level in the Merwede River; it also appeared to be the favorite option of the session participants – although declared controversial by the steering group (Veerschelling, 2003: 12). But despite the possible controversy, it was again the vision of a wide-open Biesbosch that aroused interest and was elaborated further towards an operational plan.

As shown by the 1995 flood, the Merwede bottleneck addressed, among others, by the 1730 Cruquius plan, remained problematic. The area was not exempt from dramatic events: in January 1995, 9000 inhabitants of Gorinchem had to flee the threatening flood risks from the Merwede River, and a thousand were temporarily hosted in an evacuation center for several days (De Gast, 2004). After this near-catastrophe, options were again sought in the surroundings to lower water levels along the sensitive urban shores of Gorinchem, Dordrecht and upstream.

As a part of the elaboration of the 2000 "Integral Foresight of the Lower river," landscape architects Bosch & Slabbers were commissioned to study possible landscape adaptations in the Biesbosch Region, in collaboration with the Planning Department of the National Water Agency Rijkswaterstaat, which resulted in the report "River widening and landscape development in the Biesbosch" (RIZA and Bosch & Slabbers, 1999). The team explored the history of the region and analyzed the different compartments fragmented by modern channels and land use specialization. Not only had the Biesbosch been divided by the digging of the Nieuwe Merwede and Bergsche Maas channels, it had also lost its coherency through changes and various concentrations in land use. The Sliedrechtse Biesbosch consisted of small spaces unified by a dense, organically grown water network, just as the south of the island and the west of the Brabant side. South of the Nieuwe Merwede, the landscape was characterized by numerous small polders surrounded informal, ancient streams bordered by linear vegetation. East and south of the region had lost most of their former wetland character and now formed continuous lands with a few, wide waterways. Finally, a singular, vast and strongly engineered landscape characterized the Dordrechtse Biesbosch Polder.

While stressing the various qualities of the Biesbosch landscape, the authors lamented the fact that "in the current situation, it is impossible to imagine that the whole area stems from the same initial situation, that it once was a united system. The spatial coherency is lost. (...) The Biesbosch is brought back to a limited nature area surrounded by crop polders" (id.: 67). The study advocated the reopening of historical streams that have been progressively dammed since the nineteenth century, at their upstream end or both up- and downstream. It also suggested reshaping the farming polders and returning them to a scale corresponding to an earlier stage. Consequently, the authors supported the reopening of the Noordwaard polder to old creeks and saw it as an opportunity to emphasis the historical archipelago structure of the Biesbosch and use it as a framework to shape a more dynamic water landscape. They stressed the possibility offered by the option to "reinforce lost coherency" and the "creation of new spatial quality" (RIZA and Bosch & Slabbers, 2000: 53).

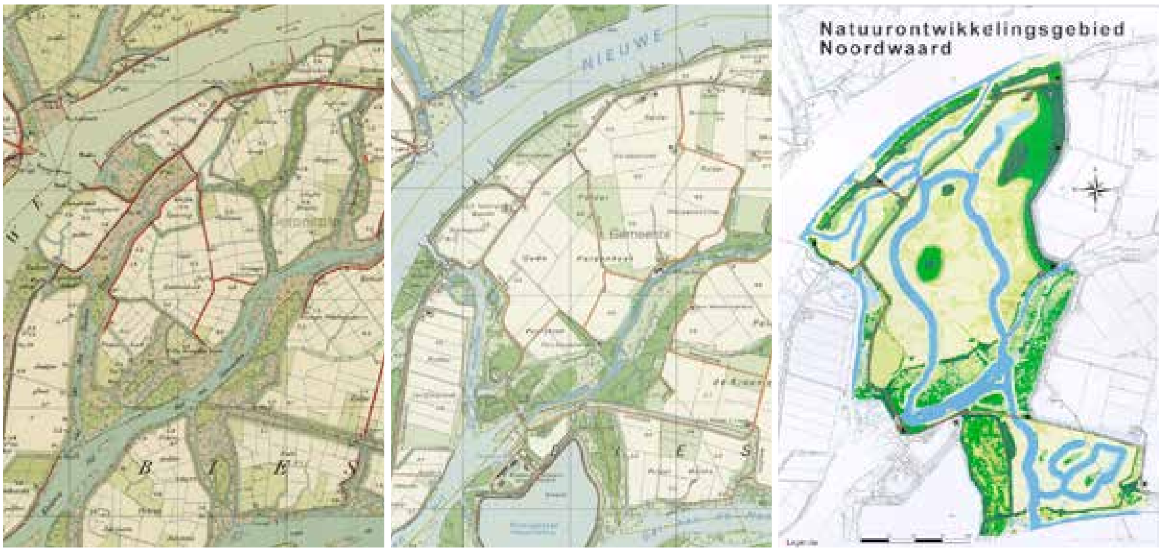


Proposed landscape structure for the Biesbosch
(from RIZA, Bosch&Slabbers, 1999)

Noordwaard gradual landscape

Before the landscape study could lead to concrete results, there has already been a plan to turn the western part of the Noordwaard area into wetlands and expand the National Park De Biesbosch by another six hundred hectares. This local plan existed already in 1992 and materialized at the end of the nineties, as a contribution to the "EHS" project – a new nature corridor through the whole country, and as a part of the governmental program Nadere Uitwerking Rivierengebied (NURG), meant to develop "new nature" along the large river. After its official validation in 1998, a third ambition was added to the project: contribute to the reduction of river flood risks, in accordance with the 1996 "Room for the River" governmental guidelines. The project was consequently adapted to offload the Merwede channel during peak discharge and contribute to the safety of the neighboring cities. Eventually, the clay gained from the project was also be welcome for the construction and reinforcement of new levees within the Deltaplan. The final design presented by the engineering firm Grontmij was validated again in 2002.

Led and designed by the Rural Areas Department and the Governmental Water Agency, this initial project progressed rapidly. The process was accelerated by a ten percent "sale bonus" offered to farmers and inhabitants, along with a possible land exchange with neighboring parcels owned by the Department of Rural Areas (Van Herwijnen et al., 2003: 33). Arable land was removed, topography was lowered and unformalized, new channels were dug to let waters flow in, and the area was totally transformed into a large wetland punctuated by a few heightened islands and later a land art piece at the Northeast. In May 2008, the "Small Noordwaard" nature development was officially opened by Prince Willem of Oranje. However, this first "renaturation" project, today celebrated as a "bird mecca," paradoxically accelerated the disappearance of the Biesbosch cultural landscape praised in the 1999 landscape study, again in the final "Foresight lower rivers" report finalized in 2000, and yet again in the 2005 report "Noordwaard: Designing with cultural history" elaborated by Bosch & Slabbers in collaboration with the Water Agency Rijkswaterstaat and various governmental departments in charge of archeology and heritage. In spite of these consecutive recommendations, the "Small Noordwaard" was reshaped without much concern for the initial landscape structure, born out of ancient streams and mudflats, and characterized by small and rounded patches of heightened land and a fine, reticulated network of tidal streams: The former contours, dikes, channels and ditches, already altered by the 1950s re-allotment, were further erased and replaced by a vast wetland fed by a formless water network, unrelated to the past nor to the present surrounding landscape of the area.



"Nature Development Noordwaard," plan area in 1950, 1988, and project map, 2002
(Topgrafische kaarten Kadaster, project Rijkswatersaat/Grontmij)

The "Integral foresight large rivers," however, envisioned a wider plan, whose priority was to allow the Merwede to flow right through the Noordwaard polder during high discharge, from Werkendam to the estuary. The regional development plan already integrated the potential transformation of the area in 2002 – although the "Room for the River" program was not yet officially validated and the polder remained officially dedicated to stock farming. The 2006 Key Decision "Room for the River" confirmed the long-term plan and defined the ambitions: a lowering of the river level by at least 30 centimeters in Gorinchem at peak discharge 16,000m3/s at the Dutch-German border, along with increased spatial quality. The de-poldering was presented as "the first step in the direction of a sustainable long-term solution for this area" combined with a "positive impulse given to its spatial quality": "the de-poldering of the Noordwaard materializes an area around the Biesbosch that is shaped in a more natural and more dynamic way" (Projectorganisatie Ruimte voor de Rivier 2006: 50).

Prior to the validation of the Room for the River program, the Dutch population was made aware of flood risks through a nation-wide campaign, "The Netherlands lives with water" (Nederland leeft met water, 2002-2006), but local reality has been less harmonious, and the inhabitants were less enthusiastic about another de-poldering operation. The first Noordwaard Nature development project had not yet been completed, when a new de-poldering project was planned right next to it. One building had just been relocated from the "renaturated" area towards exactly that area, which was meant, in turn, to be re-opened to high waters – an isolated case that, however, damaged the image and credibility of the public authorities (Houwing, interview, 2012).

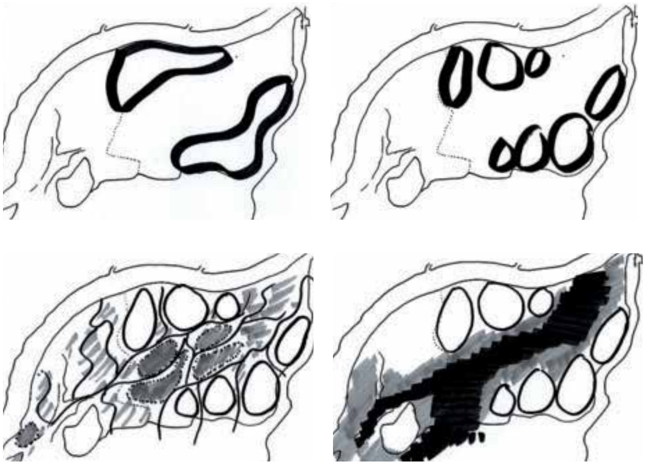
Furthermore, many felt that rural areas are again paying the price for the safety and recreational needs of urban regions. During the workshops organized by the "Lower Rivers Agency" (Bureau Benedenrivieren), many locals opposed the new plan and blamed public authorities for the incoherent policy and for the continuing uncertainty inflicted on the inhabitants and businesses. They joined forces within the local action group Alternatief Platform Behoud Noordwaard, which proposed a set of alternative measures that they considered sufficient to reach the goals set by the government without actually reopening the polder to (high) waters (2006, PKB 4: 118). This alternative was, however, rejected by the government and later by the Council of State for the reason that "the proposed alternative seems to reach the goals in the short term, but de-poldering remains necessary in the long term" (Projectorganisatie Ruimte voor de Rivier, 2006: 50).

Robbert de Koning, landscape architect from Arnhem, was commissioned to give shape to the project, in collaboration with the engineers and advisors of the Governmental Water Agency, working under the aegis of the newly opened "Bureau Noordwaard." A preliminary plan was soon presented (Ontwerpvisie, 2006), followed by an adapted version refined during a regional consultation round (Ontwerpvisie, Regio Alternatief, 2007).

All existing constructions were surveyed in terms of their resistance to future floods. Constructions that could hinder the flow, as well as those positioned too low to resist future water levels, were bought out by the state at "binnendijkse" value – meaning at the price one would pay for the same construction were it protected by a primary levee. This allowed farmers and inhabitants to move out of the area or plan a new construction within the Noordwaard, adapted to its projected situation.

Out of the twenty-five exploitations, only eleven could eventually remain in the plan in a traditional form, since the central flow corridor could not accommodate regular crop fields that would be damaged at every flood but only allowed for extensive livestock breeding. Since there were more candidates than places, a long and difficult negotiation process was necessary to redistribute land and building plots – a negotiation made more complex after the government granted all inhabitants the possibility to remain living in the area, committing the designers to providing new homes for those who wished to stay. New "terpen" were eventually built along the highest dikes to build replacement houses and barns at a safe level.

Work drawing overlapping actual levees and 1905 topographic map
(Detail, ca. 2005, Robbert de Koning)



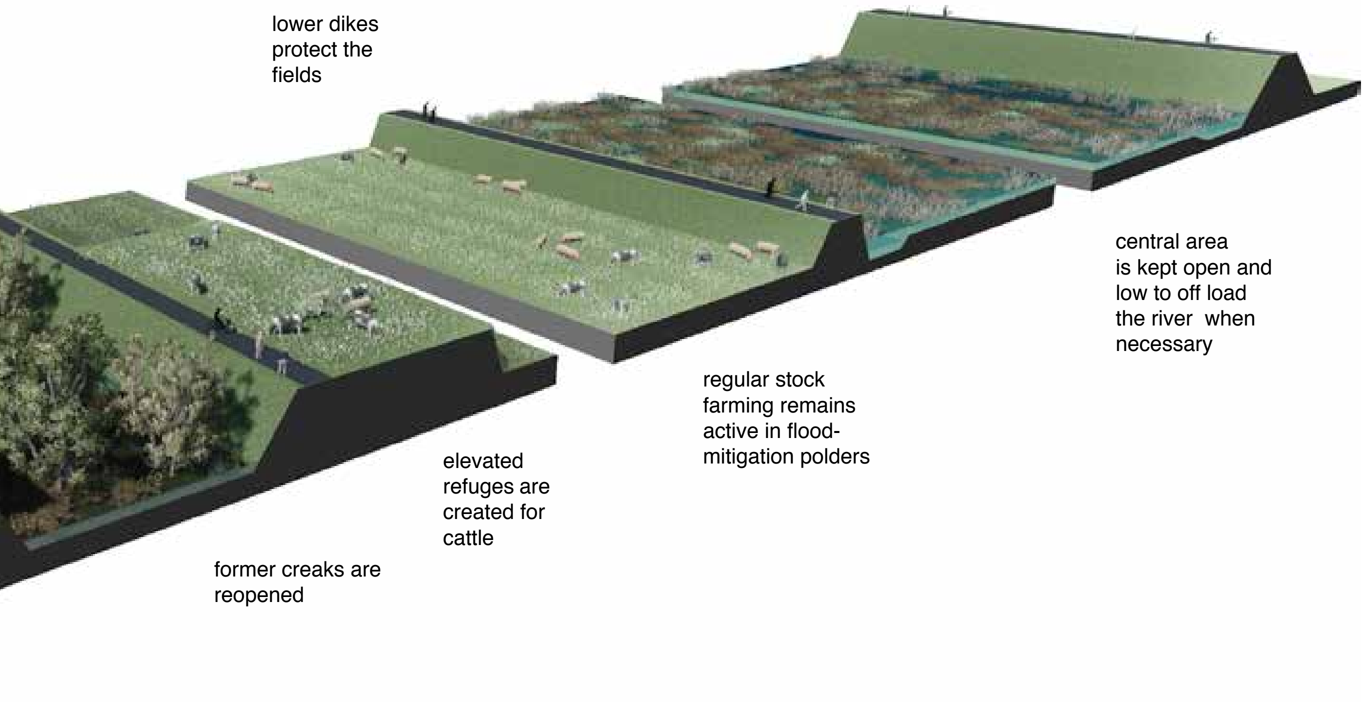
Study drawings for the Noordwaard Polder:
Central area open as emergency spillway,
two option for the periphery: large or small compartments
The chosen structure: high polders on the sides,
low floodable polders in the central area to let the stream
flow through at peak discharge. (from Bureau Noordwaard, 2006)

Following the direction suggested by Bosch & Slabbers in their 1998 and 2005 studies, De Koning took the 1905 topographic map as a reference and under-layer in order to shape the new "flood-ready" landscape. For the landscape architect, the Biesbosch was, before that point in time, "very wild, a barely cleared landscape," as "the river ruled (...) and the water was high." The configuration in 1905 was "more in balance. More embankments had been built; more land was cultivated. In terms of structure, the situation then better matched the current situation" (De Koning, 2013). Around this time, the Biesbosch had indeed largely been reclaimed by water, but the fine and meandering network of streams was still structural, forming, together with small polders, a complex but coherent cultural landscape.

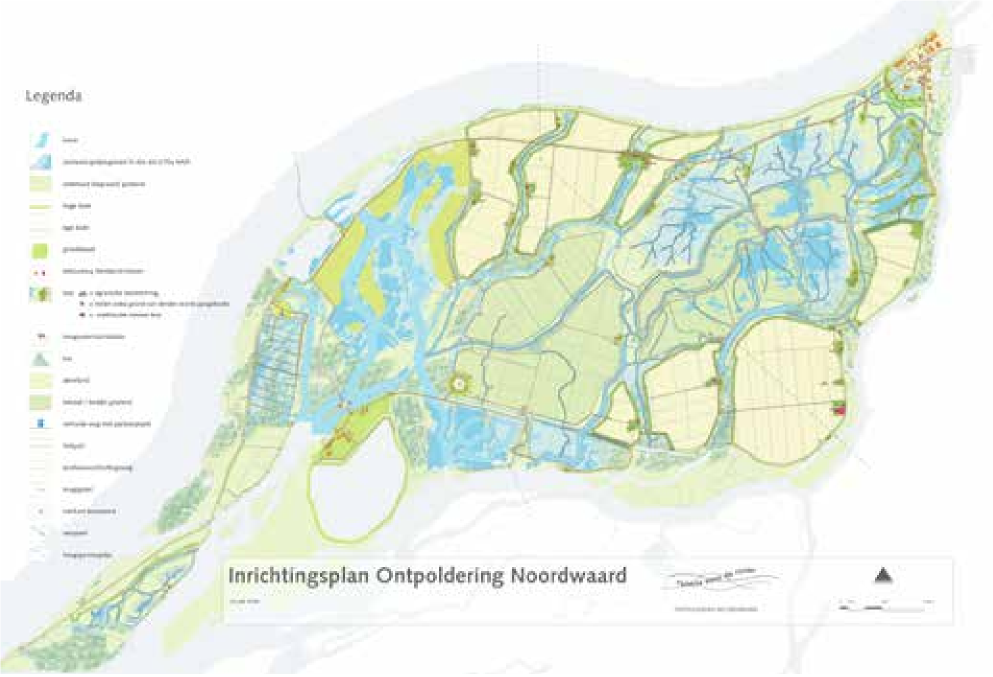
Overlapping a CAD drawing of actual levees and the 1905 map, the landscape architect thus looked for remaining lines and structures that could help to recompose a Noordwaard open to water. Many traces of former streams and embankments were still visible in terrain maps: Where streams used to flow the ground lay a few decimeters lower, since the organic materials present in the water had compacted. Former embankments could be traced back from the soil map. The old traces, however, were not literally rebuilt, for technical and aesthetic reasons. The newly built dikes needed to be slightly higher and wider than the historical dikes; instead, the landscape architects "mainly sought to create beautiful lines and views" within a "more differentiated space." The differentiation between high-dike polders bordered by trees at the periphery, and low-dike polders with low vegetation in the central flow corridor, created strong variations in openness.

Hydraulic studies showed that a wide, diagonal corridor was the shortest and most efficient way to let large amount of waters overflow from the Merwede towards the estuary. Furthermore, a southwest/north east corridor better respected the orientation of existing creeks and avoided existing inhabited hamlets; a large corridor of about 1500 meters width, where vegetation was kept low, precluded the costly construction of a narrow channel, which would include important spatial disruption and heavy digging and damming works. Finally, the chosen option allowed the existing polder structure to be maintained inside the emergency flood corridor (Bureau Noordwaard, 2007: 13).

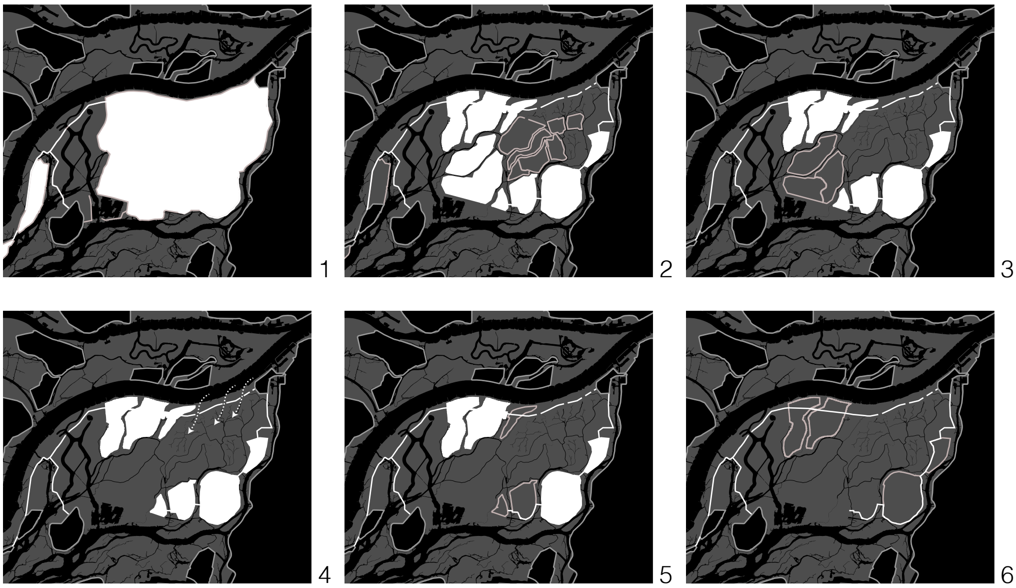
Opponents regretted that this option also enlarged the surface that needed to be regularly flooded, and thus reduced even more the land available for arable farming. Legal appeals were rejected, however, on the grounds of the "spatial quality" criterion: a large flood area integrating the historical creek structure was considered by the Council of State as more qualitative than a new canal dug through the Noordwaard (Beroep en oordeel Raad van State, 26.10.2011).



Schematic section of the flood gradient: permanent farmland within high dikes, new houses built on elevated platforms connected by high dikes, historical creeks reopened, low farmland diked but floodable by high water, nature area permanently opened to water fluctuation (Rossano-Orfanopoulos)



Development plan “De-poldering Noordwaard” (2009, Room for the River, Robbert de Koning)



Noordwaard /Biesbosch: diked/open areas in 2010 (1),
Submersion phases after project completion (2-6).
(Terrain data AHN/Rijkswaterstaat, image Rossano, source Projectbureau Noordwaard, 2007: 50)

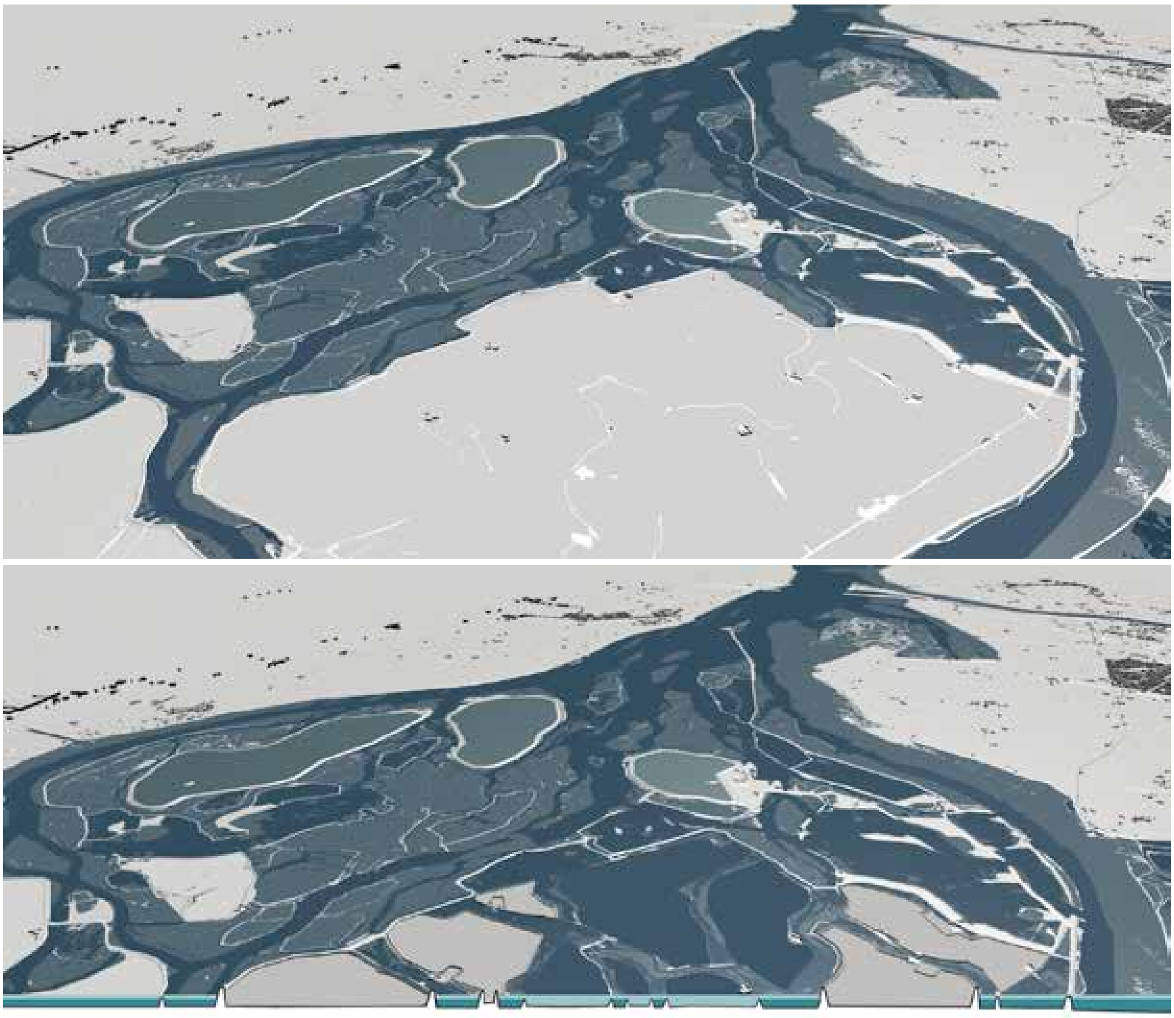
In terms of flood mitigation, the project allowed for various flood stages, from daily tidal flooding to extreme events, following a gradual transformation rather than a binary one. In the preexisting situation, Noordwaard formed an enclosed polder with a 1/2000 years flood probability (1). After completion of the project, five flood stages could occur. About 25 to 100 times a year, average high waters would come in from the estuary and progressively cover the areas surrounded by low dikes (2-3). Once a year, on average, the Merwede level would reach two meters above NAP

(Dutch reference level), and the river would flow in through the inlets created in the winter dike (4). Small high-dike polders would face a 1% chance of inundation per year at peak discharge (5). Eventually, the whole Biesbosch could be flooded at extreme discharge, with a flood probability of 0.1 % per year (6).

For the high-dike polders alongside the flood corridor, the designers chose seven small instead of two large polders in order to bring more differentiation between the inhabited and cultivated areas – making them more intimate and wooded – and the vast open horizons of the central portion. Farmers opposed the idea, preferring larger and continuous farmland over small compartments, but the inhabitants eventually chose the proposed option, attracted by the perspective of having more streams and creeks around the area and along the houses (De Koning, interview: 2013). Despite the differentiation among open, low-dike and high-dike areas, the whole Noordwaard officially changed status, from an "inside-the-dike" area to an "outside-the-dike" area (binnendijk and buitendijk, two distinct statuses in Dutch law). Depending on their altitude, part of the preexisting constructions were considered safe, while others would be uninhabitable. In this latter case, inhabitants and farmers were expropriated and compensated. Some chose to remain living in the area and to move to one of the five new "terpen" (see part 1) that were built along the new dikes. Inhabitants also would benefit from a major distribution of recreational facilities. With its new network of streams and wetlands, the Biesbosch would soon be expected to attract not only more wild species but also more human visitors. Inhabitants who had enjoyed the Biesbosch for its nocturnal darkness and its silence, feared this permanent nuisance – a word that appears no less than 27 times in the preliminary design booklet. To prevent future conflicts between ecological interests, residents, and visitors, recreational facilities were confined to two locations, with the rest of the area being restricted for car traffic.

On August 27, 2010, the project was endorsed by the government. The construction works were outsourced to a contractor, under the supervision of the "Bureau Noordwaard," and the landscape architecture office West 8 was commissioned to design specific civil works. The project progressed rapidly, with occasional verification on the part of Robbert de Koning, and, today attracts world-wide attention. Eventually a "high-water Noordwaard road map" was later distributed by the municipality to help inhabitants anticipate flood situations ("Draaiboek Hoogwater Noordwaard", 2013). In 2015, at the time of writing of this thesis, the project seems on its way to be completed in the allotted time, as planned by the "Room for the River" program.

Retrospectively, the architect concealed a few hindering factors, however, in the design process. Spatial quality appeared to be a fragile concept and had to be fiercely defended, sometimes against farmers, wanting to secure large and functional farmland, and occasionally against engineers who had difficulty putting aesthetic choices over and above technical or more economical alternatives. A similar source of concern was the outsourcing of detailed design to a construction consortium that, in turn, sub-contracted an architect for the design of specific civil works. The subordinate position of the architect appeared to weaken the aesthetic ambitions that were initially claimed by the contractor, since the architect was in no position to argue for high (and sometimes more costly) design quality vis-à-vis his own employer.



Section-perspective of the area, above the preexisting Noordwaard polder, below the new landscape in flood situation (Rossano-Orfanopoulos)

A second retrospective frustration concerned future maintenance. The Q-team "consistently required to consider the stage after implementation" (Klijn et al., 2013), since the hydraulic effectiveness of the project would later be defined by its vegetation; the maintenance regime thus had to be "decided with the responsible land manager already during the design stage." (id.) In De Koning's opinion, this aspect was not discussed in timely fashion in the case of Noorwaard - a problem he considers recurrent in landscape architecture projects. During the studies, this aspect appeared crucial, as it could greatly influence the hydraulic performance of the whole plan and possibly jeopardize the project if it appeared to hinder the expected discharge capacity. Future vegetation appeared particularly sensitive in the central area, where no obstacles should impede flood waters, implying no tree plantations allowed and a rigorous pruning of spontaneous vegetation is needed each year at the end of the summer to prepare the area for possible floods in the fall and winter. Maintenance work will thus be crucial to the long-term effectiveness of the plan but could not be agreed on during up-front studies: Legal tender procedures for public assignments made it impossible to choose and discuss with future maintenance contractors, since the selection could only be made on the basis of a finalized plan and a predefined assignment. According to De Koning, contracting the National Forestry Agency Staatsbosbeheer, by far the biggest maintenance company in the country, would for instance have allowed a useful dialogue to take place between designers and maintenance managers, a dialogue made impossible by law.

New water inlet in the former Noordwaard polder (photo Rossano, 2012)

Despite remaining doubts remain as to the future development and effectiveness of the Noordwaard landscape in the coming decades and centuries, which remain dependent on coherent and continuous maintenance, a successful design and construction process can be seen so far. Through a precise differentiation in dike elevation and profile, the new topography provides a gradual answer to flood levels that range from daily tide to a near-catastrophic situation – a range of more than three meters in terms of water levels. With this gradual approach comes a strong landscape diversity in vegetation and cultures, varying from traditional crop farming in the polders protected by high dikes, adapted agriculture for low-dike polders, to semi-natural grazing fields with minimal maintenance and open wetlands. This gradualist and multiform approach is both the strength and the weakness of the project. Within a spatial framework restored to its past unicity, Noordwaard adds new qualities and gradients to a Biesbosch that was long split between intensive agriculture and reserved nature. This new diversity, however, implies a sustained and careful maintenance, the main condition for maintaining the hydraulic effectiveness of the project in the long term.

Controlled disaster in the Overdiepse polder

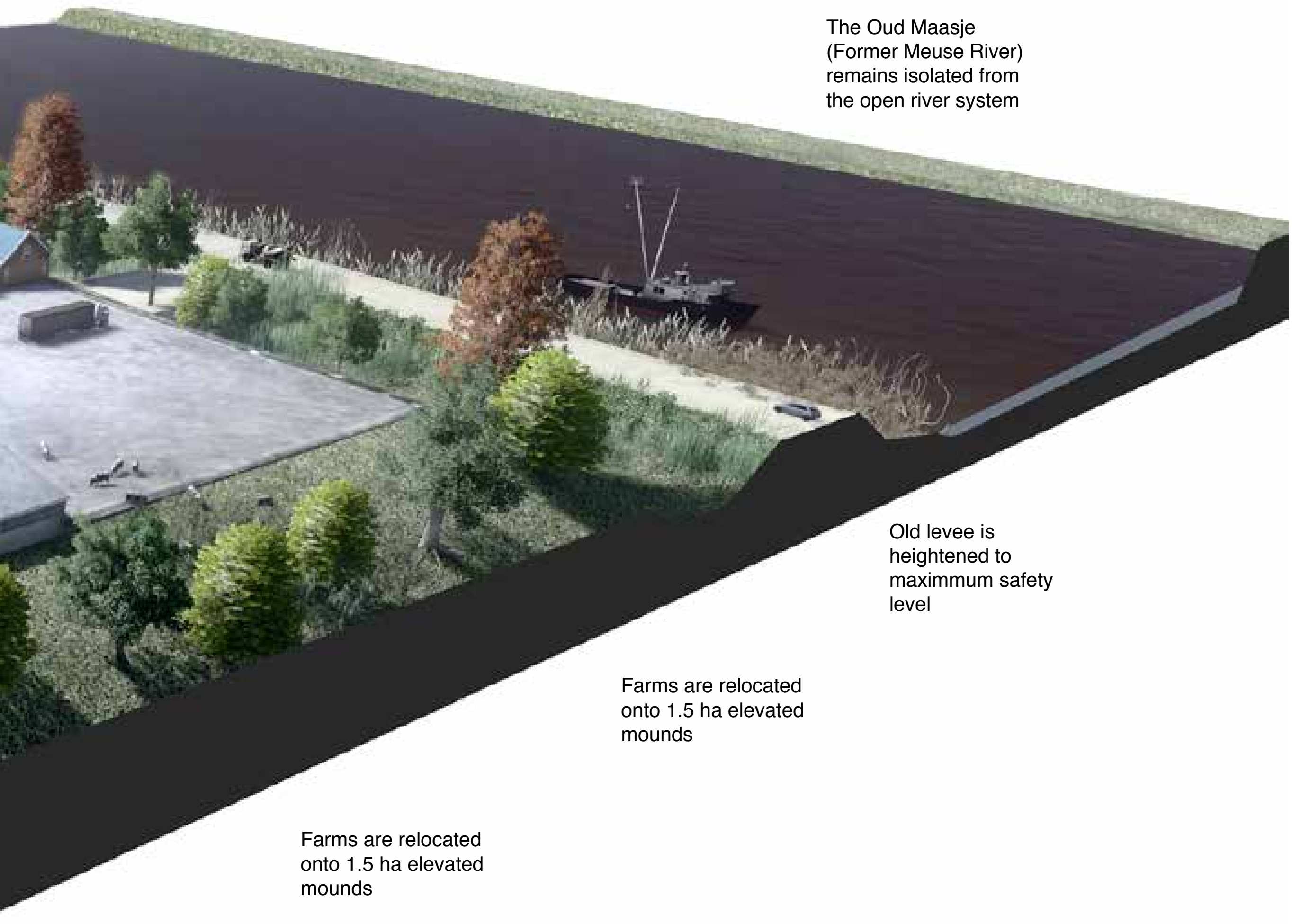
As a counterpoint to Noordwaard's diversified landscape and gradual flood response, the Overdiepse polder project brings a straightforward and binary answer to the targets set by the "Room for the River" program. The Overdiepse polder distinguishes itself by the successful combination of flood mitigation and enhanced economic activity, achieved through the active participation of local farmers in the planning process.

In 2000, the Overdiepse Polder was identified as a search area ("zoekgebied") for the "Room for the River" program, then still in an initial phase. The above-mentioned report, "Integral Foresight Lower Rivers," (Min. van Verkeer en Waterstaat, 2000b) investigated various ways to increase the capacity of the Bergsche Maas channel opened in 1904, mainly by looking at those areas flooded during the great 1953 flooding (De Jong et al., 2000: 49). The southern bank of the Bergsche Maas offered various ways to reopen former flood areas substracted from the floodplain, with the Overdiepse Polder being one of the biggest. Through the various landscape studies, reopening the Overdiepse Polder was evaluated as "very promising" (RIZA and Bosch&Slabbers, 2000: 91). More specifically, reopening the southern banks of the Bergsche Maas offered the possibility to "reinforce lost coherency" and "create new spatial quality" (id.: 61) by restoring some of the former flood meadows that had allowed the Meuse branches to fluctuate before they were channeled. Later on, the polder was identified as a potential area for water retention by

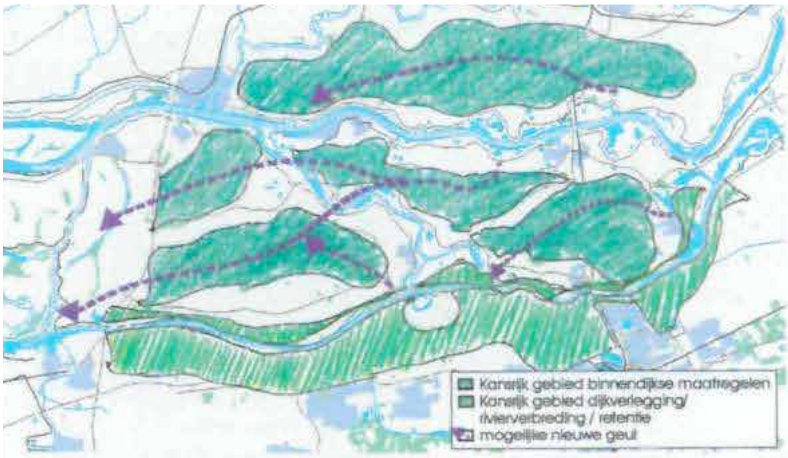
Brabant's regional development plan in 2002, although the area remaind officially dedicated to stock farming.

Contrary to the Noordwaard area, the preexisting situation of the Overdiepse polder appeared rather simple, spatially and economically. The polder was delimited to the south by the former levee of the Oude Maas, and to the north by the levee of the 1905 Bergsche Maas channel. It was located in a farming region with few recreational uses, exploited by seventeen farmers, and counted eighteen homes, all related to farming activities (Bink et al., 2011: 136; Waterschap Brabantse Delta, 2005: 23). The parcel structure along the riverbanks still reflected the pre-modern long and narrow units,

while the 550-hectare inner land shows larger plots inherited from various re-allotments programs, and for the most part owned by the users. Like most recently reclaimed areas, the land lay close to the average level of the river. With the "Room for the River" program, the Overdiepse polder was given the relatively simple but no less conflicting task of creating "Room for the River" into profitable farmland, while national and provincial policies explicitly favored combinatory solutions upon the "renaturation" of former floodplains (Van Rooy, 2003: 44).



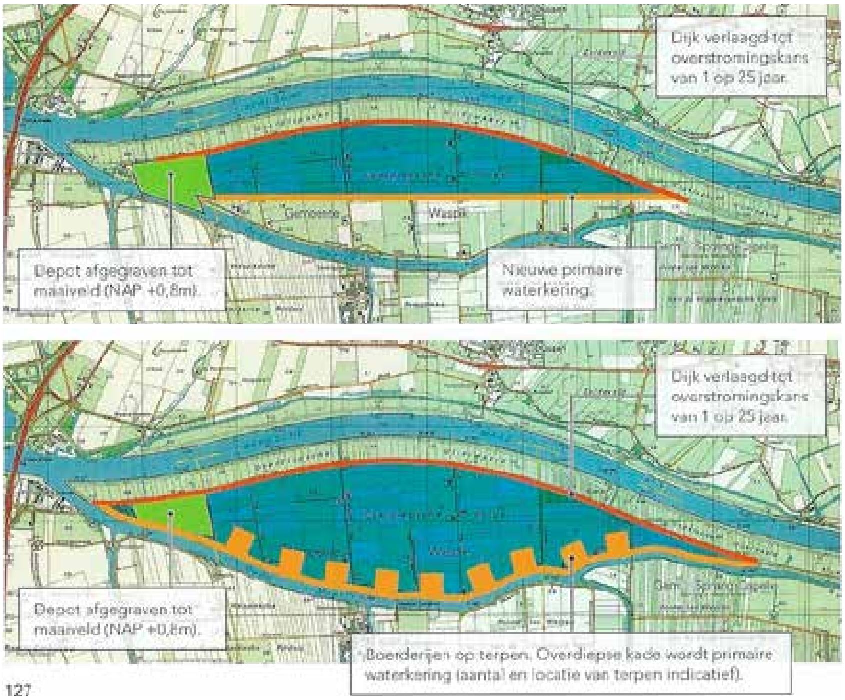
Schematic section of the project in flood situation: new farmhouses on elevated platform connected by the new primary dike. The Oude Maasje (right in the picture) remains at low level within polder borders. (Rossano-Orfanopoulos)



Potential location for new channels, de-poldering and river widening measures in the river area (Van Drimmelen et al., 2000: 35)

Following the identification of their polder as search area for river-widening measures, the local community started in 2000 to organize and explore possible options that could secure their own activity, even before official planning procedures started (Bink et al., 2001: 156). Together they imagined the possibility of maintaining their activity in the polder, in combination with temporary water retention. Ten farms could be kept along a new levee south of the polder, while the northern edge could be occasionally opened for the Oude Maas river to spread. Supported by local representatives, the initiative led in 2001 to a special planning procedure: a so-called "Spiegelproject" (mirror-project), led by semi-public organization Habiforum and by independent consultants mainly financed by the governmental agency "Room for the Lower Rivers" ("Ruimte voor de Benedenrivieren"). This parallel planning process was meant to initiate innovative and yet feasible regional development plans, and to bridge the gap between public authorities and local stake holders through an open and multidisciplinary design process. "Spiegelprojecten" were used in various regions of the Netherlands and generally focused on combinatory land use. The project's steering committee included national, provincial, and municipal authorities, the concerned water boards, as well as the interest group formed by the inhabitants of the polder to represent them in the discussions. Five meetings of the steering team and seven meetings opened to inhabitants allowed the participants to discuss and evaluate nineteen possible interventions (Van Rooy et al., 2003:11: 63). Here again, the combinatory exploration of various hydraulic measures was made possible by the Water and Public Works Agency Rijkswaterstaat, which remained the main actor for hydraulic issues, while local farmers took the initiative in the planning process under the leadship of Provincial authorities.

The design studies were conducted between July 2002 and July 2003, and led to a comprehensive report on the social, economic, and geographical situation of the polder, exposing the conclusions of the meetings and workshops (Van Rooy et al., 2003). In its introduction, the report stressed that "dike construction and reinforcement has reached its limits," and that "spatial measures are needed to face rising discharges." Considering the density of the country and its history of land reclamation, it advocated multiple land use solutions and the use of water safety measures as opportunities for new developments, mentioning the Meerstad-Groningen project as an example (Van Rooy et al., 2003: 5). The investigation confirmed that farmers feared the consequences of lasting uncertainty more than territorial change, and would therefore rather take the initiative than try to hinder the planning process. It also showed that farmers had various situations and perspectives for the future, and sometimes contradictory interests, depending on their personal, economic, and geographical situation within the polder (id.: 24-26).



127

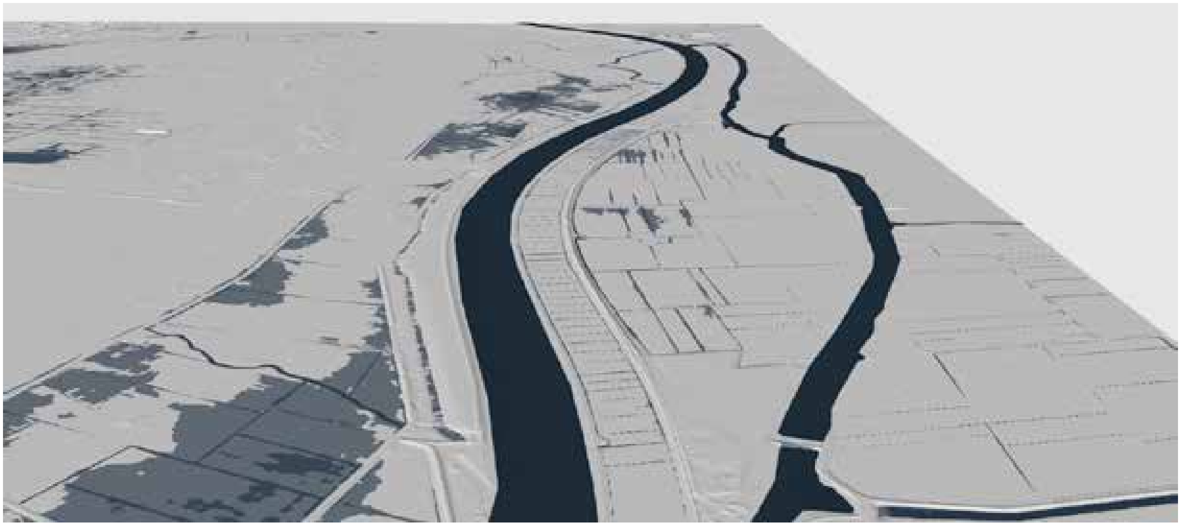
Overdiepse polder: "middenvariant" and "terpenvariant"
(from Bink et al., 2011: 157)

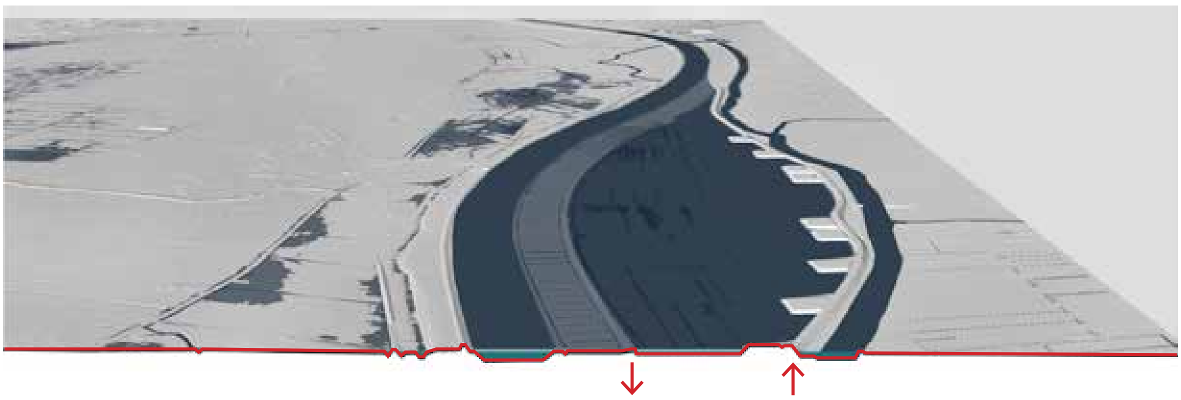
Three main alternatives eventually come out of the discussions, each of them leading to several options. An initial alternative suggested the transformation of the polder into a nature area, consisting of wetlands opened to high waters. The second "middle option" or "split polder" envisioned a division of the polder into two parts by a new primary levee, with the northern part being open to twenty-five year floods and above, the southern part being permanently protected by a new primary levee. A third alternative went further: The "terpenplan," named after the mounds built in ancient Frisia, proposed opening the whole polder to high waters by lowering the northern edge so as to upgrade the southern edge up to the level of primary levees, and relocate the farms onto a string of raised platforms leaning against the levee. Given the efficiency requisites of intensive farming, it appeared that this latter alternative would create enough space for about ten farms, including habitation and exploitation (id.: 11), implying the departure of seven exploitations and seven families.

The "nature-option" was soon set aside as the most expensive, the most destructive in terms of local economy, and as contradicting the national and regional policy that favored multiple land use over "renaturation." In the "middle option," most of the preexisting buildings could be spared, but the central division was seen as very disruptive by the local community (Provincie Noord-Brabant, 2008: 27): smaller parcels with various statuses regarding flood defense would have to be distributed among the farmers, implying long negotiations and painful arbitrages. In the third "terp-option," the full polder could be flooded, at a twenty-five year average frequency, by creating an inlet and outlet in the northern levee, or by lowering the levee for the whole length of the polder. In both cases, all existing constructions needed to be removed, whether located in the polder or along the levees. This option generated the most interest but also mixed feelings, partly because it appeared difficult for the inhabitants to imagine the "terpen" without visualization (Van Rooy et al., 2003: 26).

Despite these doubts, the "terpen" option was eventually favored for its strong effect on the river-water level, which could be lowered thirty centimeters at peak discharge, versus twenty for the "middle-option." The hydraulic inquiries confirmed that the Overdiepse polder could play a significant role in regional safety as a retention area but even more so as an extension of the river channel at extreme discharge. As it appeared, this second role, however, implied that the polder remained free from obstacles: In order to remain efficient as a temporary flow channel, its vegetation should remain low, and stock farming was thus preferred to other land use (Verschelling, 2003: 6-4). The "terpen" option also appeared to be three-times cheaper than turning the polder into a nature area, with equivalent effects on water level (Van Rooy et al., 2003: 52).

For local farmers, the "terpenplan" brought a perspective of lasting activity in a renewed landscape, and an opportunity to shape new, efficient, and secure farms on the future mounts. Paradoxically, the transformation of the Overdiepse polder into an emergency flowing area brought hope of long-term and stable activity for the remaining exploitation – with the authorities being committed to financing the achievement of the project and to a once per twenty-five year flood threshold – for the discharge expected in the 2050-2100 period on the basis of the IPCC moderate scenario (id.: 43). Following the preliminary studies, the terpenplan was further developed at a high tempo, anticipating the Planning Key Decision "Room for the River" that was officially validated in 2006 by the Dutch government. At that time, the Overdiepse polder project was already defined and the planning procedure largely engaged, making the projects one of the "frontrunners" of the "Room for the River" program.





Overdiepse polder, preexisting elevation and transect after project completion, retention situation
(ill. Rossano-Orfanopoulos, Data AHN/Rijkswaterstaat,)

More delicate would appear to be the social impact of the plan, which only in appearance left the landscape unchanged. With the creation of the ten (later nine) raised platforms to host the new farms, the project implied a radical re-allotment, necessary to secure a sustainable economy, and the transformation of two massive levees – one to be lowered to submersible levels, the other heightened to the level of primary flood defense. Differing from the planning process seen in the Noordwaard area, the project here was initiated by the users, and most of the preexisting arable land ultimately remained exploited. The process remained painful, however, for such a small community, since some families had to abandon their land to make the plan work and to secure the activity in the long term.

A second source of friction was the reluctance of the local community to share the aesthetic ambitions set by the "Room for the River" organization. The revival of the "terpen" in the Dutch landscape was seen as an important event, as was as well the construction of a series of large new farms, unseen since the completion of the Flevoland polders in the 1970s. The "Room for the River" organization and its Q-team were thus keen on reaching a high level of landscape and architectural quality. The Q-Team was keen on putting spatial ambition into each project already at the preliminary stage, rather than using posterior control: It also used its influence to involve designers in the various projects and at various stages – even when these projects were mainly directed towards local activity, as was the case for the Overdiepse Polder, where a competition was eventually organized for the design of the nine new farms.

Most of the functional aspects were strictly predefined by the future users, as the jury stressed after the first round. However, the wining architect, Onyx, managed to create diversity within a coherent ensemble through a set of simple rules for plantation and volumetry, combined with precise guidelines for construction details. A level of detail that would eventually be perceived as intrusive by some of the future users, but eventually succeeded in giving the farms an elegant and familiar aspect without contradicting the large-scale, unsophisticated, and productive character of a polder devoted to intensive farming.

The size of the "terpen" was also a matter of concern for Rijkswaterstaat spatial quality experts. Intimate in the Noordwaard area, the "terpen" in the Overdiepse polder were dimensioned for large industrial farms, with a surface of about 1.5 hectares. Eventually the ensemble was considered as successful also in terms of spatial quality, since the string of farms had its own logic and "fitted within the scale of the polder (Van der Grift and Der Nederlanden, 2013).

Paradoxically, the most striking side of the project is its ordinary aspect: the polder looks just like many modern Dutch polders, as nothing indicates that it might be covered by river water for several weeks on average every 25 years. Five years and 111 millions euros later, the Overdiepse Polder has proven that "floodscapes" should not necessarily be associated with extensive wetlands, heck cattle, and nature-like aesthetics, but can also take on the aspect of a modern and highly productive landscape.

Recently built “terp” at the southern edge of the Overdiepse Polder (Rossano, 2013)

Key points

- Ten years of project-oriented consultation allow for a faster ten-years implementation.

- Fostering local initiatives with the help of multiple-choice package lead to new insight and stronger consensus.

- Interdisciplinary approach associating design and engineering brought back spatial quality and perception within flood control projects.

- Next to hydraulic efficiency, spatial quality became the second guiding rule of the Room for the River program, allowing diverse sub-criteria of cultural, economic and ecological worth to be included within this open concept.

- Landscape architects play a key-role in the shift of focus from deterministic conservation methods to participation and action-related design.

- The combination of centralized supervision with local regional project management improves and strengthens development.

- River discharge objectives of comparable quantity can lead to a variety of land use responses that qualify landscape differently.


2

Meerstad: Flood as investment

Meerstad was born out of a rare combination of flood risks and real-estate ambitions, which drew the attention of local authorities, developers, and regional water board towards the same area east of Groningen – though for different reasons.

The region of Groningen generally has two main geological profiles: higher sandy grounds, flood-safe and naturally drained, and clay or peat grounds in the lower parts. The city itself was conveniently founded on the northern tip of a long north-south oriented sand ridge, between five and ten meters above sea level. The old city is thus settled on safe ground and is still protected against floods by its elevation, just like the many ancient villages of the province built on natural and artificial mounts (see "Early adaptive landscapes" on page 47). The Meerstard area on the contrary was located in one of the deepest polders of the region (its deepest point laying more the two meters below sea level), about four kilometers east of the city center.

From the nineteenth century on, the construction of large drainage canals such as the Eemskanaal between Groningen and the Dollard estuary, and the progress of drainage techniques has allowed urban growth to spread further away from the city and deeper into the lowlands. Lacking space to extend onto high ground, and following a logic of proximity rather than flood safety, the city grew first in its immediate surroundings, later in more distant settlements, and eventually at the end of the twentieth century the whole region became a destination for urbanites in search for affordable "green living."

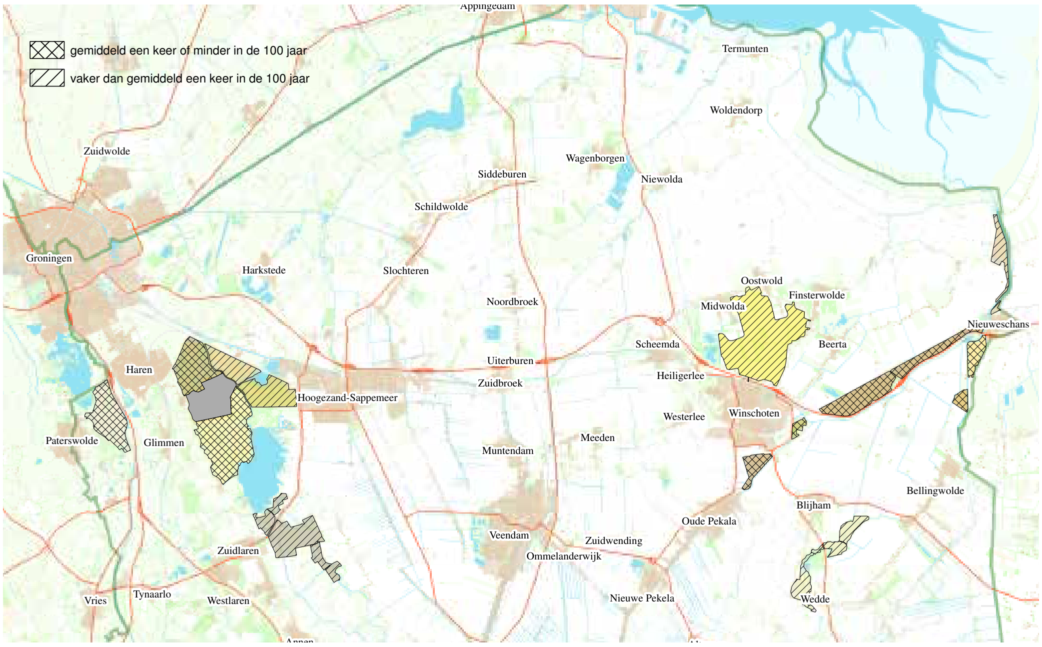
In the 1990s, while rural villages welcomed the new middle-class dwellers, the City of Groningen had trouble maintaining its tax income and coordinating its own urban growth. In the midst of a real-estate boom, most land around the center was in the hands of local developers and speculators, making it difficult for the municipality to keep control of its growth and to fund infrastructural investments with the proceeds from land sales. Private developers were reluctant to participate in public infrastructure investments induced by their projects, such as civil engineering works or public transports.

Although the municipality was successful in handling small-scale projects and relating them to the surrounding neighborhoods, the housing demand seemed still higher than what the private market could satisfy, thus opening a window for bigger projects. Another source of concern was the rapid growth of neighboring municipalities, which provided opportunities for free-standing housing a short distance from Groningen, thus depriving the city of a wealthy portion of its population – that still made used of the city's public facilities but was not contributing anymore to its revenues. This extensive growth into the open countryside was also contradicting the national policy as defined in the 1998 "Vierde Nota Ruimtelijk ordening." This Fourth Memorandum Spatial Planning and its follower, the 1990 Fourth Memorandum Spatial Planning Extra (or VINEX) had fixed national ambitions and conditions for spatial planning, which stressed the necessity of keeping cities compact, while answering a strong demand for low-density housing, fueled by a healthy economy. In the document "De stad van straks" (the City of Tomorrow) issued by the municipality under the lead of its ambitious Counselor for Planning and Housing, the area that would later host the project "Meerstad" was, in 1994, designated as a suitable extension for the city, since it answered the national ambitions for coherent growth and the tendencies of the real-estate market to provide "green living." During the ensuing years, several investigations took place, involving civil servants and designers, which tended to confirm the site's potentialities. Informal contacts were made with National and Provincial authorities, which brought political support to the initiative.

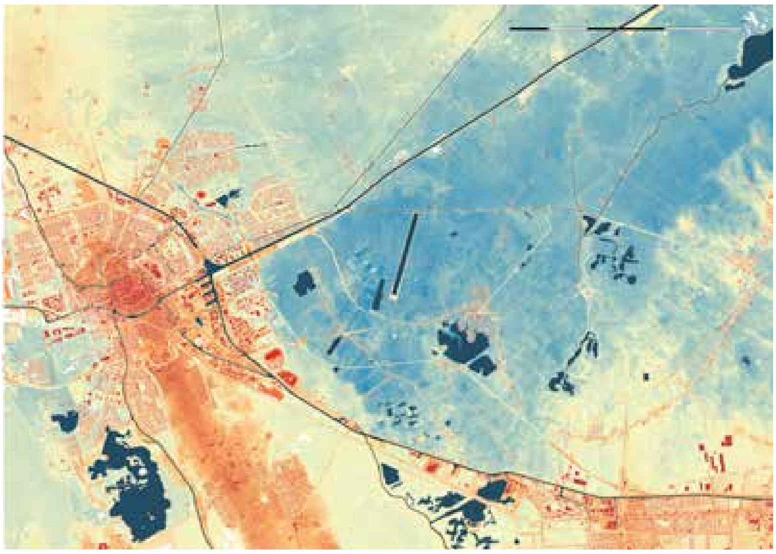
In addition to the urban ambitions set forth for the area, other regional and national housing projects suggested promising synergies with nature development and water management authorities. The Main Ecological Structure (EHS, Ecologische Hoofdstructuur), elaborated in 1990 by the Ministry of Agriculture, Environment and Food quality, envisioned a national network of existing nature areas, due to be completed through the creation of new ecological connections. One of the figured connections meant to link the coastal Wadden-area, northeast of Groningen, to the southern nature areas of Drenthe Province, crossed the municipality of Slochteren, a few kilometers away from the city. The later "Meerstad" project appeared perfectly located halfway between city center and the future nature reserve, reinforcing its suitability for an urban extension close to the city that would provide an attractive green environment.

An unexpected flood alert gave the project a new turn at the end of the nineties. Although the northern provinces had escaped the massive evacuations following river overload in 1993, in October 1998 heavy precipitation dramatically reminded them that water safety was far from guaranteed. In October 1998, massive amounts of rainwater flowing from Drenthe towards the north saturated the canals of Groningen province. The Winschoterdiep, one of its main drainage canals, reached its maximum capacity, and its dikes came close to breach point. Many houses were flooded, a residential neighborhood close to the canal had to be evacuated, while dikes were temporarily reinforced with sandbags. Besides the fear and destruction caused in the countryside and small tows, the province capital city was hit at its heart: the new Groninger Museum, completed just four years earlier, had to be evacuated, and its lower floor was flooded, damaging a part of the museum's collections. Although the risk was identified by the water board before its construction – and was due to a design mistake rather than to high water (Van Hall) – the event served, as a side effect, to empower public and political consciousness to the fact that flood exposure at the urban and regional level was calling for action and that raising dikes higher would not be enough this time. The commotion led to a compassionate visit by Queen Beatrix on the 29th of October, drawing the attention of the country to the exposure of the northern provinces.

Analyzing the event, the water board soon came to the conclusion that the flood was caused by two combined factors: widely spread and heavy rainfall, on the one hand, and a northwesterly wind that had pushed the sea water up into the Eems and Dollard estuaries, on the other, blocking the region's main outlets for several days. The origin of the problem was thus not only the discharge capacity of the regional water network but also the lack of temporary storage capacity whenever the outlets were blocked by natural phenomena – in this case an abnormally high water level in the estuary, all combined with a systematic failure to include flood risks in architectural and urban development. Consequently, after 1998, the Hunze-en-Aa's Water Board elaborated a new combinatory approach, which could simultaneously strengthen the existing water structure (its traditional task), increase temporary water storage capacity on its territory, and raise awareness among decision-makers and the general public. Local urban ambition, environmental policy, and a major flood warning were paving the way for Meerstad.



Areas available for emergency storage, average usage frequency 1/100 years or less, and more than 1/100 years. (Water board Hunze-en-Aa's)



Groningen and the Woldmeer/Meerstad area east of the city, (Digital terrain data AHN/Rijkswaterstaat, image Rossano)

From Woldmeer to Meerstad

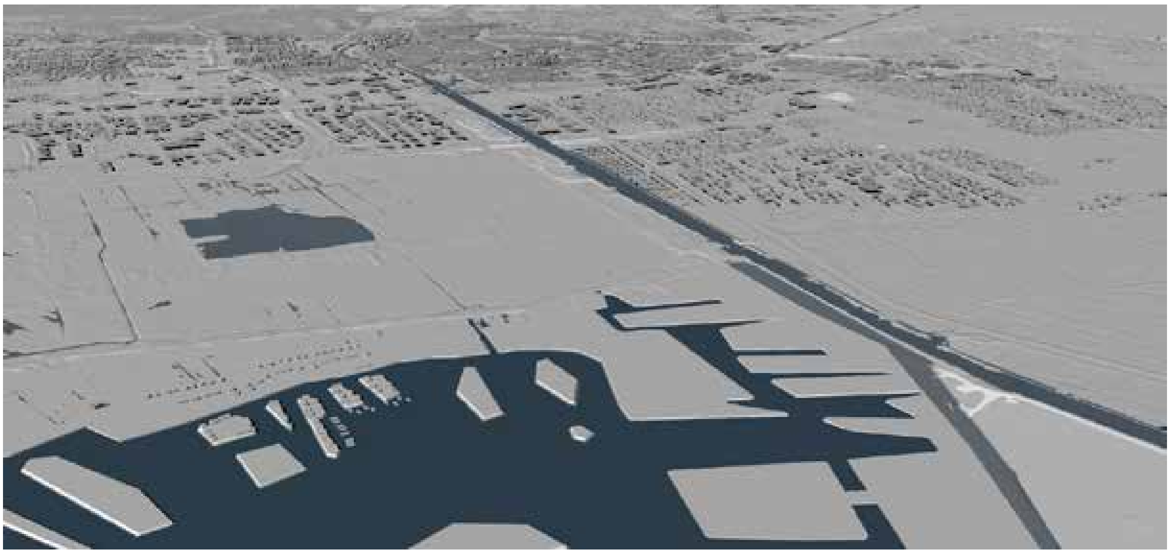
After a decade that saw the inner city becoming a successful laboratory for architectural and urban renewal under the lead of city counselor Ypke Gietema, the 1990s witnessed a new interest in the periphery and countryside. Designers were regularly involved in plans and visions elaborated for the open Groninger landscape. In September 1996, the Keuningscongres invited a large panel of designers and politicians to discuss and envision the future of Groningen's lowlands: the

Woldstreek. Christophe Girot (supervisor of the present thesis) chose to focus his contribution on the existing landscape, revealing the characteristic structure of the province polders and drainage structure (Wildemann, 1997:40). In 1998, the study "Voorbeeldplan Maximum laadvermogen" stated that intensive land use and investing in landscape development could provide excellent basic conditions for housing development in the region.

In 1999, former counselor Ypke Gietema, constructor H. Koop, and investor H. Venema, joined in a private initiative and asked architect Karelse Van der Meer and landscape architect Adriaan Geuze for a spatial proposal for the area. The resulting project, entitled "Groningen above water," envisioned a large-scale nature and urban development from Groningen to Delfzijl. A twenty-kilometer stretch of new forest and wetlands was proposed to link the two cities, putting the Harksteder polder and Rijpmapolder under water to form the new "Woldmeer." Together with existing lakes and future wetlands, they were meant to form the "Loire river of Groningen," offering a wide and open "square" connnecting existing villages with a new "village" planned on its northern shore (Archined, 16.03.1999). Comparing these future neighborhoods to the recently redeveloped Amsterdam docks (partly reconfigured by Adriaan Geuze), the designers stressed the need to address uncontrolled sprawl in the rural area, the decay of cultural landscapes, and the decline of agrarian activities due to the land's mediocrity. The local magazine for landscape and planning, Noorderbreedte, praised the project as "an important articulation within the Ecologische Hoofdstructuur, a wetland between the sandy grounds of Drenthe and the Waddenzee environment, but also more than this. Main ecological structure often means juxtaposing science-conforming ecological typologies. This leads to a landscape that has nothing to do with the Dutch cultural landscape and that is only livable for animals that often were never found earlier in the area. The Woldmeer offers more then just nature: not only the grass snake but also man is at home in and around the lake. From the city, the Woldmeer is reachable by bike within 15 minutes. This is not just ecology, but a design that fits in the landscape structure, along with all recreational possibilities. The design for the Woldmeer does not turn its back on the existing landscape; it is not "nature for nature's sake." (Abrahamse, 1999).

This integrative approach reflected a discussion that had been going on since the eighties in the Netherlands around the relation between Ecology and Landscape. The experiment initiated by the Stork Plan, which introduced the concept of two-speed landscapes and the bundling of various interests into an integrative approach of nature, had been narrowed down to a technocratic approach during the elaboration of national environmental policies, favoring the development of isolated and specific ecosystems rather then a reflective practice on a project level (De Jonge, 2009: 9). The Woldmeer project was thus not only a spatial proposal but also a pamphlet against landscape fragmentation and against a dominant technocratic form of ecology, which tended to isolate Nature from man's living and working environment, and reduce "Nature" to "natural habitats" considered only for specific targets, plants, or animals.

This integrative approach generated an enthusiastic reaction from city, province, and ministry, and later became fully part of the brief set up for the design team. The water board, however, soon appeared less univocal about the project. Although the creation of buffering capacity close the Eemskanaal, one of the province's main outlet, perfectly fit in the water board's new strategy following the 1998 flood, planning residential developments in the lowest and most exposed area of the province seemed questionable to its Chairman (Van Hall and Kuipers, 2013). The very reasons that made the area suitable for water buffering provided identical arguments against urban development: the land layed low, about two meters below sea level, and 1.55 meters below the average level of the Eemskanaal flowing along the area. The main drainage canal could thus easily be offloaded by gravity into a new mitigation lake, but it could just as well flood the future housing area in a very short time, if a dike was to weaken, slide, or break open. But as before the construction of the Groninger Museum and its (too) low basement windows, the warning of the water board remained unheard in the context of general enthusiasm for a visionary project that reconciled nature, landscape, housing and flood control in one coherent plan.



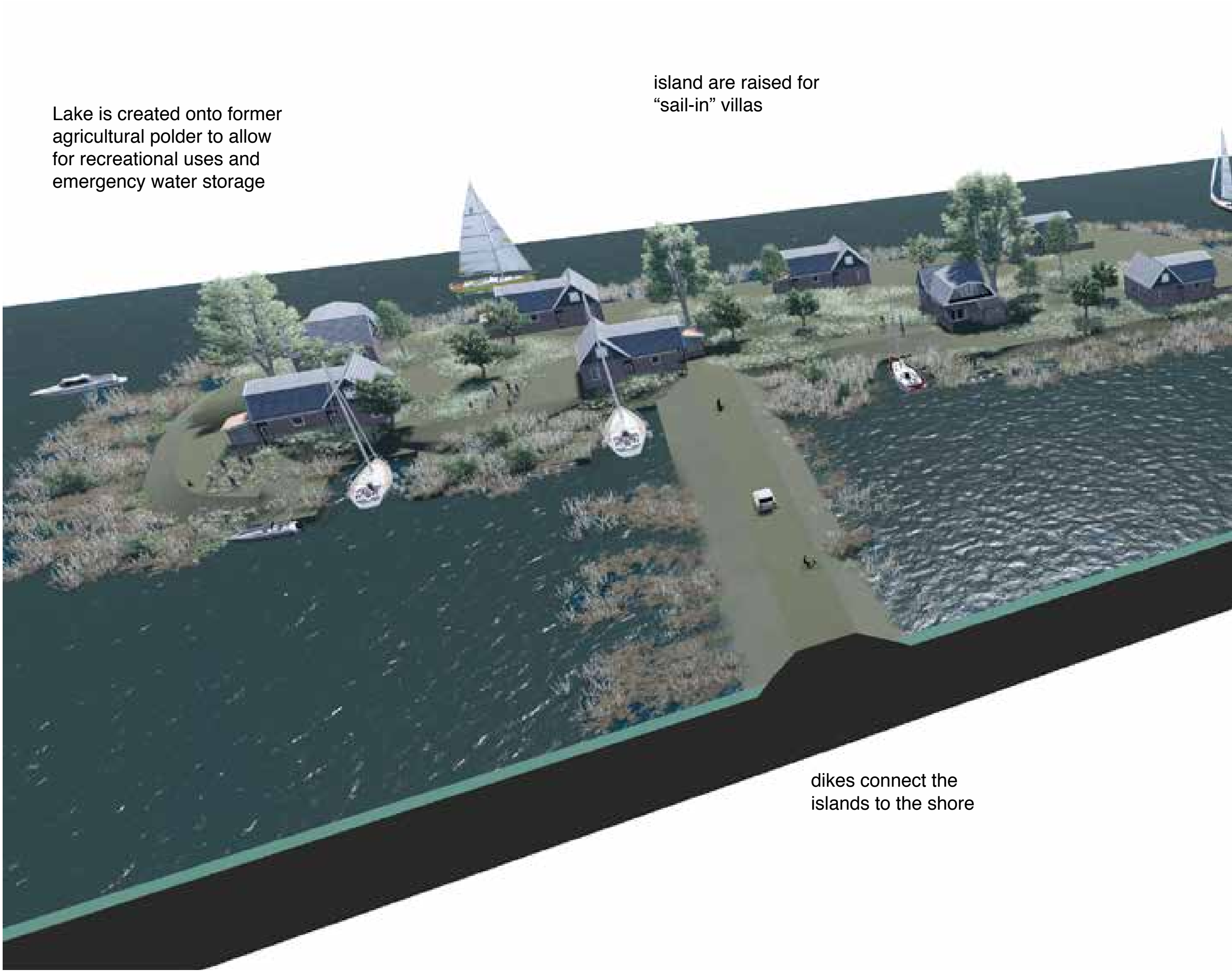
View from Meerstad towards the city of Groningen, preexisting polder structure and lake planned in the 2011 framework (Rossano-Orfanopoulos)

Following the contacts made in the previous years, several public parties officially decided in 2000 to collaborate in the development of the project. An "Intentieovereenkomst" (agreement of intention) was signed in March 2001 by the Province of Groningen; the Ministry of Agriculture, Nature, and Food Quality; the Department of Rural Areas; the Hunze-en-Aa's Water Board; and the municipalities of Groningen and Slochteren (most of the project's area being located in this small rural municipality). The agreement stated that a new development aimed at creating 8,000 dwellings around a 650 hectare lake, representing an investment of one billion guilders to be earned back on the sale of land and buildings. A few months before, the same players had selected a team of designers to elaborate a development strategy and turn the program into a spatial framework.

Alle Hosper Landscape, a renown landscape architecture office from Haarlem, associated with Kees Christiaanse, Rotterdam, was given the commission to lead the design process from 2001 on (Provincie Groningen, 2001).

Landscape economics

Private developers were not left out, in a time when the national government was again actively promoting public-private collaborations through the so-called P.P.S. programs ("Private-Publiek Samenwerking") on big infrastructural projects and urban developments. These private-public collaborations were at the time actively supported by successive Dutch governments from the early 1990s, especially for urban developments. The Fourth Memorandum on Spatial Planning urged extra effort to develop this type of joined planning processes, and involve private companies in the investments, design, construction, and marketing, and in 1999, the Ministry of Finance created a dedicated "Knowledge Center PPS" to foster new initiatives (Keuter, 2007).



Some local developers already owned part of the area, and big national real-estate companies were attracted by the perspective of securing positions in a massive housing development, comparable in scale to the "VINEX" projects under construction around most Dutch cities. In January 2002, the public parties involved signed a Collaboration Agreement ("samenwerkingsovereenkomst") with two consortia of private investors: the Grondbank Meerstad Groningen CV, regrouping national players AM Grondbedrijf BV, Koop Holding b.v., Heijmans IBC Vastgoedontwikkeling B.V., and BPF Bouwinvest B.V.; and the Twentse Combinatie formed by regional developers Rotij Projecten B.V., Timmerhuis Projecten B.V., Groothuis Woningbouw B.V., and Plegt-Vos Bouwgroep. Meerstad was identified by the Ministry of Finance as one of six PPS pilot-projects. Private stakeholders, however, were not involved in the selection of the design team – "luckily" according to landscape architect and project-leader Remco Rolvink, who later found that developers were soon inclined to lower the city's ambition and question the cost of the design process.

Schematic transect of Meerstad new inhabited landscape, from existing ribbon-villages to new lake (Rossano/Orfanopoulos)

Although neither programmatic nor juridical aspects were yet quite settled, the planning organization was set up to start an ambitious project that would from then on assume the official name of Meerstad – literally translated *Lake-City*. The new denomination, however, already generated discussions among commissioners and designers. Besides being semantically ambiguous ("meerstad" means lake-city and "meer stad" means more city – a difference hardly perceptible in oral language), the new name was also disputable in terms of program. Was Meerstad a new city, a city extension, or an inhabited landscape? Was it one lake, or a diversified water landscape? According to Remco Rolvink, private developers finally opted for the name Meerstad for its supposed persuasive value, but in doing so contradicted their own reluctance to include elements of urban typologies and density in the plan.

At the start of the actual design process, most of the plan area was still cultivated by farmers, but already for the most part owned by the project shareholders. The Ministry of Agriculture, Nature, and Food Quality had purchased a large area east of Harkstede in 1998 to secure a future ecological area, within the framework of the national E.H.S. nature corridor (Ecologische Hoofdstructuur). About 1500 hectares of farmland had been bought by private investors, seemingly without much difficulty, since the price offered for what was then seen as building land (about 20 euros per square meter) largely topped the regular price paid for farmland in the region (around 2.50 euros at the time) – but still "an honest price in terms of the expectations" (Leverman, 2013).

Although skeptical about a city extension onto what seemed then still very far from any urban pressure, the farmers were conscious of the poor quality of their land. Many, getting close to retirement age, were also uncertain about the future of their exploitation, and accepted selling their land, while still remaining active for the time-being through ground-lease agreements. Extra land was purchased closeby to make it possible for those who wished to remain in the region to do so – with five farmers ultimately making use of this possibility. A part of the area closer to the city had been bought earlier by the company Mega-Vastgoed, which declined the invitation to join the private-public agreement, and consequently lost influence in the planning.

During this active period of trade and negotiations, the presence of private investors proved to be decisive in getting control of land ownership, giving the stakeholders all the freedom to develop a coherent plan, reorganize the current and planned land use, and match land, infrastructure, and construction investments with sales benefits prospects in a balanced financial plan – a capacity that the city of Groningen had lacked in its previous urban developments.

From program to plan

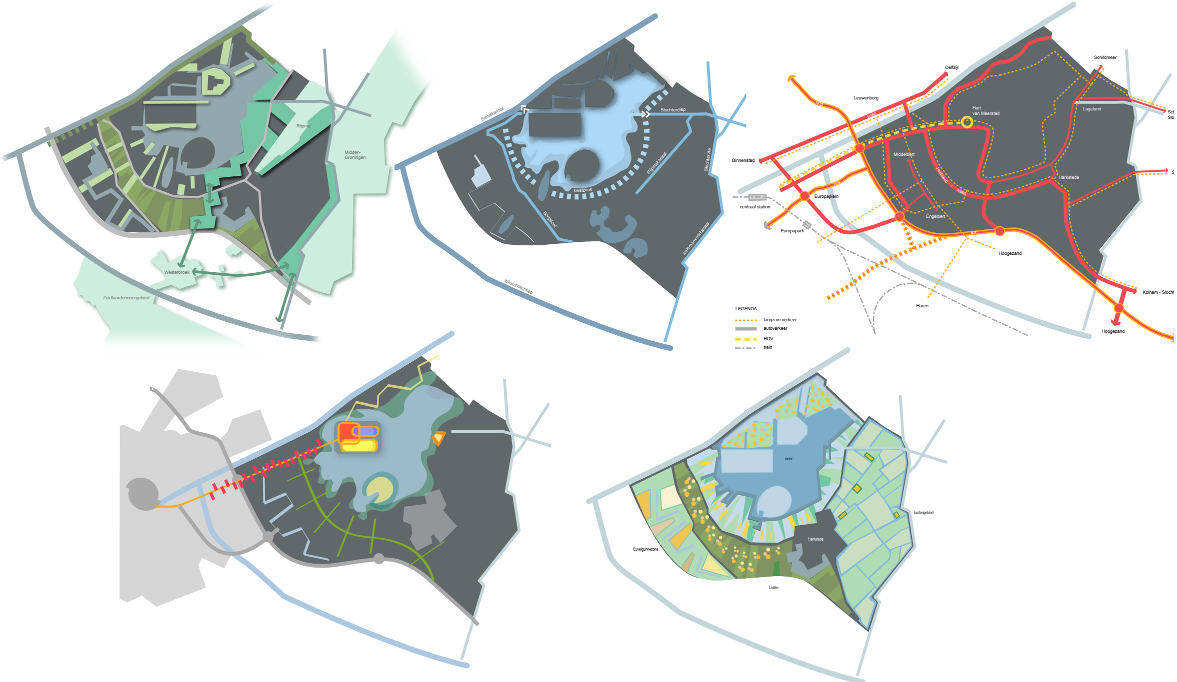
Before private developers joined the team, the public authorities that had signed the Collaboration Agreement had already set several targets for the project, based on regional prospective studies: The construction of 8000 dwellings, the creation of a wide lake dedicated to water buffering, the creation of an "attractive recreational element" (the lake itself), the development of a durable ecological connection to reinforce the city and region's ecological structure, and the development of a new high-quality landscape of substantial dimensions. Ambitious but then still vague, these targets would later be made specific with the help of public departments involved in the planning process, the input of development companies, and external advisors commissioned to investigate specific aspects – water system, landscape and ecology, recreation, transportation, housing, and economy.

The design phase started at the beginning of the year 2002, led by a Bestuurlijke Overleg (Management Board) composed of the public authorities and private developers, under the leadership of Marc Calon, Provincial Deputy. Besides Calon's regional roots and his understanding of territorial projects, the choice of a provincial deputy also had political motives (Rolvink, 2013). Although Meerstad was initiated by the city of Groningen and mostly motivated by the city's development ambitions, most of the land lay on the territory of Slochteren, a vast municipality hosting a modest population of less then 15,000 in 2000 (Gemeente Slochteren, 2012), next to Groningen's 173,000 inhabitants (Gemeente Groningen, Statistische jaaroverzichten). The role of Marc Calon was thus not only to chair the Management Board but also to prevent possible tensions among the two municipalities.

The city of Groningen provided the project-coordinator in charge of running the new dedicated Bureau Meerstad and organizing a complex process involving six public authorities and their sub-departments, with two consortia regrouping eight private companies, along with a population that expected to be informed and involved. Together with the energetic Remco Rolvink from Alle Hosper landscape Architects, they formed the driving task force, hosting multiple workshops with the groups of experts and shareholders that were formed around each specific aspect: master plan, water, sustainability, economy, agriculture, leisure, housing program, and mobility. More work groups were created to work on specific procedures related to the project: the elaboration of the Environmental Impact survey (Milieueffectrapportage or M.E.R.) and the Provincial Planning Document ("streekplan"). A specific work group dealt with communication. Last but not least influent, a work group focused on the financial balance, with the support of external advisor PAS. More then a simple work group, this assembly hosted crucial discussions about program, density, and housing typologies regarding what private developers considered as suitable for the housing market, and what designers and public authorities considered as suitable for Meerstad and Groningen in the long run. The quantitative aspect played a key role in these discussion, since the expected income had to match the expenses – which explains the raising of the initial 8000 dwellings program up to a "possible" 10,000 in the final master plan.

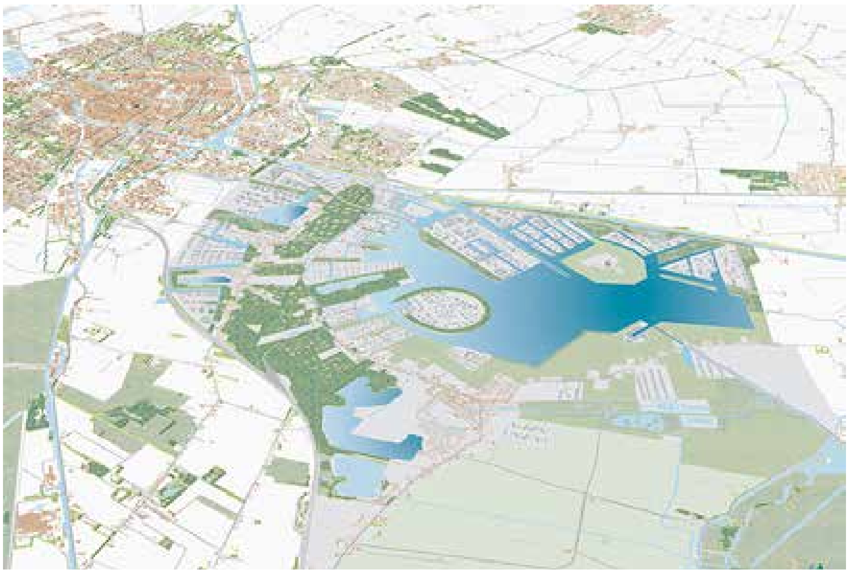
Specific to Meerstad was also the fact that the M.E.R. environmental survey, generally following the design process, was here parallel to the design process. The company Grontmij was hired by the municipalities of Groningen and Slochteren to elaborate the survey simultaneously with the elaboration of the master plan. This rather unorthodox procedure promoted by Remco Rolvink was, however, accepted by the national M.E.R. Commission and allowed designers and surveyors to interact

in a continuous evaluation and adaptation of the different scenarios, based on the pros and cons each one of them raised regarding environmental aspects. This led to a "somehow chaotic but productive project development" (Rolvink, 2013). During the year 2001, landscape architects and urban planners elaborated tens of variations and hypotheses for the distribution of programmatic elements, water, nature, housing, industry – occasionally inviting participants of the workshops to play with colored paper sheets cut in proportion to each function. This method based on multiple scenarios, followed by a rational evaluation of each one and a combinatory development, was at the time widespread in Dutch planning (Salewski, 2012) and practiced by Kees Christiaanse's office, which had made scenario-based planning one of its specialties. This methodology also supported the chosen "open plan process" that involved inhabitants and stakeholders in the elaboration of the design.



Meerstad development principles: landscape, water, traffic,
key urban features and housing areas
(Rossano for Alle Hosper and KCAP, 2004)

In 2002, a preliminary plan ("discussiemodel") was presented, that fulfilled most of the program's ambitions. The housing and industry program fitted into the framework, distributed into various landscape types – along historical roads, lake shore, city connection, and into woods and wetlands. A six hundred-hectare lake stretched from Groningen to the East, allowing fifty centimeters of fluctuation in water level, sufficient for a three million cubic meter buffering capacity expected by the water board, and formed a spectacular, attractive, and accessible landscape, suitable for water sports and leisure. A dedicated nature area was located east of the planning area, away from the city but contributing to Meerstad's overall framework. And, above all, the plan provided a legible landscape structure based on natural topography and elevation, which integrated cultural elements such as the ribbon-developments along ancient roads ("linten") and provided aesthetic and functional qualities for future and existing housing. Pursuing the goals already stated in the earliest design studies, the master plan elaborated by Alle Hosper and KCAP favored the integration of building and nature rather than functional segregation, playing on the association of various landscape types and urban typologies to create an optimal diversity, while still keeping legible landscape entities – lake, shores, ribbon-roads, wetlands. Moreover, in the small concentrated "urban" node located halfway between Groningen and Harkstede, roads and buildings played a modest role in the structuring of the landscape, mostly defined by water, wetlands, and plantation, corresponding to the initial ambitions of public authorities and landscape architects to pre-invest in a robust landscape structure that could attract, shape, and withstand long-term developments.



2005 Master plan, Alle Hosper and Kees Christiaanse
(aerial view Dienst Landelijk Gebied)

The master plan was, in the ensuing years, praised for its ambition, the integration of urban development and water management, and for its collaborative planning process. In the local architecture magazine Noordbreedte, Niek Verdonk, former director of the Groningen Urban Development department and promoter of the "compact city" policy, praised the indirect effects of the project, which "spares valuable landscapes and cultural areas" by concentrating multiple ambitions into one area (Abrahamse, 2002: 36-38). Meerstad was proposed by the province to be one of the national "model-projects for development planning". The same year, the magazine De Water published by the national water agency Rijkswaterstaat also presented Meerstad as an "example for development planning," praising the combination of flood protection and regional development (Bijnsdorp et al., 2002). In 2005, Meerstad was nominated for the "Real Estate Award" during the Rotterdam Biennial of Architecture (Architectuurbiënnale Vastgoed Award). All in all, the projects stood out for its voluntaristic and collaborative nature, materilized into integrated landscape development, water safety, and market-driven construction meant to meet the strong demand for green living that threatened the Dutch countryside.

The 2006 governmental planning memorandum "Nota Ruimte" (Min. van VROM, 2006: 28) praised again the integrated character of the project: "For Meerstad in the region Mid-Groningen, red [housing], blue and green functions are implemented within one integral regional development. Agreements among public and private parties take concrete shape in the master plan. Costs and repartition are set within the municipal exploitation company, allowing part of the profits made on farmland to be used to finance green areas in the exploitation area and to empower the Main Ecological Structure in the area" (id.: 63). The bill also referred to Meerstad as a model for the redistribution of investments and benefits among private and public parties: "The rules regarding land exploitation (...) makes municipality not only stronger but also protects against 'free-riders' [in English]: parties that collaborate insufficiently but fully benefit from improvements." Combined goals and shared investments were presented as successful "instruments for taking advantage of opportunities" ("Instrumenten om kansen waar te maken").

Red for blue and blue for red

The integration of landscape and buildings was, however, also a source of tension. The Environmental Impact Survey issued in 2003 echoed the criticism by the environmentalists from the Milieufederatie environmental organization but also relativized their relevance in regard to the global benefits the project could generate. Following the usual evaluation procedure, the Survey compared the "most environment-friendly alternative" (Meest Milieuvriendelijke Alternatief, MMA) with the "preferred alternative" (Voorkeursalternatief, VKA). Where the "environment-friendly" alternative isolated constructions from nature areas, the "preferred alternative" dissolved the building program into less dense and more diversified ensembles. This mix of housing and nature weakened the integrity and continuity of dedicated nature, but also increased its total area. Involuntarily highlighting the core dilemma of Dutch environmentalism – a segregative approach versus an integrative one, protection versus accessibility to nature – the general conclusion of the report stressed the positive aspects of the plan supported by designers and commissioners: "There is less diversity in living environments in the [environment-friendly] MMA than in the [preferred] VKA, this because the MMA focuses on the ambitioned physical ecological aspects. However, partly in relation to its long-term character and the uncertainty of future housing markets, a plan with a wider distribution of typologies over the different areas provides the flexibility needed to provide housing that corresponds to the demand. This is a strong positive effect" (Grontmij, 2003: 140-141).

This conclusion was remarkable on two levels. It acknowledged the need to provide an attractive living environment for the development of the whole plan and therefore stated, in this context, a reflexive dependency between urban expansion and nature development. And, by putting the plan in a timescale perspective, it also identified flexibility as an essential factor of the success of future development – while environmentalists aimed at a stable framework to provide a steady habitat for specific species to develop – a tension between dynamics and steadiness highlighted already with the Stork plan's two-speed concept in the mid-eighties (De Jonge, 2009). What differed here from the then common perspective is that the authors of the Environmental Impact Survey chose, above their sectoral concerns, to validate a holistic perspective that allowed human activities to interfere with nature, and the other way round, trading the risks of human disturbances for the benefits of greater joint achievements.

Taking control over the land proved to be relatively easy and fast, but joining assets into one common structure and defining the respective roles appeared to be more difficult. Although the master plan was globally known in 2003, it was only validated in March 2005, since it took two years of negotiations for the participants to engage in one single juridical structure, the Grondexploitatie Maatschapij Meerstad (GEMM), created on September 28th, 2005. The Twentse Combinatie, initially part of the Private-Public-Agreement, pulled out of the planning process at the end of 2004. Another disappointment for the projects initiators was the reluctance of the water board to participate financially in the new structure. Despite political pressures, the water board stubbornly refused to invest in the joint-operation, raising frustration on the city's side, which considered the water board as being "mildly enterprising, not collaborative and reserved," and suspected them of passively making a profit from the fact that the project would be implemented anyway by other parties (Van de Bospoort, 2013). For the water board, it was not only a strategic issue but also a question of juridical status. Dutch water boards are funded by taxes levied directly on every inhabitant in their administrative territory, specifically for providing a healthy and safe water system. Participating financially in the implementation of a retention lake thus remained within its prerogative, but joining the GEMM structure also meant investing taxpayers' money in real estate speculation. "The province asked us for both [Blauwe Stad and Meerstad] projects to carry a share of the risks. This led to a quarrel, and we made clear that we would not risk taxpayers' money. I wrote in a letter that I would not join and would not share in the profit either – they expected high benefits back then. We were consciously [passive and reserved], because we are a public authority that is only allowed to raise taxes to fulfill water-related tasks, and not to participate in a big business, or in province or city [investments]" (Van Hall, 2013). The water board thus considered that only the extra buffer capacity added to the lake could legitimate a financial participation from its side, thus running contrary to the hope that all parties would happily join the great enterprise.

In the meantime the project followed the usual procedure. Following the critical but positive environmental impact survey and the creation of the GEMM after long negotiations, the master plan elaborated in 2001-2002 was finalized and summed up in a comprehensive document presented in September 2005. In 2006, a steady accommodation for the Bureau Meerstad was opened in the plan area. A municipal zoning plan ("bestemmingsplan") was prepared for the central part of the project, "Meerstad Midden," which covered a large portion of the lake (three-hundred fifty out of the planned six-hundred hectares) and a large part of the housing program. A sub-area named Lakeshore ("Meeroevers") was chosen to be the first part constructed, which already symbolically included a piece of the lake relatively close to Groningen and addressed the principle demand for low density housing in a blue-green setting with two hundred seventeen row-houses, attached- and free standing villas. The architecture office De Zwarte Hond was commissioned to work out the urban design, delivered in November 2009. De Zwarte Hond happened to be the designer of a similar project, though less important in program, the Blauwe Stad ("Blue City"), located twenty-five kilometers east of Meerstad. After twenty-five years of dreams, visions, and projects, Meerstad was about to come true.

Beyond the housing crisis: Meerstad without Stad

The financial crisis hit the Netherlands pretty soon after it started in the United States. A long period of economic growth and accessible mortgages, largely subsidized by the Dutch government, had generated a overheated housing market and an over-exposed banking sector. Dutch private finances were particularly exposed to the real-estate market, since almost half of Dutch households financed their own house with a mortgage, and had the highest long-term debt in Europe – 125% of Dutch G.D.P. in 2011 (Notten, 2012: 208). The financial crisis had rapid repercussions on the financing capacities of potential buyers, and the housing market saw prices and the number of transactions decrease from 2009 onwards. While the Dutch Office for Statistics recorded 2200 households moving to a house they bought in 2006-07 in the East Groningen region, only 1600 did so in 2009-10 (Das and Van Daalen: 11). After a decade of 5 to 15% yearly inflation in the provincial housing market, prices stagnated from the end of 2008 and then declined dramatically in the ensuing years. It quickly appeared that the development of Meerstad would take longer, if ever completed. The land that was purchased for about 300 million euros and was accounted for 356 millions euro in 2010, was clearly not worth its estimated value, which was consequently downgraded to 317 millions in 2011, and again lost 25 million in 2012, lower than its initial purchase value.

The limited building and sale prospects drove the four private partners to withdraw from the joint venture on February 29, 2012. Associated public authorities withdrew as well at this point, leaving the municipality of Groningen as sole shareholder: The joint-venture had dissolved after only seven years of existence, turning a page on public-private collaboration in Meerstad. In 2013, 125 hectares were under construction or completed, accounting for about a hundred dwellings – far from the objective set in the initial master plan to "deliver seven hundred dwellings before 2010" (Alle Hosper, KCAP, 2005: bijlagen,113-114).

Along with the financial adjustments and the management reorganization, a new development strategy was presented at the end of 2011 by Bureau Meerstad and the urban designer earlier commissioned for the design of the first phase, De Zwarte Hond. The new strategy does not fundamentally question the ambitions nor the spatial structure set in the master plan, but reversed its approach: "we did not drop the master plan (...) but we are thinking from small to big, and not from big to small anymore" (Leverman, 2013). The strategic document subsequently identified the local landscape qualities, existing or planned, that could be exploited to qualify and develop each sub-area, stressing the programmatic flexibility of the plan. The core area, "Heart of Meerstad," that was initially planned in combination with a public beach, a harbor, and a fast public transport connection, now remains only as one of many "possible developments."

"Possible final development stage of Meerstad" (GEM Meerstad, 2011)

Today, from the windows of the newly finished villas, the lake already seems to reach to the horizon, although it is bordered by a temporary dike awaiting future extension. The subsequent phases are in the planning stage, with the development of "Lakeshore 2," along with a distant eye on the completion of the Meerstad Midden area anticipated in municipal zoning plans. The completion of the project within the framework ambitions of 2001-2005 seem today far away, however.

Jan Van de Bospoort, landscape architect and one of the early participants for the municipality, is today critical about the rigidity of the 2005 master plan: "We knew back then already [during the design phase] that it would not happen the way we were planning it. To me it is a pity that it became such a clotted plan. It could have defined flexible orientations better." To him, the housing program was simply too big for Groningen, with its countryside offering already many opportunities to live outside but close to the city. "We had to much competition from other living environments around Groningen, and there was to little regional coordination to make this happen." Not only was it impossible to concentrate the regional housing demand into one big project, but for Jan Van de Bospoort it was also retrospectively the wrong orientation, made under time and socioeconomic pressures: "We should have taken a time-out when we realized that we were not able to build in small areas, and take a break before we made the – forced – big jump."

Acknowledging the problems induced by sprawl for the regional capital, he retrospectovely doubts that Meerstad came up with the right answer: "We should not have surrendered to the political and social pressure. Is it that bad for Groningen if people go look for a house in Roden or Zuidhorn [two small towns close to Gronigen]? It is of course a concern when people outside of Groningen benefit from its public facilities without paying [taxes], but this should be solved through financial agreements. Groningen had to provide everything, urban and green environments; retrospectively it was a bad idea to develop a big residential area there."

Yet the original goals of the commissioners and designers – designing a green and blue framework that could facilitate diverse and unpredicted urban developments – have emerged reinforced from this self-critical phase. For landscape Architect Remco Rolvink, looking back at a ten-year process, "the pre-investment principle is a reality, but implemented phase after phase, with each step expanding the landscape elements and strengthening the area as a whole" (Rolvink, 2012). It is thus not so much the spatial structure that is questioned but the far too optimistic construction plan, its static building program and overambitious financial scheme that led to a financial disaster for its stakeholders. "The early 2000s were characterized by growth and enthusiasm, which to a great extent explains the massive scale of the project. Retrospectively, the project could have anticipated a more progressive development" (Rolvink, 2012).

Paradoxically, the careful and integrative elaboration of the project, from the first ideas developed in the eighties to the master plan validated in 2005, can be held responsible for the financial failure as much as it can be praised for its capacity to bundle various interests and motivate all actors through an open process: Multiple goals had a stimulating effect, since "all these functions still had to come about – nature, water, one-meter water buffering – and this brings constraints, but constraints brings about creativity. [Interdisciplinary work] was not a limitation, it just led to a different way of working" (Van de Bospoort, 2013). Furthermore, "The combination of multiple actors and ambitions, together with the involvement of the population, was a strong factor of integral quality" (Rolvink, 2013), but it was also a strong factor in the delay of the development of the plan, which eventually came too late to benefit from twenty years of booming real estate.

In 2103, what can this experiment teach us about integrated regional development and water management? Meerstad might have been seen as "a little pond for real estate developers" (Van de Bospoort, 2013) but is still a promising plan. In today's post-financial crisis perspective, the project was based on far too optimistic an economy – but this could be said about most development projects that were elaborated at the turn of the century, at the height of the housing market, and fully hit by the financial crisis in 2008. This however reveals a more essential discrepancy between the fluctuating nature of the housing sector, short-term expectancies of private investors, the relative slowness of regional development, and the necessary long-term vision of water management.

More than a financial miscalculation, Meerstad mostly failed to synchronize the short-term and fluctuating needs of the housing market, the slow and procedural pace of democratic regional development, and the urgent response needed to address flood risks after the 1998 events. The price paid for poor farmland was obviously based on a reflexive inflation, generated by programmatic ambitions based on short-term perspectives but uncertain in the long run. It, however, gave local authorities lasting control of a still promising area, securing potential for valuable long-term growth. The water board had to look elsewhere to satisfy its short-term need for reliable water storage, but will doubtless make use of the capacity offered by Meerstad in the future, since climate change projections remain pessimistic. New nature areas have already been implemented, offering new ecological and recreational quality to the region and the country. Meerstad thus still retains its original potential and, provided authorities remain faithful to their initial ambition, it should eventually become what it was meant to be: a vast and generous mix of water, nature and housing, organically grown within a unique landscape, addressing simultaneously urban growth and flood safety.

Meerstad, island under construction (Rossano, 2013)

Key points

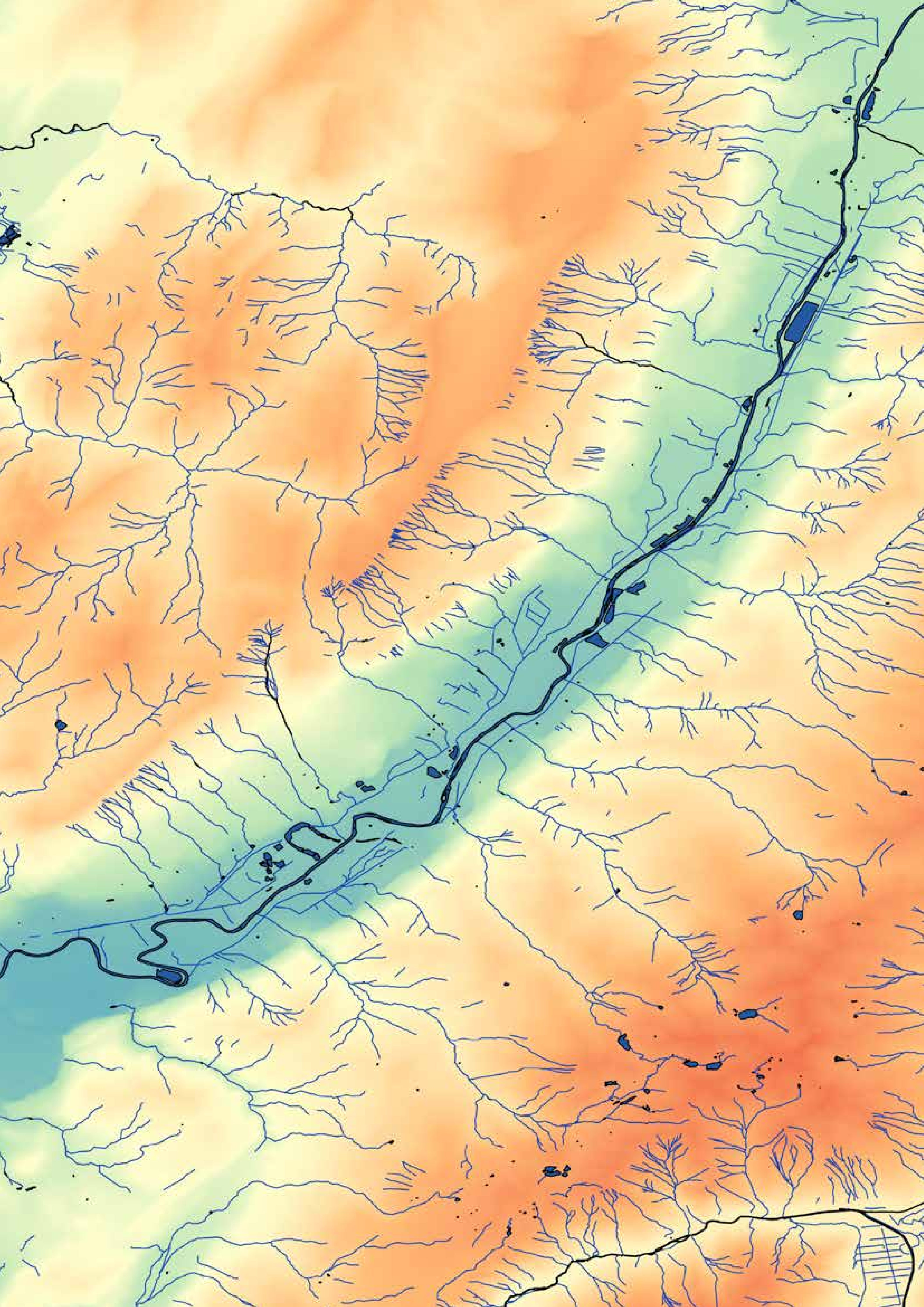
Emergency water retention can be combined with recreational uses, and support landscape enhancement and urban growth.

Private investment can co-finance and energize floodplain redevelopment on the short term, but seldom hold their goals beyond ten years

Combining public and private sectors needs synchronization of goals and means.

Combining flood protection and urban expansion needs to associate concrete and rapid measures with flexible and long-term frameworks.

Water authorities should be consulted and associated to adaptation plans, but must always maintain their independence and autonomy in order to ensure efficient management on the a long-term.



Elastic landscape for the Isère Valley

The Isère Amont project stretches over a fifty-kilometer segment of the River Isère, from the border of the Savoie Département upstream to the city of Grenoble downstream, with the name of the project ("Isère-Upstream") referring to the situation of the city. The project was initiated at the end of the 1990s, following upon a risk survey that had shown a critical state of the river's levees at several segments, and insufficient capacity to face even a thirty-year occurring flood without damage, which would put more than 100,000 people at risk. Neither raising the levees nor widening the river seemed to be efficient measures to protect the capital city of the Département, and local authorities took the decision to facilitate flooding rather than resist it, and to seek to control and mitigate its effects. A discrete project in terms of landscape impact, Isère Amont is no less radically changing the preexisting paradigm regarding flood risks in the valley. Sixteen "controlled flood fields" planned in combination with other structural measures are now being prepared and expected to be fully operational in 2021.

The French River Isère has its source in the Western Alps, draining an area of 11,800 km2 from the Italian border down to its confluence with the Rhône River (http://www.irma-grenoble.com). The river has a torrential regime due to its situation in an alpine area, but the topography of the glacial valley of Grésivaudan gives the stream a meandering course. Fed by alpine torrents and rivers, the Isère within the project area flows slowly (less then 1m/s in regular period), slowed down by the valley's topography and the confluence with the River Drac downstream from Grenoble, as the river's slope only varies from 0.1% to 0.06% before reaching the city (Castex, 2005).

Prior to dam and dike building, which occurred mostly in the nineteenth century, the valley had been through a series of metamorphoses following climatic evolution and the first anthropic influences. Throughout human history, the valley showed a relatively stable hydrology until the sixteenth century, allowing for a cultivated landscape to develop already from the ninth century onwards. During the "Little Ice Age" (1550-1850), the Isère evolved, however, from a single bed to an unstable braided morphology, as the river bottom rose, carrying large amounts of coarse sediments brought by mountain torrents, a phenomenon enhanced by the extensive deforestation of the Alps. In 1651, the level in the Isère rose 6.50 meters above the low-water mark, reaching the third floor [deuxième étage] of the city's buildings, and frequent floods followed during the seventeenth and eighteenth centuries (Bravard, 1989). The river was then still a slow stream, with a pre-photography engraving showing boats and people bathing in the center of Grenoble, but its surges were frequent and devastating. The 1733 inundation was particularly costly and laid bare the city's exposure. It would remain famous thanks to the verses written by poet François Blanc, beautifully illustrated by Rahoult and published in 1860 under the title "Grenoblo Malherou" (see "From myth to phenomenon" on page 35).

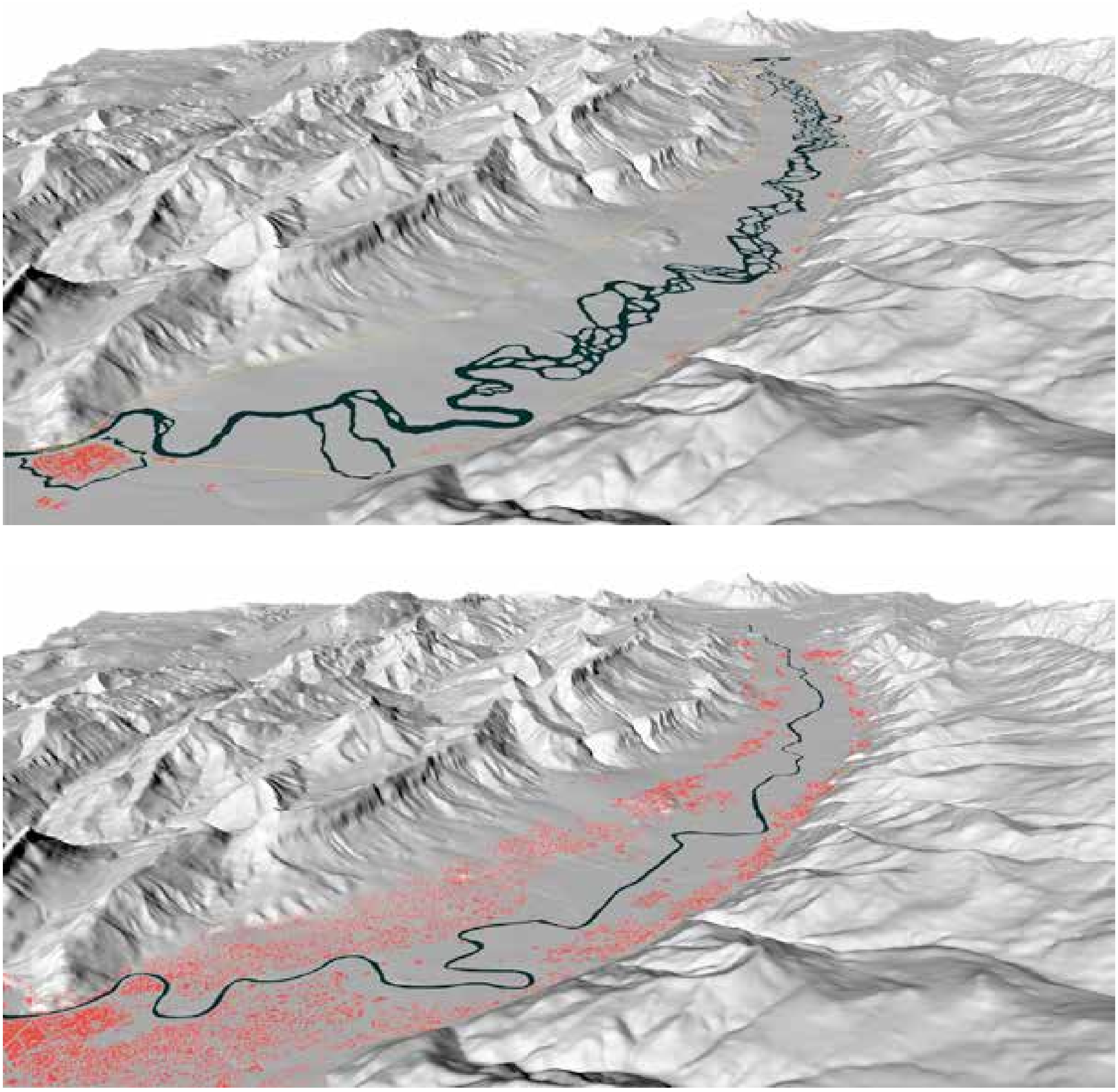
In this agitated century, fear of invasions and fear of floods inspired the 1747 project conceived by the "Génie," the French royal military corps of engineers. They proposed the creation of a second river arm, flowing south of the city, to expand the river's capacity and create a new fortification ring around the provincial capital (see "Projet de Fortification de Grenoble," on page 65). A specific aspect of this project was that it included the creation of new *faubourgs* within the new fortification, and sketched a few urban blocks on the location known today as the "Ile Verte" neighborhood. Although visionary in its integration of urban development, defense, and flood management, the project, like many of those that followed, was not implemented due to a lack of financial means from the state – with the local economy being far too modest to fund such a "Grand Projet."

Following the 1778 flooding – known as the Saint-Crespin Deluge – the national administration acknowledged and asserted again the need for a global project along the Isère, which would combine levees, flow straightening, and landfill (*colmatage*). Engineer Rolland described the situation in 1787: "Floods pour over the valley, were streams develop due to the height of the overflows, obstruct old passages with gravel deposits, and open new ones through the best parcels (...); part of the best land is already covered with sterile gravel (...); the river, when destroying its sides, widens its bed, divides its waters, and does not have enough strength to carry the materials brought in by the torrents, so that its bed rises up to the point that the smallest raise [in water level] will lead to overflow" (Rolland, 1787). A new project was drawn up, which proposed straightening 51 kilometers of the river and redrawing no less than 24 kilometers from the its original meandering course. The outbreak of the French Revolution, and the financial and political difficulties that followed, however, again postponed this plan (Pinhas, 2013).

1870-1914: the Isère channeled "for good"

Upstream in the neighboring Savoy Département (then part of the Kingdom of Sardinia), the Isère River had already been systematically channeled and its floodplain artificially raised between 1829 and 1853 (Pinhas, 2009 and Girel, 2010), approximately at the same period that saw the Upper-Rhine being channeled and straightened from Baden to Elsass (Blackbourn, 2007: 93-101). On the French side, however, the Isère was still bordered and managed by a large amount of individual landowners, locally grouped into numerous "Syndicats de riverains" or landowners' associations (Blanic, 1975). The levees visible on Raoul Blanchard's map of 1845 formed a discontinuous protective shield, managed by thirty-six associations from Grenoble to the border, without any coordination (Pinhas, 2013). The channeling of the Savoy section further increased sedimentation in the French part, where the river slowed down due to the valley's natural topography.

Further generalized between 1870 and 1914 by the associations, possibiy already from 1852 on (Castex, 2005) levees were progressively raised and supported by public subsidies (Blanic, 1975), while parallel drainage ditches, the "chantournes" were dug to drain adjacent farmlands – this, however, without any coherent plan nor any single authority to coordinate the various interventions.. The river's meandering shape remained unchanged, however, since the inhabitants of Grenoble feared that a straightened channel would lead to more floods. These protection works led to a prosperous period of agricultural development until the early twentieth century, when their disruptive side effects started again to have a negative impact on land safety and productivity. Without cutting the meanders, the correction had, however, considerably reduced the former floodplain (up to 1500 meters at its widest) down to a 100 meter-wide single channel. By putting an end to the natural spreading of sediments over the valley, the channeling thus induced the development of stone and gravel islands within the channel, islands further consolidated by silt deposits and pioneer vegetation, provoking a gradual and irregular raise of the riverbed.



Isère Valley upstream Grenoble: river course and urbanized areas
in 1765 and 2010 (ill. Rossano, data IGN)

This consequently reduced the river's discharge capacity and provoked increased damage during flood occurrences, which remained relatively frequent. The rising riverbed further led to overflowing, to infiltration and to a rise in the water table, which, in turn, transformed part of the valley into marshlands. In 1926, it was estimated that about a quarter of the valley was suffering from an excess of water (Blanic, 1975).

The 1929 Schneider plan: a manual for flood mitigation

In 1927, a competition was organized to elaborate and implement a global river correction plan. The Schneider Company won the competition in 1927 with a 260 million-franc proposal that combined the deepening the river, raising of the existing levees, and the restoration of the canals and ditches draining the valley. More specific in the proposal was the creation of areas for temporary retention in order to lower the water levels at peak discharge and protect the city downstream (Pinhas, 2009). Spillways were planned in the levees between Pontcharra and Saint-Gervais to let the flow spread over farmland and return to the main riverbed after the flood.

The idea, already suggested by the Gentil Report in 1860 (Castex and Belleudy, 2005: 18), was further developed and generalized in the Schneider proposal, which defined and described the principles of a dual system, adding to the correction of the riverbed itself the precise adaptation of the floodplain's topography to facilitate and control flood propagation: "Where the riverbed is established for good, the valley on each side will be divided into distinct compartments, protected upstream by a perpendicular flood-proof [insubmersible] levee. These compartments, defined by existing dikes along the river, would be delimited downstream by the transversal edge of the next compartment (...) The dikes would be set at the height of the ordinary flood level (3.3 meters above low-water level) and built as an intake so that it can be topped off without being overturned. The length of this intake will be calibrated so that the compartment to be submerged can be filled up to the level of the intake, before it flows over the upstream levee. Each compartment will have aqueducts with a valve to let waters flow out when the flood is over. This would guarantee the system's unsubmersibility for all ordinary floods. For large floods, waters would, on the contrary, enter the compartments by overflowing the lower part of the dike. The role of these dikes would be a storage in the valley, similar to what would happen by dike breach, but with very limited damage, as it would prevent the formation of rapid streams" (id.).

This first integral mitigation project, meant to be fully financed with public funding, was unfortunately abandoned for financial reasons but was soon followed by a major reorganization of the water administration: The various landowners' associations became members in 1936 of one single management authority for the river's levees, the "Association Départementale des collectivités intéressées à l'Aménagement des plaines de l'Isère, du Drac, et de la Romanche", which included not only private landowners but also the Municipality of Grenoble and the Isère Département authorities .

In 1940, a large flood proved a reminder of the urgency of a defense project. It followed upon an exceptional discharge of 1500 m3/s measured in La Gâche and provoked a general dike breach upstream at Brignoud. The Isère covered fourteen square kilometers of farmland, causing widespread damage. The event, however, also confirmed the potential of "preventive flooding" for the protection of Grenoble, where the river discharge was almost divided by two (900 m3/s) thanks to the involuntary spreading of the flow a few kilometers upstream from the city. The flood also secured the financial basis for the correction project in the finance bill passed in 1941. The Schneider project was further investigated and developed by the Neyrpic Company (whose engineering branch, the Laboratoire Dauphinois d'Hydraulique, became Sogreah in 1972, and worked further on the Isère correction until the preliminary studies for Isère Amont in 2000). Neyrpic retained the main principles – dredging the riverbed and raising the dikes – and added a new proposal: cut three of the river's meanders.

Between 1950 and 1969, the river correction was partially completed and was indirectly supported by urban developments: Grenoble's population soared from 102,000 inhabitants in 1946 to 161,000 in 1968, the year of the Winter Olympic Games. Out of the four million cubic meters extracted out of the Isère before 1965, 2.5 million were sold to sustain the construction of buildings and infrastructure for the city and its booming agglomeration (Blanic, 1975). In total, fifteen millions cubic meters were extracted from the river upstream from Grenoble (Pinhas, 2009): The river correction was then not only an enterprise of flood protection but also, and maybe given priority, a mining enterprise – with the extraction authorizations being actually issued by the governmental mining authorities (Jardin, 2012). On February 2, 1968, the 2650 meter-long meander called Bois Français was cut off by an 850 meter-long and 110 meter-wide channel. "At 11:17 a.m., Grenoble time, the Isère River has obeyed the engineers of the Ponts et Chaussée and changed riverbed," reported the Progrès newspaper (Progrès, 1968, quoted in Pinhas, 2009-2011). The local paper Dauphiné Libéré celebrated lyrically and with a slightly misogynous tone, the superiority of man's will upon nature's unpredictably, the "victory of 'Man' over her, the river" (the French word "rivière" being a feminine noun): "There was a time when the Isère would go its own way and be a headache for the agglomeration of Grenoble. Today the hand of Man dictates the way, and she surrenders (...) At 11.24 (...) the unfaithful Isère has adopted the bed offered by Man, who dug for her a 900 meters long channel" (Dauphiné Libéré, 1968).

With this new bypass, inhabitants upstream hoped to reduce sedimentation by accelerating the stream, following the strategy promoted by Tulla in the early nineteenth century; the City of Grenoble downstream believed the extraction had supplied an answer sufficient enough to prevent a further rise in the riverbed (Blanic 1975), and thus had agreed with the measure. Despite studies to fill and exploit the river branch cut off from the stream, it remained in place and would later be divided into five ponds dedicated to sports and leisure.

Just like the first channeling, however, this long-planned correction (1929-1969) again generated new problems and new risks. The riverbed dropped rapidly, under the combined influence of intensive extraction, increased water velocity, and a decrease in sediment input held by hydroelectric power dams built upstream. In the years following the river's transformation, the riverbed dropped, on average, thirty centimeters per year, up to three meters in some sections, threatening the stability of levees and bridges (Blanic, 1975). Furthermore, the urban section of the Isère was not adapted for large amounts of water, and the transformed upstream section was not designed to retain or delay the river discharge, worsening the risk of flood and damage within the city.

Correcting the second correction

A new plan was elaborated in 1971-72 to mitigate the effects of the previous project and again to protect the agglomeration of Grenoble that had by then largely invaded the river's natural floodplain. A stop was put to private extraction from the riverbed. Walls and dikes were raised locally within the city to resist a 1500 m3/s discharge. Although this figure was still below the discharge level of the 1859 flood (then estimated at 1800 m3/s, the highest known), it became the reference discharge, since the studies based on a 1/100 model built by the Sogreah Company showed that the city bridges and embankments could not cope with a higher discharge. Raising further the discharge capacity in the valley thus seemed counterproductive as long as the inner city remained a bottleneck, a situation that could only be changed by gigantic works and unrealistic investment. The project included (again) the deepening of the riverbed, meant to allow another 300m3/s discharge, through digging and through the creation of a reinforced fifty meter-wide and four meter-deep channel in its center. A sunken dam downstream would maintain the minimum water level and prevent a drop in the water table, along with the damage this could provoke in the wooden foundations of ancient buildings.

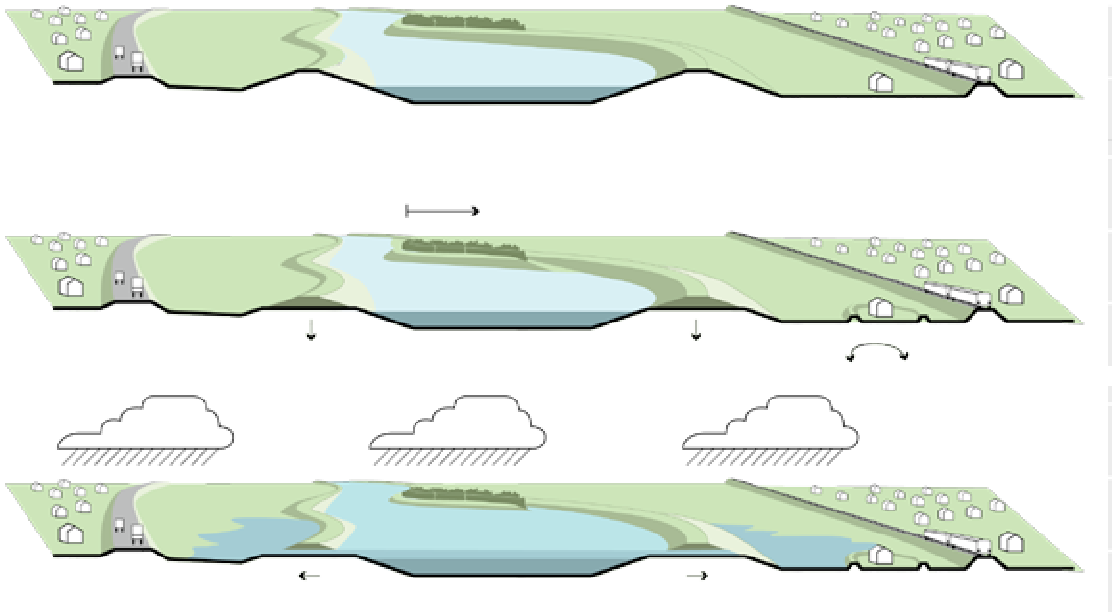
The Sogreah studies went further than the sole aim of increasing the capacity of the riverbed. Flood propagation over the valley upstream Grenoble was also investigated, as well as possible mitigation effects benefiting the city's safety. It reintroduced the idea of creating "flood fields" to protect the most valuable areas, an approach earlier proposed in the Schneider project; a mathematical model made it possible to consider and study the floodplain as a whole system of communicating basins. An attempt was made to apply this principle in Le Touvet, with the construction of a levee in a tunnel crossing the A41 motorway. The levee, meant to facilitate and regulate the flood propagation between two areas of farmland, was soon removed, most probably by farmers considering it to be a too big disruption in their daily activity and movements (Jardin, 2012). Seemingly, engineers no longer considered absolute safety as a realistic ambition and already began work on flood deviation and mitigation principles to protect urban area and spread the risks over the valley. The principle, however, still appeared to be unacceptable by the valley's main users.

The following decades saw no major floods, and the levees progressively degraded as maintenance was neglected. Meanwhile, the amount of people and goods exposed to flood risk soared, as the valley's urbanization continued its strong pace. A study conducted in 1995 showed that a 200-year flood would impact 10,000 dwellings, 120 farms, 6000 companies as well as many public buildings such as schools and hospitals. Thirty-four thousand jobs were involved, and the damage could cost 500 million euros, according to an updated survey made in 2005 (SYMBHI, 2009: 7). Although no major flood occured in this period, concerns and consciousness grew around the doubtful safety of the Isère levees and the growing exposure of the agglomeration.

The Isère Amont project

The Association des Digues, responsible for maintenance but having no mandate to invest and conduct big scale structural works, initiated in 1991-92 a Project of Public Interest ("Projet d'Intérêt Général") for the Isère Amont area. The procedure reinforced the prerogatives of public authorities that prepared a new Flood Risk Prevention Plan (PPRI), which became compulsory for all French municipalities in 1995. A diagnostic was made of the river levees, which showed great disparities in their composition and stability. The Sogréah Company, already involved in the seventies, was again commissioned to assess flood risks within the valley's now densely urbanized context, over a territory involving twenty-nine municipalities and belonging to two administrative communities: the Communauté d'Agglomération Grenoble-Alpes Métropole and the Communauté de Communes du Pays du Grésivaudan. Sogréah was also chosen to elaborate a draft project for securing the floodplain. In parallel to this risk assessment, Sogréah was also commissioned to work on a global project to address flood risks from the northern border of the Département, down to the city of Grenoble, a stretch of twenty-five kilometers, where so far no authority had succeeded in implementing a coherent flood defense system or strategy.

Conforming to the national PPRI regulations, Sogréah again took the highest water discharge known as a reference, the 1859 flood, in order to identify risk areas and potential water retention areas. The 1859 high water was, however, prior to reliable discharge measurements, and the estimations were based on available historical information, such as local water levels and flood propagation. These data, already used for the 1972 plan, were thus interpreted and developed through the use of statistical models that included a certain subjectivity in methodological choices but had great territorial consequences. So did the conclusions of Sogréah, which identified new risk areas contradicting previous planning documents (the SDAU, regional planning document, validated in 2002) and frustrated the expansion possibilities of several municipalities, locally boosting land prices up to 250% (Jardin, 2012).



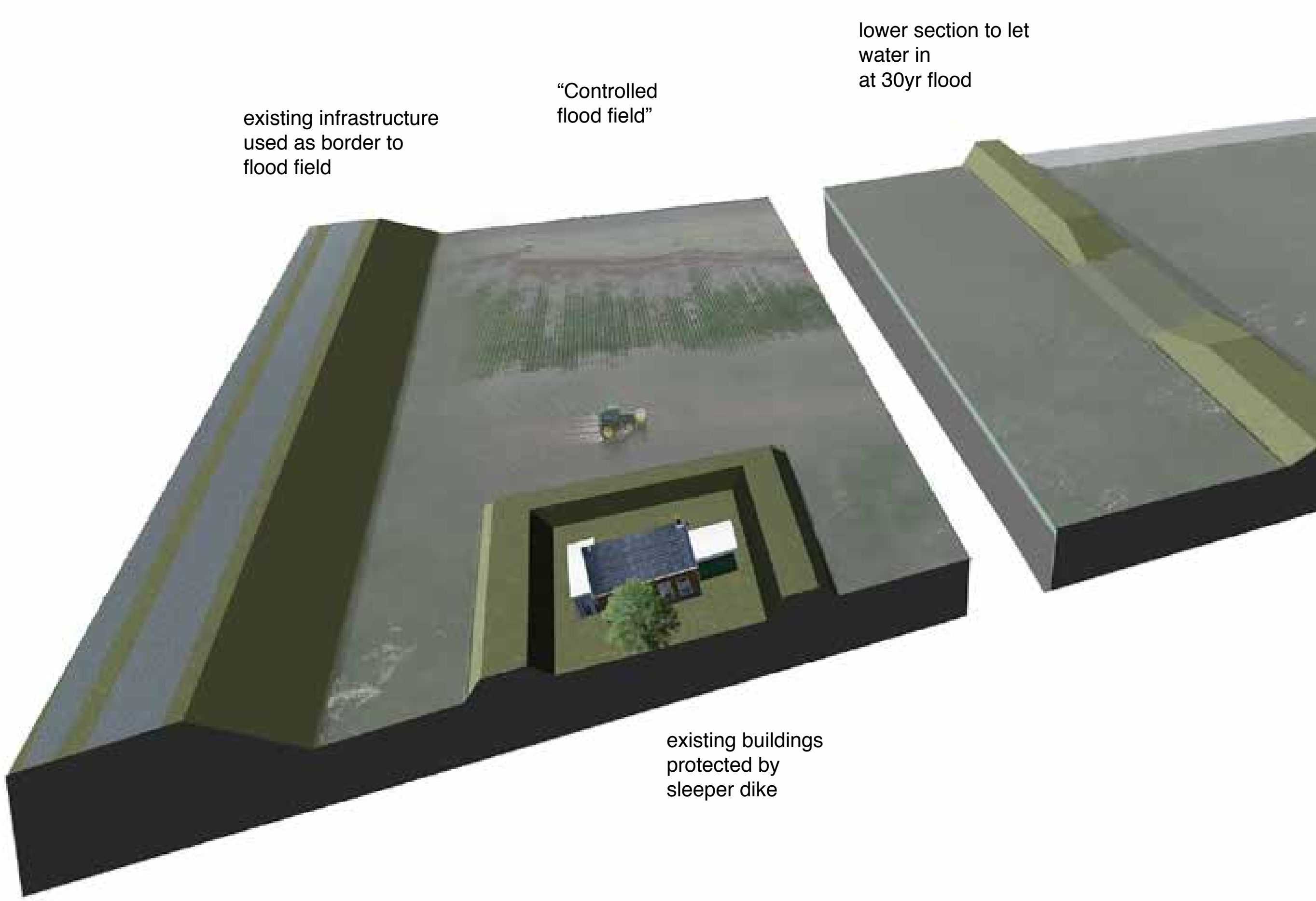
Space for the Isère: diagrams of the planned measures (Rossano)

This generated a new controversy among local authorities. Doubts were raised over the reliability of flood risk projections – allegedly over-estimated according to local representatives. In a letter sent by the municipality of Champ-près-Froges to the Conseil Général (department council), a virulent critique was addressed to the authors of the new PPRI, in particular regarding contradictory studies made on flood risks and on the impact on infrastructure, as well as regarding the preference given to the worse case scenario for the tributaries' discharge, exaggerating flood risks along the Isère River. The letter also expressed a more general frustration regarding the area that should be reserved for temporary water storage – and thus subtracted from potential urban growth. This was perceived as a sacrifice on the part of small municipalities caught between the effect of river channeling upstream, and the urban growth and increasing exposure of Grenoble: "Squeezed between Grenoble downstream and the Savoie Département upstream, the municipalities of the Grésivaudan Valley have to stand alone against the Isère big floods; upstream in Savoie, the dikes built in the nineteenth century have closed off the former floodplain, and the high floods are not absorbed anymore; downstream, close to Grenoble, between Isère and the railway, the last flood fields have been eliminated" (Letter from the Municipality of Champ-près-Froges, 2006).

For this small municipality, the new flood regulation was seen as an illegitimate limitation of its development for the sole benefit and safety of Grenoble; flood risks were allegedly overestimated, as a form of political blackmail to force small municipalities to collaborate in the big plan: "We cannot accept our construction zone being frozen in accordance with unreasonable principles that exceed the regulatory framework" (id.). Flood risk assessment might indeed have been deliberately dramatized to facilitate the project's implementation: "To get politicians to act, one needs to be maximalist, irrational in a way" (Jardin, 2012). Whether accurate or exaggerated, the maximalist view ultimately succeeded in mobilizing all the municipalities concerned: The project proposed by Sogréah was able to proceed further into the design and building phases, led by the Symbhi, a public agency specifically created in 2006 to elaborate and implement the project Isère Amont.

From scenarios to consensus

In 2004, three scenarios were defined by the engineers from Sogreah and Symbhi, based on the goals set for flood protection, environmental restoration and development of recreation along the Isère. Although the word scenario suggests an open investigation based on multiple choice, the planning process instead followed a dialectical pattern: thesis, antithesis, synthesis. The first scenario favored dike reinforcement and riverbed dredging upstream, with negative consequences for the river's fauna and flora. The second scenario proposed moving the levees further away from the river and incorporating the remaining riparian woods within the riverbed, a positive option for environmental development but negative for 180 hectares of farmland that would be flooded every five years on average – an option incompatible with vegetable farming. The third scenario was later elaborated to synthesize the remarks made by elected representatives, environment associations, and farmers during this first round of public participation. Without adding to the



existing nature reservations, it proposed associating and balancing the various approaches: allow natural water fluctuation into unexploited areas, in particular existing riparian woods; reinforce fifty kilometers of levees; and create "controlled flood fields" ("champs d'inondation controllée" or "CIC") to mitigate the effects of future floods.

In 2005, Symbhi communicated the scenarios through about 45 meetings, of which eight were public. Despite the risk of delays and conflicts – such as the above-mentioned conflict opposing the Département to Champ-près-Froges – the planning process involved communication for a large part, thus creating room for discussion and improvement. The project was promoted by deputy Robert Veyret, vice-president of the Conseil Général in charge of water policy. Robert Veyret was president of Symbhi, but also the long-time mayor of a small village between 1983 and 2001, and was very keen on involving the local population and elected representatives in the planning process.

Schematic impression of the controlled flood fields in action (Rossano-Orfanopoulos)

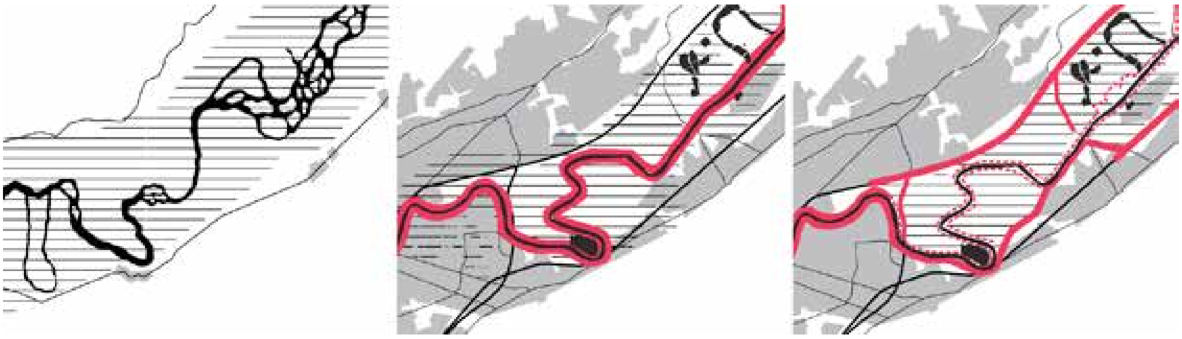
This third scenario was validated on the February 2, 2006, by the Symbhi Conseil Syndical. The project was further elaborated segment by segment – with seven areas being defined for the development of the draft. For each one of them, two meetings were organized with the local representatives, one public meeting and two workshops involving local inhabitants. Remarks were then tested by the engineers from Sogréah and Symbhi, with three-quarters of them being integrated into the draft, which was again presented to the public in October 2006. According to the Symbhi final report, most of the remarks concerned the future water system of irrigation and drainage, the recreational infrastructures, the landscape integration and ecological measures, as well as the protection of buildings located in the flood fields. The project was finalized in 2007, and again presented to the elected representatives and to the public between January and March. It was further presented to the authorities in charge of water, agriculture, environment, public and private infrastructures (railways, highways, electricity networks).

In the meantime, a specific discussion began around the elaboration of a specific compensation system for farmers, whose land was located in the future flood fields, and thus would be potentially flooded, starting from a thirty-year flood situation. The local Chamber of Agriculture represented the interests of farmers in the negotiation held by the SYMBHI. The negotiation lasted for more then two years, leading to new discussions and conflicts regarding not only the financial compensation system but also the localization of recreational facilities, parking spaces, and tree plantation – that was eventually reduced in order to maintain land productivity. The discussions saw some rather heated episodes and incidents, the most striking being the dumping of manure in front of the Conseil Général office in Grenoble. The agreement was finally signed by both parties in February 2010 and covered various types of damage that could concern farmlands designated as "controlled flood fields," as well as land exposed to a higher risk after the project's implementation. The compensation not only covered damage to buildings or equipment but also the loss of cattle and harvests. Trucking activities, their irrigation system, drainage networks and greenhouses were in essence more exposed to permanent damage than regular crop fields. The agreement thus included, in these particular cases, the compensation for potential loss in sales contracts, and opened up the possibility of implementing extra flood protection whenever the exploitation's sustainability was affected by the flood event (Conseil Général de l'Isère, 2010).

1850-2010: concluding a 160-years project

The project today implemented by Symbhi can be read as the achievement of 160 years of designs, great or modest, that successively stumbled upon controversies and financial backlashes. Although based on a new urban situation and updated hydrological models, many elements of the design can be traced back to the plans made by Engineer Cunit (1850-60), Gentil (1860), de la Brosse (1860), Schneider (1927), Neyrpic (1942-44), and Sogréah (1972). Like most of the previous projects, Isère Amont first addresses a long known problem: the disparity and weakness of the levees, and the irregular erosion and alluvion of the river, here hindering the flow, and there weakening civil works.

The 2009 project synthesis claims three objectives: Protection of urban areas against a 200-year flood and farmland against a 30-year flood; ecological improvement of the river and adjacent space; and development of nature-based recreation. Within this combined program, the first aspect is, however, the most developed and the most significant in the context of contemporary adaptation strategies. The flood mitigation system based on the controlled inundation of farmland – a principle already suggested without success by Cunit after the 1848 flood, and again in the 1929 Schneider project – is now to be applied on a large scale in coherent and dynamic system.



Isère Valley east of Grenoble: river, built areas and floodplain in 1765, 2010, and planned after implementation of the "controlled flood field" (Rossano, from Symbhi, 2009)

The distinction made between urban areas and farmland allows for a differentiated approach to risk and is adapted to exposure and to the urban reality of the valley, leaving no other choice than guiding flood waters towards open areas before they hit people and homes. The chosen gradual approach of flood phenomena clearly breaks with the perspective inherited from the Enlightenment that saw Man as a correcting power upon an irrational, imperfect, and erratic Nature (see "Tame or set free: nature and the Enlightenment" on page 74). By introducing graduated flood levels as a defining element of the design, water dynamics again became central to the conception of the living environment – a change materialized in practical terms by dike heights, spillways, functional zoning, and a compensation system for mitigation areas.

The protection goal also implicitly states a new role for the valley's farmland, from main asset to risk catcher. The two levels of protection – or risk tolerance – not only introduce a differentiation in value but also install a functional relationship between urban areas and farmland: In case of discharge higher than the statistical 30-year return value, urban grounds will be kept safe by deliberately letting the Isère flood onto corn fields upstream. Furthermore, quantifying the protection level introduces a dual land status that implicitly defines the land's functional destination and value for decades at least.

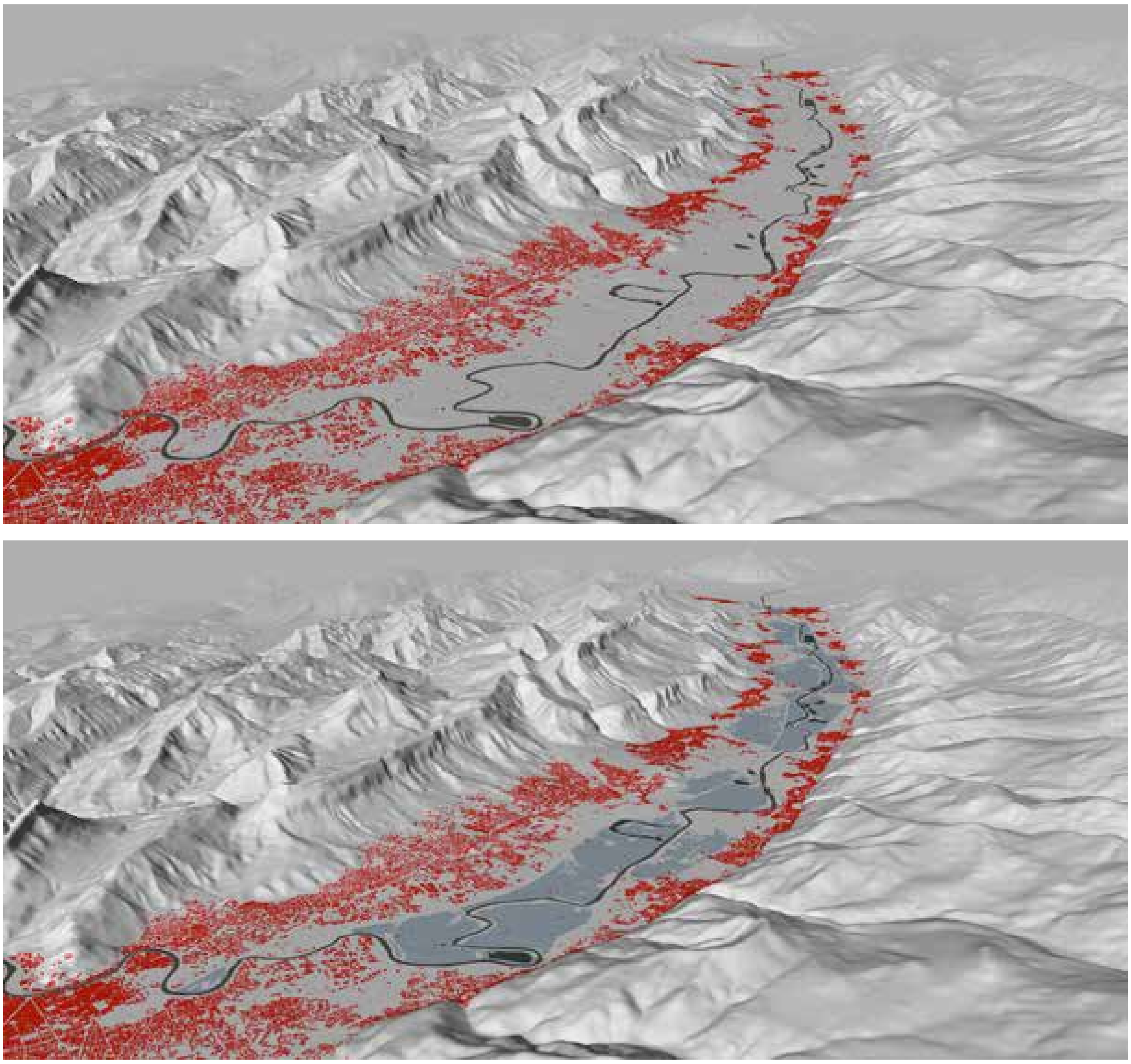
The second stated objective of the project is the restoration and development of natural habitats. The Symbhi final report presents a diagnosis of the ecological situation of the valley, pointing out the high value of the alluvial forest, but also its progressive disappearance. The alluvial forest that would naturally cover most of the valley, thanks to the Isère frequent floods and divagations, is threatened with disappearance by urban extension, by agricultural development and drainage, and by the influence of the previous river works that have interrupted the regular floods and lowered the ground water table. While 50% of the valley's open space consists of arable land, 20% is made of hardwood forest populated by species disseminated from the mountainsides, and 30% is occupied by a "mosaic of poplars, hedges, groves, and soft wood" (SYMBHI, 2008). Original alluvial habitats are not quantified in the Symbhi final report, whose authors however pinpoint the rarefaction of marshes, of wet grasslands turned into arable land, and of natural ponds turned into fishponds.

The disappearance of dynamic alluvial habitats has been a slow but ongoing process in the Grésivaudan Valley, though stretching over a longer period then in the neighboring Savoy, where river channeling, valley drainage, and landfills were completed in a shorter and more coherent way in the early nineteenth century. In the Grésivaudan, on the contrary, the lack of global and coherent maintenance or flood defense works has left a fragmented landscape and sporadic riparian vegetation, often cut off from the river stream by previous channeling attempts. The vegetation developing exclusively under unstable conditions, in particular under the influence of water, sediments, and organic materials brought in by occasional floods, is hard to find along the river's steep and calibrated embankments. "Without this perturbation and these material supplies, alluvial forest cannot function naturally" (Girel, 2006). The challenge faced by restoration supporters is thus to combine a stable and reliable flood defense, a regular and controllable water system needed for profitable crop farming, with a dynamic habitat profitable as alluvial habitats – along with several endangered species.

The first design sessions tried to elaborate a "renaturation" concept that would allow the river to fluctuate again onto larger areas and regenerate alluvial habitats, within a profile compatible with the dense use of the valley. The goal soon appeared elusive, however: "We thought that by letting the river erode fifteen meters of embankments, we would give it its freedom back," recalls dike master Michel Pinhas, but "freedom for a river should be total, or else you have only its downsides: damaged levees, dramatic floods, unstable profile" (Pinhas, 2013). The ribbon of trees on the levees and within the channel was valued as a strong landscape feature and last ecological asset. However, its presence also appeared controversial during the preliminary investigations: Trees can weaken the levees, cast shadow onto farmland, and eventually do not belong in the channel of a regulated river – "a river flowing between sandbanks, with trees, woods and islands, looks very pleasant, but one does not realize that it is a scale model of the Isère [compressed] between the levees, and that this model will be wiped away by the next flood, in the best case. In the worst case, the channel will be obstructed and the river will flow over the levees" (id.). The attention thus rapidly shifted from hopes of partial renaturation towards more modest ambitions: Reinvigorate the 260 hectares of former alluvial woods by putting them again in relation with the river floods, and reinforce the continuity of the green ribbons along the river with the plantation of about twenty hectares – "generally selected for their limited agricultural value" (Symbhi, 2009: 20), and preferably not on the levee itself.

Outside the river channel, farming activity and ecology remained two distinct components, segregated by administrative zoning, and further divided by the incompatibility of their respective needs. The economic structure and profit-focused agriculture of the valley and the limited mandate of Symbhi made it difficult for planners to envision a positive symbiosis for farming, nature, and recreative uses. Accessibility for urbanites was limited everywhere, by lack of infrastructure or, voluntarily, in order to protect biodiversity and exploitations. The three scenarios put into discussion by the Symbhi in 2005 were logically evaluated according to the respective costs and benefits for farming and nature as competing components, excluding a a symbiotic approach that would seek mutual benefits.

Former riparian wood being reconnected to the main stream (Rossano, 2013)



Isère Valley in normal situation and with activation of “controlled flood fields” mitigation areas
(Rossano, data IGN, Symbhi)

Metropolitan river: a missed opportunity ?

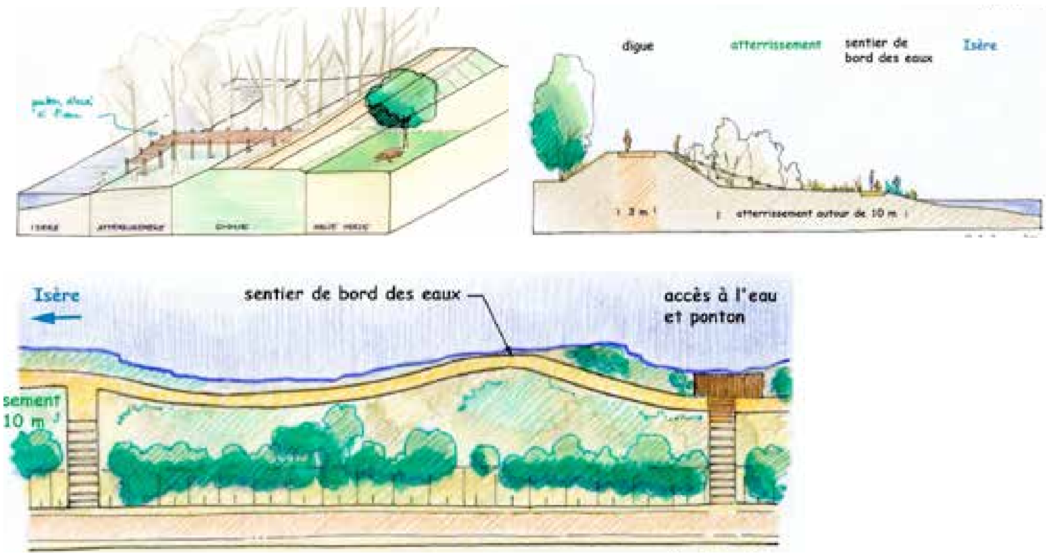
The Isère Amont project addressed the issue of connectivity, here again with restraint. Before the project started, the Isère levees were already used for recreation and slow traffic, particularly between the university campus and the city center. Taking advantage of the civil works induced by levee reinforcement, promenades and cycling paths are enlarged or created where missing on and along the levee; Narrow paths along the river are kept or developed on shorter segments to provide intimate promenades closer to the water. Static elements, such as steps allowing visitors to get closer to the water, and picnic areas, are disseminated along the river. New accesses to the water are planned for water-sports lovers.

The Isère Amont program can therefore claim a threefold approach - flood risk, ecological restoration, and recreational quality. Still the project avoids addressing spatial challenges, unwilling to enter the scope of urban planning, and restricts landscape architecture to visual analysis, local recreational amenities and plantation schemes. As Michel Pinhas, chairman of the Isère Water Board, retrospectively notes, "At the beginning it was a very hydraulic project, and than later one thought 'Let's try to do it right'". Yet the enormous potential of the river as structuring element and agent of change was left unexploited. The Isère river flows along twenty-seven municipalities in the project area alone, and links major urban functions along its way: four leisure and camping areas (Le Bois Français, la Terrasse, La grande Lône, La Taillat), several industrial and retail areas, the university campus, the regional hospital and the city hall of Grenoble, whose park had recently been extended down to the riverside. Since old centers are located on the hillsides, initially settled at a safe distance from the Isère floods, most of the post-war urban extensions were built towards the river, potentially a factor of living quality and good connectivity. Nine bridges alone cross the Isère between Grenoble and Pontcharra, one every four kilometers on average. None offer a cycling path that could safely lead inhabitants to the recreational lakes, riversides, and promenades. Physically forming the central spine of the urbanized valley, the river forms a barrier rather than a binding element.

The analysis of the existing landscape as exposed in the 2009 project report – a quarter of a page – unfortunately gives no project orientations but a static and general characterization of the valley's existing landscape, schematically divided into three parallel stretches of "residential hillside" on the north side, "industrial trench" on the south side, and "woody river between highway and railway" (SYMBHI, 2009: 9). In a longitudinal direction, the authors of the report identify five segments from east to west: nature and leisure, industry, woods, suburbia, and city. This account does not seem to have any further influence on the project itself and chooses to ignore the scattered and dynamic nature of the valley's landscape. In reality, the Grésivaudan in 2013 showed the typical aspect of global peripheries, formed by a combination of local initiatives and hydro-geomorphological constraints, rather than anything coordinated by a central authority. Eventually forming a mosaic of mono-functional zones, diverse in their substance but uniform in their isolation, residential, retail, and industrial areas are juxtaposed according to municipal ambitions and real-estate opportunities, long left uncoordinated by an administrative tax system that lets local interests prevail over regional planning. The above-mentioned conflict opposing the Municipality of Champs-près-Froges to the Conseil Général is symptomatic of a development policy that still to this day is defined locally, despite the growing integration of the valley's economy, housing market, leisure practices, and transport system.

In this context, not using the river securization project to give coherence and structure to the scattered urban fabric definitely appears to be a missed opportunity for the young agglomeration. Caught between mountains and reserved floodplain, the agglomeration can now only expand and densify in a longitudinal direction, shaping new constraints and perspectives for regional planning, and implying new challenges for the administrative structure of the valley, historically sliced transversally from mountain to river shore by municipal borders. Keeping the project within the scope of flood prevention has probably avoided long and complex debates about land use and planning coherency, debates that the local authorities will eventually have to face on another occasion The valley's spatial finiteness and the need for coherent environmental and flood policies might motivate the current discussions around a growing alpine agglomeration, the Sillon Alpin linking Geneva to Grenoble through the Savoie. A new "Pôle métropolitain" is being prepared by the major French alpine cities in order to reinforce collaboration and lay "the foundations of a common destiny," as cautiously stated in October 2011 on the information website of the Grenoble Agglomeration. The linear structure of this metropolitan network could put the river back at the center of planning policies – in terms of flood safety as well as mobility and landscape developments. It is, however, too early to judge whether this new scale jump can shed new light on the river's potential.

The Isère Amont project is paradoxically both a consecration of the political integration of the valley through flood protection policy, and a missed opportunity to address its landscape as a totality through a global and active vision, and to actively relate urban development to ecology and flood prevention. While risk operates as a binding factor, finally succeeding in reaching a long sought consensus for action, river management fails to transcend traditional boundaries between engineering, ecology, and architecture, since the questions of spatial quality, continuity, and coherency remain absent from the project definition. "The River Isère is ugly," stated the chairman of the Isère Water Board Michel Pinhas in an interview, referring to its speed and brownish color. The growing amount of citizens walking, running, cycling along its shore, however, shows that its potential and its role in the growing alpine metropolis still remains untapped in many aspects. The creation of the "Controlled Flood Fields," although bringing no added value to the agglomeration in terms of spatial quality, however, creates by default room for future developments, and might be a historical move towards the development of a vast metropolitan landscape, available for the alpine agglomeration to improve its living environment in the future.



Landscaping interventions planned along the Isère levees
and river embankments (Symbhi, 2009)

Key points

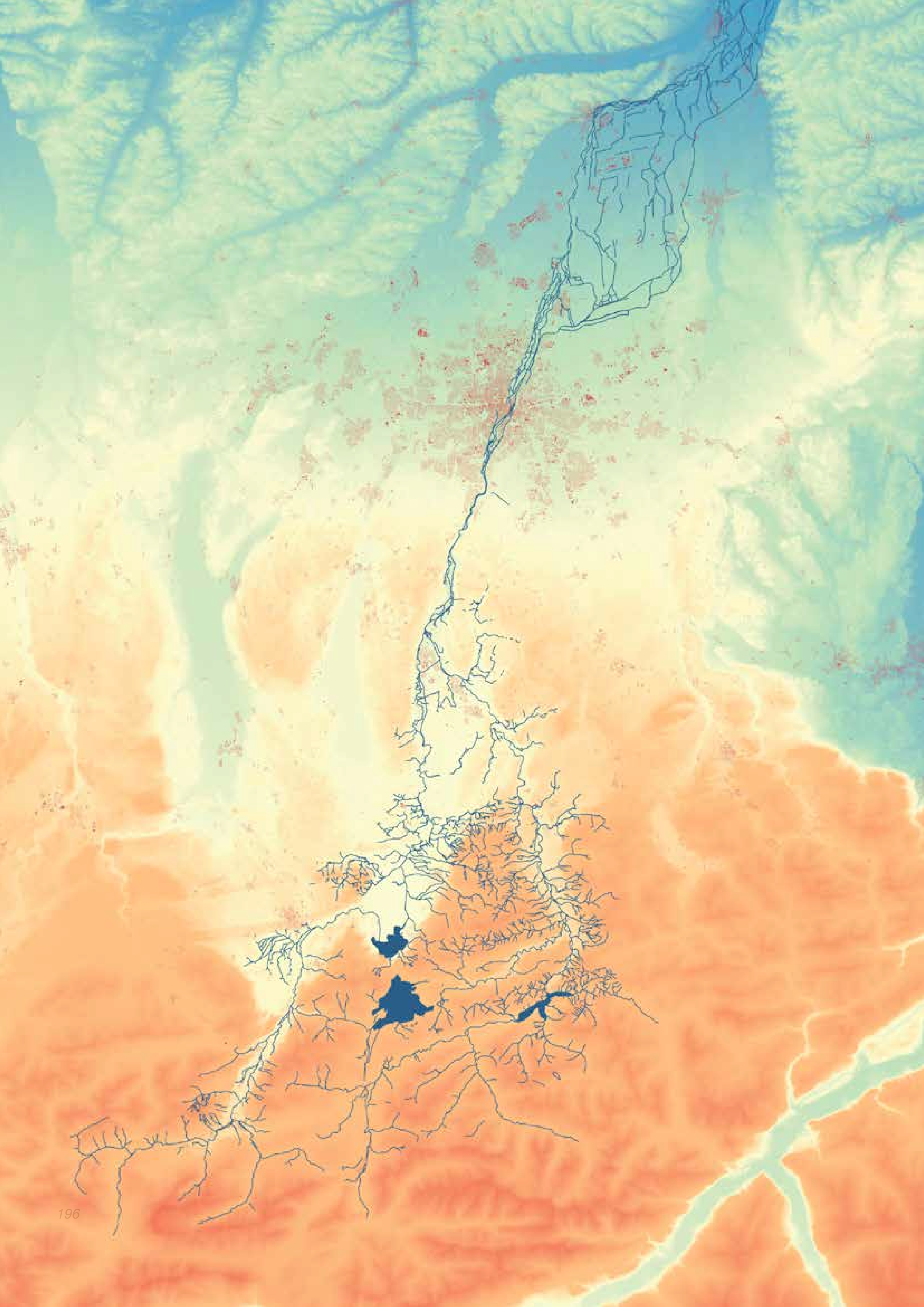
- History shows that river channeling and widening strategies alternate through history, and can be combined rather than opposed.

- Flood defense can lead to higher ecological value, but "free flow" restoration is an ideal that is incompatible with dense habitat and land use.

- Alluvial material management is an ongoing transformation process with elements held only in temporary equilibrium due to their dynamic nature.

- Controlled flooding sets necessary borders to urban sprawl and therefore can secure large open spaces in metropolitan areas; a spatial project is however necessary to exploit

the potential benefits in terms of quality of life.

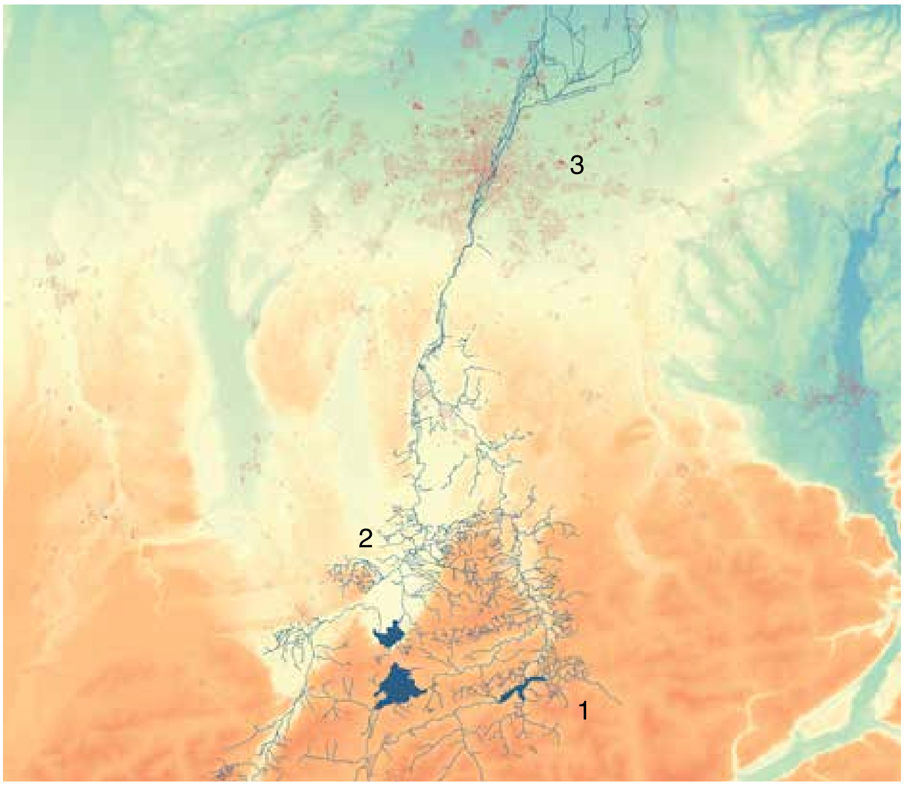


Isar Plan: the wild, the urban and the “true Alpine river”

The Isar Plan

As seen in the first part of this thesis, the shift from a vertical containment approach to horizontal strategies is closely associated with the empowerment of ecology, particularly in Switzerland where flood-risk management has merged with the renaturation ambitions of environmentalist movements and federal authorities. This double agenda was found as well in neighboring Bavaria, and brought a step further with the development of the Isar Plan in an urban context, right in the heart of the state capital Munich. While Swiss law strongly encouraged the softening of river banks and the widening of the streams in rural regions, the urbanized area were mostly left out of this movement. In Munich, the Isar Plan began outside the city, but was consistently pulled all the way to its very center, and is now planned to expand further downstream along the historical Englischer Garten. The Isar can thus be considered as the most comprehensive floodplain restoration plan so far implemented in a Western European city, a plan that closely associates flood management with ecology and urbanity, addressing what might be the biggest challenge in the field.

“How the tame Isar [river] becomes wild and beautiful”
(Lieckfeld, photo Kapitza, GEO special, 2003)



The Isar watershed upstream Munich: Silvenstein retention lake (1),
Loisach bogs and swamps (2), narrowed corridor through Munich urban area (3)
(ill. Rossano, terrain data Bayerisches Landesamt für Vermessung und Geoinformation)

The Isar Plan could be called the star among river-restoration projects: widely published, internationally acclaimed, and, last but not least, much loved by the inhabitants of Munich, who on warm summer week-ends come by the tens of thousands to enjoy the floodplain. The Plan has so far involved only eight out of the 295 kilometers that make up the river, and a bit more than half of the river's length within Munich's municipal borders. Although limited in length, the new Isar has become an iconic space for the city, one that regularly advertises its quality of life through idyllic pictures of the summer crowds sunbathing along the river and athletic young people swimming and surfing over the river's streams and canals.

However, before being a space and an icon, the river was long an infrastructural element at its best, and more often than not an enemy for the city. Economically valuable for mining, transport, and power but feared for its violent summer floods, the Isar, as a whole, has long remained a functional space rather than a factor of urban expansion and beautification. Before the Isar Plan was implemented, it would have been hard to imagine that the floodplain south of the Museum Island could ever assume such a prominent place in the city's mental geography, comparable in popularity to the Englischer Garten created in the late eighteenth century, north of the city.

Although the Isar is about the sole distinctive feature in the relatively monotonous relief of Munich's post-glacial plain, made of shallow slopes of limestone and pebble with the Alps distant at about eighty kilometers further south, the city never developed a representative river-front or riverbank promenades, contrary to most European capital cities. The Isar was long prone to flooding: The Loisach, the Isar's main tributary, is partly naturally damped by the bogs surrounding the Kochelsee (Böhm and Wetzel, 2006: 787), but the upper Isar itself has no natural buffer to temper its violence before it reached the plains. Before modern dams curbed its fluctuations, the river showed the typical character of alpine rivers: strong erosion and massive material and sediment transport leading to frequent changes in the river's morphology; and high seasonal fluctuations, with increased discharge and velocity in summertime, with most of the major floods occurring in that season (Böhm and Wetzel, 2006: 791).

Besides being occasionally dangerous, the Isar has also long been unsatisfying to the eye, as Christiane Tahlgott, former head of urban planning in Munich, says. The city "has no urban waterfront because the Isar (...) is not always a beautiful river," and more precisely it shows a fluctuating and chaotic image, with its bed sometimes almost empty and sometimes furious, with dead trees being carried along the stream through the city (Thalgott, 2013, interview). Munich thus long maintained a safe distance from the turbulent alpine river, as the location of Eastern Gate, the Isartor built in 1337, shows: It keeps the Isar's main stream at a distance of about 400m. Four hundred years later, the plan drawn by Maximilian de Groth shows a still sparse urbanization between the Isartor and the stream, although the river has clearly been contained by a dam on its western side. On Von Riedl's 1802 map, the city still has no direct contact with the water.

The "Isarraum" South of Munich: river arms and buildings in 1704, 1808, 1891, and 2011.

The Isar, however, played a strong role in Munich's economic development: as a source of limestone collected in its wide bed, as a mean of transport for alpine forestry and for passengers towards the Danube and Vienna, and later as a source of energy with the development of power plants. Several water mills placed on the side branches, as well as factories developing in the floodplain announced the coming industrialization of the city, and flood defense works slowly constrained the stream.

By the end of the eighteenth century, several dams and weirs had been constructed along the river, and segments were stabilized by light structures such as wooden fagots weighted down with stones and gravel (Rädlinger, 2012: 70). However, these various interventions were not yet following a general containment plan, which would come only at the end of the nineteenth century. In the 1840s the river banks were reinforced, and the floodplain between the Eisenbahn and the Reichenbach bridges was turned into a continuous stretch of meadow laid parallel to the river, flooded during spring/summer high waters, or else isolated from the stream by a steep stone bank. Through the Isar Vorstadt, the river was channeled and the floodplain was constrained by continuous levees, which brought it from about 500 meters wide down to less than 200 meters.

A "flood space" was defined, which gave clear borders and a fixed shape to the river and its floodplain, but a "floodscape" remained absent: No particular attention was given to spatial quality, potential usage or aesthetic value, nor to the relationship between river and city – this despite sporadic calls from local associations to allow more recreation in the area (Düchs, 2014: 17).

In the meantime, the lower Isar, downstream from the city center, had given birth to one of the world's largest and most famous parks: the "Englischer Garten." Built into the river's floodplain, the English Garden diverted, and reshaped several branches of the river into a carefully calibrated water system, civilized, cleared from its alpine wilderness. South of the old city on the other hand, the first meaningful urban intervention within the Isar landscape only came about after the devastating 1899 flood, with the construction of the Museuminsel in the middle of the stream. But there again, the water was not made accessible to the public; on the contrary, the Island was fortified against the river's fluctuations, and heightened to offer a view down upon the river from the new belvedere. The crowds passing the new Cornelius bridge could from that point on look down on the Isar like into a bear pit, with the river still roaring but kept at a safe distance. The former Coal Island, a place of industry and trade within the river's floodplain, dependent on its flow and exposed to its floods, was turned into a monumental ship of stone pointing its bow towards the Alps.

Munich, collapse of the Prinz-Regenten Bridge during the 1899 high waters.
Postcard, detail, 1899 (collection of the author)

The various transformations clearly divide the Beautiful from the Functional. On the one hand, Nature's harmony was celebrated within the boundaries of the Englischer Garten, which integrated and reshaped secondary channels into an idealized wilderness. Benjamin Thompson's romantic layout recreates an alpine landscape there, made up of quiet streams, fresh waterfalls, and clear lakes; outside this microcosm, on the other, exploited river branches were dammed and turned into straight narrow canals, with the main riverbed being almost drained dry in order to feed the power plants, and bordered by steep levees reinforced with stones. The channeling of the Isar southern section was so strict that it will later be referred to as a "Korset" by the promoters of "renaturation" works.

The taming of the Isar became fully effective with the construction of the Sylvensteinspeicher dam, in 1959. The new retention lake since then curbed the variations of the river, and no summer peak comparable to the 1940 one has been seen since its construction. Dams have furthermore largely hindered the natural transport of materials and sediments from the Alps to the plains, while channeling and straightening have petrified the stream into a stable shape, that no longer reminds one of its alpine origins. This lost authenticity and hard-won permanence is precisely one of the reasons that will later motivate the nature-like transformation of the river.

The Isar in its “Korset,” seen from the Deutsches Museum: A monotonous channel and meadow designed exclusively for flood management.
Partie an der Isar mit Blick gegen das Gebirge. Blick vom Deutschen Museum. Postcards, details, 1928 and 1939 (collection of the author)

From water machine to ecological corridor: First renaturation proposals

Despite its lack of aesthetic quality, public amenities, and elaborated maintenance, the Isar floodplain was already used in the post-WW2 years by local young people, who precisely appreciated the absence of control and the "unregulated freedom" (Düchs, 2014: 15). In the late 1970s and early 1980s, environmental concerns grew in Bavaria's capital. The population had increased from about 832,000 in 1950 to 1,315,000 inhabitants in 1975 (Statistisches Amt München, 2012). Munich's rapid growth and high per capita land use left little space for public green spaces, and "parks are rather scattered islands, except the river Isar floodplain" (Oppermann and Pauleit, 2005: 79). Enriched by its flourishing car industry, the city also suffered from air pollution and was regularly covered in smog, with no natural winds evacuating the gas emissions (Thalgott, 2013). Furthermore, only two open corridors remained those bring a bit of fresh air into the city: the east-west oriented railway, and the northeast-southwest oriented Isar – making the latter an important factor in pollution dispersion, and a much appreciated space for urban recreation, helping the inhabitants live with Bavaria's hot continental summers. Not yet a public space, the Isar floodplain south of the center was acknowledged as a key space for the city's environmental and living quality, a movement that generated discussions around its potential redevelopment.

In the early eighties, environmental concerns became tangible in the local democratic institutions. In 1982, the Green Party made its notable entry into the Bavarian Parliament, approaching five percent of the votes at its first appearance in the state's election (Bayerisches Landesamt für Statistik und Datenverarbeitung). It reached almost eight percent in the Munich municipal election held in March 1984. In these years, the city officially took the first steps that would eventually lead to the transformation of the Isar. The 1983 Urban Development Plan had already set as its goal the reshaping of the Isar into a "natural way," and the improvement of its hydrological regime (Referat für Stadtplanung und Bauordnung, 1983: IX. 3.2). In July 1984, through the motion "Nature in the City", the CSU stressed the fact that the Isar "has lost its character of alpine wild river" within the city, and suggested eight measures to restore its natural character "as far as possible." (CSU, Antrag 282, 30.7.1984) The proposed measures carefully maintained the functionality of the river as a source of electrical power and as a tamed stream that needed a flood-proof riverbed, but suggested removing all obsolete infrastructure that hindered natural development. Although the Isar's potential as a public and recreational space was not yet explicit, the multi-purpose character of the project was already stated. The motion also formulated a perspective on nature that would remain a key feature in later development: a combination of voluntarism, protection, and restoration of an "authentic" natural landscape through expanding the space available for erosion and sedimentation, and through the removal of planted alien vegetation. Although concise and precise, the motion was not free of romanticism when it suggested abandoning the winter bed's gravel banks to the "free play of Nature's forces."

In 1984, an alternative approach to cultural/ecological restoration was proposed, by Günter Grizmek, designer of Munich's Olympia Park. Grizmek, who promoted user-oriented landscapes and a structure of "connected de-concentration" (Jerney, 2003), began an initiative to promote "useful technical landscape," with the Isar floodplain being potentially one of those urban multi-purpose spaces. His proposal, however, raised a lot of protest "by those experts who held up the qualities of a well-designed formal green space" (Oppermann and Pauleit, 2005: 75), and was unable to compete with the "Alpenfluss" restoration rhetoric.

Superposition of the river course in 1704, 1808,1891 and 2011: from braided river to single channel

The "Natur in der Stad" motion was followed by a second and more developed one in may 1985, this time proposed to the City Council by the Social Democrats from the SPD. The motion was entitled: "Isar-Plan. Protection and restoration concept for the preservation and the development of the Isar area, meadows, and river banks." The modifications brought to the river after 1900 were openly criticized for their purely technological stance: "Not only did it impair the urban climatic function [of the river], it also impoverished the flora (...) and strongly reduced the diversity of experience" (SPD, Antrag 636, 03.05.1985). The Isar was described as the main structural element in Munich's growing urban area – baptized "Isarmetropole" for the occasion. It further specified the measures to be investigated and raised as well the question of minimal flow – since the Isar suffered not only from violent episodes of high waters, but also from a discharge deficit created by the multiple deviations that fueled several hydro electrical stations, leaving sometimes only a tiny stream in the main bed. The motion also noticeably added, to the goals previously identified, the improvement of the green network between the Isar and the city districts, as well as the creation of a cycle path along the river up to the town of Bad-Tölz, located 40 kilometers upstream. It also suggested the participation of external landscape architects in the design. While the first motion was clearly focusing on the environment, this second motion pinpointed the necessity to take public use into account, aiming at improving the accessibility and spatial quality of the river and its urban surroundings. This second motion was retained by the City Council, which gave directions to the municipal Planning, Environmental Protection, and Building divisions to elaborate a concept for the Isar and propose a procedure to bring the project further along, and included as well a recent study conducted by the Chair of Architectural Design and Conservation at the Technical University (Will, 1984) concerning the Mulbach, a side stream of the Isar.

The City Planning Department took the lead and eventually associated a wide range of municipal instances to this first investigation: the departments of Construction, Real Estate, Public Utilities, Environmental Protection, City Treasury, as well as the Department of the local district health administration. This procedure led to a public decision made by the Committee for Planning and Building, validated by the City Council on the June 4, 1986 (Referat für Stadtplanung und Bauordnung, 04. 06.1986). The text presented by the Planning Department related the river's history, made a balanced portrait of the Isar and stated multiple ambitions for the future. The Isar area was depicted as the "most distinctive element of Munich's urban landscape," a crucial recreational space to Munich's citizens, a regional protected natural environment, as well as a source of electrical power and (still in 1986) a part of the sewage water treatment system. A historical overview related the role of the river in the city's commercial and industrial development, as well as the dangers brought by the river's fluctuation, before the nineteenth century regulation constrained the average flow into a 45 meter wide bed and constrained high waters within a 145 meter wide floodplain. The qualities mentioned in the previous motions were summarized: positive effects on urban climate, environmental value, recreational role, and identification with the city. New problems were identified, however, and added to the brief: The floodplain had been narrowed at several points by the construction of bridges, which could lead the river to flood over the side dams.

Hydrology was to take on a new and leading role in the proposed planning procedure, as "the concept for renovation of the floodplain appeared to be the most important building block for the Isar Plan" (Referat für Stadtplanung und Bauordnung, 1986: 5), and "all planning discussion should grant safety of high water discharge absolute priority." This orientation, however, should not diminish the importance of spatial and environmental quality: "landscape planners and hydraulic engineers must work together" to elaborate the "necessary in-depths planning and substantial calculations" (id.: 7). For the first time, Munich's Water Board, a department of the State of Bavaria, was invited to bring its expertise to the work group, although it was not legally responsible for the river within Munich's municipal borders, ever since the 1907 act that transferred this prerogative to the City.

The studies were further divided into four aspects: the design of the river space, the Isar secondary branches, the restoration measures and green connections, and the walks and cycling paths. The list of recommendations made by the work groups quite accurately reflected the project that would be implemented 15 years later:

- The straight winter bed concrete edges can possibly be removed

- Part of the flat foreshore can be lowered and sloped towards the main riverbed

- Deposits that diminish the riverbed capacity can be removed to prevent indirect flooding (with reference in that regard to the Isar status of "river of first order," that could motivate a co-funding by the State of Bavaria)

- Replantation of (soft wood) groves can be considered after soil removal

- Ecologically valuable areas should preferably be developed in insular situation to protect them from intensive recreational uses

- Meadows can be laid as species-rich, meager meadows adapted to heavy use on sunny days, rather then grass areas meant for intensive frequenting

- The reinforcement of the edges and bottom of the stream bed is seen as inevitable to prevent its deepening by erosion, but should be whenever possible covered with pebble

- Existing groups of trees will be in all cases preserved, and when located on islands, these should be protected from erosion by stone embankments. Secondary river branches will be located around existing or new groups of trees to enhance their presence

- Valuable trees that grow on the dams will remain, with this linear horizon being possibly varied through planted front protections.

Besides minor amelioration brought to this first draft (the existing concrete weirs will, for instance, later be removed and replaced by an open line of stones to facilitate fish migrations), this set of measures would be further detailed and implemented in the ensuing 25 years. From 1986 to 1989, the City of Munich organized several rounds of investigation and consultation, as well as an interdisciplinary colloquium in 1987. In 1988, the City Council decided to take various steps to bring the plan further along: public information, joint planning agreement to be sealed with the State of Bavaria, development of the landscape, and hydraulic solutions in collaboration with the state's water board. In 1989, a discussion podium was organized by the Münchner Forum, an association established in 1968 as a citizen platform and since then playing an important role in Munich's planning policy. The outcome of the Forum showed the symbolic value of the Isar for the inhabitants and pointed out the need to steer recreational uses, and improve accessibility and natural qualities; it stated as well the need to integrate the "alpine nature" of the river in its layout and give space to nature where the riverbed was not suitable for intensive recreation, increasing water inlet at low discharge and improving water quality to swimming level. Finally, it pleaded for collaboration between City and the State of Bavaria (Blasy+Mader, 1998).

In 1991, the water board proposed the first joint meeting with the city to investigate the possible combination of flood protection measures and landscape improvement. During the first half of the decade, various commissions were set up to elaborate detailed studies on landscape ecology, fishery, forestry, and hydrology, finally leading to commission a preliminary design from the office of Blasy+Mader, specialized in environmental design and based close to Munich.

As the Isar Plan developed, it also became clear that recreational uses were hindered by the poor water quality. Munich then had an efficient sewage water treatment system, but this was not the case for all the municipalities upstream. Furthermore, the bacteriological quality of the river was below the recommended level for bathing. As beautiful and attractive as the Isar could become, increased public use would therefore create new sanitation and safety problems, and create new conflicts "if you [had] to tell people: do not go into the water, do not drink a drop or you get coli bacteria" (Thalgott, 2013). From 1998 onwards, the Bavarian capital thus put pressure on its upstream neighbors to improve their sanitation infrastructure and initiated roundtable discussions to address the problem simultaneously all along the river. As a result, several disinfection stations were built, and the Isar's waters reached bathing quality in 2005, six years before completion of the Isar Plan (muenchen.de). Besides water quality, the renaturation project triggered another paradoxical question: How much water should be let through the main river channel in order to restore its wild character – and is it compatible with the needs of hydro-power plants. These two preliminary conditions for renaturation – water quality and quantity – would run parallel to the morphological transformation of the river, and give the whole project a vital base before its implementation.

The ten year-long planning process engaged around the Isar Plan made it possible to define and validate a rather detailed set of goals and the means to achieve them – leaving, as it appeared later, relatively few spaces for formal digressions. Blasy+Mader used the methodologies of "landschaftsplannung" rather than "landschaftsarchitectur" to elaborate their preliminary design for the stretch located south of the city. The firm elaborated a comprehensive atlas of fauna and flora, public uses and spatial qualities, merged into a conflict and value analysis of all aspects in relation to one another. This analytical approach was used to propose a scheme that was based on the faithful translation of the brief into practical intervention at local level. Following this preliminary study, the southern part of the Isar within the municipal borders, from the Grosshesselohe bridge to the Eisenbahn bridge, was transformed by the city and the Bavarian Water Board, without design competition or broad public discussion.

In the spirit of the popular Flaucher area, the last wide and braided river segment in the Munich region, the channeled river was transformed and softened: The straight embankments were removed, restoring the accessibility of the stream. Hard edges that formed a uniform boundary between main bed and floodplain were softened, slowing down the stream along the shore, and a part of the floodplain was left open for the frequent river's fluctuations. "The Isar will flow again", writes the Süddeutsche Zeitung in 1998 about the first segment being "renaturated." (Süddeutsche Zeitung, 24.02.98)

The Design competition: expectation, conflicts and outcome

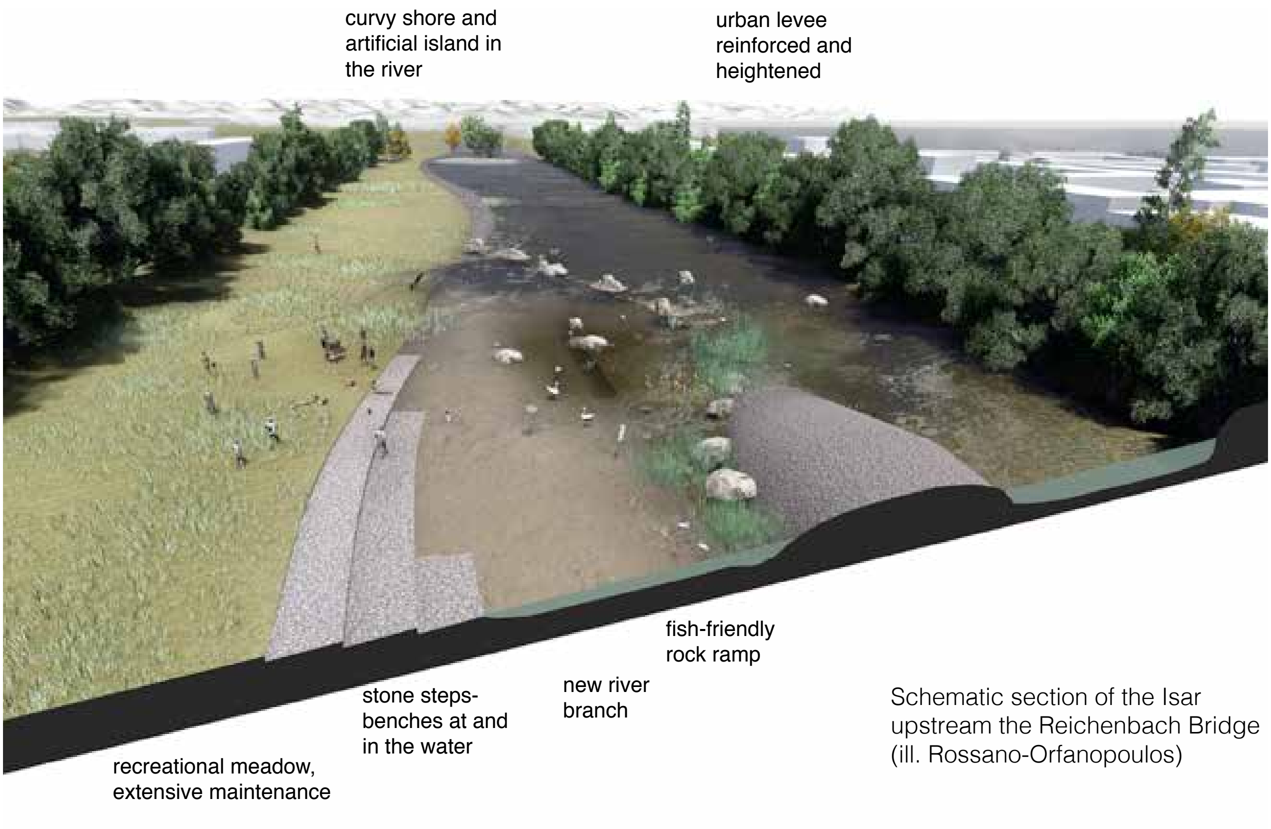
Willing to pursue the transformation of the Isar but sensitive to the special situation of the central part of the river, the Municipality of Munich and the Bavarian Water Board organized a landscape design competition in 2003 for this 1.6 kilometer segment stretching from the railway bridge down to the Museum Island. The designs should improve the biological quality of the riverbed and its shores, diversify the stream structure, and facilitate the transport of boulder by the stream. They should also facilitate recreational uses in an open "nature-like" ("naturnah") landscape. Finally, the project should be "aesthetically attractive" and enhance the cultural value of the Isar Space ("Isarraum"), combining an open character with prominent urban features (Baumeister, 2003: 10-12). Implicitly, the project should also integrate the constraints created by strong discharge fluctuations, the presence of hydro-power plant downstream, and sensitive infrastructures around and under the riverbed – which would make it altogether impossible to let the river define its own course through spontaneous hydro-morphological processes.

The first prize was awarded to the team led by Irene Burkhardt, who proposed separating the main stream and a new recreational space through a sculptural levee. While the main flow would keep its linear character, the former floodplain was to be reopened to the stream, offering shallow waters, soft embankments, and a wide open meadow for recreation. The levee itself was drawn as a hybrid structure, usable as a beach and as a pier for small boats. The second prize was awarded to the team led by landscape architect Winfried Jerney for an almost opposite proposal: a curvy informal design, suggesting a free flow forming its own meanders, islands, and edges through spontaneous deposits and erosion processes.

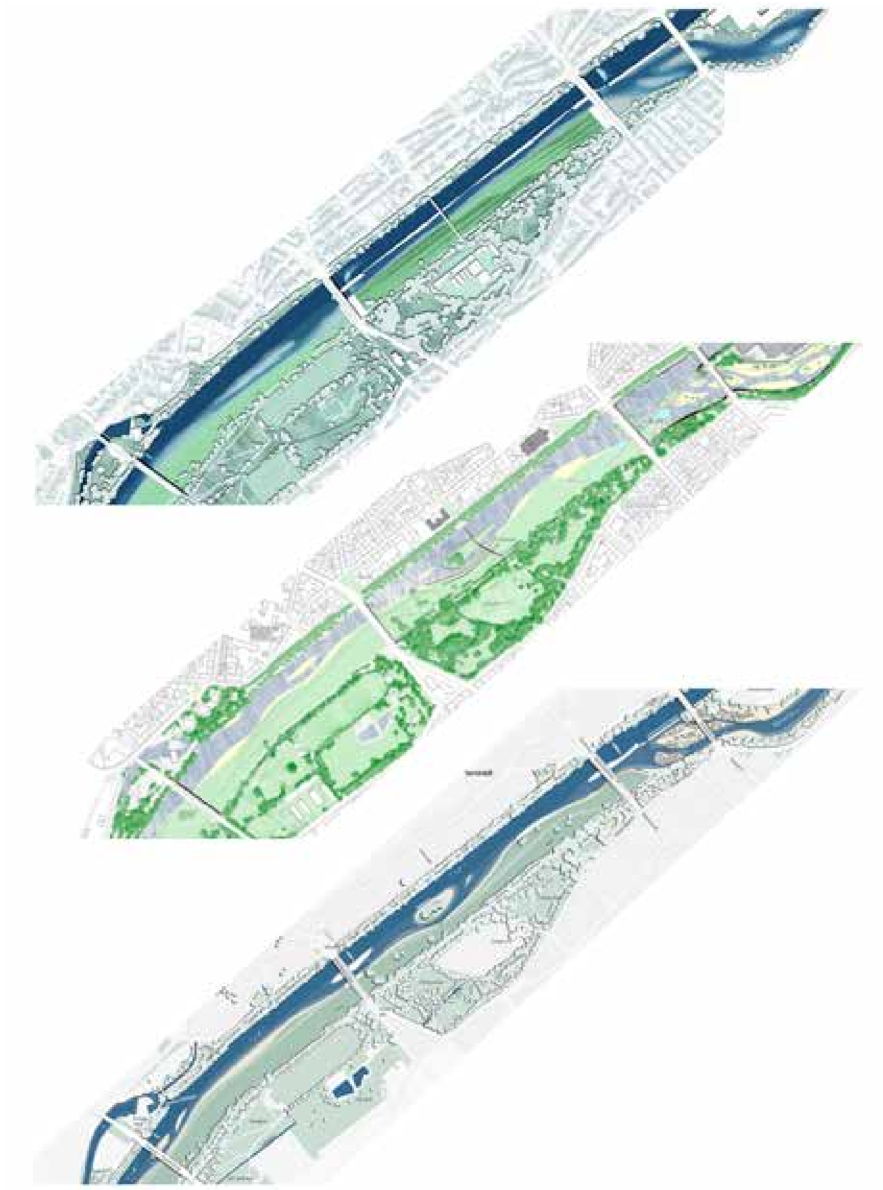
Although Jerney's project seemed romantic to the city's engineers in regard to what could actually be left to natural processes, it let the public believe in a possible restoration of natural fluctuations within the existing high-water channel. A heated discussion started around the two projects, which grew into a public quarrel opposing supporters of an urban, functional, and "honest" design, to supporters of a full renaturation who came to doubt the reality of the technical constraints set by the city planning department. Public meetings were held in the neighboring areas, where an active part of the population expressed its frustration and rejected the winning design for its built character and for the fact that the shorelines remained clearly defined instead of letting the flow trace its shore. The design was depicted as "banal" and some baptized the central pier/levee the

"Concrete monster" ("betonmonster"). Aggressive leaflets spread the slogan, "renaturing instead of concreting" ("Renaturieren statt Betonieren"), and opponents called for the implementation of the second prize, against the choice of the jury. The city through the Baureferat took a neutral stance in the controversy, stressing that both first and second entries were feasible, and leaving the designers on the front line. Without clear support from the commissioners, the construction of Irene Burckhardt's proposal seemed compromised. After a period of public consultation and emotional discussions involving commissioners, designers, district representatives, and citizens, Irene Burckhardt eventually agreed to compromise and promised "that the team [would] deal with the design in a critical way" (Süddeutsche Zeitung, 05.06.2003)

The professional press remained silent on the controversy. In the article published in the national Garten+Landschaft journal, Tilmann Zinsser from the Bavarian Water Board merely mentioned the difficulty of the assignment: "to find a good compromise that, on the one hand, copes in its form with the contradictory urban and landscape aspects but also with the spirit of a natural restructuring, and on the other, integrates the various leisure opportunities present in the central recreation area" (Zinsser, 2003:14). Zinsser wrote that "the designs of first two winning entries will be further deepened and discussed," and that a final design should be presented in 2004 - not mentioning the fact that the jury had actually awarded the first prize to the design of the Burckhardt/SKI team. The article was illustrated with photographs of the completed segments along with the "option 1" plan from the 1998 preliminary design study. No illustrations actually showed the result of the design competition for the central segment of the Isar.



Schematic section of the Isar upstream the Reichenbach Bridge (ill. Rossano-Orfanopoulos)



Isar competition: first price (Burckhardt/SKI), second price (Jerney & EDR),
final compromise (Burckhardt/Jerney/SKI)

Only in January 2005 would the Süddeutsche Zeitung announce that a compromise for Isar renaturation had been found: "The two prize-winners share the planning section" (Süddeutsche Zeitung, 12.01.05). This compromise presented by the Baureferat was finally approved two months later by the Munich City Council, opening the design phase with an eighteen-month delay. It was then too late for the plan to be implemented for the 2005 Federal garden Exhibition (Bundesgartenschau), due to open in April of that same year. Ironically, the sharp geometries imagined by Gilles Vexlard for the exhibition main ground would generate similar negative reactions from Munich people; One "really needs to get used to it," politely conceded Munich's First Mayor Christian Ude in a public Q&A session.

The alternative project elaborated by the two teams eventually ensured the safety of urban infrastructures while suggesting a relative freedom, with curvy shores and a pebble island – stabilized, however, by a stone and concrete bed to hold the "wilderness" in place. The design was published in Garten+Landschaft in 2010, after completion. Thomas Armonat – author of the article and former employee of Irene Burckhardt – described the "near-natural urban landscape" and its controversial elaboration (Armonat, 2010). The pictures showed the striking contrast between the former straight banks and the new shallow curvy shores and islands. The article, however, did not shy away from detailing the hidden fortifications built to stabilize the "near-nature" look: a sixty-centimeter thick stone bed covered by grass to resist flood erosion, an up to two-meter section trench filled with stones along the water's edge, stone pavement to fasten the river banks and floor around the city infrastructures, a stone belt to stabilize the Weideinsel, and a meters-deep concrete wall poured into the levees to avoid cutting the existing trees. And although the paradox inherent in the "renaturation" was not discussed further, a closer look into the design plan and sections left no illusions about the artificial character of the "near-nature" curves.

How wild is the Isar after "renaturation"? In terms of morphology, the riverbed is still very far from its original width and meandering nature, as a simple comparison of the river's past states shows: the limit between regular riverbed and the floodplain has changed from wall to shallow slope and stairs, but the riverbanks remain as fixed as they were a century earlier; the biodiversity seems to have increased, but this is not thanks to more curvy shores, as these are the most intensively used by the public; finally, the variability of the river course is as limited as before, as the stream tends to follow the deepest channel on the left bank side (Engelmeyer, 2013) and the river practically has not recovered a real meandering space. Near-nature or rather nature pastiche, the design for the central segment tries to combine two opposites: the impermanence of an alpine stream and the safe stability of an urban space, eventually simulating the first to achieve the second. Only the old binary variation – flood or dry meadow – has evolved towards a more gradual transformation of the river by rising waters, thanks to the new stepped banks and shallow pebble beaches.

"Something to discuss about": design as a starting point

Today, however, all the actors interviewed by the author separately stress that debate generated by the competition was necessary, despite the emotional and sometimes hostile discussions that took place in public meetings. As Daniela Schaufuß, Head of Munich's Department of Waterways, today explains, external designers and engineers brought in new ambitions, but city and water board were one step ahead: "We had already constructed [8 kilometers of river], and we had gathered so much experience during the years that it was not easy for new companies, new engineering offices, to work with us because we knew what we wanted, we knew the problems. They started with great ideas, and we just said, no, it's not possible" (Schaufuß, 2013). But for Schaufuß, who dedicated several years to the transformation of the Isar, a design competition was also necessary to reveal unrealistic expectations and to expose the different constraints to a public enthralled by the Flaucher areas further out from the city center. For Christiane Thalgott, former head of the city planning department, "it was important to show, on the one hand, how little freedom there is when the river is so important, but, on the other, to speak with people about this limited freedom we have, because people perhaps expected something much more impressive." (...) These competitions were more an educational project. It was necessary to communicate."

A point of view partly shared by one of the landscape architect authors of the project, who regretted the irrational character of the debate but retrospectively supports the organization a design competition in this context: "People needed to see something to talk about it. (...) You need design as a sort of a benchmark to have any discussion at all. If the idea is that you can start public participation without some core idea to start with, just the way it was before, then that would be just completely nuts and in vain" (Engelmeyer, 2013). The designers, however, did not always feel welcome and supported, as the competition procedure followed a period were the Isar upstream had been transformed without too much spatial ambition and public discussion. "Then there was this design competition which was initiated by the city council, and which in a way was not something that the people who did the previous work ever wanted, they just wanted to continue the same way" (id.). The intense public debate indeed was initiated thanks to concrete proposals, which clearly created a discussion platform for authorities, citizens, and designers. However, the debate lacked the preliminary information needed to evaluate the proposals: In particular, the impossibility of leaving the stream totally free within the constrained environment of Munich's city center "was not clear and that was never made clear" (id.), and the discussion was rapidly caught in a caricature opposition of design-versus-nature that neither the commissioners nor the designers had anticipated, and ultimately resulted in an ambiguous compromise rather than a clarification.

Controlled flooding as vaccine against disastrous floods

One could qualify the design made for the Isar River space as a non-design, since it lacks the formal or spectacular character one would expect in an urban public space, or call it transvestite nature that has the appearance but not the characteristics of the wild stream it pretends to be. Or as Oliver Engelmeyer clearly puts it: People "thought [our first design] was wrong because [water] management was made visible. Now we still have the same issues, hidden beneath the greenery, and every time there is a flood you have to put it back in again."

Whether beautifully informal or hypocritically nature-like, the "Isarraum" is today enjoyed by the population of Munich. Appreciated for its informal quality and the freedom of use, the Isar is officially not a park, and still is much more than a floodplain. The simple and robust design lets the river "run the show," offering the possibility to see the shores and meadows disappear under a furious stream during summer high waters, as they did in June 2013. They reappear after a few days or weeks, and are rapidly restored by the city, at a cost that is still far below the regular maintenance cost of formal urban parks. Environmentalists might regret that the Isar still has not regained full freedom of flow, but, as it was known before the design competition, full freedom was incompatible with the urban situation and constrained channel. Architects and engineers might lament the absurdity of trying to enable fluctuation, erosion, and sedimentation, even partially, when so much effort has been put into controlling these fluctuations to protect the city. Yet by removing the hard edge that used to isolate the stream from its monotonous flood meadow and by dealing with the regular but minor damage caused by flooding, the design has given public access to a space of indecision, underlining fluctuation instead of neutralizing its effects, and today offers the experience of this change to every visitor.

Beyond an ambiguous design, the Isar-Plan reveals its intrinsic value every time water covers and uncovers paths and meadows: Public space functions here as a reality check. While the original nineteenth-century design strongly accelerated and separated the main stream from the floodplain, making it even more dangerous and inaccessible, the Isar's new soft edges do not differentiate risk areas from safe zones anymore. In most cases the floodplain remains accessible, leaving the responsibility up to citizens to evaluate the degree of risk they are willing to take when entering the water – in striking contrast with most European floodplains bordered with fences and warning signs. This fact alone constitutes a radical break with a centuries-long schism between technological developments and individual perception of natural dynamics, along with a permanent and free education in living with these dynamics, free from deluge angst and beyond the "myth of dry feet" (the expression "to keep dry feet" meaning, in Dutch: to remain fully protected from flooding).

In the quest for a new paradigm in terms of the perception of flood risk, and a stronger awareness and resilience on the part of individuals as well as societies, the experience of the flood is able to bring to the fore notions of natural processes and acceptable risk, and can serve to train citizens to appreciate the pleasures and dangers involved in an adequate way, much more efficiently than communication campaigns or dramatized news or apocalyptic fictions do.

From floodplain to urban beach: Terraced promenade along the water close to the Reichenbachbrücke; Meadow opposite the St. Maximilian Church (June 24, 140m3/s river discharge at station München and September 7, 2013, 55m3/s discharge. Rossano/Künzel)

Key points

Collaboration between technicians and designers needs preparation and understanding to prevent misunderstandings and delays.

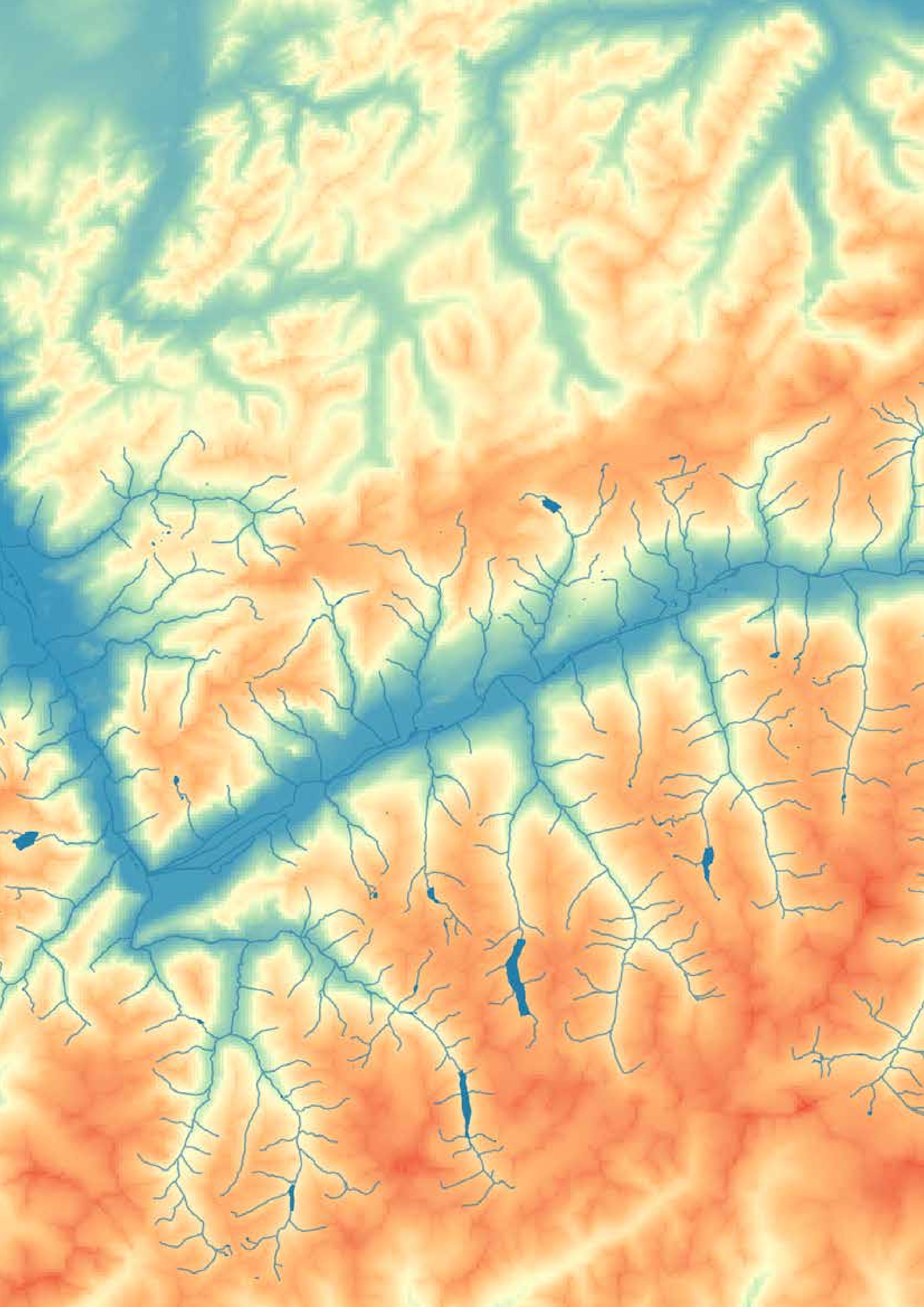
A design competition can reveal conflicting ambitions and open useful public debate but preliminary explainations are needed to clear misconceptions in the public's minds.

Flood mitigation space can provide open and informal public space at low costs and for the benefit of all.

Landscape transformation of the floodplain can safely bring the public in contact with river fluctuations, enhancing urban life and creating more awareness for natural processes.

Full ecological restoration is incompatible with urban density and intense public use, and can be compensated by nature-like aesthetics only in appearence.

Urban rivers ultimately imply voluntary design, permanent maintenance, and compromises between ecological value and public access.



The Third Rhône Correction as *Gesamtkunstwerk* ?

The Third Rhône Correction stems from a long history of human interventions on a limited space, long dominated by the river, but it is also the result of relatively recent cultural and legal shifts that took place in Switzerland at the federal and local level. Born in the early 1990s and planned to last until 2030, the program "Rhône 3" is of historical proportions, and expected to deeply transform the landscape of the Valley through the widening of the river channel, breaking with a century of coercive engineering measures. Willing to integrate all components of the densely populated valley into an integrated approach, the Third Rhône Correction has been since its origins presented as a "Gesamtkunstwerk," a comprehensive work of civil engineering capable of reconciling forces traditionally opposed, such as hydro-power, urban growth, intensive farming, recreation, and alluvial ecology. It is still too early to estimate the effects of the program on the landscape of the Rhône Valley, but already edifying to analyze the origins, ambiguities and successes of this grand enterprise set in an international perspective.

The Rhône river, from landscape to infrastructure

As seen in part 1, the Upper Rhône Valley was for millennia a space of activity and trade, object of a continuous negotiation between the river's fluctuations and human efforts made by inhabitants to adapt their environment to their needs and adapt their activity to their environment. The systematic channeling of the Upper Rhône finds its origins in the first agreements passed between the states of Valais and Bern in the seventeenth century, by which both states agreed the width the river should remain along their common border (DFI, 1964: 41). In 1756, the two states had a precise plan drawn of the river between Martigny and the Geneva Lake, including all the piecemeal works constructed along this segment. In 1768, the first general plan was elaborated for the regulation of the same segment, in the hope of making the river's course fixed – and, so, the border between the two states.

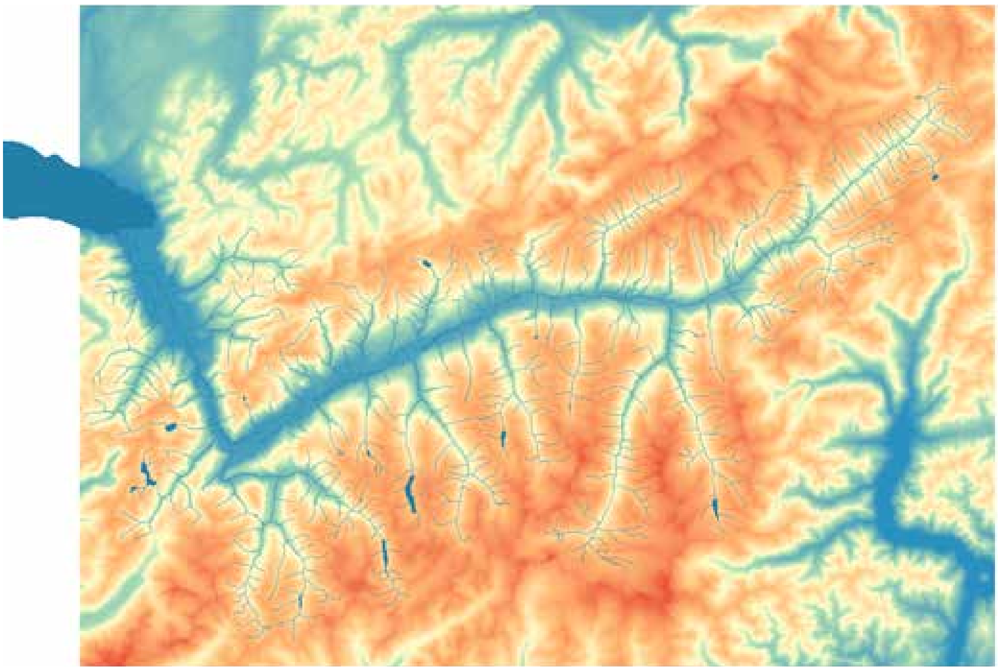
At the turn of the nineteenth century, a full correction was actively promoted by the federal commissioner in Valais, Franz S. Wild, who saw the damming of the river as a necessity for the Canton and as a personal duty (see "Rewriting history: the negation of pre-industrial economies and the apology of technology" on page 76). A second plan followed in 1825, drawn by Ignace Venetz and Adrien Pichard, respectively engineers for Valais and Vaud cantons, then both part of the Swiss Confederation. The plan, however, encountered strong resistance from the municipalities, then still in charge of maintenance and civil works on the river (DFI, 1964: 42). The two cantons, however, signed a convention in 1936 to implement the plan but without concrete applications.

Upstream Martigny, the Valais canton together with the municipalities around Martigny agreed on fixing the banks of the river, that first fixed the course of the Rhône and led to the first coordinated correction. In 1833 the canton was granted the right to set guidelines for the management of the river, although it still would not fund any works that were not related to the safety of roads and bridges (Vischer, 2003: 98). While the French Rhône was being fully channeled by the "Service

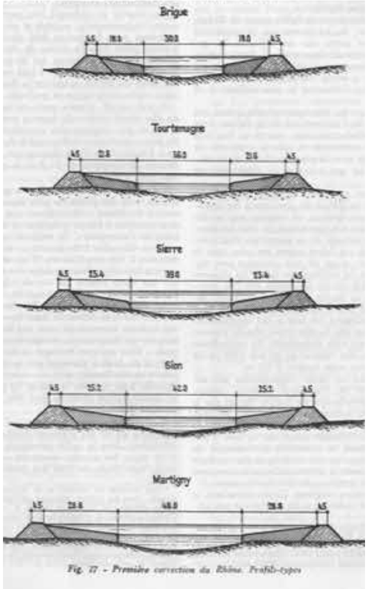
Spécial du Rhône" from 1840 onward, the Swiss part was transformed piece by piece but still without any coordinated plan. A federal report established in 1860 indicated that defense works could be seen everywhere from Brig down to the Lake, but were not cleverly combined, despite a few segments that were truly transformed in Rarogne and Martigny (id.: 99).

The situation as a whole remained precarious, and the canton was hit by a series of inundations in 1855, 1857, and the most catastrophic in 1860. After this catastrophe, local authorities agreed on the necessity of a general correction. The Canton asked for the support of the Confederation, on the basis of a preliminary plan established by Ignace Venetz before his death in 1859. The Confederation offered to finance a large part the works – provided the river was fully channeled, in a systematic way and on its full length (see "A European self-colonization" on page 61) – and appointed a commission of two engineers from other cantons, Hartmann and Blotnitzki, to examine the proposal sent by the Valais Canton authorities. They confirmed the scale of the destruction, and the origins of the floods: a flash flood from glacier torrents, aggravated by "desolate state of deforested mountains" and the "faulty slope" of the river (Blotnitzki and Hartmann, 1861) that let heavy sands obstruct the riverbed, constantly rising above the surrounding land.

As with many correction projects at the time, the first ambition was to regulate the erosion and sedimentation processes of the river, which in many places silted up and regularly flowed over cultivated areas. It was then a common idea that a well-dimensioned channel could bring a stream to an optimal velocity, and have it carry away the materials it had gained from the mountains upstream, without eroding its bed to a point that it would threaten the stability of the levees and bridges.



Upper-Rhône Valley in Switzerland (Rossano, data Swiss Topo)



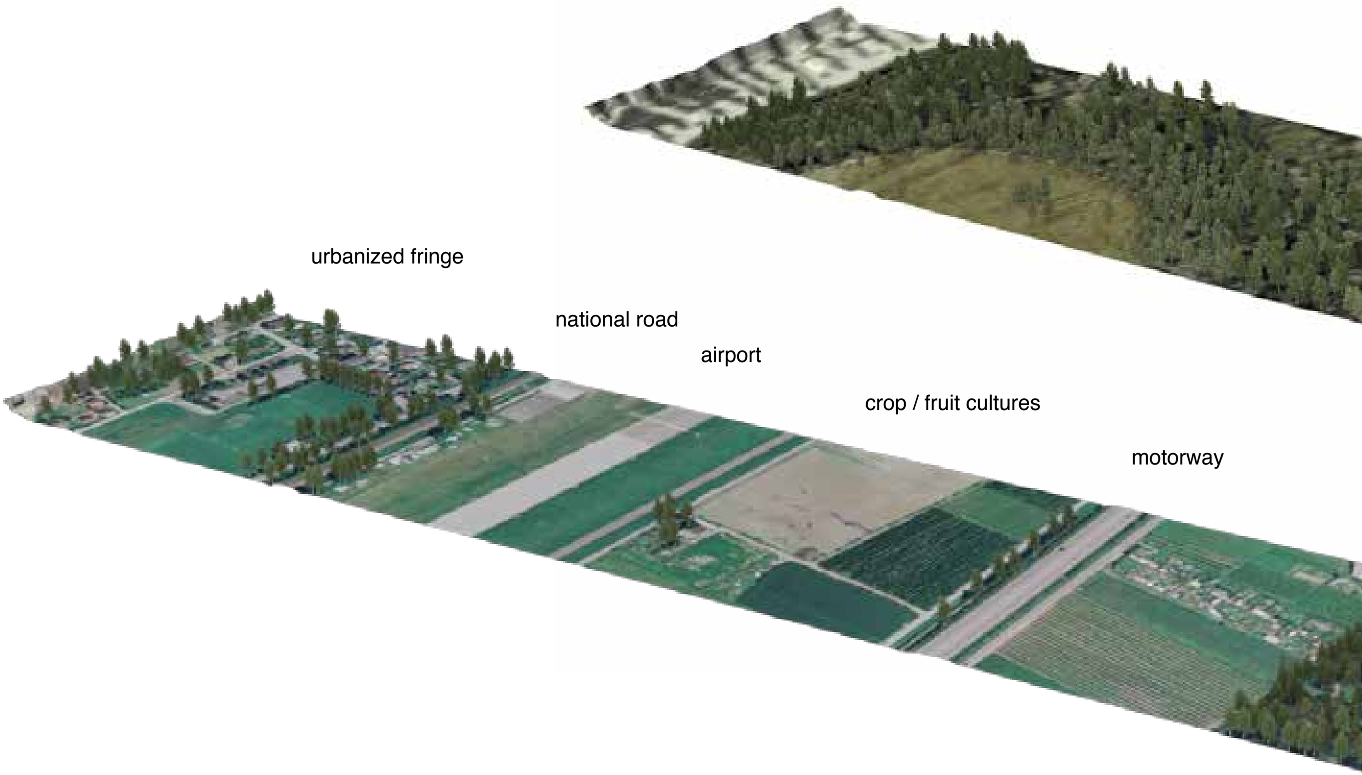
1863 Correction plan over-layered with the 1860 Dufour topographic map,
Profiles of the first correction from Brig to Martigny (Source: DFI, 1964)

Discussions about the "ideal width" for the Upper Rhône had started already in the seventeenth century. The 1602 convention signed by the states of Valais and Bern had proposed setting the river width at 185 meters (DFI, 1964: 41). In 1760, engineers had estimated the ideal size at 92.5 meters (id.: 41-42). Hartmann and Blotnitzki proposed calibrating the Rhône within fixed, flood-resistant levees distant from 100 feet in Brig to 200 feet in Monthey, equipped with groins on the whole length of the river (Blotnitzki and Hartmann, 1861). They strongly recommended the correction of all tributaries, and the construction of 200 retention dams to regulate the discharge in the Rhône itself. Noticeably, they recommended synchronizing and combining the project of a new railway to the Rhône correction: If the railway line could "follow the rear edge of the Rhône, or even use this edge as backfill, it would then be located at the highest point of the valley bottom." The railway would then "not only be protected against floods, but costs would also be lower."

Paradoxically, the two engineers who advocated a radical channeling of the meandering river lamented the way the railway had been built so far. The railway, they regretted, had carelessly damaged the curvy topography of the valley by pulling straight elevated railroad embankments, constructed by peeling hundreds of feet of land on both sides of the levee: a waste of land and a missed occasion to associate the two works of civil engineering. "We believe that forcing [the future railroad] to come closer to the path of the Rhône correction, would, in our opinion, be only a slight atonement for the way it ravaged the Valley below Sion" (id.), in the interest of the railway company as well as in the interest of the Valais Canton. They concluded their first report by stressing that the Correction should start soon and be quickly implemented, for "as long as the embankment of the Rhône and its tributaries only happens at important spots and along small portions, (...) it will be difficult to achieve the necessary result. Construction too often interrupted will always be partly removed by high waters."

This call for rapid and systematic intervention was heard by local and federal authorities: In the following years, a full survey was established, the project was detailed, and its costs more precisely estimated. An agreement was reached with the railway, "Compagnie d'Italie," that agreed to follow the Rhône channel and finance the embankments for future railways. The company, however, went into receivership in 1862 due to financial difficulties, frustrating the state's ambitions of integrated planning and shared investments.

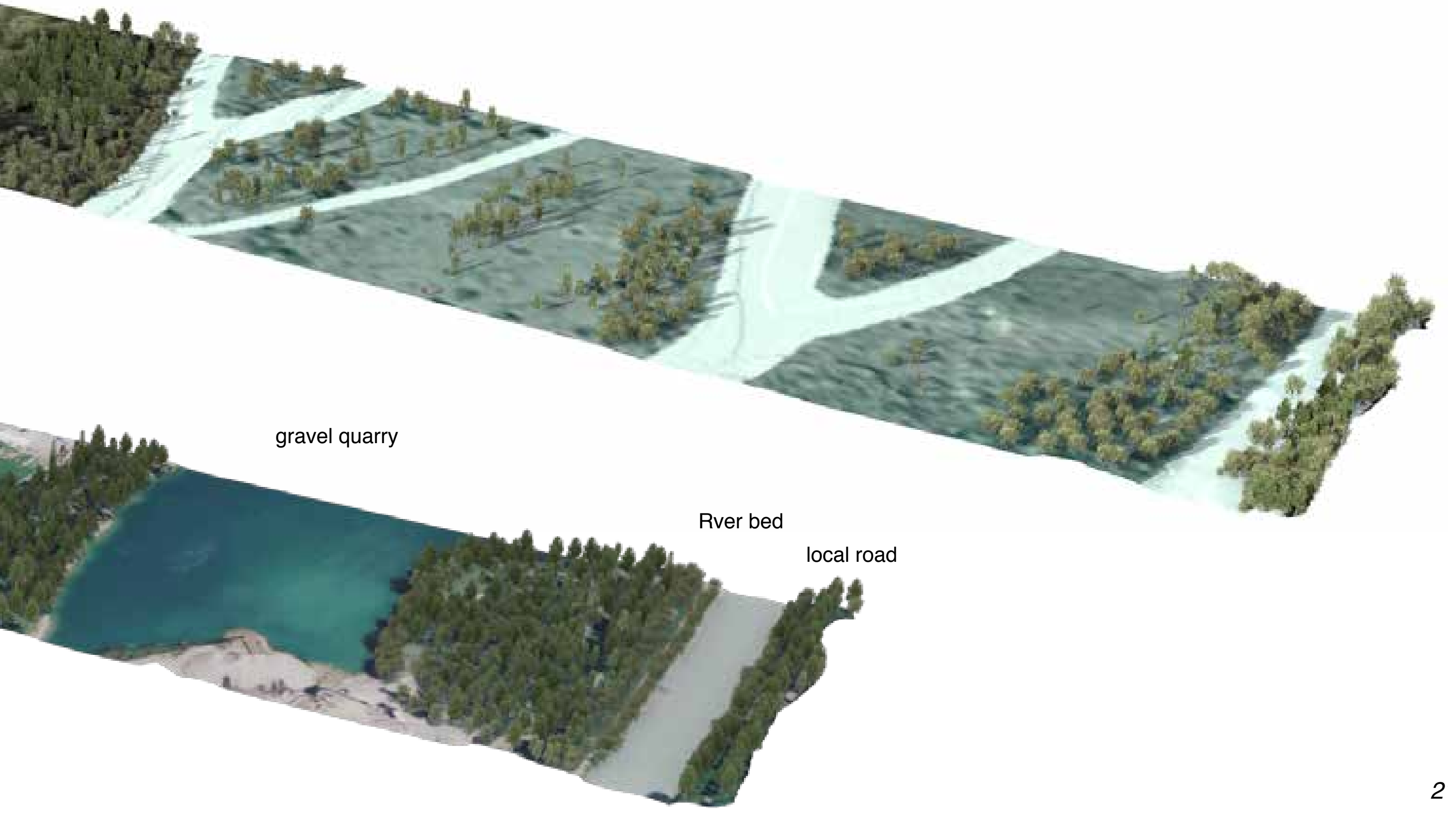
The Decree issued in 1862 by Valais' Grand Conseil specifies the project organization in its grand lines: The canton will supervise the Correction; Federation and railway company will jointly fund the works, up to a still to be defined percentage for the railway company; what is not covered by the Federation and the company, will be paid by municipalities in francs or in natura; municipalities and "bourgeoisies" (local form of community organizations) will provide the land necessary for the embankments, and will afterward retain their maintenance duties; and the correction will be fully implemented in 12 years' time.

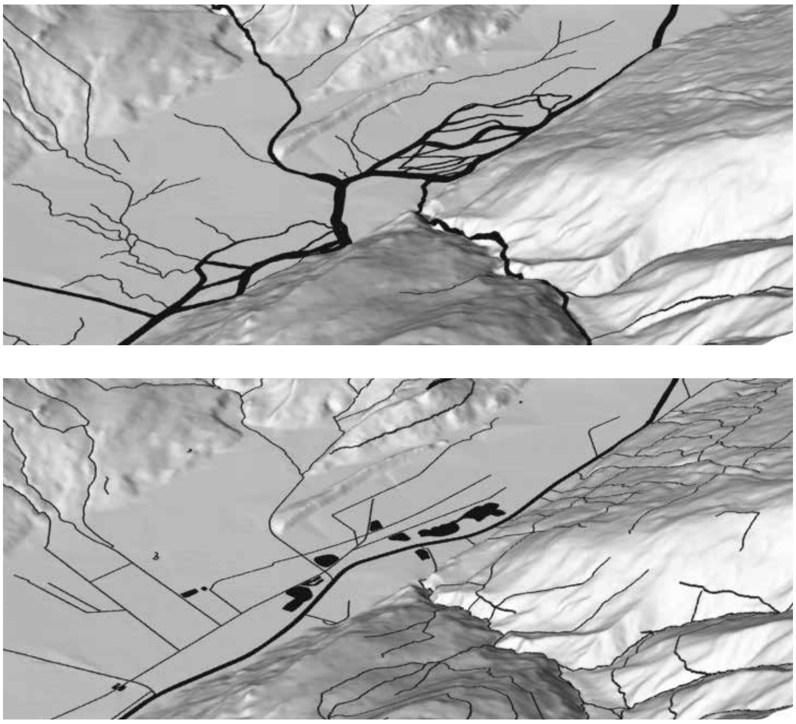


Transformation of the Rhône valley between Sion and Conthey
(ill. Rossano, based on 1860 Dufour map and 2010 aerial picture, Swiss Topo)

Furthermore, the decree specified that the forestry administration would be reformed in order to better prevent deforestation of the mountains, which was then largely held responsible for the great floods seen in the Rhône and Linth Valleys. "We will make a point of having our experts check the application of this article," replied the Federal Council in the message of July 23, 1863, in which the Federation agreed to fund Valais' project as proposed in the 1862 decree, despite the doubtful participation of the railway company. The herculean works start only three years after the triggering flood, works "that require altogether an absolute, energetic and coercive viguor" (Conseil fédéral, 1862, in DFI, 1964: 58).

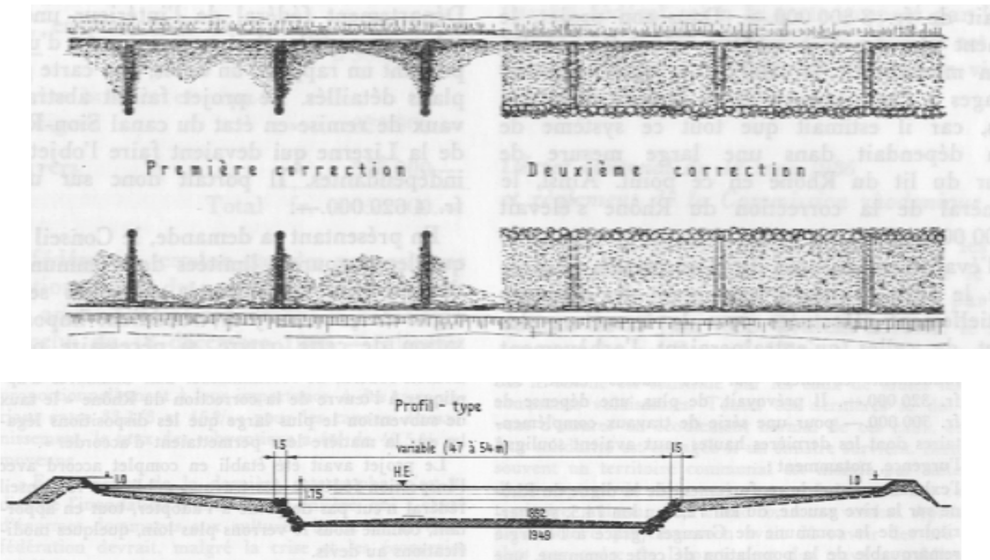
The coercive character of the Correction was indeed soon apparent, as the braided river was straightened and narrowed within a 72 to 96 meter-wide channel; its curves were stretched and enlarged; some parts of streams were fully displaced, noticeably at the confluence of Rhône and Vispa Rivers that was moved 800 meters upstream. Numerous islands and meanders disappeared, leaving standing water and wetlands behind that were later reduced by new drainage canals. Warping enterprises were undertaken to raise the land and expand farming areas, with the help of special sluices invented by Engineer Ignace Venetz to collect rich waters from the river bottom. The First Correction ended in 1884 for the main embankment works. However, frequent high waters and dike breaches occurred during this period, documented almost yearly between 1863 and 1898, leading to a continuous adjustment of the levees. The correction eventually took twice as much time than the 12 years originally planned.





Hydrography of the Rhône valley in Conthey in 1860 and 2013
(ill. Rossano, from Swiss topo: Dufour topographic ma p, TLM3D, DTM)

In parallel, from 1870 to 1884 a secondary campaign took place with the reclamation and drainage of the low areas newly isolated from the river. The valley might be protected against flood and run-off, but rainwaters were caught in many places between the tributaries' alluvial fans and the new levees, leaving damp areas unsuitable for cultivating. In twenty years, eight areas along the Rhône representing 7160 hectares in total were drained by the Canton, financially supported by the Federation (DFI, 1964: 65). Drainage canals were dug and underground aqueducts were built to lead collected water in the tributaries further downstream into the Rhône. More wetlands disappeared, increasing Valais' scarce arable area to the satisfaction of the Canton and the Federation. Once completed, the First Correction was praised as a great success by the Swiss engineers, who saw the radical transformation of the river, and praised it both for the safety it seemed to ensure and the economic development expected from the new reclamations. In the first decades of the twentieth century, it appeared, however, that the Correction had not fulfilled its goal of creating a continuous and self-regulating channel. The riverbed was progressively rising, especially in the central part of the valley, the most densely occupied and exploited part, increasing by 1.80 meter in the Canton's capital city between 1892 and 1935 (DFI, 1964: 80). Inside the riverbed, the space left open between the groins was carved by whirlpools and remained partly empty instead of filling up to narrow the central channel; the stream strayed and spred deposits instead of maintaining its permanent bed straight and clear. A correction of the correction seemed inevitable.



First and second correction, typical plan and section (DFI, 1964: 91)

The second river correction itself was planned in 1928 to complete the first and remedy the progressive raising of the riverbed. The complementary works consisted mainly in dredging the central winter bed, connecting the groins by longitudinal dikes, and filling the space left between the groins with the extracted material. More segments of the Rhône, its tributaries and confluences, were reshaped and narrowed, sometimes with the financial participation of local industry (the Lonza factory built in the Rhône floodplain, close to the Rhône-Vispa confluence, paid 23% of the local works to increase its own flood safety level).

Again a major flood in 1935, caused by a dike breach in Conthey, forced the canton to take emergency measures during the planning of the Second Correction. A hundred hectares were flooded as well downstream Sion, and a breach had to be opened in the right bank in Chamoson to let the waters flow back into the channel (id: 93). Again a destructive flood significantly accelerated the river transformation: The second correction project and budget was promptly validated six months after the catastrophe, in February 1936. Federation, Canton, and the railway company supplied most of the funds. Municipalities were accountable for 16% of the works, a total divided among them through a proportional system based on financial capacity (2/10) and arable area to be protected by the correction (8/10). This agreement allowed the program to move forward and be implemented in three main phases, with the last being completed in 1961.

The drainage works outside the levees also appeared insufficient soon after completion of the first correction, and many areas remained too wet to be cultivated. Various drainage works were undertaken already in the early twentieth century. Drainage infrastructure was built from Riddes to Martigny between 1916 and 1934, from Saillon to Fully in 1910-1919 and 1920-27, from Sion to Riddes in 1920-1954, from Saint-Léonard to Sion in 1934-1947, and from Viège to Rarogne in 1919-1936. The transformation of the Rhône Valley from a riverine landscape into fully drained intensive farmland lasted in total 90 years, from 1870 to 1960. It added a total of 10,000 hectares of arable land, drained by 215 kilometers of new canals, and absorbed more than a quarter of the total funds spent on river management in the Rhône Valley between 1863 and 1961 (DFI, 1964: 130, 131). Rob Ruckly, Director of the Federal Department of Roads and Levees, proudly wrote in 1964 that "the Rhône Correction differs from other similar enterprises in the fact that it has transformed a full, large valley, once covered with reed and swampy fields, into a vast prolific and quasi Mediterranean orchard."

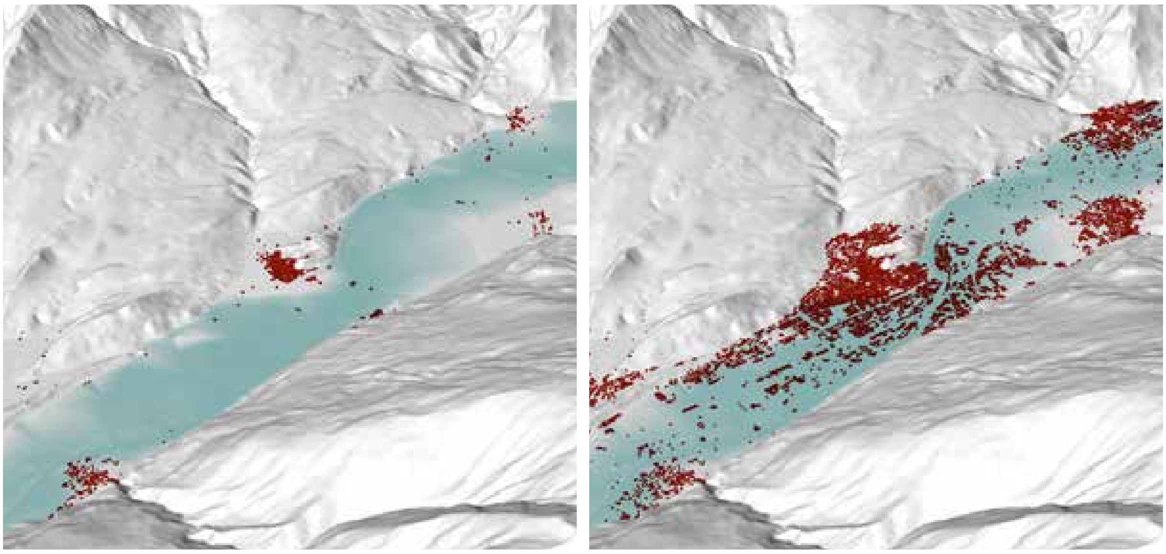
The Rhône correction was actually far from unique, certainly in the European context, where most river channeling works were for centuries motivated by the need for farmland as much as the fear of flooding (See Part 1). Ruckly's claim rather confirms that in the first half of the twentieth century, as in the nineteenth, land improvement and production increase is still given absolute priority. The valley bottom is seen, during these times of political and economic turmoil, foremost as a space of conquest and opportunities, and rarely ever as a natural habitat or a living environment. Hardly any trace can be found of concerns over these two aspects. At the most the federation does appear concerned about upstream deforestation – for the torrential floods it generated more than ecological damage. Civil engineers barely thought of the spatial quality that could be created together with the hundreds of kilometers of canals and levees, although some were concerned about the lack of coherency among the various infrastructures built in the valley. For the Valais people as for the growing amount of tourists, nature and beauty were to be found uphill, and the brutal conversion of a diverse riparian landscape into a utilitarian and mono-cultural area seemed to all a legitimate enterprise, if not a duty in modern minds. As a result, only 20 kilometers of the 160 kilometers of river still showed any natural morphology at the end of the twentieth century, about twelve percent of the Upper Rhône's total length (Projet Rhône, 2008: 80).

In the meantime, as the Rhône thinned and the valley was drained dry, infrastructure works could start and expand. In spite of the various vicissitudes, the railway extended further up and reached Oberwald and the Rhône glacier in 1915. Between the two world wars, several airports were built that benefitted from the flat lands made available by the corrections. The Airport of Sion opened in 1935, occupying about 100 hectares of drained floodplain, later followed by the airports of Turtmann (1939), Raron (1942), Ulrichen (1942), and Münster (1943).

In September 1948, following a rainy week, two breaches occurred in the levees in Fully, one of them on a length of 160 meters. About fifteen million cubic meters spread over 1200 hectares between Fully and Martigny (Hydronat, 2000). "The Rhône is not to blame", stated the Nouvelliste Valaisan on its front page, "that would be charging [the river] with wrongdoings it is not guilty of." For the Christian paper, the flood was of divine origin and beyond human influence: "The most precise science cannot predict the deluges of rain that make rivers overflow. (...) God knows when the time comes to clear the black clouds" (Nouvelliste, 07.09.1948). The Confédéré liberal newspaper instead underpined the fact that waters had spread into two municipalities where "the river [was] higher than the valley" (Confédéré, 06.09.1948), laying bare the risks inherent in the channeling of the Rhône above the valley floor, and its disconnection from the rest of the plain – making each dike breach disastrous where water spread fast and couldn't find its way back to the channel. A day later, as the rain stops and the waters progressively run off, the same newspaper claims that "the Rhône is tamed again" – but still deplores the fact that the Rhône bottleneck in Martigny had not been addressed earlier, as recommended in 1935 by local Deputy J. Luisier (Confédéré, 8.09.1948). Yet this dramatic event does not lead at the time to a change in the coercive policy conducted by the Canton's engineers, nor did it prevent the growing occupation of the former floodplain.

After the two radical corrections, the Rhône still could not carry all the materials brought down by its tributaries on down to the Geneva Lake. Even fully channeled, and its main bed dredged and deepened, the river had not reached the ambitioned self-maintaining regime, and kept on silting up. Soaring infrastructures construction and the building industry resolved the shortcomings of the two Corrections. Urban expansion benefitted from the apparent safety brought by the levees and created a strong demand for river sand and gravel. While the pre-correction map showed a handful of constructions below Sion, the floodplain was largely built on by 1980, leaving no space for potential flood control or disaster mitigation. Infrastructures followed and further boosted the construction of the valley. The Autoroute du Rhône motorway was built progressively from the seventies onwards, mostly in the floodplain and often right through farmlands, with the same brutality lamented for the railway a century earlier.

Continuous material extraction supported by ongoing construction countered the river's spontaneous silting, and avoided having to raise the levees again (Projet Rhône, 2006: 14), just as the construction boom in Grenoble did for the French Isère River in the same period. Furthermore, from the 1950s on, hydropower installations held growing amounts of materials behind the dams – with the Dixence alone collecting waters from 7% of the 5220 km2 Upper Rhône catchment area (Projet Rhône, 2008; www.grande-dixence.ch). But, there again, a permanent balance appeared out of reach, since the Rhône appeared to lose more material than what it received from the mountains, showing signs of erosion already in the 1950s. In the meantime, Hartmann and Blotnitzki's dreams of integrated planning and watershed management had vanished. Since the Rhône remained quiet for four decades, apparent safety and permissive regulations encouraged an unseen construction fever in its former territory. Farmlands, infrastructure, and built areas conquered the floodplain thanks to river containment, but with no physical connection to the river that used to shape and rule over the valley. The new dynamic balance combining channeling and dredging for the building industry showed major flaws: Apparent safety encouraged construction in the floodplain and increased exposure in case of flood; Urban sprawl and induced infrastructures consumed scarce arable land; and riverine ecosystems were considerably deteriorated by the channeling and material extraction. Eventually all three factors combine into a new critical perspective in Valais and Switzerland in the nineteen-nineties, that progressively leads to the current Rhône Correction, third of the name but intrinsically based on a different cosmogony.



Constructions in the Rhône Valley in and around Sion, in the mid-nineteenth century and 2010 (ill. Rossano, from Swiss topo: Dufour Map 1844-64, National Map1950, Vector25 2008)

Renaturation ambitions along Swiss rivers: a U-turn in federal policy

Starting from the early nineties, Swiss flood policies shifted from a model of vertical containment to a model of spatial prevention, with the 1987 floods being considered to mark the beginning of this turn from coercive to adaptive strategies (Reynard et al., 2006). The federal report on the 1987 inundations not only stressed the need to introduce passive strategies but also to prevent damage through more restrictive planning policy, based on better risk assessment (OFEE, SHGN, 1991). The various laws and ordinances on water protection and on hydraulic engineering passed in the following decades progressively brought horizontal solutions to the foreground.

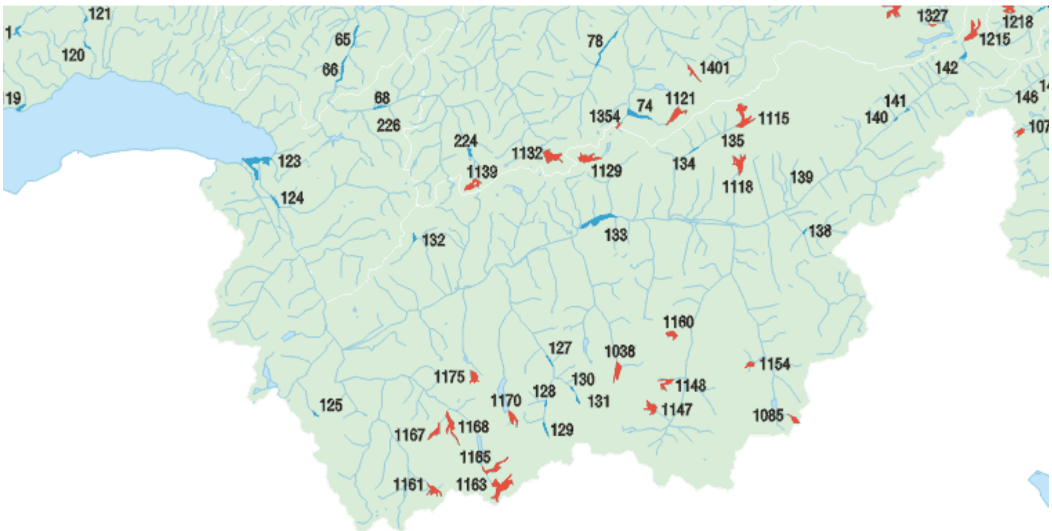
Regarding flood defense measures, the Swiss Hydraulic Engineering Law of June 21, 1991, confirmed the attribution of flood defense executive powers to the Cantons, in the continuity of the 1874 Federal Constitution. But as was already the case in the nineteenth century, the Federation remained the main sponsor of large hydraulic works, influencing greatly the decisions made by local authorities, and it took with this law a new stance on flood defense. The most striking change was explicated in article three on "measures to be taken," which gave priority to "maintenance and planning measures" and only when these measures fail to provide protection, did it allow other measures to be taken such as "corrections, damming, sediment collectors and retention basins" (Assemblée fédérale, 21.06.1991). Although the law did not explicitly mention river widening or floodplain restoration as preferable approaches to flood risk, the priority given to spatial strategies and environmental quality clearly oriented river management towards horizontal solutions. This change of perspective marked in Switzerland the end of unlimited river engineering, and publicly stated the impossibility of achieving full protection through defense works. This new stance contituted a U-turn in regard to nineteenth century federal flood-management policy that considered full river diking and straightening as the only valid strategy, regardless of environmental damage (see"A European self-colonization" on page 61).

The Federal Agency for Water and Forestry (OFEG) developed and promoted this new approach through various publications. "These last few years, specialists developed the concept of sustainable flood protection that does not seek to tame nature, but to give nature space through creating floodable areas" (OFEG, 2002: 5). Spatiality came to the foreground, long occupied only by technology: "According to this new concept, spatial planning plays an important role." The same publication noted that "Defensive civil works built for extreme situations often cost much more than the damages they are meant to prevent. It is thus preferable to take spatial planning measures in order to curb residual risk. The motto was not to fight at all costs against flood, but rather to learn how to live with it." (id.). This shift was thus not only motivated by the belief that vertical solutions had reached their capacity limits in terms of safety, but also by the rising costs of defense infrastructure, therefore stating again that state support was conditional on the outcome expected, in terms of financial gain or savings on potential damages – and was not granted for a limited short-term response.

The 1991 law also reflected growing environmental concerns regarding the state of Swiss streams and reflected the empowering of political ecology that soon occupied the center of this new arena. The Confederation introduced environmental goals into flood prevention policies, encouraging "renaturation" works in order to heal the damage of full river damming, funded and promoted since the nineteenth century by the same Federal Council. The law identified environmental restoration as a suitable goal for federal investment, creating a powerful incentive for ecological improvement. It further introduced quantitative and qualitative criteria to hydraulic engineering, as interventions on riverbeds should "as far as possible respect the natural course" of the stream, in other cases restore it, and create the conditions for riparian flora and fauna to develop on its banks. The Confederation still would not fund maintenance works, a prerogative of local authorities, but would allow the funding of restoration works meant to "bring waters affected by civil works back to a state close to natural."

In terms of legal obligations, river-widening policy stops at the boundaries of inhabited zones. The 1991 law on river engineering indeed encouraged river widening but specified that built areas could be exempted from ecological restoration (Loi fédérale sur l'aménagement des cours d'eau, 21.06.1991: 4.3), complying with the modern zoning tradition that dissociated city and landscape along theoretical borders, typically blurred in most Swiss valleys. Environmental requirements were kept outside of the living environment, where, one could argue, they were the most needed. In that regard, the federal legislation on river engineering adressed the standardization of river profiles into drainage channels. Yet it failed to address the spatial quality and the transformative potential of streams and rivers in inhabited areas, although this dimension concerned virtually all Swiss cities and is often the key element in flood-risk exposure, as is the case for the city of Sion in Valais, literally built over the Sionne stream and extended into the Rhône floodplain. The 1991 law did though restrain the tunneling of the Swiss streams – 1200 kilometers had been buried between 1972 and 1989 alone (OFEFP, 2003: 51) – but still avoided interfering with the urban realm, leaving it up to local authorities to develop possible interactions between urban life and riparian nature.

Other than public institutions, the "renaturation" motto was also actively supported by the Swiss environmental organization Pro Natura that stressed the combinatory virtues of this approach as being "beneficiary to humans and nature." Environmentalists stress the destructive effects of channeling and the possible gains of river widening for flood protection. Pro Natura commissioned a study on the subject in 1997, which concluded that streams would need about ten times their regular width to allow natural meandering, and that the big rivers such as Rhône and Rhine would need at least 200 meters to fluctuate again (Frossard et al, 1998: 4). Extrapolating from these results, the ensuing report calculated that approximately 0.5% of the Swiss territory should be reserved for river widening, tripling the area dedicated to rivers.



Pfynwald, Iles des Clous , Les Grangettes: only three large alluvial areas left along the Upper Rhône after the two Corrections (KBNL, 2001)

Thur river riverbed and riparian wood, ten years after reconfiguration (photos Rossano, July 2013)

The law on water protection was supplemented in 2011 by a new article setting goals for the determination and restoration of a "minimum space" needed for riparian ecology and flood protection (Waters Protection Act of January 24, 1991, version 2011 and later, art. 36a: Space provided for water). Eventually, the 1998 law on water protection was amended in 2011 to integrate this normative and linear approach, defining a set of standard widths to be kept free along streams and rivers: eleven meters for watercourses with a channel bed of less than two meter natural width; seven meters plus 2.5 times the width of the channel bed for watercourses with a channel bed of two to fifteen meters natural width (Waters Protection Ordinance 28 October 1998, Status as of 1 January 2014, art.41.a: Space provided for watercourses). The width should even be increased wherever required in order to guarantee protection against flooding (id.), and the reserved area should not be used for agricultural activities.

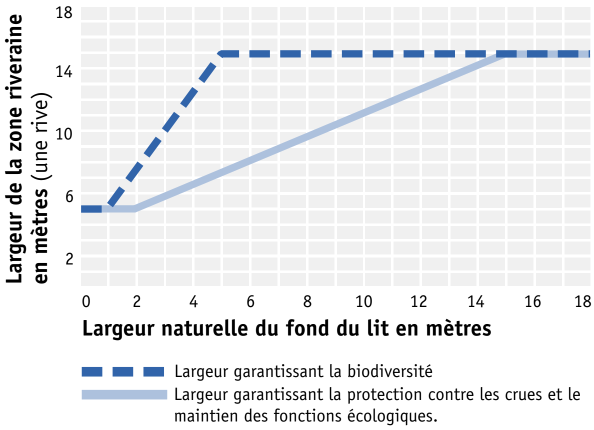
The last two decades have seen numerous state-funded "renaturation/Renaturierung/rinaturazione" projects flourish along the Swiss waterways: the Thur river (construction 1993-96/1997-2003) in Turgau Canton, the Wiese (1999-2001) and Birs (2003-04) in Basel canton, the Aire river (2002-14) in Geneva canton, the Reuss and Kleine Emme (2007-12) in Lucern canton, the Töss river (2013-...) in Zürich Canton, the Cassarate ricer (2011-2015) in Ticino... The early transformation of the Thur River, however, made it clear that the shift from systematic diking to river widening was going to be anything but consensual. Long conflicts opposed environmentalists to farmers on the level of renaturation and the surface of arable land to sustain within the floodplain areas. These conflicts revealed the gap between federal and local authorities, with the latter being more influenced by local communities and landowners, more sensitive to land productivity and more inclined to status-quo (Zaugg, 2002), as opposed to the pro-ecology federal authorities. These conflicts delayed the project for several years and soon exposed the controversial nature of the "renaturation" approach, which however further spread through Switzerland, thanks to the federal voluntarism and financial incentives.

Flood as agent of landscape architecture: from river channel to river space

In 2003 three federal agencies, the Office for Forest, Environment and Landscape, the Office for Water and Geology and the Office for Agriculture, jointly published a brochure entitled "Guiding concepts. Swiss waterways. For a sustainable management of our waters" (OFEFP et al., 2003).

This short publication summed up the new "horizontal" federal policy, and detailed the goals and the measurements required to achieve these goals. Each river should be allowed to fluctuate according to seasonal changes, stated the brochure. A good profile should accommodate high water discharge and allow the river to perform its drainage function for the surrounding areas; it should provide enough space to guarantee structural biodiversity, both terrestrial and aquatic; it should provide enough space for typical species to develop and form a network of natural habitats; it should create an attractive site for the population to relax and "integrate this landscape into its cultural environment"; finally, it should leave enough distance between exploited land and streams to prevent water pollution. Space was thus needed to perform the river's three main goals: drainage, ecology and recreation, with the addition of a new cultural dimension that was not present in the federal laws.

Although the new set of goals was to a great extent locally defined and subjective – especially regarding recreational and cultural value – the Federal agencies collaborating in the above-mentioned brochure agreed on a dimensional standards to help local authorities implement these goals. Reminiscent of the attempts made by the non-governmental organization Pro Natura in the late nineties to develop a quantitative approach to river morphology, a small chart was provided in the publication that made it possible to calculate the necessary width of the "riverine zone" needed for a stream in relation to the "natural width" of the bottom.



Calculation chart for the estimation of the width needed for biodiversity (dark blue), for flood protection, and for ecological functions (light blue) in relation to the "natural width of the river bottom" (from OFEFP, et al., 2003: 4)

The official Swiss approach to river management was, at that time, focusing on ecology rather than on environment in a broader sense, and was often linear rather than territorial, addressing the question of space through the search of normative profiles and quantitative goals. However, beyond the question of river width, the successive laws on water protection and hydraulic engineering used the notion of "space" also in a wider sense but in cautious terms, as spatial planning remained in theory the exclusive domain of local authorities (an agreement, however, regularly challenged by federal laws on transport or housing, such as the controversial "Lex Weber" passed in 2012 to regulate the proportion of second residences).

The 1994 ordinance, complemented in 1999, tried to put an end to construction on floodplains and flood-risk areas, first of all by compelling cantons to generalize flood risk assessment and actually define flood-risk areas (Conseil fédéral suisse, Ordonnance sur l'aménagement des cours d'eau, 2.11.1994: art. 21, 27). The law further excluded from federal funding any measures meant to protect new construction in threatened areas (id.: art.2.5.a). More generally, the danger zones would have to be taken into account in all planning documents and "other activities having an effect on spatial planning" (id. art. 21.3). Beyond the sole issue of flood risk, the Federal Law on water protection has, since 2011, compelled all cantons to define "the space necessary for surface waters" (Loi Federale sur la Protection des eaux, 36.a). With this new obligation placed on local authorities, the notion of river space took on a larger dimension, which integrated various states of the riverbed: the permanent bed, the high water bed, the space needed for meandering, and the space of maximum dilatation in a flood situation. It also gave this spatial aspect a real impact on river management projects, not least for the Third Rhône Correction, where the definition of "necessary space" remains to this day the most difficult to resolve in any consensual way.

Loosening the Upper Rhône, from policy to project

In the Upper Rhône Valley, four relatively quiet decades followed the 1948 flood, before threatening high waters reappeared in 1987. A year after the 1991 law was passed, the Sionne, dammed and ducted since the seventeenth century, inundated Valais' capital city and paralyzed the region's railway network. In 1993, the streets of Brig were inundated by the waters of the Saltina stream, partially covered by several meters of alluvium. This series of dramatic events generated a rapid surge in emergency measures planned between 1994 and 1997, which had mainly consisted of local reinforcement of the levees in Visp, Niedergesteln, Steg, Chippis, and Fully.

But besides this short-term classical response, these events had further consequences. The floods had shaken the trust placed in the existing flood defense structure (Hydronat, 2000). Combined with a cultural shift towards horizontal strategies and growing environmental concerns at the federal level, the floods that punctuated the end of the century progressively set the Third Rhône Correction in motion, which was about to become, with its 160 kilometers length, the biggest contemporary river transformation engaged in Switzerland. In 1995, the Canton Council commissioned in-depth studies to analyze the situation and sketch future global response to flood threats, studies that focused on the Rhône upstream Martigny, the segment that appeared to be the most exposed. Besides the restoration of the recently flooded areas, the first ConSeCru research program investigated a larger scope of variables that could orientate future measures: meteorology, hydrology, sediment and driftwood transport, flood-risk areas, along with studies for a flood protection concept that would integrate spatial planning policy and disaster management (Bloetzer et al., 1998: 139).

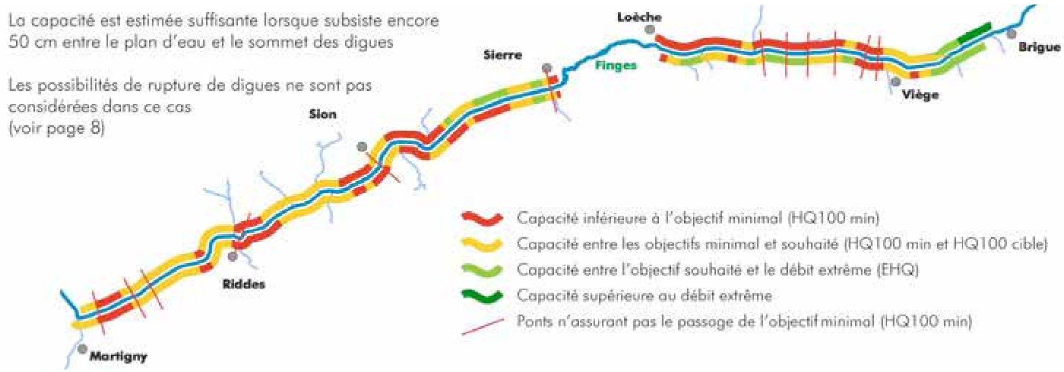
1992: the Sionne stream floods Valais' Capital city
and paralyzes the railway traffic (Robert Hofer, Médiathèque Valais, Martigny)

2000: first project of third correction

The 1995 investigation sketched a new global transformation of the river from Brig to Martigny, based on "the new philosophy regarding flood defense" (Hydronat, 2000), and financed for 70% by the Federation, where this new philosophy originated. Three sub-sectors were defined, and for each sector a team was hired. The teams were composed of six to seven engineering firms, mostly specialized in civil works, hydraulics, and ecology. Despite the repeated statement that all measures should be integrated in a coherent landscape structure, designers from urban planning or landscape architecture disciplines were broadly absent from the selection. In 1997, the propositions were delivered and discussed within the canton's administrations. The various reactions confirmed the will to "realize an integrated project that answers safety, environmental, social, and economic aspects," and a plan was researched that could "manage residual risks, give more space to the river, and incorporate farming activities, tourism, and recreation" (id.). In 1998, Hydronat, a private engineering firm, was hired to adapt and harmonize the various results. The three teams finalized and delivered their proposal in 1999, proposal that was again modified and harmonized by the project steering committee and Hydronat, also in charge of elaborating the final report. In June 2000, the Road and Waterways Department could finally present the synthesis of five years of investigations, entitled "Third Rhône Correction: safety for the future" (Hydronat, 2000), which laid out the basic principles for the future planning process and was officially approved by the Canton Council a few months later.

The conclusions of the preliminary studies in terms of flood risks and exposure were alarming: levees were instable in many places; discharges higher than the one seen in 1993 should be expected; about 7000 hectares could be flooded by a 100-year flood, a vast area, however, considering that 10,000 hectares had been reclaimed from the Rhône during the first and second correction. Even more worrying was the level of exposure reached at the turn of the century: It appeared that the same 100-year flood could potentially cause six to ten billion francs of damage. Besides flood risks, the ecology of the river had been dramatically damaged by the channeling, and the social and economic potential of the river in relation to the valley (farming, tourism, and hydro-electricity) had been neglected. In this context, the 2000 first comprehensive plan took a new stance, stating that "lasting solutions with limited maintenance will be favored and should as far as possible restore the river's natural dynamic." Furthermore, breaking with past Promethean optimism, the report acknowledged the impossibility of totally preventing flood risk and the need to mitigate the effects of extreme discharges through controlled flooding: "residual risks (...) must be addressed with the creation of a drainage corridor that avoids inhabited areas." Retention was also a full aspect of the chosen strategy: "on areas with low potential damages (...) in order to manage extreme discharges between Brig and Martigny, and prevent aggravation downstream."

Three types of possible measures were listed by the report: adaptation of existing flood defense; widening of the river space; and the creation of secondary discharge channels, distinct from the Rhône. The first type of measures were discarded for their incompatibility with ecological restoration: It should be chosen only when the river could not be enlarged. The second and third types of measure allowed for a combination of more safety and reduced clearing of riverbanks, and was to be preferred for "less constrained areas, particularly when extensive agriculture is thinkable." The potential conflicts inherent in this differentiated approach were to be resolved within a global landscape concept for the valley in order to "optimize the areas returned to the river," and as a prelude to a more detailed plan designed per segment. Accordingly, priority measures followed a parallel path, independent from the long-term and large-scale planning procedures.

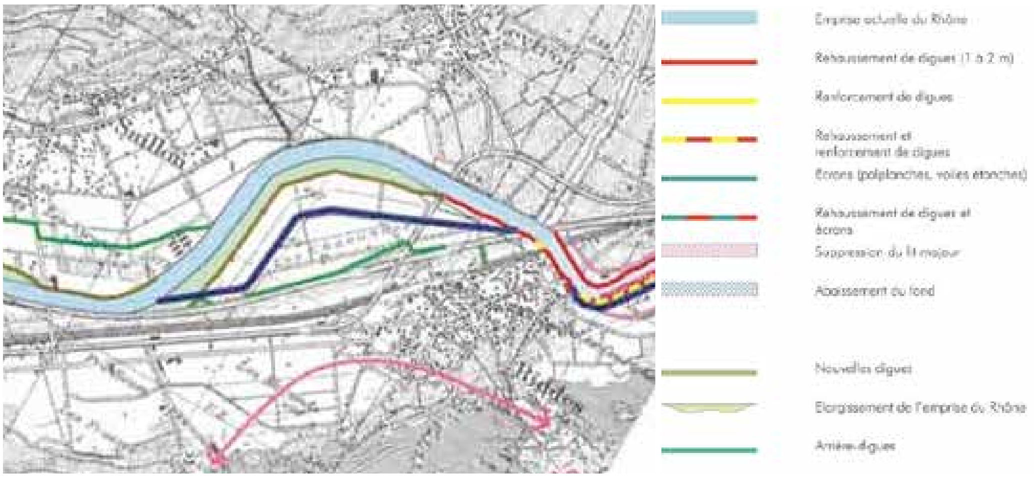


Preliminary hydraulic assesment: Only few segments appear to have a sufficient discharge capacity (in green) (Hydronat, 2000)

These two aspects, dynamic river management and controlled flooding, although conforming with Federation policy, then represented for Valais a break with more than a century of damming and channeling measures, implying a "true Copernican revolution: Levees do not protect, they threaten, the solution promoted by common sense is the problem" (Bender, 2004). Local politicians remained cautious about the application of the "new philosophy." In the report's foreword, State Counselor Jean-Jacques Ray-Bellet praised the heritage of the "many generations that have done all they could to tame [the Rhône] and made the fantastic development of the valley possible" (Hydronat, 2000). He remained indecisive about the future flood protection that should "adapt to current and future land use, valorize natural assets, and be integrated into economic and social life": a general statement that neither opposed nor supported the federal motto of ecological restoration and horizontal flood defense, and suggestd that the project should adapt to the present situation, which was the direct result of the channeling of the Rhône and the full drainage of its floodplain.

Accepting intensive land use as a constraint, the report recommended to rapidly identify potential conflicts, and advocated the elaboration of a "global landscape concept for the valley." From the very beginning, the Third Rhône Correction's ambition was for a global and integrated transformation of the river, a territorial Gesamtkunstwerk that would incorporate all active components present in the valley, its past and its future. The drawings inserted in the 2000 report, however, illustrated the difficulty of the exercise. Showing already concrete intervention proposals, the plans seemed to address local conditions and reinforce the Rhône corridor rather than look for an overall landscape structure. More explicit than the text, the plans clearly indicated a "constrained area," where the existing channel cannot be modified but only adapted, generally corresponding to built areas, and an "unconstrained area," where the channel could be widened or doubled with a secondary branch, corresponding to farmland, a classification that soon would appear controversial.

Despite these conflicting realities, for the authors of the 2000 synthesis the only path to follow was an all-round project satisfying all parties who should consequently all be involved in the planning. "Only a process fully integrating the different domains from the very beginning can fulfill the goals and lead to the realization of a project in accordance with the sustainable development of the Canton." And indeed the scope of the project was widened, and an extended study was commissioned that included the Canton of Vaud, on the right bank down to the Geneva Lake; three large research programs were also launched by the Valais Canton and various federal institutions, focusing on specific aspects of the mega-program: flood response and emergency (program MINERVE), the design of spillways (program DIFUSE), the multi-functional potential of the correction, and possible development of hydro-power plants (SYNERGIE). In parallel, the European Interreg III program funded a large research project on the Upper Rhône basin in Switzerland and France, comprising an extensive cartographic study of the Swiss Rhône Valley between 1800 and 2000 (Dupont et al., 2008, and Staueble, 2009).

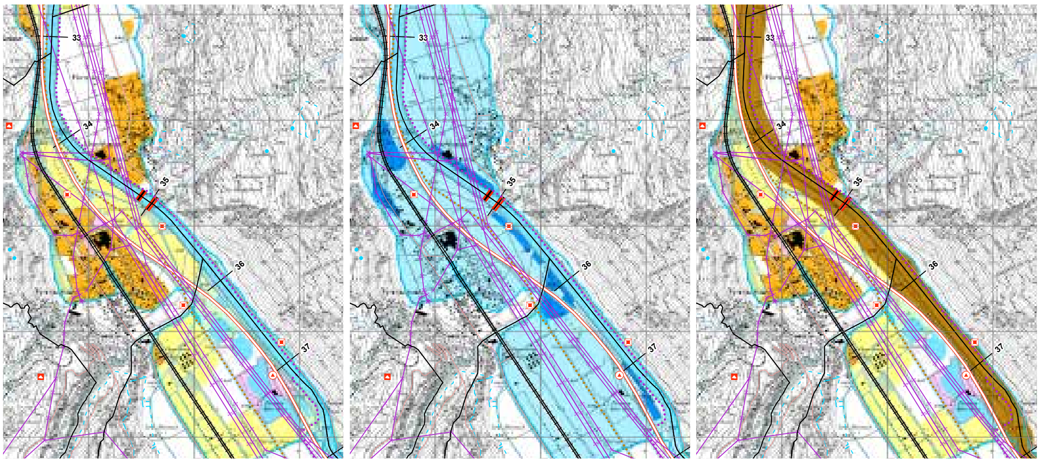


Preliminary proposal for the Third Rhône Correction, detail Riddes-Saillon area (Hydronat, 2000)

2000: the wake-up call

"The danger [of flooding] is not perceived in everyday life along the Rhône, as the memory of the last severe floods is lost for the inhabitants of Valais," lamented the report published in May 2000. In October 2000, heavy rainfall poured over the south of Switzerland, and the Rhône sent a painful wake up call. The river swelled up again, and the discharge measured in Sion surpassed the 1993 record. Massive flooding occurred in Valais and Ticino Cantons. The floods caused the death of sixteen victims and provoked 670 million Swiss francs in damage, 470 million in Valais alone, out of which 62% involved public infrastructure (OFEG, 2002: 16-17). The catastrophe confirmed the conclusion of the first studies and the need to engage in a new project that would this time address both the risk and the exposure of Valais' inhabitants and the infrastructure projects that had been built in the former floodplain, sometimes meters below the high water level.

In 2005, a preliminary version of the *Plan sectoriel* was communicated as a recommendation to all concerned parties, to which environmental organizations reacted with disappointment. They endorsed the general concept but considered the proposal insufficient regarding the ecological ambitions set by the initial project and by federal laws. Four organizations including the World Wide Fund for Nature WWF and Pro Natura joined forces to elaborate a common proposal to ask for "more space for the Rhône" and a global ecological restoration of the valley through a network of biological corridors. The counter-proposals addressed the width of the enlarged segments as well as their amount. While the Canton proposed to locally double the width of the Rhône to achieve a basic ecological value, the organization considered a factor of three to five as necessary to allow ramifications in the river course and "the reestablishment of the biodiversity of desired species and their vital biotopes." The document included zoning plans that illustrated their demands in terms of widening and land use adaptation, this on 24 sites along the Rhône (WWF et al., 2005: 5-6).



The three-steps approach of the “Plan sectoriel”: the territory, the flood risk area, the river space (Canton du Valais, 2006, détail)

The final "Plan Sectoriel" published by the Canton Valais in 2006 integrated more strongly the federal guidelines and the new discourse on flood prevention into the project description. The document defended an approach through three key notions, illustrated on its cover: "Territoire" was written on an aerial picture of Sion; "Danger" showed areas of high and moderate flood risk in light and deep blue over the same picture; and "Espace" showed a fluctuating corridor clearly related to the stream, but not limited to the existing channel, nor covering the full risk area: the newly define "river space" or "Espace Rhône".

The definition of the "Espace Rhône" was clarified inside the document. "This space was defined according to safety requirements; inside this safety space, environmental and socioeconomic functions can also find their place. It generally includes the current Rhône [channel] as well as a surface equivalent to the current width of the Rhône (on each side), but it respects important constraints existing in the valley and is therefore reduced to ten meters from the base of the levee, when close to built areas." (Projet Rhône, 2006: 5) The document stressed the fact that this river space (espace) differed from the space actually occupied by the stream (emprise): The Espace Rhône is a multi-functional space, defined but negotiable, depending on the priority given to the different contextual or projectual elements in place – a flexibility opposed by environmental organizations.

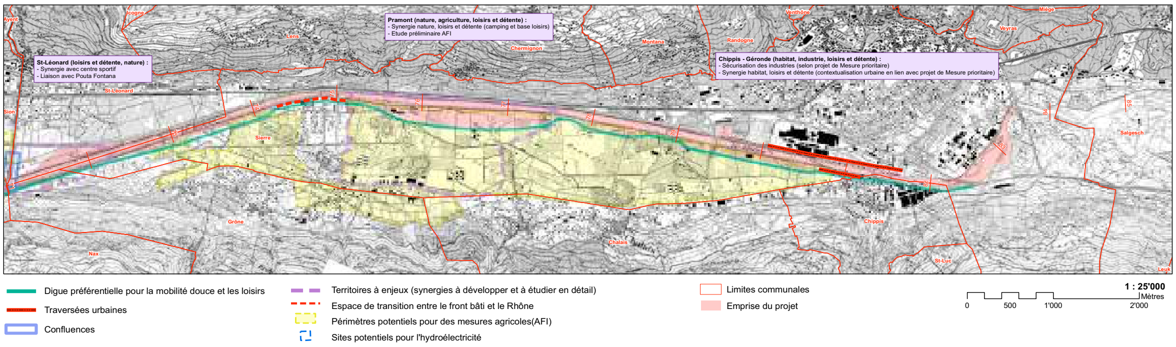
The law on hydraulic engineering passed by the Grand Conseil du Valais in 2007 again confirmed the integration of federal orientations into regional policy, although trying to counterbalance environmental requirements with an impressive list of interests to be taken into account in the maintenance and transformation of rivers. As stated in its first article, the law aimed at ensuring flood protection, fixing potential flood damages and "maintaining, restoring or developing streams into a state as natural as possible" (Grand Conseil du canton du Valais, Loi sur l'aménagement des cours d'eau, 15.03.2007, art.1). Its second article mentioned "active and passive flood protection," to be reached following no less than fourteen principles enumerated in Article Five. These included: the "preservation of [free] space to facilitate flood protection"; the "conservation or restoration, as far as possible, of streams' natural character through renaturation measures"; the application of measures allowing the installation of a diversified fauna and flora along the streams; the maintenance of riparian vegetation, and if necessary its replacement by a more adapted vegetation; and "taking into consideration the requirements of spatial planning, of the protection of environment, nature, landscape, as well as of fishery, agriculture and forestry, (...) the interests of navigation or the use of hydraulic power" (id., art. 5e, g, h, i, k, l). This new law indirectly framed the Third Rhône Correction, which was then already in the planning phase and from 2008 on could count on the Canton's funding for its implementation.

The mission described in this law was at the same time clear in its integrative ambition and complex in its implementation: the list of interests to be taken into account suggested a holistic and consensual approach, that in the dense context of the Rhône valley seemed retrospectively hard to reach, if even achievable. As the architects of the correction liked to stress, the valley floor was intensively exploited and inhabited; the state had no land buffers to compensate eventual losers and absorb the shocks of the re-allotments induced by the goals set for the correction. The discussion around the project logically quickly focused on the quantitative aspects: Each party counted the lost and won hectares, arguing over the legitimacy of the opponent's territorial claims. Willing to "make room for" ecology, safety, farming, recreation, construction (...), the program created high expectations and brought the question of repartition to the foreground. With this ambition, land distribution became the core element in the negotiations, far above spatial coherency or possible synergies.

The "Rapport de Synthèse" published in 2008 specified the quantitative choices made during the design process: a widening factor of 1.9 would be necessary to ensure an "ideal profile for the lasting securing of the valley" (Projet Rhône, 2008: 42). However, it was thought that the Rhône's river space could eventually be only 1.6 times larger with local enlargement of a factor two or three, this being considered as the minimum for "lasting safety" (a term, however, partly tempered: the profile did not take into account the "possible effects of climate change on high water discharges"). Eventually, twenty segments were planned to be enlarged, at more than 1.6 and up to 2.5 times the existing width, on accumulated length of 25 kilometers (Veuve et al., 6).

In the same years, the project was further detailed in parallel local consultation trajectories. The Rhône was divided into five sectors led by steering committees – "Commissions régionales de Pilotage" or "CoRePil", representing 53 municipalities. Each committee was composed of local representatives and organizations, in charge of envisioning the local application of global goals and measures predefined by law and by the Rhône authorities, and elaborate a "Concept de Développement de la Plaine." While some of the CoRePils were already anticipated in 2003 and mobilized many actors in a genuine and broad reflection on territorial issues (notably in Sierre), the results were eventually narrowed down to a choice between limited options, and evaluated according to quantitative aspects rather than dynamic visions (Largey, 2013). The authors of the 2008 landscape study praised the results of the local workshops, but lamented the physical impossibility to translate these ideas into projects (Veuve et al., 2008: 22).

The work done by the local Corepil committees indeed resulted in fourteen "plans of territorial and landscape insertion" ("Insertion territoriale et paysagère du Rhône dans la plaine") added to the general report, plans that appeared more the result of quantitative negotiation than of a vision on future landscape and spatial quality. Contradicting their denomination, the various plans consisted of a general zoning scheme, combining factual information ("urban fringes", "transition spaces"), specific functional orientations (possible location of recreational routes on the levee, re-allotment measures or hydropower plants), and areas vaguely classified as "challenging zones." In the end, the plans avoided any structural proposal, but rather indicated a sum of local compromises, far from securing the expected "Concept de Développment de la Plaine".



"Insertion territoriale et paysagère du Rhône dans la plaine (selon Concept de developpement de la Plaine)" for the Sierre region (Projet Rhône, 2008)

Despite the consultation procedure that surrounded the definition of the "Plan d'aménagement," many farmers still fiercely opposed the plan, contesting the very necessity of river widening. They joined forces in 2007 and establish the ADSA, or Association for the preservation of farmland. Two main principles guided their action: Flood safety, they believed, could be better obtained without returning space to the river, but instead by lowering its bed; arable land was too precious to sacrifice to natural restoration, and should be secured and protected just as urban areas were. The first argument was developed in an alternative plan just like environmental organizations had done in 2005, consisting of a minimal project supported by technical studies commissioned by the ADSA on the effects of dredging: a plan "three times cheaper, three times faster and using three times less arable land," claimed the ADSA during its public campaign. They supported a prolongation of the two previous corrections, both focusing only on discharge capacity and the management of alluvial materials. The best alternative for the ADSA was thus to dredge the riverbed to lower the water levels, to keep the channel narrow to ease the evacuation of deposits, and to reinforce and locally heighten the levees where needed. The second argument reached further into local politics and psyche: Keeping the Rhône in its channel and defending arable land was a case of "respecting the work of our ancestors and the needs of future generations" (ADSA, 2008). Valais lacked arable land, a land that was "indispensable to provide the country with food." Only safety concerns could justify the sacrifice of this precious land, they argued, implicitly rejecting the environmental requisites contained in federal laws on river management and the expectation of environmental organizations in the Rhône valley.

The land argument, however, appeared to be a reversible one, as the debate organized by local TV channel Canal 9 showed in 2011. The delegate from the ADSA pointed out the contradiction between promoting a local and self-sufficient agriculture and widening the Rhône precisely at the cost of local farmland, and accused environmental organization of illegitimately claiming the Valais territory for ecology alone. Thierry Largey, representing Pro Natura Valais denounced, in response, "a great paradox": "the greatest [land] consumer is the 'concrete', but they [developers] always manage to oppose nature to agriculture, and never get involved in the debate" (Le débat, Canal 9, 08.06.2011). The statement was supported by land use statistics that showed that "every eighteen months, the equivalent of the farmland needed for the Third Correction is being built on in Valais." For Largey, farmers and environmentalists were not fundamentally competitors but faced a common enemy: the "concrete." Largey repeatedly suggested uniting in a common fight against the building industry and inefficient planning, but lamented the fact that farmers instead preferred to "fight for the leftovers," remaining prisoners of their own interests in rising land prices and for some selling their land to developers while fighting the Rhône Correction (Largey, 2013).

Trying to balance opposing interests but unwilling to open a new debate on land use and urban sprawl, the Canton Road and Waterways Department defended the hydraulic concept of the Third Correction in various media, eventually adapting the project to slightly reduce the surface taken from farmland to enlarge the river. Tony Arborino, chief engineer of the Rhône Correction, put forward two criteria to achieve efficient flood protection: flexibility and robustness. "Typically," stated Arborino, "solutions such as raising levees and lowering the river floor are often less flexible than widening the rivers, since should the discharge evolve, the whole system must be changed" (Arborino, 2011: 3). This flexible system should be achievable through a three-levels intervention. The main measure was the widening of the riverbed wherever possible in order to accommodate a reference discharge: the statistical 150-year flood peak (1200m3/s in Sion), a reference level that does not take into account potential climatic evolution, but does include the recent peaks measured in 1987, 1993, 2000, and 2005 (id.: 2). Above this level, the capacity available in power dams should be put to use to curb the river discharge, through establishing a closer collaboration between public water authorities and private hydroelectricity companies. Finally, above the discharge levels manageable by the two previous measures, the activation of the "residual risk management corridor ("corridor de gestion du risque résiduel") should protect inhabitants and valuable assets by letting the river flow over submersible levees towards unpopulated areas (Arborino and Perret, 2008: 10).

Still, with the insistant demands of environmental organizations for more river space and the frontal opposition of the ADSA to the concept of river widening, the debate around the Rhône correction became increasingly dichotomous, with the project carried by the Canton being caught up in a haggling process, yet still without any clear overall structure.

Landscape, at last

Contrary to what the first 2000 report recommended, no landscape structure was shown in the 2008 synthesis to support a coherent development of the Rhone correction within a wider context, local or regional. Landscape as such was introduced as a subsidiary aspect of the plan, relegated to the position of second-last "specific theme," below hunting, fishing, and energy, and occupying two pages out of the 160 pages of the report (Projet Rhône, 2008: part 6.9). These two pages consisted of a dense summary of a specific study entitled "Landscape guidelines for the Rhône and the Valley," elaborated between 2005 and 2008 in parallel with the local planning consultation process that resulted in the above-mentioned "plan of territorial and landscape insertion." The landscape study was commissioned by the Canton from a group of urban planners and landscape architects and was published together with the project synthesis in May 2008. The goal of the study was to "define landscaping principles applicable to the Rhône Valley in general and to the Third Rhône Correction in particular." (Veuve et al., 2008). It promoted two main ideas: First, the Rhône levees should become a "life corridor," a continuous and car-free recreational route along the whole valley, giving access to its various natural and cultural assets; and, second, "it is the river's natural dynamic that [would] create its own landscape" within the river space. The study further detailed guidelines for the transformation of the historical levees, taking into consideration their large-scale perception as well as their small-scale practicability, spatial quality, and maintenance.

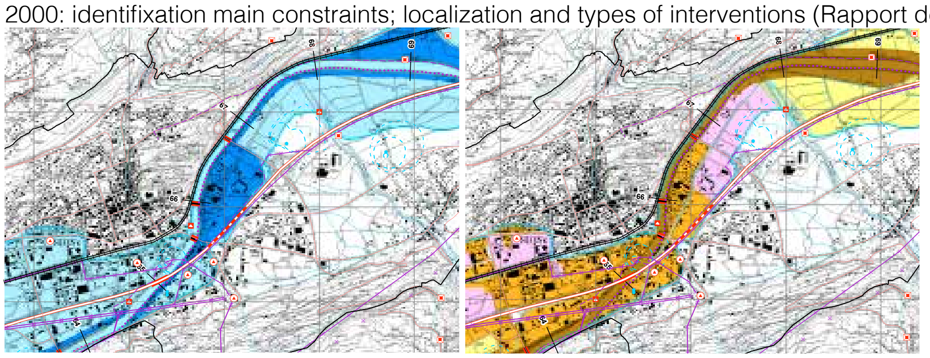
Just as in the general report, no overall landscape structure or even general spatial orientations could be found in the landscape study, both showing the same restraint when it came to defining spatial structures and relations between river and valley. With a surprising openness, the authors partly turned the report into a pamphlet against shortsighted and opportunistic planning in a situation where the new spatial mitigation policy should provide an opportunity to create a coherent structure and prevent further degradation. They blamed the fragmented structure of the planning authorities and its consequences on the valley's landscape: The Rhône 3 Project might benefit from its own dedicated administration, but "all the aspects relating the project to the rest of the valley and its future are diluted among the canton's various departments, regional organizations without political power and a profusion of public and private local interests." The present weakness, they pointed out, "is in striking contrast with the expectations of the Canton's various departments, which like to think that the Third Correction Project should deal with all the coordination issues present in the Valley." As for the authors, the effort made so far to connect flood defense and regional planning would remain vain without structural evolution: "The structure of territorial organization needs to change (...) in order to compensate for the valley's growing fragmentation and lack of legibility through large landscape interventions (gestes paysagers)."

The authors seemed, however, disillusioned by the limited scope of their own assignment. They lamented the fact that "for time and resources reasons, and because the problem is sensitive, the spatial translation of the goals and measures could not result into a concept for the development of the valley, leading to a vision for the valley's future" (id.: 22). "Shall we continue with a piecemeal development fulfilling local and immediate needs?" asked the report; "Which degree of inter-municipality cooperation can we accept? Everyone his own industrial zone?" With this rhetorical question, the authors openly criticized the lack of cooperation among Valais' towns and villages, which were following competing strategies that accelerated urban sprawl and landscape fragmentation instead of coordinating their developement. "This way of considering land as a consumer product, amorphous, indifferent to place or history, leads to a dead end" (id. 23). The landscape report concluded with a vibrant call for more regional ambition and coordinated planning, underpinning the "close interdependency between the Third Rhône Correction Project and the Valley." However, if the Rhône project stimulated reflections outside the "Espace Rhône," it was not its task to develop them, they concluded, an ambiguous statement calling for a large and inclusive analysis but a limited project in its practical applications.

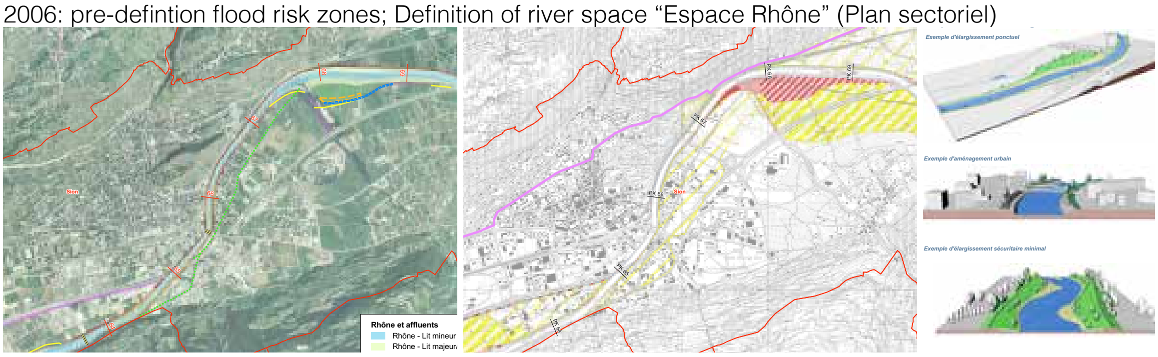
Still, the report reaffirmed that "Third Rhône Correction offers an extraordinary opportunity to think about the organization of the valley," an opportunity that called for greater commitment and resources: "It would be unfortunate, harmful even, to let the [river] project go further without securing equivalent means and quality of work for the valley" (id.: 32). This conclusion was echoed in a milder way by the author of the 2008 synthesis report, who admitted that "the development concepts elaborated by the CoRéPil committees show the limits of an approached restricted to municipal borders, and highlight the necessity to pursue the planning reflections above municipal level," yet without suggesting any further concrete proposal to remedy the lack of structural coherency (Projet Rhône, 2008: 79).

Next page: main steps in the planning chronology of the Rhône Correction from 2000 to 2012, illustrated with the example of Sion and surroundings.

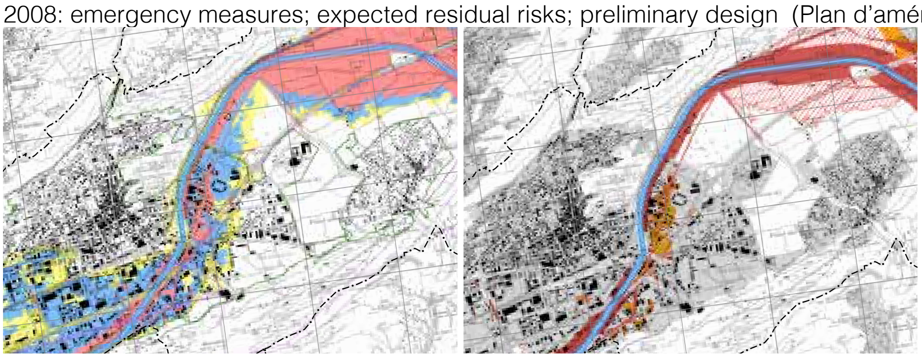
2000: identifixation main constraints; localization and types of interventions (Rapport de Synthèse)



2006: pre-defintion flood risk zones; Definition of river space “Espace Rhône” (Plan sectoriel)



2008: emergency measures; expected residual risks; preliminary design (Plan d’aménagement)



2011: flood-risk zones; high risk in built areas and building zones (Zones de danger d’inondation du Rhône)

2012: adapted layout; landscape design (Plan d’aménagement; design competition Paysagestion)

Sion-sur-Rhône: landscape studio as *agent provocateur*

In 2008, the state capital city of Sion still relied on the measures proposed by the Canton's Department of roads and waterways. The Sion planning department and chief architect were aware, however, of the river's potential for urban renewal, lamenting its inaccessibility and unattractiveness, but an initial attempt to organize a design competition was blocked by the City Council (Gross, 2013). The Council then saw the Rhône Correction foremost as a flood safety issue, as a prerogative of the Canton authorities, and thus not eligible for municipal funding. Considering the high level of flood risk in the low part of the city, it was then thought that the Correction would be implemented as it was sketched in 2000, by mechanically widening the river in "unconstrained" (farming) areas, on the one hand, dredging the bed and reinforcing the levees in the "constrained" (urban) area, on the other.

At the end of 2008, Professor Christophe Girot (supervisor of this doctoral thesis) and his team brought up the idea of the organization of a design studio along the upper Rhône at the chair of Landscape Architecture of the Zürich Federal Institute of Technology. The Chair had been focusing for a long time on riverine sites and on flood mitigation, and the challenges posed by the Rhône Correction seemed to offer a rich and instructive base for a semester studio. In February 2009, a program was set up by the author of this thesis together with Isabelle Duner, and the studio was entitled "Braided Streams," in reference to the multiple linear infrastructures that compete within the narrow valley floor. The studio brief challenged the students to "elaborate a global vision for the Rhône Valley in Sion, integrating flood protection and urban redevelopment along the river" (Girot et al., 2010: 22).

First Design workshop in Sion, discussion with Didier Tille, hydrologist for the Projet Rhône.

The studio was joined by seventeen students and started with a winter "boot camp" in Sion, oscillating between field trips, work days in the space put at disposal by Sion planning department, and nights in the deserted camping "Les Iles," located in the Rhône floodplain down from the city center. The city planning department and the Rhône Correction team provided the necessary data information to the studio, though leaving the entire responsibility for the methods and results to the teaching team. They also provided feedback during the student's presentations, both on the hydrological and urban issues raised by the projects. Between February and June, the students elaborated six visions for the reconfiguration of the river, involving the whole water network of tributaries, drainage canals, and artificial lakes left by gravel pits, which they closely associated with the city's future development. Rather then channeling the Rhône further by raising the dikes, the projects suggested enlargement and diversions through the lower city's loose structure, creating opportunities for developing meaningful urban space and qualitative housing in the valley, which had so far been neglected and treated as a side issue. The results, based on precise terrain model and topography but free from political constrains, perked local interest. The Zürich team decided to refine the six projects through a new elective studio, "Captive River," held during the winter semester 2009-2010. This studio finally led to a publication named "Sion-sur-Rhône", edited by the author of the present thesis. This apparently descriptive title was at the time meant to seize the historical moment that could see a city, which always defined itself by its alpine landscape and elevated position, as discovering another aspect of its identity: its riverine side, so far left unexploited. This was stressed by the student's project, which suggested giving the river a secondary branch within the city, creating a unique urban island out of industrial leftovers and giving new heart to the agglomeration.

Sion-sur-Rhône design studio:The Rhône river as agent of urban redevelopment (ETH Zürich, 2010)

Perspective onto the proposed second branch and new urban island (Rossano/ETH Zürich, 2010)

Winning entry for the Sion-sur-Rhône design competition (Paysagestion, 2010)

The resulting design investigation was presented to the city counselors in April 2010, and to the public in June 2010, with the publication of the "Sion-sur-Rhône" pamphlet by the Zürich GTA publishing house prefaced by Sion's city Architect Nathalie Luyet. Simultaneously, an outdoor exhibition was opened in Sion by Jacques Melly, State Counselor and responsible for the Valais Department of Transport, Infrastructure, and Environment. "Another vision, uncertain but carrying an indispensable dream element, is the one given by the students from the ETH Zürich, who imagined what the city of Sion-sur-Rhône could become tomorrow," Jacques Melly later wrote in Rhône magazine (rhone.vs n.17, sept. 2010: editorial). The exhibition lasted five months and was shown in various locations. "The exhibition was a success, and people really appropriated the term Sion-sur-Rhône," recalls Damien Gross from the Planning Department; "through the students" projects, we could raise awareness for the potentiality of this project, that it was not just a problem of security but also a formidable opportunity to bring quality to the city along this river" (Gross, interview 2013).

Taking advantage of this momentum in the planning process, city and canton decided to take the Rhône Correction to a higher level of ambition, and jointly organized a design competition for the reconfiguration of the Rhône River and surroundings within the borders of Sion. The brief took the title "Sion-sur-Rhône" that remained associated with the project to this day. A team led by landscape architecture office Paysagestion, co-author of the 2008 landscape report, won the competition in 2012. The chosen design did not literally take over the urban island envisioned by the Zürich studio but developed the idea to turn the "problematic" river into an element of urban redevelopment. Paysagestion proposed a new park in the flood zone and accessible embankments that could be progressively flooded at high water. A substantial construction program, capable of extending the city center down to the river, was also proposed for the right bank. The suggestion to re-use former gravel pits and drainage canals to improve peripheral neighborhoods was integrated as well into the new project. Paysagestion and its team were eventually commissioned for further plan studies, and for the detailing and the implementation of the project.

For Sion and for the Rhône correction, this unsolicited intrusion of a teaching and an academic institution into the planning process has proved so far to be a useful ice-breaker. While inside voices calling for more ambition were not heard at the political level, the city's planning department was able to facilitate the contribution of the Federal Institute of Technology without necessarily endorsing its conclusions, using the school as an agent provocateur to bring elected representatives to commit themselves to a more ambitious design than the original problem-solving plan proposed by the Canton Transport, Infrastructure, and Environment department. Furthermore, it could attract the attention of a population, which hitherto had shown little interest in what was presented as a problem of flood safety with few possible solutions. Obviously, the design envisioned by the students during the two design studios was not literally adopted, but it did, at a crucial moment, bridge a gap between the large scale Rhône Correction program and local potentialities that would probably have remained unexploited.

In search of coherency

In 2015, the Third Rhône Correction is pursuing its development step by step, through the design and implementation of local measures, but still without a large and coherent plan for the valley, and without a large consensus.

The ADSA Association "for protection of arable land" reclaimed and obtained, in January 2015, a referendum over the cantonal law funding the Third Correction, hoping to hinder indirectly the official project. The ADSA referendum, supported by the UDC conservative party, by the Chamber of Agriculture, and chaired by the Chamber's president, is still fighting for a combination of riverbed lowering and dike reinforcement as an alternative for river widening and emergency spillways. In the background of the campaign, both Canton and ADSA are arguing over the amount of building land that might be lost. According to the Canton, 1100 hectares of potential construction area would return to "no-building" flood zone if the Rhône 3 program is not implemented. According to its opponents, the same program implies that 300 hectares of building zone should be returned to farmland to compensate for the land used to widen the Rhône, in application of federal laws for the preservation of arable land. On June 14, 2015, a majority of 57% supported the financing law, and, indirectly, the implementation of the official Rhône Correction program. The urban issue remains the "elephant in the room", yet not addressed with coherent and structural long-term proposals.

The most advanced projects – Sion in particular – however, illustrate the potential for river transformation at a local level. The Chablais region is studying the combination of the Rhône Correction project with its regional plan ("Projet d'Agglomeration" that includes a landscape and agriculture structural plan) and might succeed in implementing the new flood mitigation strategy within a coherent landscape structure. A structural plan for the whole Upper-Rhône Valley is still not in sight, and might never come about, showing the difficulty of engaging all parties in an integrated design on a geographical scale, a factor for decades if not centuries. Only the final result, expected in 2030, will tell whether the planning process failed to achieve its initial goal, or whether the ambition to include all the aspects that compose the Rhône landscape into a large Gesamtkunstwerk simply was not adaptable to the situation. The local and tailored translation of global guidelines into well-defined sub-regions – such as the "Corépil" ensembles – might eventually prove just as successful in terms of flood safety and environmental quality. However, the spatial quality of the result remains, so far, dependent on local initiatives, good will and "happy accidents" that allow design to enter and eventually disrupt the planning process, whereas it could still be more structurally integrated in the planning process.

Key points

- Promises of one-fits-all solutions later generate legitimacy conflict and difficult arbitrages.

- The definition of river space and flood-risk areas is a strong factor in cultural and spatial change.

- Urban issues should be included in the spatial negotiations alongside environmental and agricultural interests.

- Landscape coherency should be set as a goal but not as a means of securing floodplains: too much integration can hinder the development of the project.

- Design-based investigations can bring new options and consensual response to flood risk that cannot emerge from a quantitative approach.

- Spatial structuration through river correction is scarcely attainable on the scale of a state, but clear guidelines and local initiatives can enhance the project's global quality.


III. Comparisons and conclusions: Designing flood-ready landscapes

Previous page:
Isar floodplain, Munich, in June and September 2013 (Rossano/Künzel)

Setting goals and communicating concepts

The decision to address river safety on a grand scale was taken almost simultaneously in Valais, where the investigations were launched in 1995, and in Holland, with the 1996 "Room for the River" governmental bill (Min. van Verkeer en Waterstaat et al., 1996). Both programs marked a turn in the history of flood defense, by favoring spatial measures over channeling infrastructure, and by reintroducing flood mitigation into regional planning. For both programs, also, authorities sought to generate understanding and consensus around the chosen strategy, although using very different narratives. While the Dutch government chose to communicate with a general and simple motto, the government of the Valais Canton sent a message that was altogether more specific and more complex when introducing the "Third Rhône Correction." The name itself suggested, in the Dutch case, a historical shift towards horizontal measures, while the Swiss denomination implied a repetition or at least a continuation of the two previous river corrections implemented in 1863-1894 and 1930-60, which resulted in the full channeling of the river and its tributaries, and eventually led to the full drainage and exploitation of the valley (Vischer, 2003). Despite similar scales, the Swiss and Dutch programs differed greatly in their conceptual approach, each program coping in its own way with the vastness of its planning area and the historical proportions of the enterprise.

Correction - coercion?

Semantically, the title Third Correction suggested coercive measures applied to a wild and dysfunctional element (Luyet in Girot et al., 2009: 9), a vision widely accepted at the time of Engineer Tulla but rather misleading considering the claims of integrated approach attached to the new plan – a plan that was meant to conform to the federal orientation promoting spatial and environmental measures over strict channeling. The logo chosen for the program suggested that all elements of the landscapes would be taken into account by the new project: river, transportation (road/railway), cultivated land, built environment, and nature (a bird, a tree). Although not all fourteen territorial elements listed in the 2007 cantonal Law on Water Engineering were then represented (see "2000: the wake-up call" on page 231), the logo used from 2000 onwards communicated a holistic and integrated approach that treated equally the four main types of land-use present in the valley: infrastructure, nature, built area, and agriculture – plus the space occupied by the river itself. Three types of measures were equally introduced: river widening, secundary channel, and flood storage areas.

The drawings made to illustrate the main intervention principle, however, communicated, already in 2006, a different message. A quite precise cross-section illustrated the widening of the channel, showing a levee moved sidewards to make space for the river, represented as a fluctuating and meandering stream (Projet Rhône, 2006: 17). One riverbank was framed by a main road and a traditional levee with groins that remains unchanged; the opposite levee was shifted and transformed into a shallow slope covered with spontaneous-looking riparian wood, doubling the width available for the stream to flow and fluctuate. A dotted line showed the existing dike being moved. The "before/after" diagrams (ibid.: 18) were even more precise: The existing straight channel squeezed between built areas, fruit trees, and farmland was transformed into a wider, shallow, curvy, and irregular bed, which let the stream meander between spontaneous pebble and mudflats; as a result, cultivated land was shrunk by about thirty percent, and the presence of a secondary dike between built areas and farmland indicated that the farmland adjacent to the river was meant to be part of a future flood zone, protected to a lesser degree than the rest of the valley.

Title, logo, section, and diagrams actually told four different stories: The first one suggested a reinforced channeling; the second a consensual one-fits-all solution; the third a river renaturation; the fourth a land and risk redistribution to the benefit of the river, and built areas to the farmers' disadvantage. Already at an early stage, the reality of the Rhône Correction thus appeared complex and multi-faceted: Various, if not contradictory strategies would be applied to different sections. The areas showing the biggest exposure – industrial installations in Visp, dense urban areas in Sion – were to be addressed, by priority, through dredging and reinforcement techniques. The junctions of Rhône and tributary streams were to be later widened and enlarged, to prevent turbulences and dike breaches, through shifting existing dikes backwards into the plain, often to the disadvantage of fruit trees. Where the river was bordered by farmland, the channel would be indeed widened.

While the local application of the program appeared more diverse than communicated (and maybe originally thought), conflicts remain to this day determined by the original ambiguity of the program itself: Is it a river "correction" as suggested by the name, or the "liberation" of a stream," "whose dynamic will create its own landscape" as stated in the landscape report (Veuve, 2008: 6)? Will it bring "lasting safety for the valley and its inhabitants" (Melly, 2015) or rather redistribute the risks – as implied by the "corridors of residual risks management" (Projet Rhône, 2008: 21)?

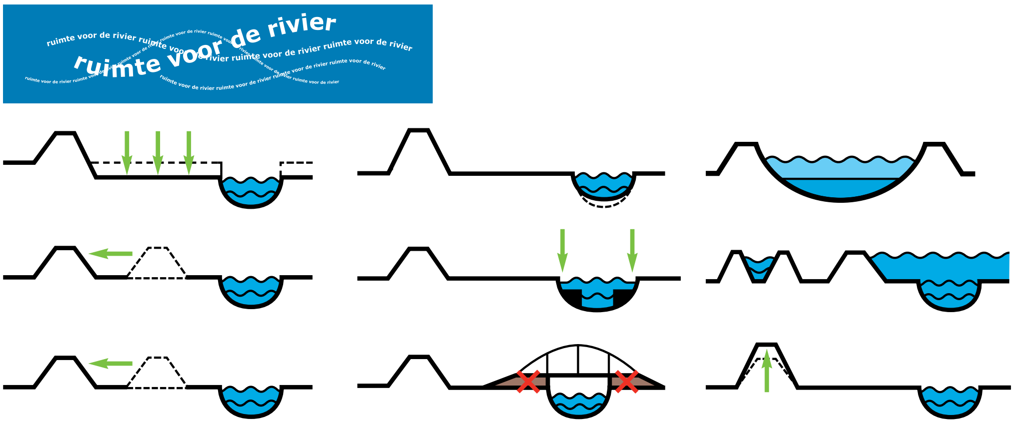
As it now appears, combinatory measures over-simplified into contradictory messages paved the way for persistent conflicts. What would eventually be a sum of negotiated local solutions soon became a frontal opposition among competing interest groups – particularly environmental and agricultural – mixing arguments of local and national interest. Insolvable dilemmas polarized the debate still further: differentiated flood risk versus protection for all; food self-sufficiency versus nature protection; arable land versus widened riverbed. Twenty years after the first investigations started, the referendum launched in 2015 to hinder the Third Rhône Correction project showed that these dilemmas still dominated the debate, on one hand, putting relevant questions on the canton and Federation agenda, while, on the other, intentionally slowing down a long prepared project that still in many places requires proposals to be discussed and ameliorated with a focus on the local landscape rather than general issues, which cannot all be dealt with within the framework of the Rhône Correction.

Negotiating Room for the River

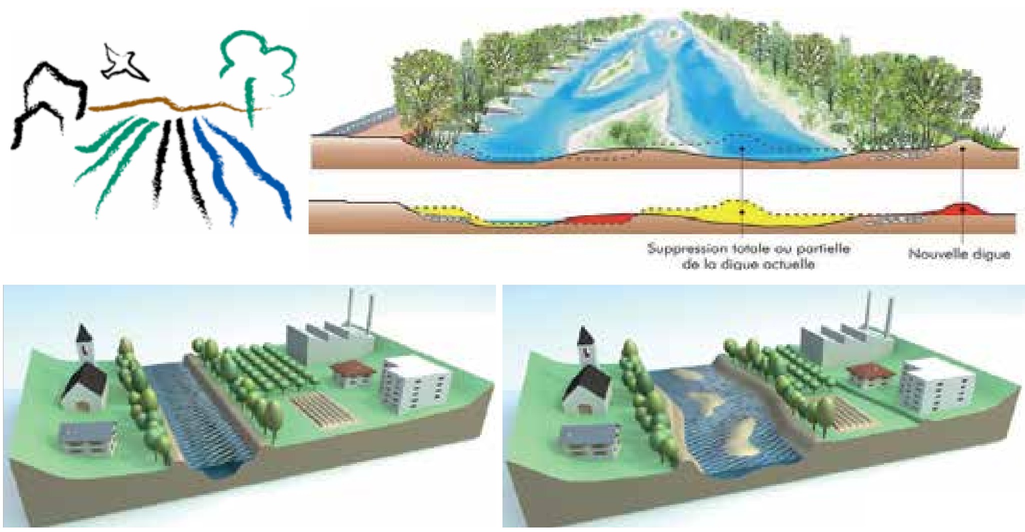
At the other end of the river network, the Dutch authorities started as well to promote spatial measures over dike reinforcement from the 1990s on. The Fifth Memorandum on Spatial Planning reaffirmed the global orientation of national water policy towards horizontal solutions. The memorandum's summary depicted an alarming hydrological situation: "Water claims an ever increasing space. Storms grow in intensity, and river discharge increases; sea level is rising, and land is subsiding. Safety risks and the probability of flooding are rising. (...) Continuing with only "hard," water-damming solutions has reached its limits and isn't sustainable anymore."

The solution for this new challenge lay in spatial planning, stated the governmental report: "The Netherlands has to learn to 'move with water' and to keep more space for water" (Rijksplanologische Dienst, 2001: Samenvatting, 34).

More specifically, four measures were listed to address the problem: Find and design areas permanently dedicated to water; adapt land-use in order to create extra space for water; proceed towards limited adaptations for controlled flooding in emergency situations and for small-scale improvements on local level; set aside space for future safety measures (ibid.: 35). With this Fifth Memorandum, the need to create more space for flood was officially acknowledged – although using cautious language ("limited adaptations"). Differing from the Swiss federal approach that promoted ecology but left aside the question of uses, spatial quality was prioritized by Dutch law (ibid.: 3. 32) and the density of the country forced water management to interact with regional planning: "It's all about finding capacity, no matter how," as Dike Master Albert van Hall summed it up (Van Hall, 2013).



The "Room for the River" logo and tool box (Room for the River, Fact sheet, 2007)



Third Rhône Correction: logo; principle section; before/after diagrams
(Troisième correction du Rhône, Plan Sectoriel, 2006, p.1, 17-18)

The Room for the River program communicated, from its very beginning, its two main ambitions, safety and spatial quality, but kept a wide range of options open for local interventions, thus avoiding polarization. Communicated through various official documents, web pages, and information folders, the options were illustrated by schematic sections that confirmed that space was left for interpretation of the "Room for the River" concept.

Traditional measures that contradicted the program's name and belonged, really, to "hard" channeling techniques become part of the toolbox, however. This addition wasn't made without generating internal debates between partisans of spatial measures and defenders of the defensive techniques applied for centuries. Dirk Sijmons fiercely defended the spatial approach and instead spoke about the "six pack of space-makers," "urgently needed in addition to the "traditional" strengthening of the levees" (Sijmons, 2009: 62-63). Although Dirk Sijmons maintained the distinction between authentic spatial measures and traditional, "pavlovian" diking, governmental publications and brochures maintained dredging and dike heightening within the palette of possible interventions (see i.a. Ruimte voor de Rivier, 2009: 27). And indeed traditional "vertical" measures did play a prominent role in the "Room for the River" program, although official communication put spatial interventions in the foreground. This debate remained, however, hidden from the larger public, which was addressed using a continuous and coherent message through national and project-related communication, facilitating acceptance for necessary measures.

The "Room for the River" governmental agency centralized the funding, management, and communication of the various projects, and communicated through a common "Room for the River" website (roomfortheriver.nl). Despite criticism of the positivism of the "Room for the River" public participation programs (Heems and Kothuis, 2012: 454), this global communication eventually proved to be coherent, allowing for rapid and practical negotiation once the basic principle was set, supported, and communicated at all levels. The simplicity of the message – rivers need more space to fluctuate in order to protect the land – rapidly allowed for concrete discussions to take place, generally orchestrated by local authorities. On the contrary, the complex and sometimes ambiguous message sent out for the Third Rhône Correction program remains until now a subject of discussion and conflict on a basic level, making local projects and consensus more difficult to reach. So it would seem that large programs of spatial adaptation need to be communicated with few words and clear images to facilitate preliminary consensus and rapid implementation.

But as the two mega-programs show, the full and continuous widening of river channels, whether motivated by flood safety, environmental restoration, or spatial quality, appear out of reach in urbanized floodplains: historical land use and structures resist systemastic measures, urban and infrastructural bottlenecks form strong obstacles. Initial visions of global transformations were soon decomposed into combinatory and differentiated approaches, resulting in negotiated risk distributions and landscape new deals rather than grand gestures. Fostering local initiatives whithin a coeherent but flexible framework proved a better strategy to reach global spatial quality.

Landscape New Deals

The necessity of fear

Beyond the engineering of civil works, high waters are today also predictable through complex networks of forecasting and information providers, from satellite pictures to physical inspections still widely used. Water boards play a central role in the interpretation of this complex information and in the coordination of multiple installations, sometimes remotely controlled through a dematerialized and reflexive chain of command. Upcoming danger will eventually lead to preventative action such as the removal of potential obstacles from the riverbed, or gradual access restrictions to the river dike, shores, and floodplains, implemented by the municipalities according to a fixed protocol (the city of Munich protocol is, for instance, divided into seven sets of actions to be taken, activated each time the discharge measured in the river Isar exceeds one of the seven predefined thresholds). Besides prevention action, serious threats activate mitigation measures, such as the controlled flooding of nature areas and farmlands, located kilometers away, in order to lower the water level in the most sensitive areas. This last measure can be implemented through the remote activation of heavy machinery, such as the flap gates that control the inlet of the Koller Island Polder in Germany, or by mechanically removing predefined segments of levees, a primary but efficient system used by the Dutch Water Board of Hunze-en-Aa's, or even more simply by lowering sections of levees that let water overflow whenever the stream reaches threatening levels. The complexity then lies not necessarily in the technological aspect of flood protection but rather in the coordination of various means of anticipation, protection, and mitigation that need to be precisely interpreted, activated, and synchronized.

These complex systems show how simple measures applied on a territorial scale can connect and multiply the effects of various means of intervention, but they also contrast sharply with the lack of actual and practical anticipation, which applies generally to regional planning authorities as well as individuals. Despite known risks, vast housing projects have been built in Europe right behind river levees, on widely known flood-prone areas lying lower then the high water level, and thus exposed to a risk of major damage in case of a dike breach. Flood defense infrastructure plays an ambiguous role here, being both protection and entrapment, as it often encourages risky behavior in the protective shadow of the levee. The case of the Netherlands water policy is in that regard particularly revealing, since a large part of the country's viability depends on the efficiency of its flood protection. One would expect the Dutch authorities to be particularly sensitive to flood exposure when planning new towns and neighborhoods, but, surprisingly enough, planning policies and regulations have long ignored this aspect, or rather downsized the issue to a binary issue: one lives "within-the-dike" or "outside-the-dike" (in Dutch: binnendijk or buitendijk), leaving little space for nuance. Within the dike ring, the safety level is defined by law, guaranteed by the state, and provided for by its powerful water administration.

This guarantee is, however, only relative, since levees can hide the rivers from the inhabitants but still won't ensure absolute protection, as the near floods of 1993-95 showed, and the concentration of knowledge and responsibility within one specialized authority leads here to a paradoxical result. The Netherlands is simultaneously extremely well protected thanks to a coherent and centralized water management system, but also needlessly exposed to extreme damage as a consequence of excessive self-confidence. A form of collective denial seems to be at work, possibly created by cognitive dissonance – after all, would one rather be constantly reminded of the fact that you live, work, and invest in a place exposed to destruction by flood, or rather trust blindly in world-famous technological know-how? Another factor in this denial is the absence of any alternative. When the short-term growth of a city, a region, or even a country, in the case of the Netherlands, is in direct contradiction with its long-term safety, the former might win over the latter. As Alfred van Hall, Dike Master of the Hunze-en-Aa's region in the north of the Netherlands, pointed out in an interview held about the Meerstad project: "It can happen, and it happened here, which you build on the worst spot for reasons other than water-technical reasons," reasons that Harm Küpers, Director of the same Water Board, expressed in a few words in the same conversation: "We are in one of the world's most densely populated regions. If we build only where reasonable in terms of hydrology, we simply couldn't fit all the people into the Netherlands."

This perception of exposure as a forced choice can be seen in the urban development of many riverine cities, such as Bordeaux in France, Sion in Switzerland, or Hamburg in Germany, which planned and built massive urban developments within known flood zones, having no "safe" ground left to offer to developers, and thus being bound to choose between risky growth or no growth at all. Flood events have a limited effect on risk awareness, if any effect at all, as a Swiss study showed for Valais, reporting that "practical effects onto land value and land management practices are relatively weak," mentioning the fact that in Saillon, Valais, "most new constructions are built in the Rhône plain and thus in a flood-prone zone," this only six years after a dramatic flood that covered large parts of the municipality (Barbisch et al., 2006: 6).

Flood risk denial can thus find its origins in various dimensions: excessive faith in technology, the collectivization or out-sourcing of the problem to specialized entities, or the lack of any positive alternative. Collectivization, technicization, or relativism thus make flood risk controllable and acceptable, but they can also increase flood exposure and weaken the awareness of inhabitants and representatives, since self-confidence leads to needless risk-taking or insufficient investments in protective measures. The consequences of this denial for spatial planning in the Netherlands was recently confirmed by a comparative study held on the localization of sensitive facilities in England and the Netherlands, which showed that in the specific case of a regional hospital, exposure to flood played a minor role in the Dutch planning process, in contrast to its English equivalent, and despite the compulsory "water test" that since 2003 requires the recommendation of the water board for new building plans.

Construction site in the Rhône floodplain in Fully seen from the river levee
(Rossano, 2013)

Laconic reaction to official warnings:
cars parked around flood warning signs
in Rotterdam (Rossano, 2015)

The need for an active risk-reminder to guarantee a responsible long-term vision is also confirmed by the humorous prayer commonplace among the Dutch water management authorities: "Dear Lord, give us our daily bread and a flood once in a while." In other words, individuals need to be regularly reminded of the need to protect themselves from something that they most probably won't experience during their lifetime in order to secure efficient and long-term protection.

Besides its effects on flood prevention, this lack of awareness can equally affect mitigation capacity, as witness the Dutch Randstad, an agglomeration of seven million people, which does not provide an effective evacuation plan nor supplies emergency instructions to its inhabitants. In an investigation published in 2011 by the magazine HP de Tijd, journalist Marc Traa revealed the total lack of preparation of the agglomeration, although even the then-Prince of Orange and now King Willem-Alexander had pointed out several times the enormous damage to be expected in case of dike breach. "A breach in dike ring 14 [that protects about two third of the inhabitants of the Randstad area] could today generate 37 billion euro in damage" (speech by Prince Willem-Alexander at the City Hall of Amsterdam, March 2008, quoted in HP de Tijd, 2012). "And with a lead time of 8 to 10 hours, it is out of the question that all 4.5 million inhabitants of this dike ring can be evacuated in an orderly way" (speech of Prince Willem-Alexander at the Royal Academy of Sciences, Haarlem, May 2011, ibid).

The issue is thus not only the evacuation of the population, but also the ability to react adequately and withstand a flood situation that might last for weeks or months before the dike can be fixed and the polders pumped dry again. Surprisingly, in the one country that invests the most in flood prevention, flood is not an option. Bas Kolen, from the consulting firm HKV, explained this situation to Marc Traa as an excess of confidence: "A specific prepared planning for the evacuation of dike ring 14 is currently lacking," he explains. "The confidence placed in water managers and in the quality of the Dutch dikes has contributed to the fact that the preparation of the Netherlands in terms of aid has received little attention." Or as Dike Master Albert van Hall sums it up: "It is a contradiction. The better we do our work, the fewer the people who are aware of water." And so thanks to the efficiency of the Dutch flood protection system, flood has become a foremost technological issue to be dealt with at the regional or national level, and flood risk is today as invisible as the rivers themselves, hidden behind massive levees.

Paradoxically, flood can be repressed from individual consciousness and yet be increasingly present in mass media and popular culture, in a dramatized or mythological form. Whenever a flood hits a city in Australia, Canada, Indonesia, or Europe, similar images of drifting cars and inundated homes immediately reach millions through computer and TV screens. Much more seldom seen are pictures of well-prepared evacuations, images of children playing in a street turned into a lake, or reports of successful post-flood restorations. The need for dramatization tends to stress the devastating effects of flood, and their spectacular and exceptional nature, rather than their inscription into a predictable chain of events and actions. Authorities are expected to play their part not only in practical interventions but also in the emotional field. Carefully staged compassionate journeys remain a central element in information narratives, as they offer a public demonstration of national concern and personal commitment from the highest state representatives.

For obvious reasons, popular cultural productions tend as well to exaggerate the dramatic and extraordinary nature of flood rather than its practical and predictable aspects. By staging flood as a collective enemy of graspable origins and one ultimately beaten by coordinated action, catastrophe movies sustain a dichotomous relationship between man and nature. The promise of a final victory of technology over nature is, however, losing ground in current practice and in the official discourse of public authorities, where more and more the goal is to seek to create space for prevention and damage control. Analyzing the Dutch communication on the subject, Heems and Kothuis concluded that "the discourses in the flood safety debate that are used until now (the discourses of fight, victory, and threat) are, all three, based on risk control. The discourse of care, however, is based on the acceptance of vulnerability." Still, "studying the debate on flood safety at the beginning of the 21st century made clear that most citizens showed little interest in getting informed about flood safety nor in changing their behavior" (Heems et al., 2012).

The fear of inadequate public reaction to flood events isn't specific to the Dutch polders. As shown by the flood simulations made for the Upper-Rhône Valley, flood damage is neither immediate nor inevitable, but is determined by relatively slow flood propagation and by the use that is made of this delay by individuals and public services – even in the case of a 100-year flood. Besides flood defense infrastructure, "existing measures of land management, emergency intervention, and the culture of risk can allow to live with this danger and spare some construction works" (Arborino, 2011).

A specific study on this "culture of risk" has demonstrated as well "the importance of "risk memory" for the implementation of necessary corrections after the crisis, and to maintain a state of active stand-by" (Barbisch et al., 2006: 6). However, this study concluded that "farmers have a rather vernacular but pretty explicit knowledge, while inhabitants of Lully and Saillon are virtually lacking any knowledge on hydrological risks," (ibid.: 104) in two villages hard hit by the 2000 ad 2002 floods. The 2000 floods could have caused less harm if inhabitants had reacted more promptly and adequately, as a better understanding "would have diminished potential damage and therefore the actual damage as well" (ibid.: 106). But how can individuals, and in particular urbanites, stay informed, aware, and concerned by a risk of extreme gravity but of low probability? How can they be reminded that water dynamics never were under total control and that flood remains an option?

Risk transfers

Paradoxically, urbanites are generally the main benificiaries of mitigation strategies and the most ignorant of flood risks. The landscape recently transformed for flood mitigation were directly related to urban exposure and constraints, in particular to the limited resistance of existing urban embankments, levees, bridges, and railways that offered few flexibility to accommodate natural fluctuations. The (re)creation of space dedicated to flood waters generally counterbalanced the historical restriction of natural floodplains by agricultural and, foremost, urban development. It thus revealed an outsourcing of flood risk from city to landscape, a transfer legitimated by different land-use, the one use being considered as more valuable then the other, or, as the euphemism used for the Third Rhône Correction, carrying more "constraints" (Hydronat, 2000). Floodscapes were in all cases meant to give rivers the leeway they lacked in urban areas – a rigdity due to lack of foresight and uncontrolled growth.

Logically, goals and flood thresholds set for mitigation spaces were defined by maximum water levels allowed to flow through or along cities. The "de-poldering" of the Noordwaard area was shaped in order to keep the level Merwede River below a predefined maximum in the city of Gorinchem: The river had to be lowered by thirty centimeters at peak discharge in order to avoid massive damage in the built area. A similar relationship linked the transformation of the Overdiepse Polder to the safety of urbanites. The transformation of the polder was partly justified by the necessity to protect the people living upstream, up to the regional capital 's-Hertogenbosch located 25 kilometers away (Waterschap Brabantse Delta). Here the goal was set at a thirty centimeter level drop in the Bergsche Maas river in Waspik, allowing for a ten centimeters drop in 's-Hertogenbosch.

The planned integration of the Meerstad Lake into a regional network of emergency water storage was "encouraged" by the 1998 floods in the city of Groningen and the residential municipalities located along (and below) the main outlet canals. The Isère valley is now transformed so as to spread future floods before they wipe out the old bridges and embankments in Grenoble, which cannot withstand more than a c. 1000m3/s river discharge (Castex et al., 2005). Finally, the Third Rhône correction should eventually protect inhabited areas from extreme floods through the implementation of a "corridor of residual risks"; priority was also given there early on to the securing of cities and industrial areas even before the project was fully defined (Arborino, 2008: 10), focusing on the urban areas of Visp and later Sion, Chablais, Martigny, and Sierre-Chippis. The density of inhabitants and workplaces was in all cases an argument put forward to legitimate a risk transfer from city to countryside, and to justify the level of investment. Communication around "Room for the River" evoked four million people living in the Dutch river area, while the Third Rhône Correction reported 100,000 inhabitants at risk.

Entwined river and infrastructures in the Rhône valley (Rossano, 2013)

Infrastructure represented, however, a crucial motive for flood mitigation, although communicated on a lesser scale, with this especially so in linear landscapes concentrating all means of evacuation within one single geomorphological corridor. The example of the Rhône Valley is in that regard significant. The first topographical map of the Rhône was established by Napoleon's cartographers for the improvement of the route linking France and Italy over the Simplon Pass (Lechevalier, 2005). The First Rhône Correction was later strongly associated with the simultaneous construction of the railway, which radically affected the hydraulic structure of the valley. The Upper Rhône Valley today not only hosts a large part of the canton's population, but also the "Route Cantonale," the "Autoroute du Rhône," five airports and an international railway. A flood covering the valley floor could virtually isolate the entire region from the rest of the country, with the only remaining link to the capital being the Lötschberg tunnel railway connecting Bern to Visp, which station area is considered to be of high risk for flooding (Projet Rhône, 2011: 20). A major flood between Visp and Brig could block this evacuation route, as well as cut off the railway leading to Italy through the Simplon tunnel. The 2.5 billion Swiss Franc investment planned for the Third Rhône Correction (Projet Rhône, 2008: 66) might seem incommensurate if only related to the amount of inhabitants living in the flood-risk area (25,000 Swiss Francs per individual at risk). The figures, however, need to be related to the concentration of infrastructure in the Valley, and the extreme variations in potential damage. The municipality of Visp, a transport hub and industrial center, hosts only 2.2% of the Canton's population, covers 3.2 % of the area potentially affected by a flood but represents 20% of the potential damage with almost two billion Swiss Francs of assets at stake (Projet Rhône, 2008: 12, 106).

Fuse landscapes

Paradoxically, some of the most radical measures of controlled flooding are also the most discrete, and take place outside the legible riverbed and channel. Since the 1990s, the water board of the Hunze-en-Aa's region has progressively built a network of "sleeper agents," lakes, nature areas, and wetlands, which can be turned into retention areas any time flood would threaten urban areas and valuable infrastructures. Since the 1998 floods, eight polders representing about 4.000 hectares have been designated or created to secure the waterways that lead rain and drainage waters from Drenthe to the Wadden Sea (Van Hall and Kuipers, 2013). These temporary retention areas can be mobilized by the water board any time the situation is considered critical, starting with the polder that is estimated most efficient in a specific situation (ibid.). The Isère Amont project, which will make 3,411 hectares of land ready for controlled inundation, includes few visible interventions besides the lowering of a levee on a few short segments to let the river flow into the flood compartments. The most visible intervention will be the construction of sleeper dikes built to isolate built areas from the "controlled flood fields." The "Corridor of residual risk management" planned in the Upper Rhône Valley should leave land-use unchanged and consist merely in a few spillways and outlets, used only for extreme floods. Even more discrete are the Dutch "calamity polders" ("calamiteitenpolders"). For the Noordwaard and Overdiepse Polders, due to be operational as flood mitigation areas in 2016, the only visible signs of their new status are the elevated platforms built for farms, homes, and cattle refuges, platforms that emerge a few meters above the flat landscape of the Dutch estuary.

Emergency floodscapes investigated for this research show that this type of strategy isn't in essence determined by the timescale taken into consideration, which differs from 50 years to unlimited in terms of protection horizon, and from daily flood to a 200-year flood in terms of expected flood frequency. In the two Alpine cases, Isère Amont and the Third Rhône Correction, flood fields and flood corridors are thought to answer residual risks in the long term, regardless of possible changes in climate and hydrological conditions. For the Swiss Rhône in particular, the determination of corridors of emergency flooding consisting of a series of bypasses, is seen as the key answer to long-term uncertainty, thus as a global safety valve rather than a case-specific solution. "Typically, it is about avoiding dam breaches with discharging systems, anticipating that 'the worse can happen', and not 'fighting to find out whether the system is perfectly dimensioned for the hundred-year flood'" (Arborino, 2011a: 20).

Olivier Manin, project leader of the Isère Amont project, stressed as well the fact the controlled flood fields created along the River Isère have no upper limit – provided that they are well maintained. Although no specific long-term projections were available to him to integrate possible climate evolutions (Manin, 2012), it was thus the system itself that was seen as more sustainable, since it wasn't based on a fixed threshold but rather functioned as a safety valve: Beyond certain discharge levels, controlled disaster would be favored upon flood defense and absorb "extreme floods."

	total mitigation area (hectares)	amount mitigation/ diversion areas	concerned stream length (Km)	building costs (Millions €)	implemen-tation	population protected
Rhône 3, corridor of residual risk management*	unknown	15	80/160	unspecified	...-2030 +	100.000
Isère Amont (FR) Controlled flood fields**	3387.4	16	50	€112	2006-2016	100,000-300,000
Room for the River (NL)*** (total program)	4400	10	745	€2300	2006-2015	4,000,000
Overdiepse Polder (NL) retention polder****	550	1	14	€111	2008-2015	
Noordwaard (NL) retention polders + diversion corridor*****	2050	1 (7 sub-areas)	15 (70km banks)	€295	2009-2015	

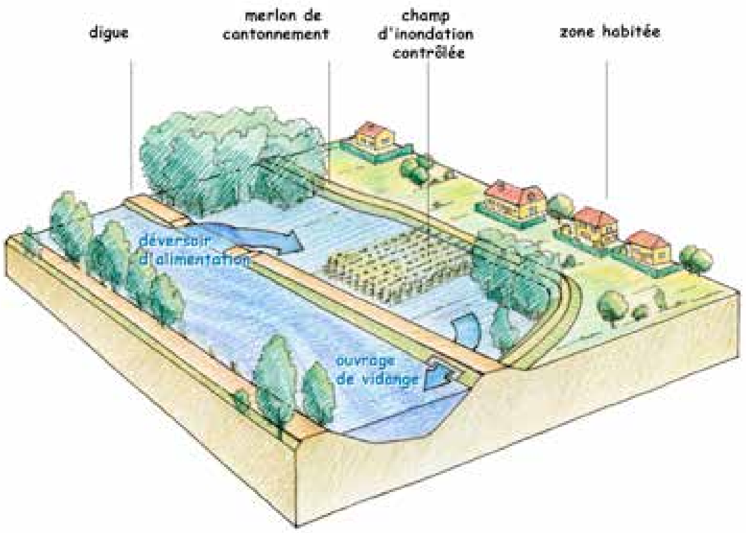
Mitigation/flood deviation areas in four projects
Sources: *Hydronat, 2000, and Projet Rhône, 2011 (Mitigation areas from Brig to Martigny, estimated from the 2000 preliminary plan). **Blondeau, 2006, and Symbhi, 2009:1, 28. *** Klijn et al., 2013. ****Waterschap Brabantse Delta, Witteveen en Bos (2008), *****DHV, Arcadis, and Haskoning (2010), (NB: project costs are global and preliminary estimations for ongoing projects)

	activation threshold/ expected submersion periodicity	timescale taken into consideration
Rhône 3* (corridor of residual risks)	> = 100 years	unlimited
Isère Amont** (flood fields)	1x 30 yr.	unlimited
Overdiepse Polder *** (emergency retention polder)	1x 25 yr.	2050 (levee) 2100 (inhabited mounts)
Noordwaard **** (semi-open wetlands and emergency retention polders)	1x p.day (tidal wetlands), 25/100x p. yr. (low dikes), 2/3x p.y. (low dikes, direct upstream inlet), 1% p. y. (high dike polders), 0.1 % p.y. (all polders)	2015-2050

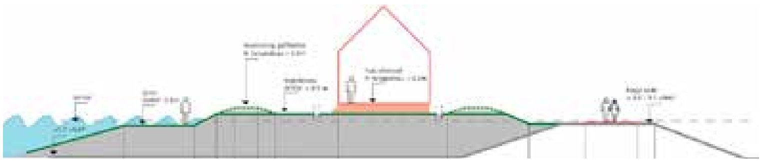
Activation threshold and timescale of four systems of controlled flooding
Source: *Projet Rhône, 2006: 17-18, and 2008:43. **Symbhi, 2009: 1, 17. *** Witteveen and Bos, 2008: 64. Mer: 27. ****Projectbureau Noordwaard, 2007: 50.

The timescale taken into consideration to calibrate the "Room for the River" program was, however, more precise and more limited: The interventions made along the Rhine and Meuse branches were dimensioned to resist a discharge of 16,000 m3/s in the Rhine and 4300 m3/s in the Meuse, values that were expected to correspond to a 1250-year flood in 2015, in regard to the previous 15,000m3/s and 3650m3/s reference peak discharges (Projectorganisatie Ruimte voor de Rivier 2007: 12). In the first two cases, flood diversion areas were seen as an ultimate tool to face long-term uncertainty, while in the Dutch case they were created to reach a precise and limited goal set for a limited timescale. Nevertheless, the adaptations made today in the Dutch river area aren't seen as a final stage but rather as a step in a process of bringing flexibility back into the river system, which will possibly be extended depending on future climatic and hydrological development in the Rhine and Meuse catchment areas.

All these landscapes play a similar role of hydraulic fuses, and were preferred to other measures for their large mitigation capacity and the possibility they offered to sustain productive land-use in the concerned areas. They differ from permanent transformation (river widening, stream renaturation, or floodplain restoration) in several key aspects. Less intrusive, they imply relatively limited interventions; more controllable, they can be set into motion only when necessary. Cumulative, they allow multiple land-use and potential cost reductions – for water authorities "the solution [for flood defense] as we can't serve one goal on our own." (Van Hall and Kuipers, 2013).
The expected activation of these "safety valves" also greatly differs in expected frequency (see table). The Rhône "corridors of residual risk," still to be defined precisely, are meant to offload the main river channel less than once in 100 years, the discharge level reference used to calibrate the transformation of the river channel. The Dutch Overdiepse "calamiteitenpolder" and the French Isère "champs d'inondation contrôlée" are calibrated to be submerged on average every 25 and 30 years, respectively. In the Noordwaard area, each flood area is meant to be submerged at a frequency varying from once a day for areas open to tides, down to only 0.1% chance per year for the most valuable polders. The expected flood frequency influences all aspects of the design: planning process, stakeholders' involvement, physical interventions, and compensation system.



Schematic representation of a "Controlled flood field" (CIC)
along the Isère (SYMBHI, 2009)



Diagrammatic cross-section of elevated platforms for the de-poldering
of Noordwaard (De Koning, 2010)

Drawing of the future "terpen" in the Overdiepse Polder, in normal
and flood situations (Rudolf Das, 2008)

Another aspect that remains underexposed are the terms of the risk redistribution agreed between the collectivity on the one side, and farmers and landowners on the other. In the article "Who likes to live in the calamiteitenpolder," the Dutch newspaper NRC echoed the debate following the proposal of the Luteyn governmental commission to designate several emergency retention polders, where waters from the Meuse and Rhine rivers could be diverted to in case of threatening high waters (NRC, 02.12.2002). House owners complained that their properties had lost in value, even though the proposal was still at an early stage. In the French Isère Valley, opposite protests were heard when regional authorities announced the creation of 16 champs d'inondation contrôlée closed for construction: local representatives saw land prices soar around one of the designated flood zones, threatening municipal housing policies. In both cases, local economies were influenced by the mere eventuality of a status change that would turn (potential) building land into designated flood area.

While public authorities stress the collective advantages of controlled flooding compared to higher levees or river widening, stakeholders fear the individual losses implied by this strategy. The main disadvantages expressed in the various contexts involve: short-term uncertainty generated by complex planning processes; transfer of flood risk from urban areas onto farmlands; long-term uncertainty for future harvests, and the induced loss of reliability towards purchasers of agricultural products; restrictions on future types of production; finally loss of speculative value for land that, in a normal situation, could possibly become building ground in the future and see its price soar to the benefit of the owner. On the other hand, the projects where flood areas are now agreed and defined (Noordwaard, Overdiepse, Meerstad, Isère Amont) show, as counter balance, that several positive effects can be expected from controlled risk transfer. The planning and design process, although generally experienced as stressful, opens up opportunities to re-organize and upscale existing exploitations, as it happened through local land-consolidation schemes in the two "Room for the River" projects, while those who wished to give up their farms could do so, eventually for higher prices when the land was assigned to construction (Meerstad).

In the long term, the flood mitigation function brings real uncertainty, since the future frequency of extreme floods can only be anticipated through statistical calculations based on past records, and their arrival can only be announced a few days or hours in advance. However, the status of "official mitigation area" offers supplementary coverage: Since the land is purposely flooded for the common good, its user is guaranteed compensation for his loss in all circumstances, which is not the case for regular exploitations located in a floodplain and exposed to high flood risks. The farmers of the Hunze-en-Aa's Water board jurisdiction first rejected the proposal to lend their land to emergency flood mitigation, but eventually realized during the negotiations that they were better off exploiting an "emergency polder," and with a guaranteed compensation, than not having this guarantee and still exploiting flood-prone land (Van Hall, 2013). A change in status from regular flood protection to controlled flood area can therefore have positive effects, and cannot only be understood in terms of risk catchers and beneficiaries but also in terms of mutual benefit.

Negative aspects	Positive aspects
SHORT TERM	
- uncertain future for the exploitations - uncertain value of farm and land, restraining investment, transmission or sale	- opportunity for optimization of land-use - opportunity for changes in land ownership within the area - no heightening/enlargement of levees onto farmland
LONG TERM	
- additional risk to existing constructions - additional risks of bad/lost harvest - untrustworthiness vis-à-vis buyers - restrictions on productions sensitive to flooding - restrictions on productions involving infrastructures or constructions (greenhouse, irrigation) - no possible profit on future change in land-use zoning - uncertainty on future flood frequency	- opportunity for optimization of parcels division - potential revenues from recreational functions when project is linked to nature development - secure agricultural zoning and protection from land speculation - investments hedged by compensation agreements - financial compensation for all flood events, including at discharges above reference levels - public guarantees for long-term maintenance

Advantages and disadvantages of controlled flooding for farmers and/or landowners

Farmers vs. beavers: Legitimacy conflicts in land-use adaptation

Contrary to vertical solutions such as dredging riverbeds and raising levees, horizontal measures engage vast areas and always imply a general redistribution of flood risks and land-use. Whether the emphasis is put onto human lives or infrastructures, a new hierarchy is constructed that proactively differentiates the levels of exposures, turning what is perceived as an external condition (passive flood risk) into a chosen strategy (active flood mitigation). Where in the initial situation, responsibility can be placed on external and (apparently) natural factors, the situation created by flood mitigation strategies is defined by human will, since the risks are consciously redistributed, and by collective responsibility, since the decisions are generally negotiated and ultimately taken by elected representatives. The redistribution is thus rightly perceived as a risk transfer, and often also as the "sacrifice" of some for the safety of others, a sacrifice that doesn't go without negotiation and compensation.

As seen for the Noordwaard and Overdiepse Polders, or for the Rhône and Isère Valleys, discussions often departed from the terrain of hydraulic goals and efficiency, and to shift to the larger question of cultural and socioeconomic legitimacy. As it appeared, flood safety was perceived as a legitimate and unquestionable goal, a feeling reinforced by the floods and near-floods seen in the 1990s; integrating other dimensions into flood protection measures quickly broke the consensus open and led to new conflicts. The horizontal approach advocated by the Swiss as well as the Dutch or French authorities was first cautiously presented as a technical necessity and a rational choice made in a dead-end situation: Traditional vertical options couldn't be brought further without loosing efficiency and increasing exposure; horizontal strategies were therefore the only way left to provide lasting safety for land, buildings, and people.

However when it came to identify areas to be turned into flood mitigation zones, it became clear that farmland was the main victim of this risk redistribution. Where the land was poor, farming activity declining, and financial compensation generous, the transfer was easily done (Meerstad). On the contrary, the suggestion that rich land carrying profitable exploitation could be used for flood mitigation – and possibly turned into nature areas – generated acrimonious reactions, in particular from farmers and landowners. In these situations, along the Rhône, Meuse, or Isère Rivers, the measures were opposed on the level of principle, next to technical and financial issues.

Introducing the Third Rhône Correction, Valais' State Councilor Jean-Jacques Rey-Bellet balanced narratives of acceptance and conquest: On the one hand, he acknowledged the original creative force and nourishing river that had shaped the land, and, on the other, the effort made by the population of Valais to conquer its living space against natural elements: "If the Old Country [vieux pays] is inherited from the river that shaped it, the Rhône river is inherited too: from Nature first, which made it crude and often violent; from the many generations that did everything they could to tame it and allow the fantastic development of the valley" (Hydronat, 2000). In 2006, Rey-Bellet more specficially defended river-widening as a flood safety measure: "The high waters of the end of the twentieth century have taught us that the only way to protect ourselves is to define a space for the river, free from new construction en capable of facilitating the inherent functions of a waterway. It is indeed very complicated and expensive to secure a river bordered by houses" (Projet Rhône, 2006: 6).

Protest sign in the Biesbosch Polder:
"Keep the polder, no nature nonsense!"
(Rossano, 2012)

The multiple ambitions set for the Rhône Correction, partly under pressure from federal laws, however, shifted the debate from hydraulic engineering to the domains of spatial planning and long-term policies, raising the question of global balance between urban, agricultural, natural, and recreational land-use. The project was soon opposed by farmers, this on a hydraulic, economic, political, and symbolic level. Regrouped in the association ADSA – acronym for "Association for the Defense of Farmland" – opponents contested the widening of the Rhône, arguing that dredging and reinforcement could be as efficient and much cheaper. Widening the river onto farmland was also in contradiction, they argued, with the ambition of local and national food self-sufficiency: Less arable land would mean more import and more transport and thus indirectly be a threat to the environment and a threat to national independence.

Symbolically, discourses of environmental restoration were interpreted as a regression discarding centuries of reclamation: "Human needs should be the focus of the attention" (ADSA, 2008). Furthermore, farmers opposed the two-level safety proposed by the project, and refused to carry more risk than urban areas did, stating that "protection against the 1000-year flood should be guaranteed all along the Rhône and exclude residual risks," adding that "farming areas cannot be sacrificed for safety only, (...) and the strategy chosen for urban areas should apply everywhere, also to farming areas" (ibid.). "Farmers want to tame the Rhône and the environmentalists," summed up national newspaper Le Temps in May 2010, as the conflict still went on ten years after the publication of the preliminary plan.

In their answer to the ADSA, environmental organizations also raised legitimacy issues, this time not concerning the loss of farmland to the benefit of nature areas but regarding the global loss of open land to construction and infrastructure. To the complaint that the widening of the Rhône claimed too much space for ecology at the cost of farmers, Pro Natura replied that most farmland lost in the past decades had been used for construction (Canal 9, Le débat, 08.06.2011).

Official statistics confirmed indeed that farming had lost a significant area between 1983 and 2007 (see table), even at a higher pace in Valais compared to the rest of the country, and that this loss went parallel with strong urban expansion. Looking for common ground, environmental organizations tried to initiate a debate on the limits that could be put to urban sprawl in order to secure space for nature and agriculture (id.). The farmers lobby, however, didn't react positively to the proposal and chose instead to focus their fight aginst the widening of the river (Largey, 2013).

	SWITZERLAND		VALAIS	
	hectares	%	hectares	%
total area	4,128,498		522,442	
SURVEY 2004-09				
urbanized area	307,897	7.5%	16,659	3.2%
farmland	1,481,669	35.9%	103,273	19.8%
forest	1,293,062	31.3%	121,824	23.3%
unproductive	1,045,870	25.3%	280,686	53.7%
VARIATION 1979/85 - 2004/09				
urbanized area	+58,422	+23.4%	+2945	+21.5%
farmland	-85071	-5.4%	-7628	-6.9%
forest	+38,537	+3.1%	+5463	+4.7%
unproductive	-11,888	-1.1%	-780	-0.3%

Variations in land use in Switzerland and Valais (Source OFS Statistiques Suisse de la superficie - AREA)

Although the issues of land-use and planning were used by both parties in the negotiations, a democratic debate on land-use has as yet not taken place – at least not for the Rhône Valley. On the contrary, the arguments exchanged during the 2015 referendum against the financing bill of the Rhône Correction, showed that the urbanization of the plain wasn't questioned by the authorities nor by the ADSA, announcing new confrontations to come when the "corridors of residual risks" were detailed and implemented to protect urbanized areas from extreme floods. A widening of the debate, from flood management to regional and urban planning, might slow down the planning process, but remains a core issue in the necessary redistribution of flood risks – the difficulty for the state authorities being to articulate the different terms of the equation and engage in a constructive dialogue.

Combined ambitions for multifunctional landscapes: Are floodscapes lost spaces?

The main argument used against the widening of rivers and against horizontal flood mitigation strategies is partly true and partly contradicted by old and new examples: Floodscapes are indeed generally lost for regular intensive farming, in particular for cultures that require costly equipment and built infrastructures, and lost for regular urban extensions, which cannot withstand temporary flooding. Floodplain cultivation and flood-resistant urban spaces, however, have long existed, as seen in the first part of this investigation, and recent research and projects show that solutions exist to combine space for flood mitigation and profitable land exploitation, provided this combinatory approach is integrated at an early stage. As previously shown for past flood-resistant civilizations, flood-prone areas have long been exploited, not only in-between the floods but also through the exploitation of the flood itself for fertilization or land-making. For the farmers of the Overdiepse Polder, cultivating flood prone spaces wasn't new either: From a 730 hectare-large area, 180 hectares were located in the floodplain of the Bergsche Maas River, below high water level and nevertheless cultivated since the Middle Ages. When the Bergsche Maas channel was dug in 1904, a winter bed was kept outside of the levee to allow for extra capacity at peak discharge. This winter bed remained exploited after the construction of the channel – the trees planted in the floodplain conveniently marking its edges for ships to remain on course even at high waters (De Bont, 2013).

In 2003, more than half of the farms active in the Overdiepse Polder was still renting land in this floodplain, using it mainly as meadow and, for a small part, for corn culture (Van Rooy et al., 2003). The majority of the farmers were thus used to exploiting flood-prone land, long before the polder itself was identified as potential space for flood mitigation, which was not the case along the Swiss Rhône and the French Isère Rivers. This familiarity with combinatory use can explain the fact that the farmers of the Overdiepse Polder actively participated in the planning process, even initiating an accelerated procedure to promote a solution that allowed them to sustain their activity in the future flood mitigation space. For the farmers of the Overdiepse Polder, just as for the farmers of the Isère Valley, the land is today no less productive than before, despite its change of status.

The case of the neighboring Noordwaard Polder is different in that regard, since the area will function as a by-pass for the Merwede and should be flooded at a higher frequency, making intensive farming more uncertain. As a consequence, farmland in the 2050 hectare flow area will decrease from 80% to about 50% after completion. The Noordwaard Polder is, however, located in the heart of the Biesbosch and surrounded by several isolated nature reserves: Its transformation was thus partly a step towards the restoration of a greater and more natural Biesbosch that made sense on a regional and national scale – although nature restoration was not communicated as a primary goal but rather as a side effect welcomed between two conurbations. The re-balancing between nature and farming was more difficult to defend for the architects of the Third Rhône Correction, where river widening was explicitly related to the restoration of riparian nature, excluding productive land-use in a Canton where more than 50% of the land is classified as unproductive (see table).

Paradoxically, floodplains preserved within the urban environment eventually appear to be profitable, since they provide large recreation space at relatively low construction and maintenance cost, which can partly be covered by the budgets allocated for flood protection. Besides environmental and farming opportunities, floodscapes are able to provide urban recreational spaces, such as the Isar floodplain, and can be motor of urban development, as the Sion-sur-Rhône and Meerstad projects show. As the popular success of the Isar Plan shows today, there is a strong demand for large, informal, and open landscapes in cities, which can provide space for unforeseen and unprogrammed activities. While the densification of European cities implies rules and arrangements to organize a peaceful cohabitation among a growing number of inhabitants, workers, and travelers, floodplains offer generous spaces of free movement, without predefined activities, building, or facilities. Furthermore, an increase in retail activities in the vicinity of the Isar floodplain showed that the transformation of the central section benefited the local economy, in particular ice cream parlors and cafés located near the bridges, and increased the neighborhood's attractiveness for inhabitants and investors.

Still officially considered as flood-defense infrastructure, the Isar floodplain isn't subject to the limitations that apply to regular urban parks, meaning more freedom for visitors, but also more latitude for its maintenance: "It's not a park, it's a floodplain (...) If it was a park, we would have to ask continuously: 'are we allowed to take a tree out? Are we allowed to cut the grass?' It would be much more difficult for us to take care of this area" (Schaufuß, 2013).

Thanks to this hybrid status, the managers can rapidly take the necessary measures to ensure that the floodplain can fulfill its hydraulic function without facing long procedures, in particular, for the removal of riparian vegetation that could hinder the flow. Due to the nature of flood mitigation spaces, the design of the Isar floodplain has sought to curb the cost and frequency of maintenance work, and ensure its resistance to flooding. Calculations based on discharge statistics, as well as erosion simulation, were taken into account during the design phase to create a submersible landscape with acceptable maintenance costs. This balance could, however, be reconsidered in the future, as "the Isar has seen three 100-year floods in the last 15 years" (Engelmeyer, 2013).

The (re)creation of floodplain and mitigation space combined with urban redevelopment can offer similar opportunities in the long term, as is expected in Groningen with Meerstad and in Sion with the Sion-sur-Rhône project. In the first case, however, initial ambitions had to be scaled down as a result of the 2008 crisis, which had rapid effects on the Dutch real-estate sector. Nevertheless, the combinatory value of the project remains in the long term, housing construction taking place at a slower pace than initially planned, and the creation of the recreation and retention lake are being phased accordingly. The Meerstad project, however, shows that too many combined ambitions can weigh down and slow down a project to the point that it might miss its initial combinatory goal. On the contrary In Sion, Switzerland, the redevelopment of the industrial area between railway tracks and river now has a new impetus generated by the transformation of the Rhône. The enterprise involves in this case a smaller area and a limited amount of ambitions - mainly flood defense and urban developement combined through the creation of new public embankments and a large park in the flood zone. This focus has so far allowed for a relatively fast planning process, that should allow for a successfull and timely combination of hydraulic measures and urban growth. Notwithstanding the prevailing fad for integrated planning, combinatory approaches should clearly communicate priorities, address established needs, and ensure that they are compatible in time and scale.

Meerstad: promenade between building land and
new recreation/mitigation lake (Rossano, 2013)

Meadows in the Bergsche Maas' winter bed along the Overdiepse Polder,
seen from the current primary levee (Rossano, 2013).
Elevation map of the same area (Ill. Rossano, Data AHN)

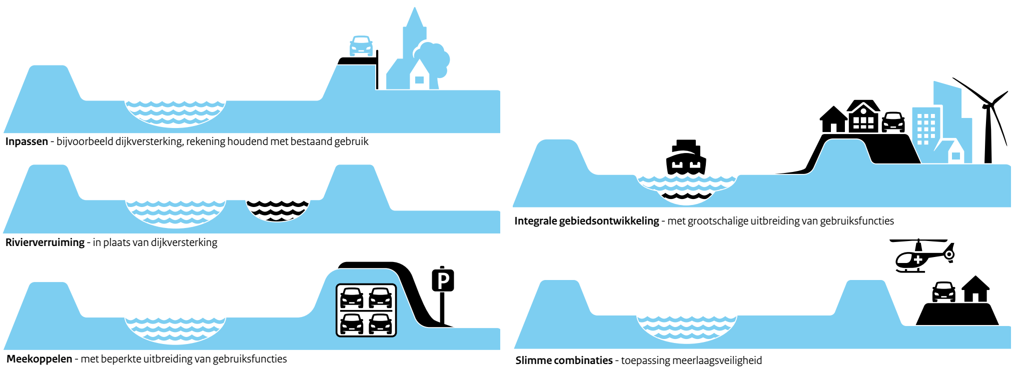
Isar floodplain opposite the St Maximilian Church, Munich
(Rossano, Künzel, June/September 2013)

Besides urban renewal and extension, urban mobility also generally benefits from the restoration of floodplains and the adaptation of riverbanks. Riverbanks offer *de facto* an opportunity to implement continuous paths, a possibility used in Sion, Grenoble, Munich, Meerstad, and in the Biesbosch. Improving both recreational network and global mobility, the creation of new public routes for slow traffic and promenade allow for a larger public to enjoy the riversides and to observe the river's fluctuation, generating as a result more awareness for floodrisks. The levee itself is increasingly subject to various combinatory proposals, associating functions as diverse as recreation, farming, parking, and housing. "Minimizing mono-functional levees" and "maximizing levees with multiple functions" were advocated for the Rhône Correction by the SYNERGIE research program (Pellaud et al., 2005). The designs produced during landscape studios held at the Institute of Landscape Architecture at the ETH Zürich illustrated as well the potential of flood defense infrastructure as support for urban, natural, and rural developments (Girot et al., 2012). In its new "Water Plan 2016-2021," the Dutch Government is promoting as well the combination of flood defense with urban development in the form of "integral area development with large scale uses" (Min. van Infrastructuur en Milieu, 2015: 16).

	before project implementation	after project implementation
Rhône 3	fruit culture agroforestry sand and gravel mining	nature development urban recreation (Sion-sur-Rhône) recreational cycling/pedestrian route
Isar Plan	unexploited meadow	urban recreation swimming/beach recreational cycling/pedestrian route nature redevelopment
Isère Amont	crop farming isolated riparian woodland recreational ponds	crop farming riparian woodland reopened to river flood recreational cycling/pedestrian route
Meerstad Groningen	arable land intensive pasture rowing basin	water recreation sailing & rowing sports nature development (wetlands) "sail-in" villas on islands
Noorwaard	arable land intensive pasture farm buildings and dwellings	arable land intensive pasture (within high dikes) farm buildings and dwellings on "terpen" extensive pasture (within low dikes) unexploited grassland and wetlands recreational cycling/pedestrian route
Overdiepse Polder	arable land intensive pasture farm buildings and dwellings	arable land intensive pasture farm buildings and dwellings on "terpen"

Land use before and after transformation into flood expansion areas

The combinatory use of levees remains, however, controversial for aesthetic, constructive, and spatial reasons. Contrary to mitigation spaces, levees are built to resist specific thresholds in water levels, thresholds that are and will be regularly updated in the future – most probably towards higher levels. The construction of fixed urban amenities on the levees makes future adaptation difficult if not impossible, depriving vulnerable cities from future adaptive capacity. Historically, the development of water cities followed the construction of their flood defenses (as shown by the suffixes "-dam" and "-dijk" found in the name of numerous Dutch cities and streets) and many of them were indeed used for traffic and building. However, later urban extensions generally implied the construction of a new and higher levee in front of the old one, reducing the floodplain every time a bit more; this process is today compromised in most urbanized deltas and valleys, where river channels have reached their minimum width, while variations in discharge are expected to increase in the near future. The difficulties faced by the island-city of Dordrecht is in that way characteristic: The northern section of its primary flood defense is formed by the ancient Voorstraat, together street and levee clamped between buildings of great historical value; as a result, this crucial protection cannot be raised to a safe level without damaging the historic city center, leaving municipal authorities in front of an unsolvable dilemma. Secondly, the profile and the components of levees are still today the subject of research and improvement, and access to the levees appears to be a key issue in the implementation of reinforcement measures along the Rhône, Isar, or Isère, an access that was in many places hindered by construction and vegetation. Removing constructions will bring high costs for future maintenance, just as the construction of cut-off walls built in the Isar levees avoid cutting existing trees that were planted at the wrong place - right onto the levee. Finally aesthetic objections were raised by several interviewees, who objected to the disappearance of the levee as a structural element in the landscape of floodplains and riverine regions: an objection that could be reinforced by the lack of public risk awareness, which could worsen if the only permanent reminder of flood risks were to disappear under various constructions and urban facilities.



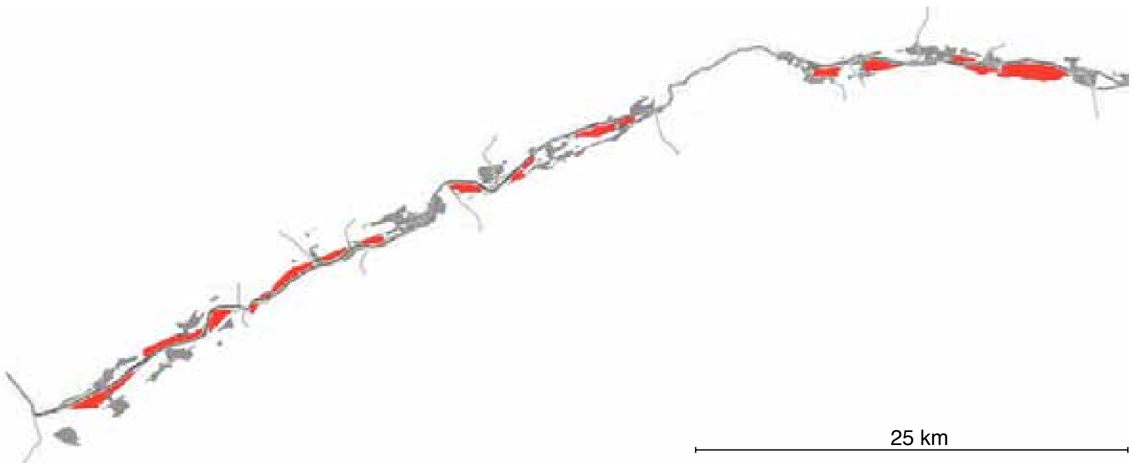
"Linking water and space": examples of combinatory flood defense from the Dutch governmental Water Plan (Min. van Infrastructuur en Milieu, 2015: 16)

The levee as urban limit and belvedere (Design Studio ETH Zürich 2011, Knuser, Murer and Weber)

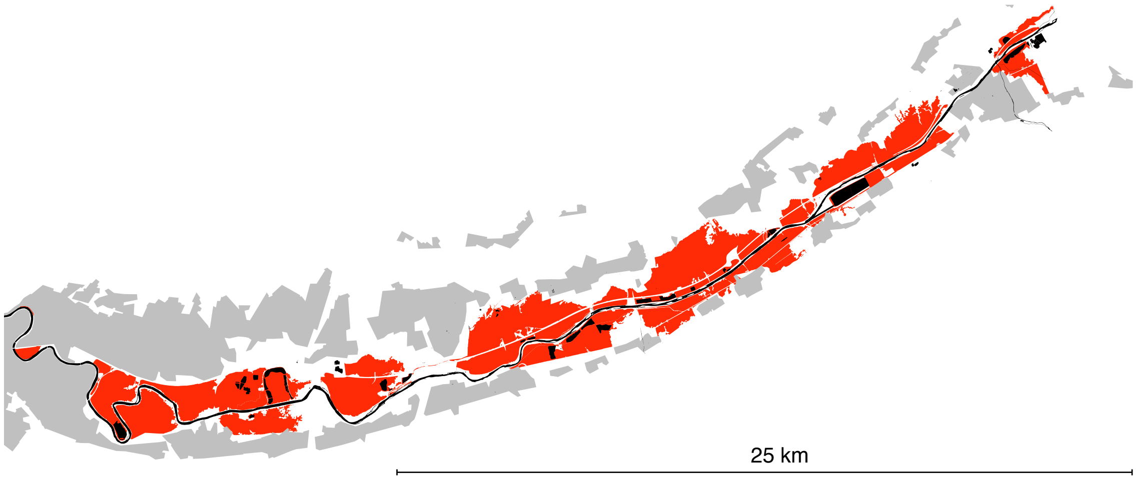
Despite the above-mentioned reservations, contemporary projects for spatial flood mitigation show that floodscapes are not necessarily lost for productive land-use, but should on the contrary be seen also as an opportunity to optimize and recompose a territory. Depending on the type of mitigation, various uses can be maintained or developed: Excess water can be temporarily stored onto permanent lake in combination with recreational uses, nature development and urban beautification and extension (Meerstad). Short and occasional floods can coexist with (stock-) farming, provided no fragile infrastructure is at stake and animals can be timely brought into safe places (Isère Amont, Overdiepse Polder). Urban recreation can benefit from new open spaces, and mobility can greatly improve with the creation of continuous cycling paths along the redefined river space. Finally urban renewal and new building programs can be associated with the creation of floodscapes, provided these enhance the quality of the living environment.

Space for flood, space for landscape?

One side effect of risk redistribution is the sharp definition of landscape entities: Areas (re) opened to flood may be multi-functional; they generally exclude new construction to secure their efficiency in the long term. This functional distinction can imply the demolition of existing buildings (Meerstad, Overdiepse Polder, Noordwaard), and their eventual replacement by new buildings located on the edges and on higher ground. The building restrictions that are applied to controlled flood areas can be perceived as a hinderance to urban growth, sometimes generating frustration for local politicians and developers, who see building opportunities shrink in order to guarantee the safety of the neighboring city, as it happened for the municipalities located upstream from Grenoble. The recent referendum on the Rhône Correction revealed that the issue of building ground was central in the limited space of the alpine valleys: while environmental organizations were reclaiming more space for the river and denouncing the extension of building zones in the floodplain (Largey, 2013), the President of the State of Valais and the President of the Chamber of Agriculture were competing in the opposite direction; during their electoral campaign, both promoted their own plan as the one that would be able to secure the most building ground for the future (Melly, 2015 and Giroud, 2015).



“Flood evacuation corridor” planned along the Upper Rhône between Brig and Martigny (urban areas in gray, flood mitigation areas in red. Rossano from Hydronat, 2000)



"Controlled Flood Fields" planned along the Isère between Grenoble and Pontcharra
(urban areas in gray, flood mitigation areas in red. Rossano from SYMBHI. 2007)

The creation of space for controlled flooding is indeed double-edged in terms of urban planning: By securing the rest of the plain, it allows for more farmland to be later classified as suitable for building; by designating areas officially opened to controlled flooding, it creates no-go zones for developers, contains urban growth and prevents the trivialization of floodplain landscapes. What is initially meant to protect build areas has the paradoxical effect of defining open landscapes within metropolitan areas, securing vast urban clearings that can be crucial for the future quality of growing agglomerations. The Meerstad project was in that regard the most explicit, since a hundred percent of its mitigation capacity was to be implemented in the form of a large lake at the edge of the city, in a mixed suburban landscape. In the Southwest of the Netherlands, the "Room for the River" program motivated the "de-poldering" of the Noordwaard area not only with hydraulic goals in mind but also using the argument that "developments in the Biesbosch reinforce its function of green buffer between the urban networks of 'Randstad Holland' and 'Brabantstad,'" two major Dutch agglomerations (Projectorganisatie Ruimte voor de Rivier, 2007: 27).

The effects of controlled flood areas could in the future be even more significant in the narrow space of Alpine valleys. With the Isère Amont project, an open area of 3,400 hectares is reserved for controlled flooding, and secures a vast and steady green corridor in the center of the valley, bordered on both sides by densifying urban areas and transport networks (see map). This forms a precious reserve for the population of the Grésivaudan and Grenoble Agglomerations, counting 100,000 (http://www.le-gresivaudan.fr) and 450,000 inhabitants (http://www.lametro.fr), respectively. The Upper Rhône Valley as well could be positively affected by the future "Flood evacuation corridor," which should freeze large parts of the floodplain and ensure a lasting protection against urbanization.

The long-term territorial impact of these projects remains, however, underplayed, particularly in the French and Swiss context, since these long and complex flood-mitigation programs could be jeopardized by the above-mentioned legitimacy conflicts. Locally trading farmland for flood protection is generally accepted as legitimate, yet setting a fixed limit to urban sprawl remains controversial. The subject was therefore for all intents and purposes kept out of the Isère and Rhône projects in spite of their obvious implications for future land-use in regional planning, most probably to avoid engaging in a broad debate with outcome unknown. The Swiss "Flood evacuation corridor" and the French "controlled flood fields" were presented in both cases as a necessary burden to be minimized in size and reduced to discrete interventions, rather than celebrated as a sustainable spatial policy capable of benefitting inhabitants, securing farmland, and protecting natural assets from building pressure. Although a debate on land-use would be far-reaching and highly sensitive, relating flood mitigation to the quality of urban environments has proved to be a great leverage for projects such as Meerstad in Groningen, "Room for the Waal" in Nijmegen, or the Isar Plan in Munich. Unfortunately, this potential remains clearly under-exploited in the French and Swiss examples. Judging by the practices developing in the newly opened floodplains, whether recreational or agricultural, flood areas are not anymore seen only in terms of technical necessity and denger, but are actively exploited and enjoyed. The definition of areas for controlled flooding could thus rightly be celebrated as a multi-purpose instrument of flood safety, sustainable urban planning, and landscape development, securing open space for densifying metropolitan areas. Flood fields, spillways, by-passes and sleeper dikes should therefore not be hidden and forgotten, but rather become a matter of landscape design and be affirmed as a legitimate and valuable component of a resiliant landscape.

Redefining riverine aesthetics

In the long negotiations surrounding the widening of rivers or the creation of "controlled flood fields," landscape design has appeared to be a useful partner for authorities and stakeholders when actively involved in the planning process. Whether initiated by designers or by stakeholders, topographic investigations brought new possibilities to light, which could answer legitimate fears for future flood safety and visualize the possible advantages that could be obtained from mitigation projects. For the two investigated "Room for the River" projects, inhabitants and farmers were able to interact with architects in the design of their future living and working environments, both in terms of functional and aesthetic aspects. Similar workshops were held at the local level in the Rhône Valley, notably in Sierre, to open up discussions and create a common ground among the various stakeholders.

The fluctuating role of landscape architects

As the Rhône and Isère cases show, spatial measures taken for flood mitigation aren't everywhere and always acknowledged as matters for landscape architecture, in spite of their obvious implications on water, vegetation, land-use, public accessibility, and visual perception in the areas concerned. This is translated in the role given to landscape architects that varies greatly in terms of the various countries, projects, and design phases.

In the preliminary planning phase, the role of landscape architects was crucial for the elaboration of the "Room for the River" program, from the very definition of the global strategy to the setting of practical ambitions, both of which provided a prominent place for "spatial quality." Landscape architects were involved, long before the program was officially launched, in order to investigate possible strategies in the River Region (RIZA and Bosch & Slabbers, 1999), and were given a powerful position with the appointment of Dirk Sijmons as chairman of the Q-team, which would foster and defend the role of designers in the planning process. In the Upper Rhône Valley, on the contrary, landscape architects intervened only eight years after the publication of the first plan report, thus encountering great difficulties in elaborating a coherent landscape strategy within a framework that had already been set (Hydronat, 2000 and Veuve et al., 2008). This discrepancy between the two programs can find its origin in the divergent river and flood management policies in Switzerland and the Netherlands, closely related to ecology in one case and to spatial planning in the other. A second explanation can be found in the position occupied by the profession: closely involved in Dutch reclamation and planning history but long absent from planning practices in Switzerland.

Looking closer from a project level, the Dutch examples stand out again for the degree of involvement of landscape architects at all stages, from sketch design to supervision. Even in the case of the Overdiepse Polder, implemented in a farming area and largely driven by the farmers themselves, landscape architects and architects were involved in the elaboration of various options and in the design of the new farms. In the other cases, the role of landscape architecture seems more often than not determined by the initial task set by decision-makers. For Isère Amont, landscape was integrated as a subsidiary aspect of environmental measures, not as an overarching dimension. The role of landscape architects was thus confined to analytical investigations, with a limited impact on the project, and to the definition of local measures such as retention ponds and recreation facilities. The two projects concerning central urban areas in Munich and Sion were, on the contrary, led by landscape architects from the moment local authorities had identified them as matters of urban design, in addition to hydraulic and environmental issues. In both these cases, the brief clearly put the emphasis on the integrative aspect of the task, as well as on the multiple scales involved, and in both cases a two-step design competition was organized. At project level and in the urban context, spatial measures against flood risks were thus almost everywhere acknowledged as matters of spatial design, and as tasks for landscape architects. On a regional scale, landscape architecture, however, tended to be ignored or involved as a subsidiary aspect, contradicting official demands for coherent spatial frameworks for flood mitigation policies.

STAGE >	preliminary studies	design	final design	excecution drawings	supervision
			PROGRAMS		
Rhône 3 (CH)	-		-	(see projects)	?
		landscape guidelines			
Room for the River (NL)				(see projects)	
	general policy	design-based investigation			
			PROJECTS		
Sion-sur-Rhône (CH)				?	?
	academic studio	design competition	(current)		
Isar Plan (DE)					-
	landscape analysis	design competition			
Isère Amont (FR)				?	-
	landscape analysis		local measures		
Noordwaard (NL)					
	prel. design studies	leading	leading	associated in consortium	chair Q-Team
Overdiepse Polder (NL)	-			?	
		associated in consortium	associated in consortium		chair Q-Team
Meerstad Groningen (NL)					
	prel. design studies	lead draft and planning	lead masterplan	design public space	external supervision

Role of landscape architects in various phases of the programs and projects investigated:
leading (black), subsidiary (gray), nil (-), unknown (?)

The need for images and visions

Athough hydrology remains the leading discipline in most flood mitigation projects, hydrology alone often appears insufficient for sharing, communicating, and articulating complex interventions. The Dutch tradition of "research by design" and scenario-based investigations, well established since the 1980s (Salewski, 2012), is visible in the development of the "Room for the River" program. Plans for the transformation of the Biesbosch into a large bypass and mitigation area were drawn up long before the program itself was officially launched (see "First regulation and first mitigation project" on page 122). However, the elaboration and diffusion of images representing possible measures and landscape transformations functioned in this context as a support for discussion rather than the communication of a finalized solution, and as an entrance for stakeholders to become involved in sensitive negotiations: "Good communication is key to success. The use of images, field trips, etc., is therefore very important for various stakeholder to connect."

As the Isar controversy showed, images brought by landscape architects can have far-reaching consequences – in this case a public quarrel and a two-year delay in the initial planning. All the protagonists interviewed for this case, including landscape architect, city and water board representatives, however, stressed the fact that the competition had revealed a latent conflict rather than generated it, and had allowed for an open and necessary discussion: "People needed to see something to talk about. (...) You need design as a sort of a benchmark to have any discussion at all. (...) If people had started with an empty stage, with the thousands of people living around here, there would have been so many ideas, it just wouldn't have fitted together." (Engelmeyer, 2013). The delay was, in their opinion, more the result of confusing communication about preexisting constraints, confusion exacerbated by political maneuvers. Yet, "At one point you just have to try and do a design, and then discuss it" (ibid.).

More than images, Valais' environmental associations first asked for the construction of a "sample" on a section of the Rhône Correction, a proposal that was rejected. Retrospectively, Pro Natura's director for Valais lamented the lack of a political vision that could allow the population to become involved in the definition of the project. "An engineering project was made, in engineering language with engineering concepts", instead of elaborating " a political project; that is where a landscape vision would have been interesting: for people to connect on a global project" (Largey, 2013).

Local stearing committees were set up with a similar ambition, but retrospectively denounced by as "a way to divert attention while engineers worked out the project" (Largey, 2011), ultimatly asking stakeholders to choose between predefined options. In Sion, however, the combination of urban renewal with the Third Correction, first ambitioned by the city urban planning department, eventually took off after the students from the ETH Zürich visualized the benefits that the city could gain from the transformation of the river. Tactically, the municipal authorities largely communicated the outcome of the studio, by displaying models, plans, sections and perspectives, for five months in seven locations. The interest generated by the exhibition paved the way for a concrete project, and the city soon thereafter launched a landscape design competition for the project currently being developed.

The Munich and Sion design competitions showed how landscape architecture could bring to light latent expectations, and how plans and projects could offer a platform for cultural evolution – turning the distant, dangerous river into a motor of urban renewal and a platform for spatial negotiation, opening up the discussion around the space devoted to the different components of the landscape. However, the frustrations expressed in the various projects show that images and visions are necessary tools to be handled with care, since they can awaken false hopes and new opportunities at the same time.

Setting aesthetic values

As seen previously, the engineers of the great river corrections did propagate certain aesthetic values, but explicitly based these on necessity – the necessity to feed and protect growing populations from erratic nature. For the engineers of the Enlightenment, Beauty was the result of human technical know-how but not its purpose, as an underlying moral scale that opposed Man's rational and useful oeuvre of geometrization and exploitation to the amorphous and purposeless existence of Nature. This process liberated science from belief and sensory perception, but also implied a "deculturing" of the world (Berque, 1992: 73). Despite the attempts of Ruskin and Rousseau to reconcile the natural world and modernity, the strict distinction between civil engineering, sensitive perception, and aesthetic value remained dominant throughout the whole modern era, with the integration of public necessity and meaningful aesthetics even being rejected as characteristic of fascist regimes by Walter Benjamin in his critique of the "aestheticization of politics" (Gomart, 2006).

At the end of the twentieth century, the reintroduction of spatial perception, aesthetics, and cultural values into flood prevention still appears to be a multiple challenge. Could complex and relative variables, such as coherency or beauty, be defined and integrated into planning procedures? Could civil works reconcile these qualities with safety and efficiency? Should massive public means be invested in subjective, cultural productions? Should democratic representatives integrate new cultural values into public works production, or, on the contrary, defend civil engineering from irrational trends and volatile public taste?

With the reintroduction of the spatial dimension within the scope of flood management (see "Embedding spatial quality into flood prevention" on page 138), qualitative questions arose together with more subjective criteria, engaging governments and citizens in a complex exercise of cultural redefinition. These issues emerged simultaneously within the scope of changing flood policy in Western European countries, although not in any coherent and legible order: Qualitative criteria today vary greatly from one country to another. Five key notions emerge, however, from a transnational perspective: openness, robustness, coherency, spatial quality, authenticity, and freedom.

Freedom and authenticity

Paradoxically, the fluctuating nature of alpine streams is perceived both as a past ideal state and as a cause for public disinterest by some decision-makers. For Christiane Thalgott, former head of urban planning in Munich, the city "has no urban waterfront because the Isar is a mountain river that brings pebbles, trees, so it was also and still is a bit wild. The water level is changing quite a lot: In the summer you have hardly enough water for anything, it is very low, and in the winter it is rather high. So it is not always a beautiful river" (Thalgott, 2013). A point of view echoed by Michel Pinhas about the Isère, chairman of the Isère Water Board: "Alpine rivers aren't full rivers; their level is often very low; waters aren't dirty but they are murky and full of alluvions; they don't add value to the areas they flow through" (Pinhas, 2013). They can be frightening as well, according to the secretary of Valais Pro-Natura organization: "People are afraid of the Rhône, and it is frightening when you stand next [to the river banks]," a fear that was most present among parents of young children according to a survey made by the organization (Largey, 2011).

Still in the contemporary discourse surrounding river and floodplain restoration, authenticity is generally associated with the notion of freedom that should be returned to nature for ecological but also cultural and aesthetical reasons, not unreminiscent of Rousseau's apologia for free streams and his critique of river channeling (see "Tame or set free: nature and the Enlightenment" on page 74). The transformation of channeled rivers into "free streams" was considered or promoted in various projects investigated, particularly in the Alpine context. The acknowledgment that riparian nature was conditioned by dynamic and partly destructive processes grew at the end of the twentieth century, and ecological criteria shifted from quantitative to dynamic and combinatory. The traditional compensation measures, focusing on the gross area dedicated to nature, were thus completed with a combination of aspects meant to shape a context for alluvial ecology: discharge minima and maxima, flood periodicity, stream velocity, input of alluvial materials, water quality, space available for fluctuation. Never leading to a hypothetical climax, ecological restoration was thus to be directed towards the "the maintenance of processes, in particular hydrological processes" (Girel, 2005). In the practice of river transformation, this was complex to translate into measurable goals. In Switzerland, despite the standards set by Pro Natura (Frossard et al., 1998) and by the Federation (OFEFP, et al., 2003), the "optimal width" of the Rhône river in terms of ecological value remains controversial to this day: For the Canton of Valais, a 1.9 widening factor is desirable, and a factor 1.6 considered reasonable in combination with local wider segments (Projet Rhône, 2008: 5), while environmental organizations advocate a factor of 3 to 5 to match federal requirements regarding ecological value (Pro Natura et al., 2005: 5).

In practice, the full restoration of alluvial dynamics appeared to be a presumptuous if not elusive goal for rivers constrained by urban environments: Michel Pinhas in Grenoble and associated to the design for Isère Amont, relates that during the planning process, "there was a sort of a hesitation at some stage, because we had in mind this same old 'give the river its freedom back' story, and we could believe that by giving the Isère an extra fifteen meters along its shores, we could give it back a bit of freedom. That is not freedom. Freedom has to be complete, or else you have only the downside of it" (Pinhas, 2013). In Switzerland, the designers asked to define landscape guidelines for the Third Rhône Correction defined standards for the future river channel, while within this channel "it is the river's natural dynamic that will create its own landscape" (Veuve et al., 2008: 4), offering the spectacle of a contained but dynamic environment. In Bavaria, a cultural agenda implicitly supported the ecological ambitions within the Isar Plan. One of the main motifs of the plan was from its origin the restoration of a lost "character of Alpine wild river," as stated in the first municipal motion Nature in the City (July 1984, "Natur in der Stadt"). This nostalgic rhetoric remained throughout the whole planning process, which promoted the plan as a restorative rather than transformative enterprise. In practice, the new Isar as it was ultimately shaped had little in common with the preindustrial stream, at least in the city center. Yet this approach indirectly led to the rejection of the winning project of the 2003 design competition and its replacement by a more "nature-like" ("Naturnah") proposal. The second prize would "let the stream meander through the city" (Süddeutsche Zeitung, 5.06.2003) within the existing levees. This freedom eventually appeared unreachable given the little space left for the river to play with; the meandering eventually had to be simulated by the designers and secured by concrete foundations built under the "nature-like" riverbanks. In spite of this, officials from the State Water Agency today celebrate a design that granted the river "Freedom from its concrete corset," (Mahida, 2012), dismissing the highly regulated discharge and artificial morphology of the river after "renaturation" – something the project "never was and never could have been" (Engelmeyer, 2013).

The restoration of an authentic riverine landscape and natural habitat remains on the contrary rather absent from the Dutch debate. Dutch landscape architects prefer to stress the makeability of nature, an idea supported by the creation of large scale "new nature" in the Flevoland Polders in the 1970s and integrated into governmental policies in the 1980s (Van Baaien, 1995). Dirk Sijmons then applied this idea to the landscape of Dutch rivers, believing that "nature could be made, contrary to cultural assets," and should thus be handled by designers as a flexible element rather than a fixed one (Sijmons, 2015). For the controlled flooding of the Noordwaard area, the past morphology of the Biesbosch was recalled as an inspiration but not as a fixed ideal. Late nineteenth century maps were used by the landscape architect as a model of balance between river dynamics and human occupation, rather than as a state of natural authenticity. The choice was also pragmatic: The small-scale and coherent polder structure of that period was easily transposable into existing situation at the time the design took place, while the recreation of more ancient waterscapes would have implied massive intervention (De Koning, 2013). An "authentic" restoration was furthermore illegitimate, since the Biesbosch itself resulted from the inundation of an area reclaimed in the Middle Ages.

More generally, a state of nature could scarcely be found in the Rhine-Meuse Delta, not even on historical maps, since the large-scale reclamation of the Dutch landscape was subsequent to the development of precise topographic mapping (Sijmons, 2015). In the absence of physical or documented reference, "there is no memory and no nostalgia for a past state of nature" in the Netherlands, which doesn't exclude a deep fascination for the Wild in the man-made low lands (ibid.). Besides the soft nature of estuarine grounds, this absence of preindustrial nostalgia can explain the fact that transfomative projects were relatively easily accepted in the Netherlands, while restorative rhetoric dominated the Alpine projects. Yet, within the scope of investigated projects, authenticity has so far brought more over-ambition and frustration than actual achievements, since the limited space available in the dense European valleys and deltas made the full release of channeled streams delusional, if not dangerous for the surrounding infrastructure. This didn't contradict the benefits of ecological measures such as the removal of built embankments or the regulation of discharge levels to increase the value of riparian habitats. But these interventions shouldn't be confused with a hypothetical restoration of a past state of authenticity, a notion that has, in the Isar case, brought about more conflicts and delays than actual results.

Wilderness aesthetics and aesthetics of Wilderness in the Isar floodplain: artificial island/riverbanks after the 2013 flood (Künzel/Rossano, 2013)

Spatial quality

Spatial quality, as a general goal and a criteria for the evaluation of possible measures, became progressively a key notion in the Dutch planning policy in the last decades of the twentieth century (Reindorp et al., 1998), as well as within the departments in charge of water management and flood defense (see "Embedding spatial quality into flood prevention" on page 138). The 1997 Fourth Bill for Water Management stated that, for large projects of river widening, "the promotion of spatial quality" was at least "as important as legal instruments." The bill later highlighted the economic potential of spatial quality when integrated within water management together with ecological measures: "Spatial quality can be an important economic factor, among other things, as a positive reason for business or inhabitants to settle" (Ministerie van Verkeer en Waterstaat et al., 1998: 107, 117). During the preliminary studies made for the "Room for the River" program, spatial quality was increasingly used as a criterion to evaluate possible measures (Van Drimmelen et al., 2000). It was eventually incorporated in the Governmental Guideline "Room for the River" in 2000, and became officially the second main goal of the "Room for the River" Program, next to flood safety.

Spatial quality not only referred to the perception of a three-dimensional environment but was also developed as a catch-all concept. The Key Decision "Room for the River" that officially validated the program introduced a threefold concept that encompassed use, experience, and future value. Interestingly, the governmental document didn't provide a fixed definition of the notion but rather specified that "the practical application of the spatial quality criterion is defined by the parties involved." Spatial quality was thus claimed as a flexible and overarching instrument, whose main goal was to balance and create coherency among various aspects, and that should be adapted and used by the actors of the project rather than superimposed by the authorities. For Dirk Sijmons, first chairman of the program's Q-Team, "Within the 'Room for the River' program, spatial quality included three dimensions: hydrological efficiency, robust ecology, and meaningful aesthetics," leaving room for negotiation and avoiding a focus on one isolated aspect of the living environment. Ecology was, for instance, present but "hidden within spatial quality" (ibid.). The Q-team that monitored and promoted spatial quality within the program was itself interdisciplinary: It included experts in hydrology, river management, ecology, urban planning, and landscape (Sijmons, 2015). For the water and civil engineering agency, it was important to rely on the definition set by the Q-Team in order to "reach for coherency between hydraulic efficiency, ecological robustness, and meaningful design, and base your choices on integral considerations" (Der Nerderlanden, 2013).

The architect of the Noordwaard project added a narrative dimension to spatial quality: "It's about the story" stated Robbert De Koning, insisting on the necessity for the designer to get to know the site and its past (De Koning, 2013), adding a temporal dimension to "meaningful aesthetics." However, it appeared during the public discussions around the project that the concept of spatial quality wasn't accepted as a goal as easily as flood safety, although both were associated in the "Room for the River" program. Furthermore, the different groups stressed different aspects: the environmental assessment reports summed it up in "landscape and nature assets," municipalities stressed recreational possibilities, while the inhabitants linked the concept to the quality of their immediate living environment (Heems and Kothuis, 2012: 276). The polysemy of spatial quality could thus lead to frustrations and conflicts, and had to be reaffirmed and clarified by all parties concerned; but then again, this negotiation process was part of the strategy chosen by the "Room for the River" Q-team.

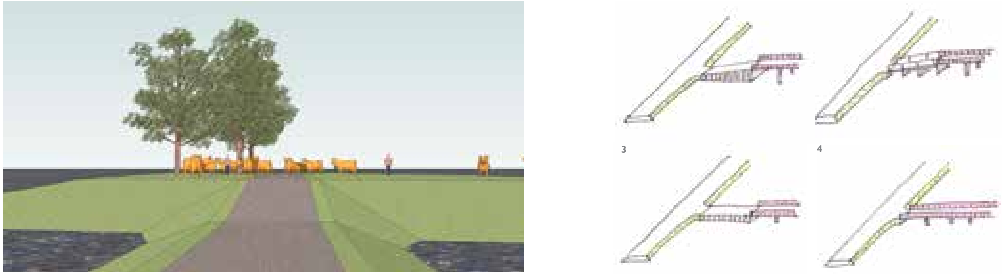
Coherency

The notion of coherency, although difficult to quantify, played an important role in the definition of large-scale flood protection and mitigation programs. The need for coherency was affirmed for the complex programs that involved multiple disciplines and numerous administrations, and concerned not only the rivers but also all components of the territory. Furthermore, river widening was seen from the beginning as an opportunity to bring coherency to landscapes fragmented by transport infrastructure and urban development.

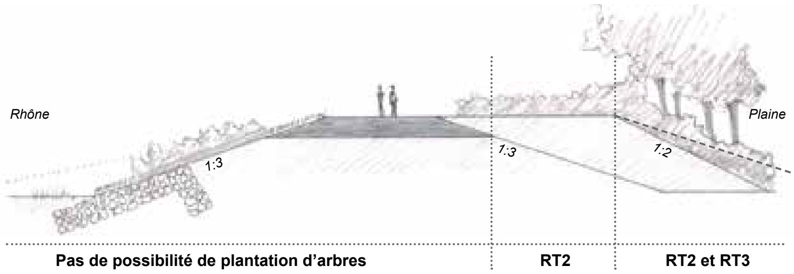
The Rhône Correction Program stated in its first comprehensive document that "all environmental measures would be based on a global landscape concept from Brig to Martigny in order to ensure their coherency" and that "only a full integration of the different domains" could lead to a "sustainable development of the Canton" (Hydronat, 2000). Coherent policy and coherent landscape were seen as two interdependent aspects, both being conditions for and the result of the other. Unfortunately, the elaboration of this "coherent landscape concept" was subsidiary to the definition of the main principles and measures that had already been defined by the core team, and the task of elaborating this global concept was assigned to two departments that played a minor role in the development of the program – the department of Forest and Landscape and the Department of Buildings, Monuments, and Archeology (Projet Rhône, 2006: 29-30).

The external team hired to define guidelines for the landscape development of the Rhône and the plain reaffirmed that "the transformation of the landscape of the Rhône [river] would go along with the transformation of the valley. This is an obvious demand of coherency" (Veuve et al., 2008: 4). However, the team failed to propose a global concept but instead lamented the fact that the conditions for a coherent plan weren't present within the project's framework and the Canton's administrative structure (see "Landscape, at last" on page 235). The following 2008 Project Synthesis presented the evaluation matrix used to evaluate the different options made for local interventions, where it appeared that the "global coherency" criterion was given a weighting of 1.5% in the evaluation process (Projet Rhône, 2008: 46). The sole global element should eventually be the continuous recreational route that should be implemented along 160 kilometers of river, a route meant to transform the "canal into a corridor of life" and susceptible of providing a continuous, if not coherent, perception of the landscape. It was yet at the more local level that a coherent framework was introduced with the Sion-sur-Rhône competition: The winning entry clearly inserted its proposal for the river transformation into a structural proposal for the area of Sion, looking for parallel and transversal connections that could give the river its central role of backbone for the valley.

In the Netherlands, by contrast, spatial coherency was early used as a criterion to evaluate the various measures of river widening and flood mitigation (Van Drimmelen et. al., 2000), and as a tool to assemble and articulate possible combinations into a global vision. A substantial part of the 2006 governmental "Room for the River" Key Decision was dedicated to spatial quality, and presented three possible strategies to connect and relate the proposed measures (see "From policy to proposal: Opening the scope of possible measures" on page 132). More than concepts, these strategies envisioned concrete orientations at the regional scale. Typically, the Dutch government chose to decompose and recompose the three strategies into a combination of "urban developments, the development of robust nature core areas, and recreational possibilities" (Projectorganisatie Ruimte voor de Rivier, 2007: 27). Coherency was thus a twofold criterion, conceptual at the regional level, and spatial at the scale of each project.



Noordwaard design guidelines for refuge platform and bridge over the creeks (De Koning, 2010: 47, 59)



Design guidelines for the profile of future levees along the Rhône (Veuve et al., 2008: 13)

At the other end of the spectrum, global guidelines were elaborated for local application, as an intermediary step between spatial concept and landscape design. They provided information on profile measures and land-use but also formal recommendation comparable to the one set for the Rhône. In a "contemporary interpretation of the historical situation," landscape architect Robert De Koning proposed for the future levees to create "smooth lines alternated with sharp turns," and here again to give water sufficient space to shape future landscape, through profiles that give natural processes the chance to shape the creeks in the future" (De Koning, 2010: 42). For the Third Rhône Correction program, which concerned one continuous stream, these guidelines included design principles for the adaptation of river junctions and existing levees, and for the creation of new levees. Besides recommendations for the width, slope gradient and plantation, the guidelines also included aesthetic recommendations: The levees "will be characterized by a soft geometry, without sharp turns or breaks," while local uses and urban context will dictate the future form of the Rhône in the city (Veuve et al. 2008: 6).

Robustness

During the investigations, robustness was mentioned by several designers as a key value for the design of flood-ready landscapes, as a combination of formal simplicity and physical resistance. For the designer of the Noordwaard Polder, the results form "a robust landscape, something different from a nice waterfront at the edge of the city. You don't need to design everything down to the paving stones." Landscape architects should design with restraint, "but the objects that are made should be beautiful and well integrated with the paths, the embankments" (De Koning, 2013). Some even regret the time when limited means meant good and plain design: "Technically, anything is possible [nowadays]. A century ago, technical options were limited, and therefore better integrated in the landscape – although enormous measures were taken (...), they somehow followed the morphology of the river" (Der Nederlanden, 2013). They reject multi-functional levees for the same reasons: Levees are linear elements and should be legible in the landscape, rather than disappear under building or fade into shallow slopes. In order to combine multiple functions onto one levee, designers "oversize them to be able to build or plant, turning slim, fitted levees into wide bodies where you can dump anything you like," regrets one of the Rijkswaterstaat experts about spatial quality (ibid.). Nowadays, "there are ways to make an ugly design," they conclude, and before you know it the river landscape is "cut unto pieces and fragmented into dull little things" (Van der Grift , 2013).

This focus on simplicity was shared by the Q-team of Room for the River, which not only intervened to promote and check spatial quality but also to prevent the addition of useless elements meant only for beautification: "In fact, the Q-team tried to safeguard sobriety and simplicity, and we counted that this eventually saved tax-payers 50 to 60 million euros" (Sijmons, 2015). Experts at the Rijkswaterstaat agency saw in "meaningful aesthetics" the third aspect attached to spatial quality, a motivation to avoid decorations: "Meaningful [aesthetics] mainly means that you can explain why you should do it, and why it should look like this, not just to a way to give a nice tint or to cheer up the intervention" (Der Nederlanden, 2013).

The design of the Isar floodplain shared a similar ambition of simplicity and robustness, since it was anticipated that the area could be flooded nearly every year. Consequently, the design was meant to resist up to the hundred-year flood (1100 m3/s). As seen in 2013 after the discharge level reached 750 m3/s in Munich, the "Isarraum" was restored within a couple of weeks through "a very low-key [restoration]: repair is basically bringing a bit of gravel somewhere" (Engelmeyer, 2013). Besides resisting floods, the hydraulic function of the floodplain implied that no buildings could be built in the high-water channel, not even the basic amenities that would serve a public space hosting up to 30,000 visitors in a weekend. However, the limitations put on mass recreation are today valued by the inhabitants: "You can't have events happening, and people like it for that; there is nothing you have to pay for, no beer gardens (...), it doesn't have to stand right next to the river. It's a nice thing to have, such a space that is... empty" (Engelmeyer, 2013). The lack of amenities and services can thus be valued as relaxing, in contrast to fully-equipped and commercial urban spaces. In these two examples, robustness thus associated solidity to formal simplicity and economy of means.

Restoration of the Isar floodplain after the 2013 flood (Rossano, 2013)

Old warning signs and new openness in the Isar floodplain (Rossano, Künzel, 2013)

Reopening the riverbed to the public: Design for a pedestrian promenade along the Rhône in Sion (Competition, Paysagestion, 2012)

Openness

The recreational potential of floodplains, especially when located near or within dense urban areas, was long identified but left unexploited for safety reasons. Within the frame of flood mitigation projects, large areas were officially made accessible again to the public. The restoration of open and accessible floodplains, combined with softer embankments and slower streams, shaped new opportunities for promenade and relaxation; flood protection programs paradoxically offering an opportunity to bring people closer to water. The restoration of accessibility and openness was, however, motivated by arguments as diverse as hydraulic performativity, visual perception, landscape restoration, or the development of a recreation economy, arguments sometimes contradicting each other.

The first parameter that motivated openness was in all cases hydraulic efficiency: In order to secure enough storage and discharge capacity to mitigate flood events, floodplains should remain free from obstacles. In particular, vegetation growth and silting had to be avoided to secure lasting efficiency, which was often a constraint for landscape architects and a frustration for environmentalists. Tree plantation or spontaneous tree growth needed to be avoided on the levees, but were already in place at the time the projects started, often as a result of poor maintenance. The removal of this vegetation was generally opposed as damaging to the historical urban landscape (the left bank levee in Munich) or to the already empoverished ecology of the river (Rhône, Isère).

In all projects, wider accessibility combined with a richer and more dynamic landscape was linked to the development of recreational routes. In practical terms, the adaptation of existing levees, whether heightened or lowered, allowed the creation or connection of footpaths and cycling paths everywhere on or along the dikes. The development of a recreation economy was occasionally promoted as a potential by-product of flood mitigation works. This, however, appeared to contradict ecological goals and generate fear among the inhabitants, leading to diversion strategies. Both the Isar Plan and Noordwaard projects tried to control and concentrate the expected flows of visitors. In Noordwaard, much loved by its inhabitants for its quietness, recreational amenities were concentrated in two peripheral areas. In Munich, there were already possible conflicts of use during the first rounds of public consultation: "A lot of people said 'we want true wilderness here in the city, and no one should go there' (...) Other people wanted to have parties all the time there, with mobile discos systems" (Engelmeyer, 2013). Today the large crowds using the central areas clearly hinder the development of alluvial vegetation, but one should see "ecological value in a different way: [The central meadow] keeps people here, and the areas upstream with more ecological value are not as heavily used as in the past" (id.). Although no building is allowed in the floodplain that could host new businesses, indirect economic benefits can be seen in the neighborhoods adjacent to the river, with a rise in activity for local businesses, a rise in real-estate value, and an acceleration of gentrification processes (id.). In both cases, accessibility to river and floodplain was thus not blocked but rather channeled in order to concentrate recreational facilities, motorized vehicles, and large groups, considered to bring more damage and trouble to plants, animals, and residents.

Finally, besides physical accessibility, visual openness was often also a prerequisite in the elaboration of the projects: Floodplains should not only be usable; they should also be visible and provide panoramic views. In urbanized regions, floodplains were already appreciated for their visual openness in contrast to the built environment. The prerequisite of visual openness was thus a strong one, although often running contrary to the criteria of authenticity and ecological value. Many, for instance, associated the Isère River with an open landscape, although this visual openness was not a natural condition but the result of past works of massive channeling, clearing, and drainage (Girel, 2013). In Munich, the Isar Competition brief required the competitor to design an open landscape and restore alluvial vegetation, two obviously contradictory prerequisites. In both of these cases, the designers had to make choices locally in order to achieve both visual openness and the restoration of ecological corridors: alternating local clearings so as to provide windows onto the horizon with new plantations to reinforce ecological value.

Floodscapes as reality check

Opened up visually and physically accessible, floodscapes participate in the repositioning of natural processes within the living environment, and therefore within the field of spatial design. They reintroduce physicality and positivism into what had long been a defensive and a literally "petrifying" urbanization process, one that had associated safety with permanence and efficiency with absence of care.

Creating a space that emphasizes fluctuation instead of neutralizing its effects – this in and of itself constitutes a radical break with the coercive flood defenses that have dominated European flood management since the Enlightenment, and which had turned most rivers into drainage channels, and had hidden risks and flood processes behind ever-higher levees. Contrary to this, floodscapes form a permanent display of natural variation, offering every citizen the experience of change, which will eventually influence the perception of flood processes, adding individual cognitive experience to a theoretical knowledge that appears insufficient even in the most exposed areas. Witnesses to a flood period along the Isar, Meuse, Rhône, or Isère Rivers are – or will soon be – able to see and experience the effects of natural fluctuations, contemplating the river's seasonal changes not only in height but also width and area, affecting the aspect and the use of their daily environment, and giving meaning and presence to the term "floodplain." Floodscapes as reality check can serve to help appreciate the dangers involved in an adequate way, much more efficiently than communication campaigns, dramatized news, or apocalyptic fiction does. In that regard, floodscapes not only mitigate the direct effects of the flood but, by making it visible, tangible, and acceptable, they also help foster stronger resilience on the part of individuals and community, a key aspect for addressing the destructive effects of flooding.

Like yesterday's Promethean dams and surge barriers, today's floodscapes are the expression of a new cosmogony, which sees a logic of negotiated cohabitation with natural processes replace the old narratives of heroic fight, and hypothetical conquest of a permanent safety. Technology, in particular hydro-engineering, is no longer perceived as the absolute remedy against natural threats but as one ingredient in the delicate balance that needs to be found, in every specific situation, between natural fluctuations and human needs. From that perspective, floodscapes are a collective achievement for those societies that have succeeded in reaching a difficult consensus in terms of risk redistribution, and have made a concerted and lasting effort in terms of investment, negotiation, design, and care. Curiosity and pride should logically follow, as they already have done in Munich with the Isar Plan, now a celebrated urban landscape and city icon. Or as farmer Nol Hoijmaijers, whose land in the Overdiepse Polder is now reopened to flooding at high waters, told a journalist from NOS radio: "I hope that I'll be there when [the flood] happens. The polder has been transformed to play its role at extreme water levels, and so make it visible, also for the whole community" (Hoijmaijers, 2011). Judging by the first projects implemented, farmers and urbanites are ready and willing to play an active role in this historical turn, and together to search for combinatory benefits. There is every reason to believe that more floodscapes could and will be imagined, negotiated, and designed, both by necessity and as a positive and flexible answer to an uncertain future.

Island in the Flaucher area, Munich (2013, June 24, September 7, Rossano/Künzel)

Epilogue

On the eve of the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, or COP 21, planned in December 2015, in Paris, no clear horizon is yet secured for global and coordinated action on climate change. In many regions, changing precipitation, or melting snow and ice are altering hydrological systems (IPCC, 2014), and yet calls for rapid and efficient measures to reduce greenhouse gas emissions and keep global warming below 2°C still come up against economic and political objections, exacerbated by the recent financial crisis and by legitimate aspirations of development. The parable written 5000 years ago in the rich Mesopotamian plains could today apply to water landscapes and societies worldwide: Flood punishes the "uproar of mankind" and its chaotic growth.

In the current context, future change in climatic and hydrological regimes seems inevitable. Furthermore, the current uncertainty about future global warming and its consequences shortens the horizon that it can be dealt with to a few decades, climate scenarios being after that too divergent to provide a solid base for specific measures. This will most certainly put more living environments under stress in the coming decades, and make the shift from fixed flood-containment measures towards flexible spatial strategies, although not totally new, even more relevant. More than sustainability (in the sense of lasting permanence), elasticity should be ambitioned for the valleys and estuaries that should cope in the future with increased fluctuation.

As this research shows, the adaptation of inhabited landscape is highly specific, historically, geographically, and culturally, and dependent on economic and political ups and downs. Yet the pioneering work done in the past twenty years can be exploited to reflect on the modus operandi that can lead to consensual and successful transformations, and allow landscape architects to play a prominent role in future transitions. Increasingly, processes and fluctuations are the core objects of landscape design: Beyond Promethean ambitions, symbiotic dreams, and science fiction, negotiated solutions between natural forces and human interests should be the focus of our research and practice for the present and the near future.

Frédéric Rossano, October 2015

Appendix

From watercolors to point clouds: floodscapes design tools

Parallel to historical investigations and case studies, various experiments were made in the course of this research in order to visualize and model the components of floodscapes designs, through the use of combined cartographic and digital tools. The results of this experiment are partly visible in the main corpus, illustrated with various terrain models, sections and perspectives produced by the author and the assistants of the ETH Zürich, on the base of the information provided by national and European geographical institutes (see "Data and statistical sources" on page 313).

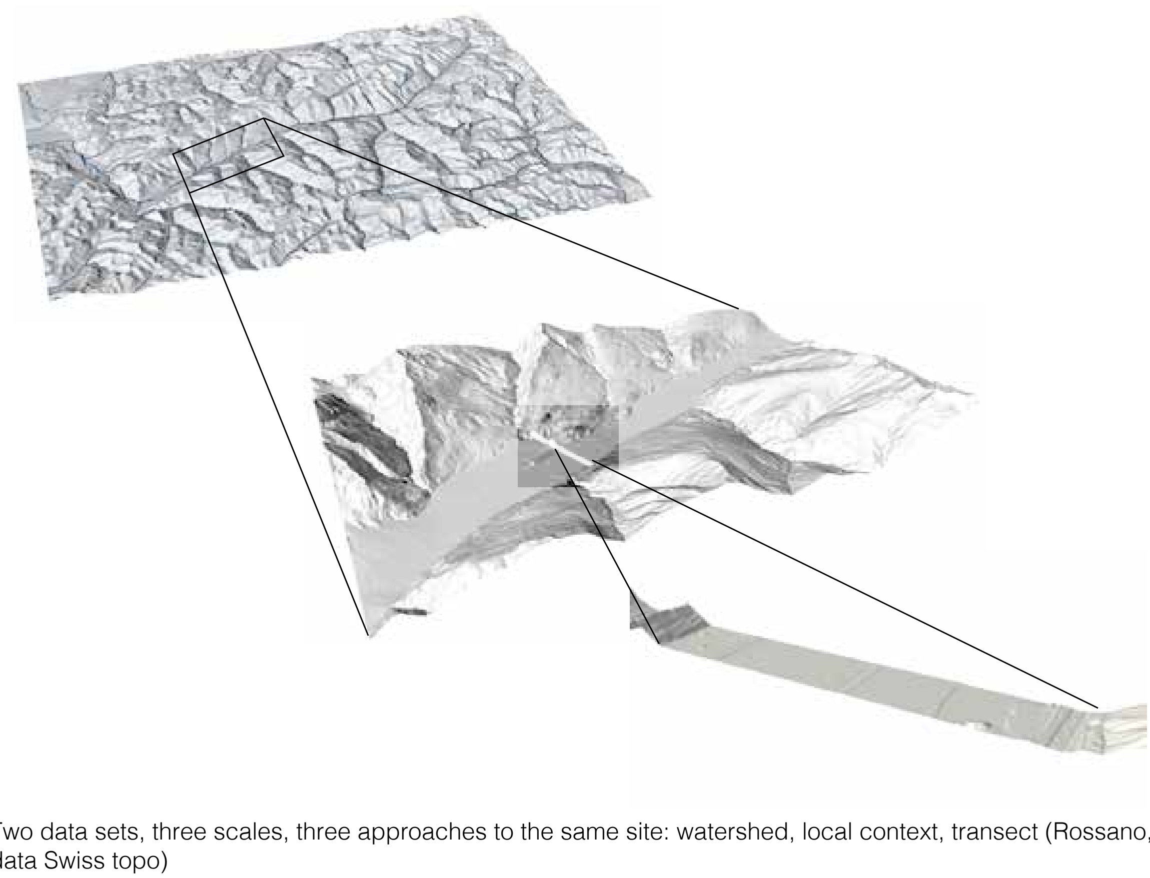
Another part of this experiment is a so-called "research by design", which aimed at simulating a design process onto two locations put under stress by increasing flood risks: the island of Dordrecht in the Netherlands and the region of Sion in Valais. Obviously, the context of this research didn't allow for a coordinated design process and nor for the large consultations that are intrinsic to the elaboration of coherent design: the result is thus not a design proposal, but a suite of analytical and design investigation onto two test-sites. It focuses on the means of design and digital tools today available to landscape architects to better analyze, manipulate and design with topography and flood levels, and how these tools can be combined and improved. This involved the use of GIS, 2D and 3D applications, used to explore some of the new possibilities offered to designers by available terrain data and geographical information.

The following pages illustrate parts of this parallel investigation, which will be further communicated through digital media.

Shifting scales

In this research by design, three active scale were used and associated into connected 3D environments, allowing to jump from one scale to another and keep all levels of reflection interdependant.

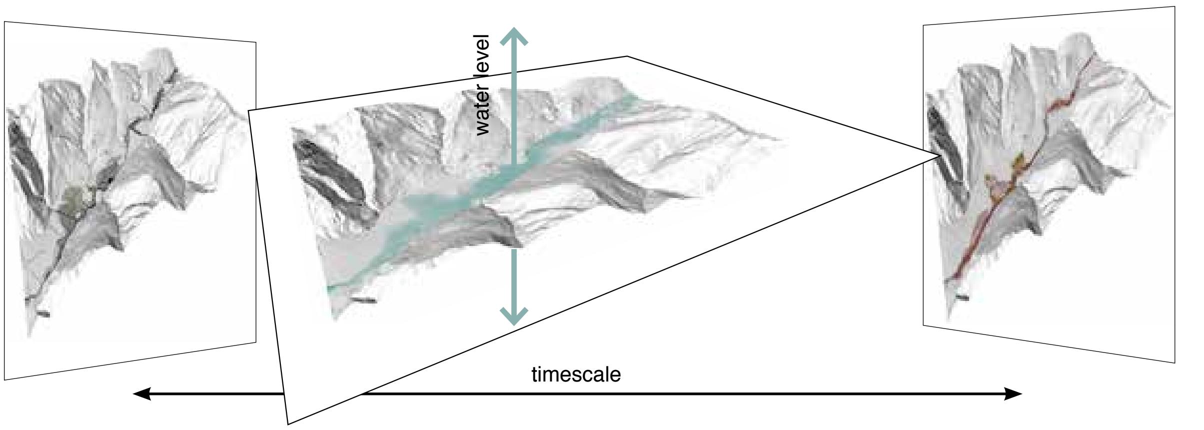
Although the natural scale of flood management is intrinsically regional and can generally be measured in hectares or kilometers, its motivations are also to be found at the smaller scale of a specific site, and at the larger scale of a watershed. It is thus crucial that site and watershed remain within the scope of the design work during the whole process, allowing the different scales to influence each other.



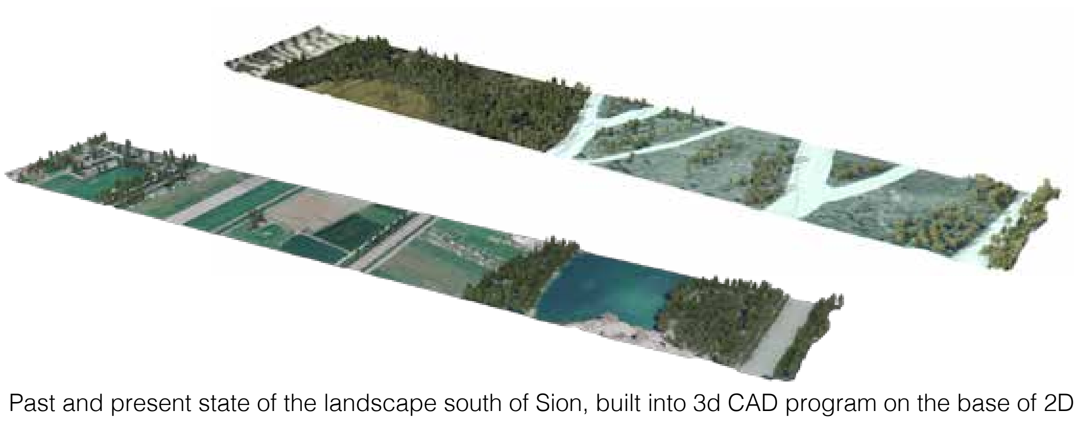
Two data sets, three scales, three approaches to the same site: watershed, local context, transect (Rossano, data Swiss topo)

Synchronization: Historical maps and future visions

The width and the course of European rivers has changed greatly in the the past centuries, both under the influence of climatic and anthropic factors. These changes have affected the occupation of valleys and floodplains and influenced the degree of risk and exposure along the streams. For landscape architecture, bound to deal with slow and ongoing processes, the design can be seen as one stage in a longer history that gains to be known and represented. Easily shifting back and forward between historical material, present state and future visions helps put in perspective the vast areas and massive investments at stake. It also allows to evaluate the validity of future options: the past distribution of built areas, wetlands, roads, irrigation and drainage tells about the natural conditions that have guided past choices, and can help future decisions.



A single terrain model of Sion allows to compare the past state of the river with present flood areas and future scenarios, and put them in relation through the use of variable water levels

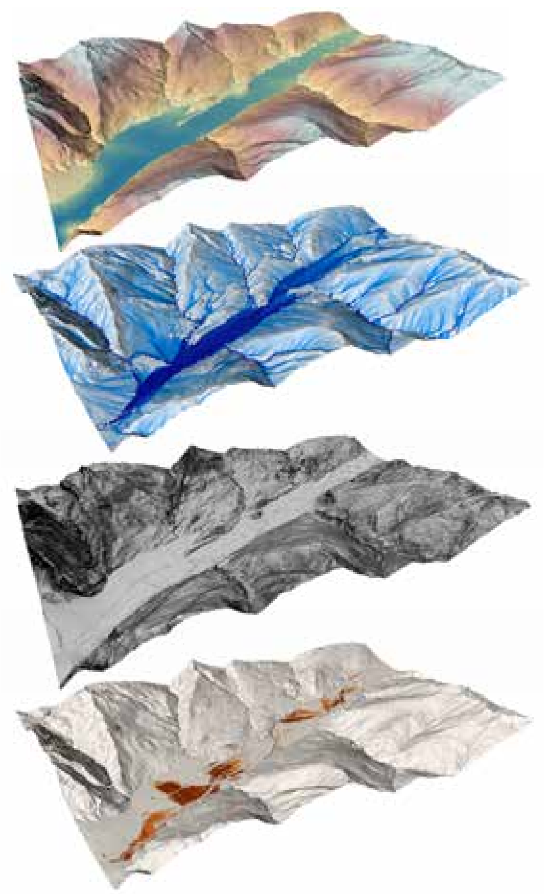


Past and present state of the landscape south of Sion, built into 3d CAD program on the base of 2D maps and point cloud terrain model

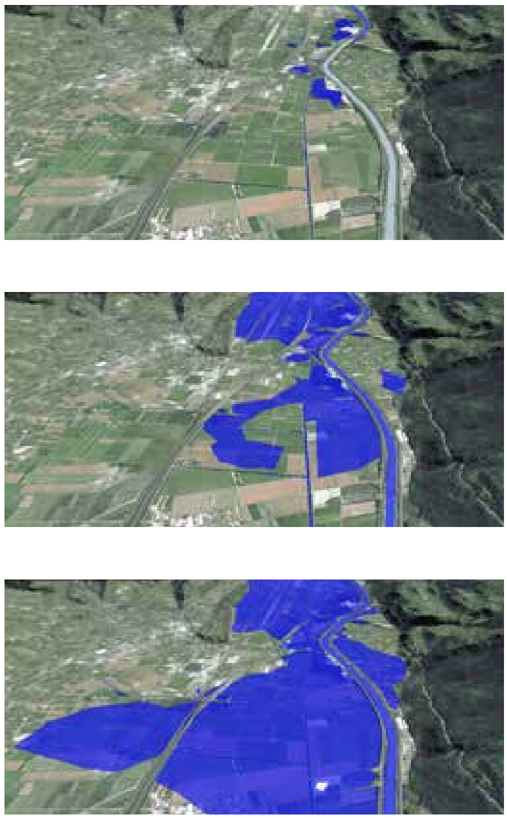
Landscape morphology as risk map

Digital terrain models not only allow for modeling and visualization, they also offer a source of precious information, that can be retrieved through the use of GIS processing programs - such as the identification of potential flood area, runoff patterns, slopes, and hydraulic compartments.

In the design of flood-prone areas, it is ultimately the water level that distinguishes the "safe" from the "submersible". Although other hydrological variables play an important role in flood dynamics (such as erosion or velocity), water levels have the most direct influence on the degree of safety/exposure that can be attributed to a building or a public space, and can be as such easily simulated to evaluate the effects of a spatial intervention at various flood levels, or to envision the potential effects of sea level rise for coastal regions.



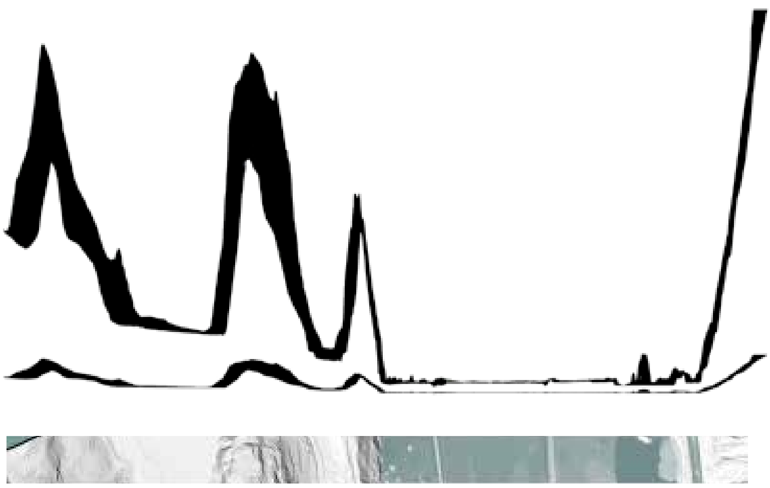
Extracting key informations from terrain model (elevation, runoff, slope, hydraulic compartments)



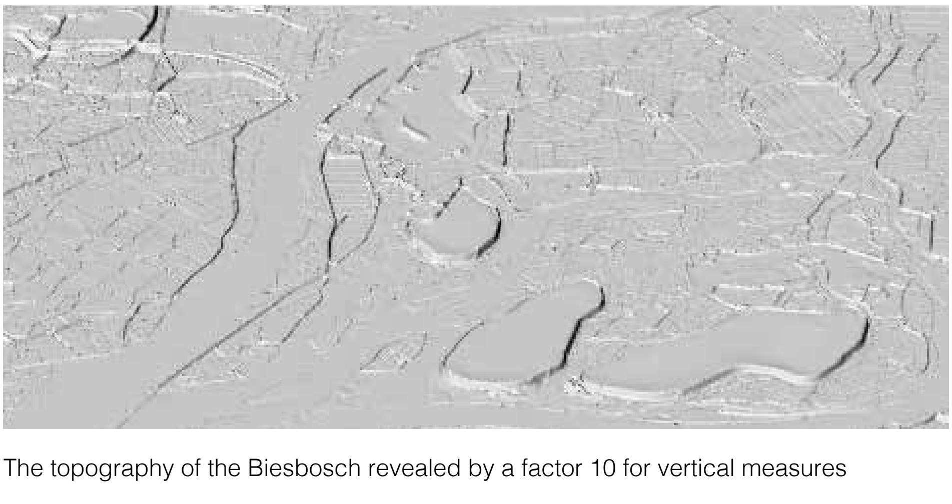
Indicative simulation of flood levels with virtual plane

Revealing micro-topography

Water follows gravity and floods are defined by a micro-topography that is hardly perceptible to the eye, and yet of crucial importance for any intervention in flood prone area - as underpinned by the "Braille Urbanism" promoted by Kelly Shannon (Bax et al., 2012). Subtle asperities are however registered by high precision terrain models, that can in their turn be manipulated and exaggerated to reveal the substratum of landscape design.



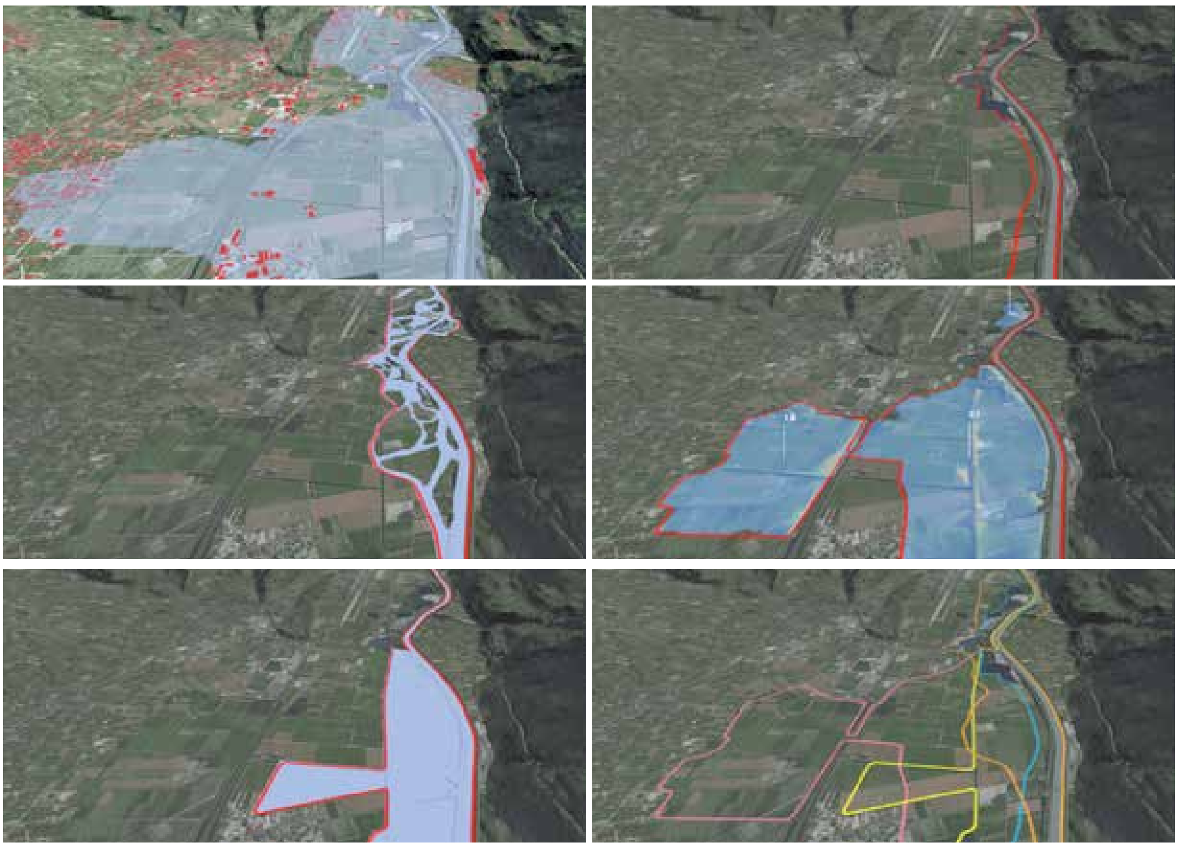
Transect of the Rhône valley south of Sion: top view with floodplain, side view of the same section, same section with factor 10 on vertical axis



The topography of the Biesbosch revealed by a factor 10 for vertical measures

Sketching scenarios

The complexity and reflexive nature of territorial information makes it necessary to connect and combine various aspects of the same area - for instance, the amplitude of urban expansion within flood-prone areas, flood zones and existing obstacles, etc. While pre-digital design and presentation only allowed for the juxtaposition of information, CAD allows to shift from one layer to another, adjust their order and transparency, and sketch various possible strategies related to the different variables. Four scenarios were tested for the Sion and Dordrecht region, all four based on the stragegies found in the case studies: differentiated widening of the riverbed; restoration of former river morphology; creation of flood fields on the lowest areas; creation of permanent ponds with large fluctuation capacity. The above mentioned tools of historical reconstruction and floodplain modeling allowed to model and represent these various scenarios into realistic and interactive models, revealing constrains and potentialities, and offering a support for design and discussion.

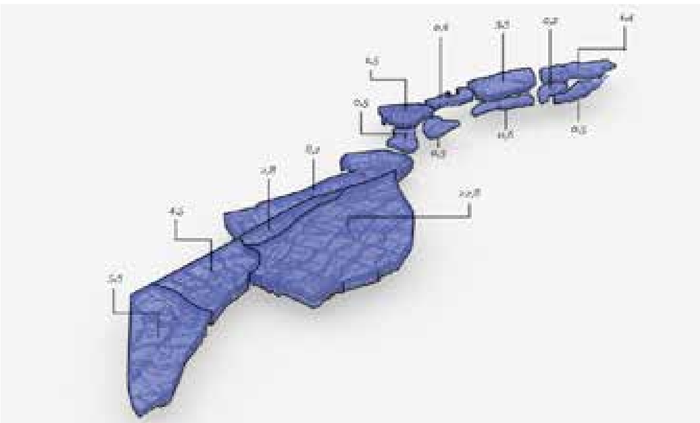


Floodplain between Vetroz and Conthey, four possible strategies for flood mitigation (differentiated river widening, restoration of pre-correction channel, flood meadows, permanent mitigation ponds)

Quantifying options

Finally these options can be easily can be quantified in terms of retention capacity and displaced ground. Both mesh and point cloud models were tested to determine these two crucial dimensions of floodscape design that generally involve large and costly earthworks, using customized tools added to the Rhino CAD software.

With the help of these measuring tools, quantitative and performativity assesment can be done within the interface of a common architectural CAD application, allowing for rapid approximate evaluations during the design process.



Scenarion “fuse polders” in Dordrecht: Evaluation of retention capacity of existing polders (millions m3)

Scenario “extended floodplain”: Modelling and quantifying the volume of displaced ground to restore discharge capacity along the Merwede river (existing levee is displaced and terrain is lowered)

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Bibliography

Quotes in the text originally written and published in other language than English were translated by the author.

Part I

Formation of the deluge myth

Aristotle (1931), Meteorology. Written 350 B.C.E, trans. E. W. Webster (retrieved from http://classics.mit.edu).

Bild.de, 'Von Schmidt bis Merkel - Politiker im Hochwasser. Wahlkampf in Gummistiefeln'. <http://www.bild.de/politik/inland/flut/entscheidet-das-hochwasser-die-bundestagswahl-30691242.bild.html>, accessed 05.06.2013.

Blackbourn, David (2007), The Conquest of Nature. Water, Landscape and the Making of Modern Germany (London: WW Norton & Co).

Blanc, François, known as La Goutte (1733), Grenoblo malhérou (Grenoble: ed. 1733: René Faure; reed. 1860 illustrated by D. Rahoult and engraved by E. Dardelet).

Boersema, J.J. (2011), 'Deugt de Natuur', in B. Siertsema Musschenga, B. (ed.), Het kwaad. Reflectie op de zwarte zijde van ons bestaand. (Vught: Skandalon), 109-22.

Boulanger, Nicolas-Antoine (1766), L'Antiquité dévoilée par ses usages, ou Examen critique des principales opinions, cérémonies et institutions religieuses et politiques des différents peuples de la terre (Amsterdam: Marc Michel Rey).

Buffon, Georges Louis Leclerc, comte de (1778), Histoire naturelle, générale et particulière : supplément. (Volume 5: Les époques de la nature; Paris: Imprimerie Royale).

Champion, Maurice (1858-64), Les inondations en France depuis le VIe siècle jusqu'à nos jours, 6 vols. (Paris: Dunod).

Chepalyga, A.L. (2007), 'Late glacial great flood in the Ponto-Caspian basin', The Black Sea Flood Question: Changes in Coastline, Climate, and Human Settlement (Dordrecht: Springer), 119-48.

Coeur, Denis. La plaine de Grenoble face aux inondations. Genèse d'une politique publique du XVIIe au XXe siècle. Quae, Versailles, 2008.

Courrier du Valais, 10.06.1856, 'Toujours les inondations !', sec. Nouvelles étrangères p. 4.

Creyke, Ralph (1845), 'Some Account of the Process of Warping', The Bristish Farmer's Magazine, 9, 28-36.

Dalley, Stephanie (2000), Myths from Mesopotamia. Creation, The Flood, Gilgamesh, and others (Oxford: Oxford World's Classics).

Diodorus Siculus (1933), The Historical Library of Diodorus the Sicilian, trans. C.H. Oldfather, et al., 15 vols. (Harvard University Press).

The Epic of Gilgamesh (N.K. Sandars, 1972 edn., London: Penguin).

Gornitz, Vivien (2009), 'Sea Level Change, Post-Glacial', Encyclopedia of Paleoclimatology and Ancient Environments (Encyclopedia of Earth Sciences Series: Springer), 887-92.

Kircher, Athanasius (1675), Arca Noe (1675 edn.; Amsterdam: Amstelodami, Apud J. Janssonium a Waesberge).

MacDonald, David (1988), 'The Flood: Mesopotamian Archaeological Evidence', Creation Evolution Journal, 8 (2), 14-20. http://ncse.com/cej/8/2/flood-mesopotamian-archaeological-evidence (accessed 3.12.2014)

Mallowan, M. E. L. (1964), 'Noah's Flood Reconsidered', Iraq, 26 (2), 62-82.

New York Times, 17.12.1996, 'Geologists Link Black Sea Deluge To Farming's Rise'.

Ovid (1893), The Metamorphoses, trans. Henry Thomas Riley (London: Bell).

Origen (1982), Homilies on Genesis and Exodus, trans. Ronald E. Heine (Washington: Catholic University of America Press).

Picon, Bernard and Allard, Paul (2006), Gestion du risque inondation et changement social dans le delta du Rhône (Cemagref).

Plato (4th century BCE), Laws, trans. R.G. Bury. Cambridge (1967 & 1968 edn., Plato in Twelve Volumes, 10 & 11; Cambridge, London: Harvard University Press, William Heinemann Ltd.).

Polyaenus Stratagems, trans. R.Shepherd (1793 edn.: http://www.attalus.org/).

Rigord, Breton, G., Delaborde, H.F. (1883), Oeuvres de Rigord et de Guillaume le Breton, historiens de Philippe-Auguste: Chroniques de Rigord et de Guillaume le Breton, 2 vols. (1: Librairie Renouard, H. Loones, successeur).

Rooijendijk, Cordula (2009), Waterwolven: een geschiedenis van stormvloeden, dijkenbouwers en droogmakers (Amsterdam: Atlas Contact).

Rose, Jeffrey I. (2010), 'New Light on Human Prehistory in the Arabo-Persian Gulf Oasis', Current Anthropology, 51 (6), 849-83.

Rossignol-Strick, Martine (1995), 'Sea-Land Correlation of Pollen Records in the Eastern Mediterranean for the Glacial-Interglacial transition: biostratigraphy versus radiometric time-scale', Quaternary Science Reviews, 14, 893-915.

Rousseau, Jean-Jacques (1780-89), 'Discours sur l'origine et les fondements de l'inégalité parmi les hommes', Collection complète des oeuvres de J.J. Rousseau (Genève).

Ryan, William B.F., et al. (1997), 'An abrupt drowning of the Black Sea shelf', Marine Geology, Volume 138 (1–2), 119–26.

Ryan, William B. F. (2007), 'Status of the Black Sea flood hypothesis', in Valentina Yanko-Hombach, et al. (eds.), The Black Sea Flood Question: Changes in Coastline, Climate, and Human Settlement (Springer Netherlands).

Sartre, Jean-Paul (1938), Nausea, trans. Lloyd Alexander (1969 edn.; New York: New Directions Publishing).

Smith, George (1873), 'The Chaldean Account of the Deluge', Transactions of the Society of Biblical Archaeology, 2, 213-34.

Svitoch, Aleksander Adamovich (2009), 'Khvalynian transgression of the Caspian Sea was not a result of water overflow from the Siberian Proglacial lakes, nor a prototype of the Noachian flood', Quaternary International, Volume 197 (15 March 2009), 115-25.

Voltaire, François Arouet and Frédéric II, Roi de Prusse (1736-1778), Correspondance de Voltaire avec le Roi de Prusse (1889 edn.; Paris: Librairie de la Bibliothèque Nationale).

Wuhrmann, Sylvie and Cariel, Rémi (2006), ''Diluvio e sua dimostrazione in pittura': les enjeux artistiques du déluge', Visions du déluge de la Renaissance au XIXe siècle (Paris: Réunion des Musées Nationaux).

Yanko-Hombach, Valentina, et al. (eds.) (2007), The Black Sea Flood Question: Changes in Coastline, Climate, and Human Settlement (Dordrecht: Springer).

Yanko-Hombach, V.V., Dolukhanov, P., and Gilbert, A.S. (2010), 'The great Flood hypotheses in the Black Sea: Caspian and Mediterranean impacts in the Pontic Basin seen from environmental and cultural perspectives', The Caspian Region: Environmental Consequences of the Climate Change (Moscow: Faculty of Geography).

Biblical quotes retrieved from the Common English Bible (2008-2011) and retrieved from https://www.biblegateway.com

Pre-industrial floodplains

Alexander, David (1984), 'The Reclamation of Val-di-Chiana (Tuscany)', Annals of the Association of American Geographers, 74 (4), 527-50.

Allard, Paul and Labeur, Christine (2009), 'Evolution des vulnérabilités des riverains du Bas-Rhône (France) du XVIIIe à nos jours', Le Rhône: Dynamique, Histoire et Société (Cahiers de Vallesia 21; Sion: Vallesia), 177-96.

Appolonius Rhodius (3rd Century B.C.), The Argonautica, trans. 1912 R.C. Seaton (Cambridge MA: Harvard University Press).

Bink, Kees, et al. (2011), De Overdiepse Polder. 750 jaar geschiedenis van een polder in de delta (Waspik: Heemkundekring Op't Goede Spoor).

Boersema, Jan J. (2011), 'Deugt de Natuur', in B. Siertsema Musschenga, B. (ed.), Het kwaad. Reflectie op de zwarte zijde van ons bestaand. (Vught: Skandalon), 109-22.

Boersma, J. W., et al. (1972), Terpen, mens en milieu, ed. J. W. Boersma (Haren: Knoop & Niemeijer).

Bonaparte, Louis Napoleon (1856), 'Lettre de l'Empereur à son Ministre des Travaux Publics', (2S 99; Plombières: Archives Départementales du Loiret).

Borgeat-Theler, Muriel, Scheurer, Alexandre, and Dubuis, Pierre (2011), 'Le Rhône et ses riverains entre Riddes et Martigny (1400-1860)', (Cahiers de Vallesia, 66; Sion: Archives de l'Etat du Valais), 1-106.

Cadell, W. A. (1820), A journey in Carniola, Italy, and France in the Years 1817, 1818 (Edinburgh: A. Constable).

Choron, M. (1871), 'Mémoire sur le colmatage des terrains de la vallée de l'Isère, partie comprise dans la Savoie entre le pont de Grésy et la limite du département', Annales des ponts et chaussées. Mémoires et documents relatifs à l'art des constructions et au service de l'ingénieur, (5e série, 2e semestre), 311-60.

Cook, Hadrian, Stearne, Kathy, and Williamson, Tom (2003), 'The origins of water meadows in England', The Agricultural History Review, 51.

Courrier du Valais, 03.07.1856, 'De l'utilite d'une école d'agriculture en valais'.

Creyke, Ralph (1845), 'Some Account of the Process of Warping', The Bristish Farmer's Magazine, 9, 28-36.

Direction Départementale de l'Equipement du Loiret (2010), 'Plan de Prévention du risque d'inondation de la Vallée de la Loire'.

Drizard, Antoine (1868), 'Mémoire sur le colmatage des terrains de la vallée de l'Isère, partie comprise dans la Savoie entre le pont de Grésy et la limite du département', Annales des ponts et chaussées. Mémoires et documents relatifs à l'art des constructions et au service de l'ingénieur, 16 (4e série, 2e semestre), 593-632.

Foreville, Raymonde (1961), 'Roger Dion, Histoire des Levées de la Loire', Annales de Bretagne, 68 (3), 491 - 94.

Fournier, Marie (2008), 'Quelle place pour les riverains dans la gestion des inondations de la Loire ? Les leçons du passé', (Orléans: Etablissement Public Loire).

Girel, Jacky (2008), 'River Diking and Reclamation in the Alpine Piedmont', in Christof Mauch and Thomas Zeller (eds.), Rivers in History. Perspectives on Waterways in Europe and North America (Pittsburgh: University of Pittsburgh Press), 78-88.

Girel, Jacky (2010), 'Histoire de l'endiguement de l'Isère en Savoie : conséquences sur l'organisation du paysage et la biodiversité actuelle', Géocarrefour, Vol. 85 (1).

Guillou, Samuel and Maurin, Jean (2005), 'Les levées de la Loire : des turcies au Plan Loire, huit siècles d'évolution', Ingénieries EAT, Spécial Sécurité des digues fluviales et de navigation, 31-39.

Kempenaer, J. G. de, Brandenburg, W.A., and Hoof, L.J.W. van (2007), 'Het zout en de pap. Een verkenning bij marktexperts naar langeretermijnmogelijkheden voor zilte landbouw', (Utrecht: Innovatienetwerk).

Lebecq, Stéphane (1979), 'De la protohistoire au Haut Moyen Âge : le paysage des "terpen" le long des côtes de la mer du Nord, spécialement dans l'ancienne Frise ', Actes des congrès de la Société des historiens médiévistes de l'enseignement supérieur public, 10, 125-51

Lebecq, Stéphane (1997), 'Entre terre et mer : la mise en valeur des contrées littorales de l'ancienne Frise', Histoire, économie et société, year 16 (3), 361-76.

Lendering, Jona, (2002), 'The Edges of the Earth'. <http://www.livius.org/concept/the-edges-of-the-earth-1/>

Lendering, Jona and Bosman, Arjen (2012), Edge of empire: Rome's frontier on the Lower Rhine (Rotterdam: Karwansaray).

'Lex Frisionum' (ca. 785) (Basel: transcription by Joannis Basilius Herold, 1557, trans. Kees Nieuwenhuijsen) <http://www.keesn.nl/lex/>, accessed on 19.01.2015

Loudon, J. C. (1871), An Encyclopedia of Agriculture (London: Longmans, Green and co.).

Mauch, Christof, et al. (2008), Rivers in History. Perspectives on Waterways in Europe and North America (Pittsburgh: University of Pittsburgh Press).

Meriaux, Patrice and Royet, Paul (2004), 'Les déversoirs fusibles le sont-ils vraiment ? Are fuse weirs so fusible?', Sécurité des digues fluviales et de navigation (Orléans, France: Cemagref), 187-199.

Oudot, D. (1989), 'Les Îles de la Loire angevine armoricaine', Norois, 205-23.

Pliny the Elder, Natural History, trans. John Bostock and H.T. Riley (1855 edn., London: Taylor and Francis).<http://www.perseus.tufts.edu/hopper/text?doc=Perseus%3Atext%3A1999.02.0137%3Abook%3D16%3Achapter%3D1>, accessed on 6.01.2015.

Schoeneich, Philippe (2009), 'Histoire des aménagements du Rhône et de la plaine dans le Chablais', Cahiers de Vallesia (21; Sion: Archives de l'Etat du Valais), 151-66.

Sereni, Emilio (1997), History of the Italian Agricultural Landscape (Princeton: Princeton University Press).

Smart, P. J., Wheeler, B.D., and Willis, A. J. (1986), 'Plants and peat cutting: Historical ecology of a much exploited peatland - Thorne Waste, Yorkshire, UK ', New Phytologist, 104 (4), 731-48.

Smith, Thomas M. (2012), ' Enclosure & agricultural improvement in north-west Lincolnshire from circa 1600 to 1850', PhD (University of Nottingham).

Ter Haar, Gerard and polhuis, Peter L. (2004), De loop van het Friese water. geschiedenis van het waterbeheer en de waterschappen in Friesland (Franeker: Van Wijnen).

Van Wijk, Wim (2012), Historische Atlas van de Biesbosch (Zwolle: W Books).

Varenius (1734), A compleat system of general geography, eds Isaac Newton and Dr Jurin, trans. Dugdale (London: Stephen Austen).

Williams, M. (1963), 'The Draining and Reclamation of the Somerset Levels, 1770-1833', Transactions and Papers (Institute of British Geographers), 33 (Dec., 1963), pp. 163-79.

Dreams and achievements of the Great Reclamation works/ After the Correction

Agard, Maurice (1942), 'L'endiguement de l'Isère en Grésivaudan', Revue de géographie alpine, 30 (4), 701-71.

Attinger, Victor, Godet, Marcel, and Turler, Henri (1930), 'Dictionnaire historique et biographique de la Suisse', (Neuchatel: Administration du Dictionnaire historique et biographique de la Suisse).

Bender, Gabriel (2001), 'Où est passée la Camargue valaisanne?', in Pierre Dubuis (ed.), La mémoire dans la vie (Sion), 87-103.

Bender, Gabriel (2004), 'Correcting the Rhone and the Valaisans : three centuries of works and debate', Revue de Géographie Alpine, 92 (92-3), 62-72.

Bink, Kees, et al. (2011), De Overdiepse Polder. 750 jaar geschiedenis van een polder in de delta (Waspik: Heemkundekring Op't Goede Spoor).

Blackbourn, David (2000), '"Conquests from Barbarism": Interpreting Land Reclamation in 18th Century Prussia.', International Congress of Historical Sciences (Oslo).

Blackbourn, David (2007), The Conquest of Nature. Water, Landscape and the Making of Modern Germany (London: WW Norton & Co).

Blotnitzki, L. and Hartmann, A. (1861), 'Rapport d'expert sur la Correction du Rhône au Département fédéral de l'Intérieur et des Travaux publics. (Du 6 Avril 1861.)', Feuille Fédérale Suisse, 14 Février 1863 (15, 1, 7; Bern), 294-306.

Boersema, Jan J. (2011), 'Deugt de Natuur', in B. Siertsema Musschenga, B. (ed.), Het kwaad. Reflectie op de zwarte zijde van ons bestaan (Vught: Skandalon), 109-22.

Bonaparte, Louis Napoleon (1856), 'Lettre de l'Empereur à son ministre des Travaux Publics', (2S 99; Plombières: Archives Départementales du Loiret).

Bonaparte, Louis Napoleon (1860), 'Lettre de l'Empereur au ministre d'Etat', in Journal d'Agriculture Pratique, yr. 24 (1).

Borgeat-Theler, Muriel, Scheurer, Alexandre, and Dubuis, Pierre (2011), 'Le Rhône et ses riverains entre Riddes et Martigny (1400-1860)', (Cahiers de Vallesia, 66; Sion: Archives de l'Etat du Valais), 1-106.

Buffon, Georges Louis Leclerc, comte de (1778), Natural history: general and particular (1780-85 edn.; Edinburgh: William Creech).

Champion, Maurice (1858-64), Les inondations en France depuis le VIe siècle jusqu'à nos jours, 6 vols. (Paris: Dunod).

Confédéré du Valais, 28.02.1864, 'A la rédaction du Confédéré du Valais', sec. Canton du Valais p. 1.

Confédéré du Valais, 17.09.1913, 'Exhumation', p. 1.

Conseil Fédéral Suisse, Fornerod, and Schikks (1863), 'Message du Conseil Fédéral à 'Assemblée Fédérale concernant la correction du Rhône dans le Canton du Valais (Du 19 Janvier 1863)', Feuille Fédérale Suisse (15, 1, 7; Bern), 273-93.

Cooke, Alice M. (1893), 'The Settlement of the Cistercians in England', The English Historical Review, 8 (32).

Corbin, Alain (1988), Le Territoire du vide. L'Occident et le désir du rivage, 1750-1840 (Paris: Aubier).

Curtis, Daniel R. and Campopiano, Michele (2013), 'Medieval land reclamation and the creation of new societies: comparing Holland and the Po Valley, c.800-c.1500', Journal of Historical Geography, 30, 1-16.

Dapples, et al. (1861), 'Rapport de la Commission du Conseil des Etats sur la correction du Rhin (Du 11 juillet 1861.)', Feuille Fédérale Suisse (13, 2, 45; Bern), 663-71.

Dauphiné Libéré, 02.02.1968, 'Au Versoud, l'Isère a changé de lit'.

De Torrenté, Charles and de Kalbermatten, Arnold (1964), La correction du Rhône en amont du lac Léman (Bern: Service fédéral des routes et des digues).

Du Buat, Pierre L. G. (1786), Principes D'Hydraulique Vérifiés par un grand nombre d'Expériences faites par ordre du Gouvernement, 2 vol. (Paris: Imprimerie de Monsieur).

Du Buat, Pierre L. G. (1789), 'Lettre à Gamon de Monval, ingénieur à Grenoble', in Champion, Maurice (1858-64), Les inondations en France depuis le VIe siècle jusqu'à nos jours, 6 vols. (Paris: Dunod).

Evéquoz-Dayen, Myriam (2009), 'Des sources pour l'étude du Rhône valaisan', Le Rhône: Dynamique, Histoire et Société (Cahiers de Vallesia 21; Sion: Vallesia), 47-62.

Girel, Jacky (2005), 'Les paysages alluviaux alpins (histoire, diagnostic, gestion, restauration et protection)', (Université Joseph Fourier Grenoble, Laboratoire d'Ecologie Alpine).

Haenni, William (1929), 'Le Rhône Valaisan et ses corrections', 3e congrès du Rhône (Geneva), 37-45.

Historisches Lexicon der Schweiz [online text], <http://www.hls-dhs-dss.ch/d/home>

Hydronat (2000) Rapport de synthèse (juin 2000) [online text], Canton du Valais. Département des Transports, de l'Equipement et de l'Environnement. Service des Routes et des Cours d'Eau <http://www.vs.ch/Navig/navig.asp?MenuID=5256&Language=fr>

Laval (1845), 'Rapport sur un mémoire de M. Puvis relatif à l'endiguement de la Saône', Annales des sciences physiques et naturelles, d'agriculture et d'industrie, 8, 217-31.

Lehouck, Alexander and van Acker, Jan (2011), 'Vorming van monastieke landschappen? Domeinbeheer door religieuze instellingen in Noordwest-Europa van de 12de tot de 18de eeuw', Novi Monasterii. Jaarboek Abdijmuseum Ten Duinen, 1-9.

Lenthéric, Charles (1892), Le Rhône : du Saint-Gothard à la mer : histoire d'un fleuve, 2 vols. (Paris: Plon).

Locke, John (1690) Second Treatise of Government [online text], <http://www.gutenberg.org>

Lortet (1846), 'Rapport fait à la Société Royale d'Agriculture, etc, de Lyon, dans sa séance du 5 Juin 1846, par M. le Dr Lortet, sur un ouvrage intitulé: Atterrissements artificiels dans la vallée de l'Isère supérieure, cause des fièvres endémiques et périodiques de cette vallée et moyens de les prévenir; par Ant. Chiron, Architecte de la Ville, à Chambéry', Annales des sciences physiques et naturelles, d'agriculture et d'industrie, 9, 729-36.

Pautou, Guy, et al. (1995), 'Hydrologie, paludisme et démoustication. (L'exemple de la Région Rhône-Alpes)', Revue de géographie alpine, 83 (1), 33-52.

Pichard, Georges (1995), 'Les crues sur le bas Rhône de 1500 à nos jours. Pour une histoire hydro-climatique', Méditerranée, 82 (03.04.1995), 105-16.

Pigeon, et al. (1845), 'Rapport sur un Mémoire de M. Puvis, concernant l'endiguement des rivières en général et celui de la Saône en particulier, par M. PIGEON', Annales des sciences physiques et naturelles, d'agriculture et d'industrie, 8, 233-44.

Puvis, Marc-Antoine (1844), De l'Endiguement des fleuves, des rivières et des torrens (Paris: Mme Huzard).

Puvis, Marc-Antoine (1847), Über die Eindämmung flissender Gewässer, trans. Carl Müller (Vienna: Carl Gerold).

Rousseau, Jean-Jacques (1763), 'Lettre à M. Le Maréchal de Luxembourg, le 28 janvier 1763', (Môtiers).

Rousseau, Jean-Jacques (1754), 'A Dissertation on the origin and foundation of the inequality of mankind', (1923 edn.; London and Toronto: J.M. Dent and Sons).

Rousseau, Jean-Jacques (1763), 'Letter to Beaumont', in Roger D. Masters and Christopher Kelly (eds.), Letters written from the mountains and related things. The collected writings of Rousseau. (2001 edn., 9; Hanover & London: University Press of New England).

Schenk, et al. (1863), 'Rapport de la Commission du Conseil des Etats sur la correction du Rhône (Du 24 juin 1863.)', Feuille Fédérale Suisse (15, 3, 29; Bern), 33-65.

Schoeneich, Philippe (2009), 'Histoire des aménagements du Rhône et de la plaine dans le Chablais', Cahiers de Vallesia (21; Sion:

Archives de l'Etat du Valais), 151-66.

Smith, Thomas M. (2012), ' Enclosure & agricultural improvement in north-west Lincolnshire from circa 1600 to 1850', PhD (University of Nottingham).

Speich, Daniel (2002), Linth Kanal. Die korrigierte Landschaft – 200 Jahre Geschichte (Glarus: Baeschlin).

Speich, Daniel (2002), 'Draining the Marshlands, Disciplining the Masses: The Linth Valley Hydro Engineering Scheme (1807–1823) and the Genesis of Swiss National Unity', Environment and History, 8, 429-47.

State of Valais, (1907), 'Constitution du Canton du Valais du 8 mars 1907'. <http://www.admin.ch/opc/fr/classified-compilation/19070006/index.html>

Staüble, Sabine (2009), 'Evolution de la plaine du Rhône suisse du début du XIXe siècle à nos jours: étude cartographique dans le Valais central', Le Rhône: Dynamique, Histoire et Société (Cahiers de Vallesia 21; Sion: Vallesia), 167-76.

Summermatter, Stephanie (2006), 'Naturkatastrophen in der Schweiz im 19. Jahrhundert', Forum, 8 (Thema: Hochwasser), 5-13.

Tulla, Johann G. (1825), Über die Rektifikation des Rheins von seinem Austritt aus der Schweitz bis zu seinem Eintritt in das Großherzogthum Hessen (Karlsruhe: Müller).

Van Acker, J. (2014) 800 Jaar Cîteaux in Zuid-West-Vlaanderen [online text], <https://www.academia.edu/>

Van Wijk, Wim (2012), Historische Atlas van de Biesbosch (Zwolle: W Books).

Venetz, Ignace (1851), Mémoire sur les digues insubmersibles, sur les écluses à cheminées pour le colmatage et sur les principes à suivre dans les corrections des cours d'eau, avec leur application spéciale aux redressements de l'Orbe et de la Broye et à l'assainissement des marais adjacents. (Genève: Bibliothèque Universelle).

Vierlingh, Andries (1579), Tractaet van Dyckagie (1920 edn.; Den Haag: Martinus Nijhoff).

Voltaire, François Arouet and Frédéric II, Roi de Prusse (1736-1778), Correspondance de Voltaire avec le Roi de Prusse (1889 edn.; Paris: Librairie de la Bibliothèque Nationale).

Walckenaer, Charles A. (1798), Essai sur l'histoire de l'espèce humaine (Paris: Du Pont).

Walter, François (1990), Les Suisses et l'environnement. Une histoire du rapport à la nature du 18e siècle à nos jours (Geneva: Zoé).

Warner, Jeroen Frank, Buuren, Arwin Van, and Edelenbos, Jurian (2013), 'Making Space for the River. Governance challenges', in Arwin Van Buuren Jeroen Frank Warner, Jurian Edelenbos (ed.), Making Space for the River. Governance experiences with multifunctional river flood management in the US and Europe (London: IWA), 1-13.

Part II

New European floodscapes

Bax, Judith, et al. (2012), Rising Waters, Shifting Lands., ed. Frédéric Rossano (Pamphlet, 16; Zurich: GTA).

Hajer, Maarten, et al. (2006), Een plan dat werkt. Ontwerp en politiek in de regionale planvorming, eds Maarten Hajer, Dirk Sijmons, and Fred Feddes (Rotterdam: NAi).

Warner, Jeroen Frank, Buuren, Arwin Van, and Edelenbos, Jurian (2013), 'Making Space for the River. Governance challenges', in Arwin Van Buuren Jeroen Frank Warner, Jurian Edelenbos (ed.), Making Space for the River. Governance experiences with multifunctional river flood management in the US and Europe (London: IWA), 1-13.

Climate change expectations and narratives

Aristotle (c. 350 B.C.E), Meteorology, trans. E. W. Webster (1931 edn.: http://classics.mit.edu).

Benton, George s., et al. (1977), 'The Atmospheric Sciences: Problems and Applications', (Washington, D.C. 1977: Committee on Atmospheric Sciences, Assembly of Mathematical and Physical Sciences, National Research Council).

Behringer, Wolfgang (2010), A Cultural History of Climate (Cambridge: Polity Press).

Buffon, Georges-Louis Leclerc, Comte de (1779), Histoire naturelle, générale et particulière, supplément, Volume 5: Les époques de la nature; Paris: Imprimerie Royale).

Buffon, Georges Louis Leclerc, comte de (1778), Natural history: general and particular (1780-85 edn.; Edinburgh: William Creech). supplément. (Tome Cinquième. Septième et dernière Époque. Lorsque la puissance de l'Homme a secondé celle de la Nature. (1780-85 edn.; Edinburgh: William Creech)

Committee on Atmospheric Sciences, Assembly of Mathematical and Physical Sciences, and National Research Council (1977), 'The Atmospheric Sciences: Problems and Applications', (Washington: National Academy of Sciences).

Duhem, Pierre (1958), Le système du monde : histoire des doctrines cosmologiques de Platon à Copernic (9; Paris: Hermann).

Duhem, Pierre (1958), Le système du monde : histoire des doctrines cosmologiques de Platon à Copernic (9; Paris: Hermann).

Folland, C.K., T.R. Karl, J.R. Christy, R.A. Clarke, G.V. Gruza, J. Jouzel, M.E. Mann, J. Oerlemans, M.J. Salinger and S.-W. Wang, (2001), '2001: Observed Climate Variability and Change.', in R.K. Pachauri and L.A. Meyer Core Writing Team (ed.), Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (Houghton, J.T.,Y. Ding, D.J. Griggs, M. Noguer, P.J. Van der Linden, X. Dai, K. Maskell, and C.A. Johnson edn.; Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press).

Heems, Geertruida C. and Kothuis, Baukje L. M. (2012), 'Waterveiligheid; Managen van Kwetsbaarheid. Voorbij de Mythe van Droge Voeten. De Nederlandse omgang met overstromingsdreiging in sociaal-cultureel perspectief', PhD (University of Maastricht).

Holzhauser, H. and Zumbühl, H. J. (1999), 'Glacier Fluctuations in the Western Swiss and French Alps in the 16th century', Climatic Change 43 (1), 223-37.

IPCC (2014), Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, ed. R.K. Pachauri and L.A. Meyer Core Writing Team (Geneva).

KNMI (2014), 'KNMI'14-klimaatscenario's voor Nederland; Leidraad voor professionals in klimaatadaptatie', (De Bilt: KNMI, Koninklijk Nederlands Meteorologisch Instituut).

Lesher, James (2014) Xenophanes [online text], The Stanford Encyclopedia of Philosophy (Fall 2014 Edition) <http://plato.stanford.edu/archives/fall2014/entries/xenophanes/>, accessed 11.03.2015.

McGrath, Math (2014), 'Dissent among scientists over key climate impact report', BBC news, Sciences and environment, (25.03.2014). <http://www.bbc.com/news/science-environment-26655779?print=true>, accessed 09.03.2015.

Météosuisse, Office fédéral de météorologie et de climatologie (2014), 'Scénarios climatiques Suisse – un aperçu régional', Rapport technique n° 243 (Bern: Département fédéral de l'intérieur DFI. Confédération suisse).

Meyer, Han, Bobbink, Inge, and Nijhuis, Steffen (2010), Delta Urbanism: The Netherlands (Chicago and Washington: American Planning Association).

Oppenheimer, Clive (2003), 'Climatic, environmental and human consequences of the largest known historic eruption: Tambora volcano (Indonesia) 1815', Progress in Physical Geography 27,2 (2003) pp. 230–259, 27 (2), 230–59.

Ovid (c. 8 AD), The Metamorphoses, trans. Henry Thomas Riley (1893 edn., London: Bell).

Peterson, Thomas C., Connolley, William M., and Fleck, John (2008), 'The Myth of the 1970s Global Cooling Scientific Consensus', Bulletin of the American Meteorological Society, (89), 1325–37.

Reeves, Robert W. and Gemmill, Daphne (2004), 'Origins of a 'diagnostics climate center'', 29th Annual Climate Diagnostics & Prediction Workshop (Madison, USA).

Steno, Nicolaus (1916), The prodromus of Nicolaus Steno's dissertation concerning a solid body enclosed by process of nature within a solid, trans. J. G. Winter (Macmillan and Company; New York, London).

Theopheastus of Eresus (300 B.C.E), On Winds and Wheather signs, trans. Jas. G. Wood (1894 edn.; London: Edward Stanford).

Varenius (1734), A compleat system of general geography, eds Isaac Newton and Dr Jurin, trans. Dugdale (London: Stephen Austen).

Venetz, Ignace (1833), 'Memoire sur les variations de la température dans les Alpes de la Suisse (Rédigé en 1821)', Denkschriften der Allgemeinen Schweizerischen Gesellschaft für die Gesammten Naturwissenschaften, 1 (2), 1-38.

Volkskrant, (1.04.2014), 'Reele klimaatscenarios dramatisch samengevat. Analyse IPCC rapport', p. 3-4.

Volkskrant, (26.05.2014), 'Nederlandse winters gaan op die van Bordeaux lijken', <http://www.volkskrant.nl/vk/nl/9104/2014/article/print/detail/3661910/Nederlandse-winters-gaan-op-die-van-Bordeaux-lijken.dhtml>, accessed 29.05.14.

Framing a new flood management policy

Blanc, François, known as La Goutte (1733), Grenoblo malhérou (Grenoble: ed. 1733: René Faure; reed. 1860 illustrated by D. Rahoult and engraved by E. Dardelet).

Ministerie van Verkeer en Waterstaat (2006), 'Spatial Planning Key Decision 'Room for the River'. Investing in the safety and vitality of the Dutch river basin region', (the Hague).

OFS, Office fédéral de la statistique (2013), 'Produit intérieur brut par grande région et canton. Rapport de méthode et brève analyse des résultats', (Neuchâtel: Confédération Suisse, Département fédéral de l'intérieur).

Projet Rhône (2008), 'Troisième correction du Rhône. Sécurité pour le futur. Rapport de Synthèse du Plan d'aménagement', (Sion: Canton du Valais, Département des transports, de l'équipement et de l'environnement, Service des routes et des cours d'eau).

Projet Rhône (2011), 'Zones de danger d'inondation du Rhône. Rapport technique, 26 mai 2011', (Sion: Canton du Valais, Département des transports, de l'équipement et de l'environnement, Service des routes et des cours d'eau).

Rode, Sylvain (2012), 'Le chêne ou le roseau : quelles stratégies de gestion du risque d'inondation en France ?', Cybergeo : European Journal of Geography [Online]. Accessed 19 August 2013.

Ruimte voor de Rivier (2011), Samen werken aan een veilig en mooi rivierengebied (Utrecht: Programmadirectie Ruimte voor de Rivier).

Vierlingh, Andries (1579), Tractaet van dyckagie (1920 edn.; Den Haag: Martinus Nijhoff).

Vischer, Daniel L. (2003), 'Histoire de la protection contre les crues en Suisse', Rapports de l'OFEG, Série Eaux (5; Bern: Office fédéral des eaux et de la géologie).

Room for the River: reversible landscapes in the Rhine-Meuse Delta

Bink, Kees, et al. (2011), De Overdiepse Polder (Waspik: Heemkundekring Op't Goede Spoor).

Dauvellier, Peter (1991), 'Ruimtelijke kwaliteit: de oorsprong en de toepassing van een begrip', Symposium Werkgroep Landelijke Gebieden / LU (Wageningen).

De Gast, Cees (2004), De macht van het water. Leven met water tussen Maas en Merwede (Raamsdonkveer: Verse Hoeven).

De Jong, S.A., et al. (2000), Vergroting van de afvoercapaciteit en berging in de benedenloop van Rijn en Maas. Bestuurlijk advies aangeboden aan de staatssecretaris van Verkeer en Waterstaat door de Stuurgroep Integrale Verkenning Benedenrivieren. (Rotterdam: Rijkswaterstaat, Directie Zuid-Holland).

De Jonge, Jannemarie (2009), Landscape Architecture between Politics and Science. (Wageningen: Blauwdruk).

De Koning, Robbert, Eshuis, Liesbeth, and ARCADIS (2008), Rivieren en Inspiratie (Utrecht: Programmadirectie Ruimte voor de Rivier).

Heezik, Alex van (2007), De strijd om water (HNT Historische producties, Rijkswaterstaat: The Hague).

Hullu, Elk de (1995), 'Natuurontwikkeling bij Staatsbosbeheer', De Levende Natuur, 96 (5), 141-47.

Kappers, F.I. (2000), 'Overlaten: (g)een oplossing van de problemen bij te veel water? Een bijdrage aan de geschiedenis van de overlaten in het Nederlandse rivierengebied in de 18e en 19e eeuw.', (Lelystad: RIZA).

Klijn, Frans, et al. (2013), 'Design quality of room-for-the-river measures in the Netherlands: role and assessment of the quality team (Q-team)', International Journal of River Basin Management, 11 (3), 287-99.

Leenders, K.A.H.W. (1999/2005), 'Landschapsgeschiedenis van de Hoekse Waard', Tekst van een voordracht op 27 mei 1999, gehouden voor de KNMG afdeling Zuid-Hollandse Eilanden. <http://users.bart.nl/~leenders/txt/hoeksew1.html>, accessed 13.08.2015.

Ministerie van Verkeer en Waterstaat, et al. (1997), 'Vierde Nota waterhuishouding. Regeringsvoornemen', (The Hague: Ministerie van Verkeer en Waterstaat).

Ministerie van Verkeer en Waterstaat (1997b), 'Deltaplan Grote Rivieren, Voortgangsrapport 4, Stand van zaken per 1-1-1997', (The Hague).

Ministerie van Verkeer en Waterstaat, Directoraat-Generaal Rijkswaterstaat (2000), 'Ruimte voor de rivier. Kabinetstandpunt', (The Hague).

Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Directie Zuid-Holland (2000b), 'Integrale Verkenning Benedenrivieren', (Rotterdam).

Ministerie van Verkeer en Waterstaat and Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (1996), 'Beleidslijn ruimte voor de rivier', (The Hague).

Nienhuis, Piet H. (2008), Environmental History of the Rhine–Meuse Delta. An ecological story on evolving human–environmental relations coping with climate change and sea-level rise (Springer).

Projectbureau Noordwaard (2006), 'Ontpoldering Noordwaard. Ontwerpvisie', (Rotterdam: Provincie Noord Brabant, Waterschap rivierenland, Gemeente Werkendam, Ministerie van Landbouw Natuur en Voedselkwaliteit, Ruimte voor de Rivier, Nederland leeft met water).

Projectorganisatie Ruimte voor de Rivier (2003), '2e Voortgangsrapportage 1 januari 2003 – 30 juni 2003', (The Hague).

Projectorganisatie Ruimte voor de Rivier (2005), 'PKB deel 1. Ruimte voor de Rivier. Ontwer Planologische Kernbeslissing. Nota van Toelichting', (The Hague: Ministerie van Verkeer en Waterstaat, Ministerie van Volkshuisvesting Ruimtelijke Ordening en Milieubeheer, Ministerie van Landbouw, Natuur en Voedselkwaliteit).

Projectorganisatie Ruimte voor de Rivier (2006), 'Planologische Kernbeslissing Ruimte voor de Rivier: Nota van Toelichting', (The Hague: Ministerie van Verkeer en Waterstaat, Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, Ministerie van Landbouw, Natuur en Voedselkwaliteit).

Provincie Noord-Brabant (2008), 'Rivierverruiming Overdiepse Polder. Projectnota/MER', ('s-Hertogenbosch).

RIZA and Bosch & Slabbers (1999), 'Landschappelijke verkenning rivierverruimende maatregelen', (Lelystad: Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling, Projectteam Integrale Verkenning Benedenrivieren IVB, Rijkswaterstaat, Ministerie van Verkeer en Waterstaat).

RIZA and Bosch&Slabbers (2000), 'Landschappelijke verkenning rivierverruimende maatregelen', (Lelystad: Ministerie van Verkeer en Waterstaat Rijkswaterstaat, Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling (RWS, RIZA), Projectteam Integrale Verkenning Benedenrivieren IVB).

RIZA, Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling (2002), 'De spankracht van ons rivierenland. Eindrapport Spankracht', (Lelystad: Ministerie van Verkeer en Waterstaat, Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieu. Ministerie van Landbouw, Natuurbeheer en Visserij, Provincies Utrecht, Gelderland, Overijssel, Zuid-Holland, Noord-Brabant, Vereniging Nederlandse Riviergemeenten, Unie van Waterschappen).

Sanderse, Wouter, et al. (2004), 'Voor de watersnoodramp van 1953'. <http://www.deltawerken.com/Voor-de-ramp-van-1953/24.

html>, accessed 21.08.2015.

Saeijs, Henk L. F. (1999), ' Levend water goud waard. De achterkant van het ongelijk', Symposium "Het Verborgen Vermogen (Midddelburg), 59-78.

Sijmons, Dirk (2006), 'Het deskundigenoordeel als instrument voor ruimtelijke kwaliteit', Jaarverslag Kwaliteitsteam Ruimte voor de Rivier 2006-2007 (Utrecht: Rijkswaterstaat, 2008).

Smit, Henk, et al. (1997), 'Ecosystem responses in the Rhine-Meuse delta during two decades after enclosure and steps toward estuary restoration', Estuaries, 20 (3), 504-20.

Stolwijk, Herman and Verrips, Annemiek (2000), 'Ruimte voor water. Kosten en baten van zes projecten en enige alternatieven', (Den Haag: Centraal Planbureau).

Van de Vorstenbosch, Harry (2011), 'De verlegging van de Maasmond', Brabants Historisch Informatie Centrum. <https://www.bhic.nl/ontdekken/verhalen/de-verlegging-van-de-maasmond>, accessed 20.08.2015.

Van Drimmelen, Camiel, et al. (2000), Integrale Verkenning Benedenrivieren, Landschap (Ruimte voor later. Kansen voor rivierverruimende maatregelen in de Rijn-Maas monding; Lelystad: Rijkswaterstaat, RIZA, Directie Zuid-Holland).

Van Herwijnen, M., et al. (2003), 'Succes- en faalfactoren van natuur-ontwikkeling in en langs het water', (Amsterdam: IVM Instituut voor Milieuvraagstukken, Vrije Universiteit).

Van Rooy, Peter and Slootweg, Roel (2003), 'Spiegelproject Overdiepse polder : rapportage verkenning', (Gouda: Habiforum , Vereniging "Belangengroep Overdiepse polder", Bezinningsgroep Water, Stuurgroep Benedenrivieren).

Van Wijk, Wim (2012), Historische Atlas van de Biesbosch (Zwolle: W Books).

Vandersmissen, Hans (1998), Het woelige water. Watermanagement in Nederland (Teleacnot / INMERC).

Verschelling, Eelco (2003), 'Riverkundige analyses maatregelen Benedenrivierengebied ten behoeve van PKB Ruimte voor de Rivier', (Lelystad: DG Rijkswaterstaat RIZA).

Vis, Joh A. (1936), De inpoldering van den Zuidhollandschen Biesbosch (Dordrecht: Vereeniging De Biesbosch).

Waterschap Brabantse Delta (2005), 'Rivierverruiming Overdiepse Polder. Startnotitie m.e.r.', (Breda).

Meerstad: Flood as investment

Abrahamse, Jan (1999), 'Woldmeer op de website', Noorderbreedte, y. 23 (2). <http://www.noorderbreedte.nl/nog_niet_toegekend/woldmeer-op-de-website/>, accessed 19.03.2013.

Abrahamse, Jan (2002), 'Groningen, de compacte stad', Noorderbreedte, Themanummer 'Ruimtelijke ordening in Noord-Nederland', no. 5a, 36-38. accessed 19.03.2013.

Alle Hosper landschapsarchitecten and KCAP architects and planners (2005), 'Masterplan Meerstad', (Haarlem: Gemeente Groningen, Gemeente Slochteren, Provincie Groningen, Ministerie van Landbouw, Natuurbeheer en Visserij, Dienst Landelijk Gebied, Waterschap Hunze-en-Aa's, Grondbank Meerstad Groningen).

Archined (1999), 'Het Woldmeer gelanceerd', Archined.nl. <https://www.archined.nl/1999/03/het-woldmeer-gelanceerd/>, accessed 19.03.2013.

Bijnsdorp, Rob, et al. (2002), 'Meerstad: meer water en meer stad', De Water, waterbeleid en -beheer in uitvoering, 103 (nov. 2004), 7-8.

Elerie, J.N.H. (1996), Duurswold: naar een duurzaam stadslandschap tussen Groningen en Delfzijl (Stichting Noorderbreedte).

GEM Meerstad (2011), 'Het Verhaal van Meerstad. Ambities en ontwikkelingen', (Groningen: Grondexploitatiemaatschappij Meerstad C.V.).

Gemeente Groningen, dienst RO/EZ (1994), 'De stad van straks : Groningen in 2005 : concept structuurplan', (Groningen).

Grontmij (2003), 'Milieueffectrapport Masterplan Meerstad Groningen', (Groningen: Waterschap Hunze-en-Aa's, Gemeente Slochteren, Gemeente Groningen, Provincie Groningen).

Keuter, Mark (2007), 'Samenwerken: waar, wanneer en met wie?', Master Thesis (University of Twente).

Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (1988), 'Vierde Nota ruimtelijke ordening', (The Hague).

Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (1990), 'Vierde Nota ruimtelijke ordening Extra', (The Hague).

Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (2006), Nota Ruimte. Ruimte voor ontwikkeling. Katern over nieuw ruimtelijk beleid in 2006 (The Hague).

Notten, Frank (2012), 'Hypotheekschuld in Nederland', De Nederlandse economie 2011 (9; The Hague: Centraal Bureau voor de Statistiek), 206-24.

Provincie Groningen (2001), '"Meerstad Groningen" nieuw kwalitatief hoogwaardig woongebied', (Groningen: press release).

Reuver, Ellen, et al. (2006), 'Publiek-private samenwerking: sámen werken aan meerwaarde. Leerervaringen opgedaan in PPS-project 'Meerstad Groningen'', (Ministerie van landbouw, natuur en voedselkwaliteit. Directie Kennis, april 2006).

Salewski, Christian (2012), Dutch New Worlds: Scenarios in Physical Planning and Design in the Netherlands, 1970-2000 (Rotterdam: 010 Publishers).

Elastic landscape for the Isère Valley

Agard, Maurice (1942), 'L'endiguement de l'Isère en Grésivaudan', Revue de géographie alpine, 30 (4), 701-71.

Blackbourn, David (2007), The Conquest of Nature. Water, Landscape and the Making of Modern Germany (London: WW Norton & Co).

Blanc dit Lagoutte, Grenoblo Malhérou. Drawing D.Rahoult, Engraving E. Dardelet, Grenoble, 1860.

Blanic, M., Verdet, G. Quelques travaux de correction sur le cours de l'Isère. La Houille Blanche, n.2/3, pp191-197. 1975

Blondeau, Sylvie (2006), 'Isère Amont : un grand projet pour éviter les risques d'inondations', Isère Magazine, (mars 2006), 12-13.

Bravard, JP. La métamorphose des rivières des Alpes Françaises à la fin du Moyen-Age et à l'époque moderne. Bulletin de la Société Géographique de Liège, 1989, n. 25. pp151-154

Castex, Joëlle, Belleudy, Philippe, 2005. L'Isère endiguée dans le Grésivaudan. Du risque zéro à la rivière libérée: entre ces deux utopies, quelles attente sociale? Programme de recherche Risque Décision Territoire, Laboratoire d'études des transferts en hydrologie et environnement. Université Joseph Fourier, Grenoble.

Conseil Général de l'Isère, Syndicat mixte des bassins hydrauliques de l'Isère (SYMBHI), and Chambre d'agriculture de l'Isère (2010), 'Projet Isère amont. Accord cadre portant sur les incidences agricoles', (Grenoble).

Coeur, Denis. La plaine de Grenoble face aux inondations. Genèse d'une politique publique du XVIIe au XXe siècle. Quae, Versailles, 2008.

Dauphiné Libéré, 02.02.1968, 'Au Versoud, l'Isère a changé de lit'.

Direction Départementale de l'Equipement de l'Isère (2005), 'Plan de Prévention du Risque Inondation de l'Isère, dans la vallée du Grésivaudan, à l'amont de Grenoble. Rapport de présentation', (Grenoble).

Girel, Jacky (2005), 'Les paysages alluviaux alpins (histoire, diagnostic, gestion, restauration et protection)', (Université Joseph Fourier Grenoble, Laboratoire d'Ecologie Alpine).

Girel, Jacky and Marnezi, Alain (2009), 'Les vallées de l'Isère et de l'Arc en Savoie en 1859 : un paysage inédit marqué par l'endiguement-chenalisation.', Colloque 'ISERE 1859-2009'. 150ème anniversaire de la Crue de Référence de l'Isère (Grenoble).

Girel, Jacky (2010), 'Histoire de l'endiguement de l'Isère en Savoie : conséquences sur l'organisation du paysage et la biodiversité actuelle', Géocarrefour, Vol. 85 (1).

Pinhas, Michel (2009), 'Rétrospective historique du système d'endiguement de l'Isère dans le Grésivaudan', Colloque ISERE 1859-2009. 150ème anniversaire de la Crue de Référence de l'Isère (Grenoble).

Pinhas, Michel (2009-2011), 'Histoire des digues de l'Isère amont au 20e siècle !'. <http://www.isere-drac-romanche.fr/?Histoire-des-digues-de-l-Isere>, accessed 08.04.2013.

Le Progrès, 02.02 1968, 'A 11 h 17, heure de Grenoble, l'Isère a obéi aux hommes des Ponts & Chaussées et changé de lit'.

Rolland, 1787. Mémoire sur le projet de redresser le lit de l'Isère dans la vallée du Grésivaudan jusque au dessous de la ville de Grenoble et de contenir les eaux de cette rivières entre les terres. Bibliothèque Ecole Nationale des Ponts et Chaussées, Paris, Mémoire in folio 501 (2027)

SOGREAH, ingénierie, BRL, and GAY Environnement (2008), 'Projet d'aménagement de l'Isère de Pontcharra à Grenoble dans un objectif de protection contre les crues et de mise en valeur des milieux naturels. Pièce F: étude d'impact ai titre des articles L. 122-1 A L. 122-3 du code de l'environnement', (Grenoble: SYMBHI, Syndicat Mixte des Bassins Hydrauliques de l'Isère).

SYMBHI Syndicat Mixte des Bassins Hydrauliques de l'Isère (2006), 'Rapport de présentation synthétique du schéma d'aménagement du projet «Isère Amont»', (Grenoble).

SYMBHI, Oliver Manin (2009), 'Présentation du projet Isère amont', Isère 1859-2009. 150ème Anniversaire de la crue de référence (Saint Martin d'Hères).

SYMBHI Syndicat Mixte des Bassins Hydrauliques de l'Isère (2009), 'Rapport de présentation synthétique du projet Isère Amont', (Grenoble: Conseil Général de l'Isère).

Isar Plan: the wild, the urban and the "true Alpine river"

Armonat, Thomas (2010), 'Isar - drei Ziele, ein plan', Garten+Landschaft, (nov. 2010), 20-24.

Arzet, Klaus and Joven, Stefan (2008), 'Erlebnis Isar - Fließgewässerentwicklung im staädtischen Raum von München', KW – Korrespondenz Wasserwirtschaft, 1, 17-22.

Baumeister, Nicolette (2003), 'Neues Leben für die Isar. Ergebnisse des internationalen Wettbewerbs zwischen Braunauer Eisenbahnbrücke und Deutschem Museum in München', (Munich: Landshaupstadt München, Wasserwirtschaftsamt München).

Binder, Walter and Hoelscher-Obermaier, Rudolph (2003), 'Die Wildflusslandschaft Isar', Garten+Landschaft, (Dec. 2003), 16-19.

Blasy + Mader (1998), 'Isar-Plan. Verbesserung des Hochwasserschutzes und naturnahe Umgestaltung der Isar unter Berücksichtigung der Erholungsnutzung zwischen der südlichen Stadtgrenze und der Corneliusbrücke in München. Kurzfassung zur Vorplannung', (Munich: Landsehauptstadt München, Wasserwirtschaftsamt München).

Böhm, O. and Wetzel, K.-F. (2006), 'Flood history of the Danube tributaries Lech and Isar in the Alpine foreland of Germany', Hydrological Sciences Journal, (51:5), 784-98.

CSU-Stadtratsfraktion München (1984), 'Natur in der Stadt. Antrag Nr. 282 der Stadtratsfraktion der CSU vom 30. Juli 1984', (Munich: Landeshauptstadt München).

Deutsches Baublatt (2011), 'Die gezähmte Isar wird wieder wild', Deutsches Baublatt, 354 (17).

Düchs, Julia (2014), Wann wird's an der Isar wirder schön? Die Renaturierung der Isar in München. Über das Verständnis vin Natür in der Großstadt., ed. Insttut für Volkskunde/Europäische Ethnologie der Ludwig-Maximilians-Universität München (Münchner Ethnographische Schriften; München: Herbert Utz Verlag).

Hoppe, Malvina, Müller, Maria, and Schmidt, Marijana 'Ökologische Bewertung eines Bauabschnitts der Renaturierung der Isar im Münchner Stadtgebiet', (Technische Universität München).

Jerney, Winfrid (2003), 'Rasen betreten erlaubt - Günther Grzimek: Planung mit den Bürgern', Garten+Landschaft, (8).

Lieckfeld, Claus-Peter (2003), 'Wie die zahme Isar wild und schön wird', GEO Special, 2 (april-may 2003), ex-folio.

Mahida, Nivedita (2012), 'The Isar River Restoration Project: 'Isar-Plan', Important Facts and Sights', 2d IAHR Europe Conference (Munich: State Office for Water Management).

Mahida, Nivedita (2012), 'The Isar river - Freedom from its concrete corset', RESTORE- Integrating River Restoration Into Spatial Planning: Delivering Multiple Benefits (Arnhem, Netherlands: State Office for Water Management Munich - Bavarian State Ministry for Environment and Health).

Mahida, Nivedita (2012), 'The Isar river - Freedom from its concrete corset', RESTORE- Integrating River Restoration Into Spatial Planning: Delivering Multiple Benefits (Arnhem, Netherlands: State Office for Water Management Munich - Bavarian State Ministry for Environment and Health).

Nohl, Werner, Werkstatt für Landschaftsund Freiraumentwicklung (1998), 'Die Isar - Münchens besonderer Erlebnis- und Erholungsraum', (Wasserwirtschaftsamtes München Landeshauptstadt München).

Oppermann, Bettina and Pauleit, Stephan (2005), 'The Green structure of Munich: The need for and risk of regional cooperation', Green Structures and Urban Planning. Final Report (European Cooperation in the field of Scientific and Technical Research - COST Action C11), 72-79.

Oppermann, Bettina (2005b), 'Redesign of the River Isar in Munich, Germany. Getting coherent quality for green structures through competitive process design ?', Green Structures and Urban Planning. Final Report (European Cooperation in the field of Scientific and Technical Research - COST Action C11), 372-78.

Rädlinger, Christine (2012), Geschichte der Isar in München, ed. Stadtarchiv München (Munich: Franz Schiermeier Verlag).

Referat für Stadtplanung und Bauordnung (1983), 'Stadtentwicklungsplan', (München: Landeshauptstadt München).

Referat für Stadtplanung und Bauordnung, Landeshauptstadt München (1986), 'Beschluß des Ausschusses für Stadtplanung und Bauordnung vom 4. Juni 1986', (Munich).

SPD, Ortsverein München-Au (2004), 'Einwohnerversammlung: Wie frei fließt die Isar?', spd-muenchen-au.de, News von der Au. <http://www.spd-muenchen-au.de/news/2004/041014_Isar-Plan.html>, accessed 04.06.2014.

SPD-Stadtratsfraktion München (1985), 'Isar-Plan. Konzept zum Schutz und Wiederherstellung, zur Erhaltung und Erschließung des Isarraumes, der Auen und der Hangkanten. Antrag Nr. 636 der Stadtratsfraktion der SPD vom 3. Mai 1985', (Munich: Landeshauptstadt München).

Statistisches Amt München, (2012), 'Die Bevölkerung seit 1900'. Landeshauptstadt München <http://www.muenchen.de/rathaus/Stadtinfos/Statistik/Bev-lkerung/Bev-lkerungsbestand.html>

Süddeutsche Zeitung, 'Die Isar soll wieder wild fließen. Bagger beseitigen Uferbefestigung / Fluß wird aus dem Betonkorsett befreit', (24.02.1998), 39.

Süddeutsche Zeitung, 'Mehr Wasser für die Isar. Bayernwerk befürchtet das Aus für fünf Kraftwerke', (30.07.1999), L6.

Süddeutsche Zeitung, 'Freiheit für die Isar. Staatsregierung will auf 260 Kilometern renaturieren', (29.09.2001), 61.

Süddeutsche Zeitung, 'Banales Betonmonster. Isar-Renaturierung: Bürger lehnen Siegerentwurf ab', (05.06.2003), 42.

Süddeutsche Zeitung, 'Streit um den Fluss des Flusses. Grauer Beton oder grüne Wiesen – Runder Tisch soll Kompromiss um Baumaßnahmen finden', (18.11.2003), 45.

Süddeutsche Zeitung, 'Kompromiss für Isar-Renaturierung gefunden', (12.01.2005), 38.

Süddeutsche.de, 'Renaturierung. Münchner Beachparty', (17.05.2010). <http://www.sueddeutsche.de/muenchen/renaturierung-muenchner-beachparty-1.743243>.

Sueddeutsche.de, 'Mehr Leben am Fluss', (18.11.2010). <http://sueddeutsche.de/muenchen/muenchen/politik/innenstadt-mehr-leben-amfluss-1.1025351>, accessed 22.11.2010.

Will, Thomas (1984), 'Der Auer Mühlbach. Architektonisches Entwerfen als Interpretation des Ortes. Studienprojekte für einen Münchner Stadtbach', (Munich: Technische Universität München/Lehrstuhl für Entwerfen und Denkmalpflege).

Zinsser, Tilmann (2003), 'Neues Leben für die Isar', Garten+Landschaft, (dec. 2003), 12-15.

ADSA, Association de défense du sol agricole, et al. (2008), 'Remarques sur le Plan d'aménagement Troisième correction du Rhône', (Conthey).

Arborino, Tony and Perret, Jacques (2008), 'Corriger le Rhône', Tracés 6 (09.04.2008), 7-10.

Arborino, Tony (2011), 'Prise en compte du changement climatique dans la gestion du risque inondation : l'exemple du Rhône en Valais', Actes du séminaire international d'experts 'Adaptation de la gestion des risques naturels face au changement climatique' (Domancy, France).

Arborino, Tony (2011b), 'Note intégration variation climatique dans gestion des risques', (Sion: Département des transports, de l'équipement et de l'environnement, Service des routes et des cours d'eau, Projet Rhône).

Assemblée fédérale de la Confédération suisse (1991), 'Loi fédérale sur l'aménagement des cours d'eau du 21 Juin 1991'.

Bender, Gabriel (2004), 'Correcting the Rhone and the Valaisans : three centuries of works and debate', Revue de Géographie Alpine, 92 (92-3), 62-72.

Bloetzer, Werner, et al. (1998), Klimaänderungen und Naturgefahren in der Raumplanung. Methodische Ansätze und Fallbeispiele (Nationales Forschungsprogramm "Klimaänderungen und Naturkatastrophen", NFP 31; Zürich: VDF Hochschulverlag).

Blotnitzki, L. and Hartmann, A. (1861), 'Rapport d'expert sur la Correction du Rhône au Département fédéral de l'Intérieur et des Travaux publics. (Du 6 Avril 1861.)', Feuille Fédérale Suisse, 14 Février 1863 (15, 1, 7; Bern), 294-306.

Blotnitzki, L. and Hartmann, A. (1862), 'Rapport d'experts sur la correction du Rhône, au Département fédéral de l'Intérieur et des Travaux publics. (Du 20 Mai 1862.)', Feuille Fédérale Suisse, 14 Février 1863, (15, 1, 7; Bern), 307-52.

Blotnitzki, L. and Hartmann, A. (1862b), 'Rapport d'expert sur la Correction du Rhône, adressé au Département fédéral de l'Intérieur et des Travaux publics. (Du 26 Décembre 1862.)', Feuille Fédérale Suisse (15, 1, 7; Bern), 355-72.

Confédéré, 06.09.1948, 'Les frasques du Rhône', p. 2.

Confédéré, 08.09.1948, 'Après le désastre du Rhône', p. 1.

Conseil d'Etat du Valais 'Décret de financement de la troisième correction du Rhône. Votation cantonale du 14 juin 2015', (updated 18.5.2015) <http://www.vs.ch/Public/doc_detail.asp?DocumentID=33554>, accessed 7.7.2015.

Le débat. Face à Face : Rhône 3 : camps opposés? With Thierry Largey (Pro Natura Valais) and Olivier Schupbach (Association de Défense des Surfaces Agricoles) (Canal 9, 08.06.2011).

DFI. Département fédéral de l'intérieur, Service fédéral des routes et des digues (1964), La correction du Rhône en amont du lac Léman, ed. Département Fédéral de l'Intérieur (Bern: Office fédéral des imprimés et du matériel).

Dupont, Cédric and Pigeon, Patrick (2008), 'Le Haut-Rhône et son bassin versant montagneux : pour une gestion intégrée de territoires transfrontaliers. Projet INTERREG IIIA', in Institut de la Montagne (ed.), (Chambéry: Environnements DYnamiques et TErritoires de Montagne (EDYTEM, UMR Univ. Savoie–CNRS), Institut de Hautes Etudes internationales et du Développement (HEIED – Genève), Institut Universitaire Kurt Bösch (IUKB – Sion - Valais)).

Frossard, Pierre-André, et al. (1998), Mehr Raum für unsere Fliessgewässer. Ein Gewinn für Mensch und Natur / Davantage d'espace pour nos cours d'eau. Pour l'homme et la nature (Beiträge zum Naturschutz in der Schweiz / Contributions à la protection de la nature en Suisse, 19-20/1998; Basle: Pro Natura).

Girot, Christophe, Rossano, Frédéric, and Duner, Isabelle (2010), Sion-sur-Rhône (pamphlet, 13: GTA verlag).

Hydronat (2000) Troisième correction du Rhône. Rapport de synthèse (juin 2000) [online text], Canton du Valais. Département des Transports, de l'Equipement et de l'Environnement. Service des Routes et des Cours d'Eau <http://www.vs.ch/Navig/navig.asp?MenuID=5256&Language=fr>

KBNL, Konferenz der Beauftragten für Natur- und Landschaftsschutz (2001), 'Liste der Auengebiete von nationaler Bedeutung', (Federal Office for the Environment BAFU, Swiss Confederation).

Nouvelliste, 07.09.1948, 'Le cycle d'épouvante', p. 1.

OFEE, SHGN (1991), 'Analyse des causes des crues de l'année 1987 : rapport final', (Bern: Département Fédéral des Transports, des Communications et de l'Energie, Office Fédéral de l'Economie des Eaux, Département Fédéral de l'Intérieur, Office Fédéral de l'Environnement, des Forêts et du Paysage, Service Hydrologique et Géologique National).

OFEFP, et al. (2003), 'Idées directrices - Cours d'eau suisses. Pour une politique de gestion durable de nos eaux', (Bern: Office fédéral de l'environnement).

OFEG (2002), 'La protection contre les crues au fil du temps', (Bern: Office fédéral des eaux et de la géologie).

Petrascheck, Armin, Hegg, Christoph, and Schmid, Franziska (2003), 'Les crues 2000 – Analyse des événements / Cas exemplaires', Rapports de l'OFEG, Série Eaux (2; Bern: Office fédéral des eaux et de la géologie).

Projet Rhône, Département des transports, de l'équipement et de l'environnement, Service des routes et des cours d'eau (2006), 'Plan sectoriel 3ème correction du Rhône, Juin 2006', (Sion: Canton du Valais).

Projet Rhône (2008), 'Troisième correction du Rhône. Sécurité pour le futur. Rapport de Synthèse du Plan d'aménagement', (Sion: Canton du Valais, Département des transports, de l'équipement et de l'environnement, Service des routes et des cours d'eau).

Projet Rhône (2011), 'Zones de danger d'inondation du Rhône. Rapport technique, 26 mai 2011', (Sion: Canton du Valais, Département des transports, de l'équipement et de l'environnement, Service des routes et des cours d'eau).

Projet Rhône. Département des transports, de l'équipement et de l'environnement and d'eau, Service des routes et des cours (2011b), 'Zones de danger d'inondation du Rhône. Plans de synthèse. Mai 2011', (Sion: Canton du Valais).

Reynard, Emmanuel, et al. (2006), 'Apprendre par les catastrophes naturelles : le cas des inondations récentes en Suisse', Actes du colloque L'eau en montagne (Megève).

Staüble, Sabine (2009), 'Evolution de la plaine du Rhône suisse du début du XIXe siècle à nos jours: étude cartographique dans le Valais central', Le Rhône: Dynamique, Histoire et Société (Cahiers de Vallesia 21; Sion: Archives de l'Etat du Valais), 167-76.

Vischer, Daniel L. (2003), 'Histoire de la protection contre les crues en Suisse', Rapports de l'OFEG, Série Eaux (5; Bern: Office fédéral des eaux et de la géologie).

Zaugg, Marc (2002), 'More Space for running waters: Negotiating institutional change in the Swiss flood protection system', GeoJournal, 58, 275–84.

Veuve, Léopold, Feddersen, Pierre, and Paysagestion (2008), 'Lignes directrices paysagères pour le Rhône et pour la plaine', (Sion: Projet Rhône, Département des transports, de l'équipement et de l'environnement, Service des routes et des cours d'eau, Canton du Valais).

WWF World Wide Fund for Nature, Pro Natura, SLFP Fondation Suisse pour la Protection et l'Aménagement du Paysage, ATE Association Transport et Environnement (2005), 'Plan sectoriel 3ème correction du Rhône (PS-R3). La position des organisations de protection de l'environnement'.

Part III

Setting goals and communicating concepts

Girot, Christophe, Rossano, Frédéric, and Duner, Isabelle (2010), Sion-sur-Rhône (Pamphlet, 13; Zürich: GTA).

Heems, Geertruida C. and Kothuis, Baukje L. M. (2012), 'Waterveiligheid; Managen van Kwetsbaarheid. Voorbij de Mythe van Droge Voeten. De Nederlandse omgang met overstromingsdreiging in sociaal-cultureel perspectief', PhD (University of Maastricht).

Melly, Jacques (2015), 'Votation du 14 juin 2015. Décret du 11 septembre 2014 créant un fonds pour le financement du projet de la 3e correction du Rhône', Press conference 18.05.2015. <https://www.vs.ch/Press/DS_3/CP-2015-05-11-22782/fr/CP_R21_pr%C3%A9sentation_fr.pdf>, accessed 7.7.2015

Projet Rhône (2006), 'Plan sectoriel 3ème correction du Rhône, Juin 2006', (Sion: Département des transports, de l'équipement et de l'environnement, Service des routes et des cours d'eau, Canton du Valais).

Projet Rhône (2008), 'Troisième correction du Rhône. Sécurité pour le futur. Rapport de Synthèse du Plan d'aménagement', (Sion: Canton du Valais, Département des transports, de l'équipement et de l'environnement, Service des routes et des cours d'eau).

Rijksplanologische Dienst (2001), 'Ruimte maken, ruimte delen. Vijfde Nota over de Ruimtelijke Ordening 2000/2020', (Den Haag: Ministerie van Volkshuisvesting, Ruimtelijke Ordening and Milieubeheer).

Ruimte voor de Rivier (2011), Samen werken aan een veilig en mooi rivierengebied, ed. Programmadirectie Ruimte voor de Rivier (den Haag).

Sijmons, Dirk (2009), 'Room for the River', Topos, 68, 61-63.

Vischer, Daniel L. (2003), 'La correction du Rhône en amont du lac Léman', Histoire de la protection contre les crues en Suisse (5; Bern: Office fédéral des eaux et de la géologie), 97-103.

Landscape New Deals

ADSA, Association de défense du sol agricole, et al. (2008), 'Remarques sur le Plan d'aménagement Troisième correction du Rhône', (Conthey).

Arborino, Tony and Perret, Jacques (2008), 'Corriger le Rhône', Tracés 6 (09.04.2008), 7-10.

Arborino, Tony (2011a), 'Prise en compte du changement climatique dans la gestion du risque inondation : l'exemple du Rhône en Valais', Actes du séminaire international d'experts 'Adaptation de la gestion des risques naturels face au changement climatique' (Domancy, France).

Barbisch, Caroline, et al. (2006), 'Vulnérabilité des infrastructures urbaines et gestion de crise. Impacts et enseignements de cas d'inondation en Suisse', (Geneva, Lausanne: CEAT-EPFL; Géosciences, Université de Fribourg; Dpt. de Géographie, Université de Genève; IGUL, IPTEH, Université de Lausanne; Université de Zürich).

Berque, Augustin (1992), 'Ethique et esthétique de l'environnement : la lumière peut-elle venir d'Orient?', in Louis Rey (ed.), Ethique et esthétique de l'environnement. (Rabat: La Maisnie), 73-87.

Blondeau, Sylvie (2006), 'Isère Amont : un grand projet pour éviter les risques d'inondations', Isère Magazine, (mars 2006), 12-13.

Canal 9, Le débat. Face à Face : Rhône 3 : camps opposés? With Thierry Largey (Pro Natura Valais) and Olivier Schupbach (Association de Défense des Surfaces Agricoles) (Canal 9, 08.06.2011).

De Koning, Robbert (2010), 'Ambitiedocument Ontpoldering Noordwaard, versie 30 juni 2010', (Arnhem).

DHV, Arcadis, and Haskoning (2010), 'Milieueffectrapport planstudie ontpoldering Noordwaard', (Projectbureau Noordwaard, Rijkswaterstaat, Ruimte voor de Rivier).

Frossard, Pierre-André, et al. (1998), Mehr Raum für unsere Fliessgewässer. Ein Gewinn für Mensch und Natur / Davantage d'espace pour nos cours d'eau. Pour l'homme et la nature (Beiträge zum Naturschutz in der Schweiz / Contributions à la protection de la nature en Suisse, 19-20/1998; Basle: Pro Natura).

Girel, Jacky (2005), 'Les paysages alluviaux alpins (histoire, diagnostic, gestion, restauration et protection)', (Université Joseph Fourier Grenoble, Laboratoire d'Ecologie Alpine).

Giroud, Willy and ADSA, Association de défense du sol agricole (2015), 'Conférence de presse du 29 avril 2015', (Conthey).

Gomart, Emilie (2006), 'Politisering van de esthetiek. Een ethnographisch onderzoek naar het tekenen aan de Stelling van Amsterdam', in Maarten Hajer and Dirk Sijmons (eds.), Een plan dat werkt. Ontwerp en politiek in de regionale planvorming (Rotterdam: Nai), 64-93.

Heems, Geertruida C. and Kothuis, Baukje L. M. (2012), 'Waterveiligheid; Managen van Kwetsbaarheid. Voorbij de Mythe van Droge Voeten. De Nederlandse omgang met overstromingsdreiging in sociaal-cultureel perspectief', PhD (University of Maastricht).

Hoijmaijers, N. (2011), 'Brabantse boeren verhuizen naar nieuwe terp', interviewed by Nederlandse Publiek Omroep (NOS), 27 June 2011 [radio archive]. Available at: http://nos.nl/artikel/251507-nederland-krijgt-nieuwe-terpen.html, accessed 29 October 2102

HP de Site, 'Wat gebeurt er eigenlijk als de Randstad overstroomt?'. <http://www.hpdetijd.nl/2012-10-30/wat-gebeurt-er-eigenlijk-als-de-ran>, accessed 03.04.2013.

Hydronat (2000) Troisième correction du Rhône. Rapport de synthèse (juin 2000) [online text], Canton du Valais. Département des Transports, de l'Equipement et de l'Environnement. Service des Routes et des Cours d'Eau <http://www.vs.ch/Navig/navig.asp?MenuID=5256&Language=fr>

IPCC (2014), Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, ed. R.K. Pachauri and L.A. Meyer Core Writing Team (Geneva).

Lechevalier, Michel (2005), 'La mission des ingénieurs géographes français en Valais en 1802', Vallesia (5; Sion: Archives de l'Etat du Valais), 411-31.

Melly, Jacques (2015), 'Votation du 14 juin 2015. Décret du 11 septembre 2014 créant un fonds pour le financement du projet de la 3e correction du Rhône', Press conference 18.05.2015. <https://www.vs.ch/Press/DS_3/CP-2015-05-11-22782/fr/CP_R21_pr%C3%A9sentation_fr.pdf>.

Ministerie van Verkeer en Waterstaat and Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (1996), 'Beleidslijn ruimte voor de rivier', (The Hague).

Ministerie van Verkeer en Waterstaat, et al. (1998), 'Vierde Nota waterhuishouding. Regeringsbeslissing', in A. van der Beesen (ed.), (The Hague: Ministerie van Verkeer en Waterstaat).

Ministerie van Verkeer en Waterstaat (2006), 'Spatial Planning Key Decision 'Room for the River'. Investing in the safety and vitality of the Dutch river basin region', (the Hague).

Ministerie van Infrastructuur en Milieu (2015), 'Ons Water in Nederland. Nieuw Nationaal Waterplan 2016-2021', (The Hague).

NRC. Wie woont er graag in de calamiteitenpolder?, Rotterdam, 02.12.2002, Schreuder, A.

OFEFP, et al. (2003), 'Idées directrices - Cours d'eau suisses. Pour une politique de gestion durable de nos eaux', (Bern: Office fédéral de l'environnement).

Pellaud, Marc, et al. (2005), 'Objectifs environnementaux et paysagers d'un aménagement hydraulique à buts multiples. Nouveaux développements dans la gestion des crues', Conférence sur la recherche appliquée en relation avec la troisième correction du Rhône, 9 juin 2005 (Martigny).

Projectbureau Noordwaard (2007), 'Ontpoldering Noordwaard. Ontwerpvisie: Het regio-alternatief', (Rotterdam: Provincie Noord Brabant, Waterschap rivierenland, Gemeente Werkendam, Ministerie van Landbouw Natuur en Voedselkwaliteit, Ruimte voor de Rivier, Nederland leeft met water).

Projectorganisatie Ruimte voor de Rivier (2007), 'Planologische Kernbeslissing Ruimte voor de Rivier: Nota van Toelichting', (The Hague: Ministerie van Verkeer en Waterstaat, Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, Ministerie van Landbouw, Natuur en Voedselkwaliteit).

Projet Rhône (2008), 'Troisième correction du Rhône. Sécurité pour le futur. Rapport de Synthèse du Plan d'aménagement', (Sion: Canton du Valais, Département des transports, de l'équipement et de l'environnement, Service des routes et des cours d'eau).

Projet Rhône (2011), 'Zones de danger d'inondation du Rhône. Rapport technique, 26 mai 2011', (Sion: Canton du Valais, Département des transports, de l'équipement et de l'environnement, Service des routes et des cours d'eau).

Reijndorp, Arnold, et al. (1998), De Kern van het Ruimtelijk Beleid. Een onderzoek naar het begrip ruimtelijke kwaliteit (the Hague: Wetenschappelijke Raad voor het Regeringsbeleid).

Reuver, Ellen, et al. (2006), 'Publiek-private samenwerking: sámen werken aan meerwaarde. Leerervaringen opgedaan in PPS-project 'Meerstad Groningen'', (Ministerie van landbouw, natuur en voedselkwaliteit. Directie Kennis, april 2006).

Rijksplanologische Dienst, Ministerie van Volkshuisvesting, Ruimtelijke Ordening and Milieubeheer (2001), 'Ruimte maken, ruimte delen. Vijfde Nota over de Ruimtelijke Ordening 2000/2020. Samenvatting', (Den Haag).

RIZA and Bosch & Slabbers (1999), 'Landschappelijke verkenning rivierverruimende maatregelen', (Lelystad: Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling, Projectteam Integrale Verkenning Benedenrivieren IVB, Rijkswaterstaat, Ministerie van Verkeer en Waterstaat).

Ruimte voor de Rivier (2009), Samen werken aan een veilig en mooi rivierengebied, ed. Programmadirectie Ruimte voor de Rivier (The Hague).

Salewski, Christian (2012), Dutch New Worlds: Scenarios in Physical Planning and Design in the Netherlands, 1970-2000 (Rotterdam: 010 Publishers).

Schreuder, Arjen (2002), 'Wie woont er graag in de calamiteitenpolder?', NRC, (02.12.2002). <http://vorige.nrc.nl/binnenland/article1554360.ece>, accessed 28.01.2014.

Sijmons, Dirk (2009), 'Room for the River', Topos, 68, 61-63.

Süddeutsche Zeitung, 'Banales Betonmonster. Isar-Renaturierung: Bürger lehnen Siegerentwurf ab', (05.06.2003), 42.

SYMBHI Syndicat Mixte des Bassins Hydrauliques de l'Isère (2009), 'Rapport de présentation synthétique du projet Isère Amont', (Grenoble: Conseil Général de l'Isère).

Traa, Marc (2011), 'Wat gebeurt er eigenlijk als de Randstad overstroomt?', HP/De Tijd, (20 mei 2011).

Van Drimmelen, Camiel and Lagendijk, Oswald (2000), Integrale Verkenning Benedenrivieren, Landschap (Van Killen en Gateh, Waarden en Platen, Landschapstoetsing en kansen voor landschapsontwikkeling bij rivierverruimende maatregelen in de Rijn-Maas monding; Rotterdam: Rijkswaterstaat, Directie Zuid-Holland).

Van Rooy, Peter and Slootweg, Roel (2003), 'Spiegelproject Overdiepse polder : rapportage verkenning', (Gouda: Habiforum , Vereniging "Belangengroep Overdiepse polder", Bezinningsgroep Water, Stuurgroep Benedenrivieren).

Waterschap Brabantse Delta 'Ruimte voor de rivier in de Overdiepse Polder', <http://www.brabantsedelta.nl/algemeen/actueel/werk-in-uitvoering/waalwijk/ruimte-voor-de-rivier-in-de-overdiepse-polder.html>, accessed 12.04.2015.

Veuve, Léopold, Feddersen, Pierre, and Paysagestion (2008), 'Lignes directrices paysagères pour le Rhône et pour la plaine', (Sion: Projet Rhône, Département des transports, de l'équipement et de l'environnement, Service des routes et des cours d'eau, Canton du Valais).

Interviews

Isère-Amont, France

Buisson, Morgane, environment engineer for Isère-Amont, Conseil Général de l'Isère (Grenoble, 20th December 2012)

Girel, Jacky, engineer-researcher, Laboratoire d'écologie Alpine, CNRS, Grenoble. (Chambéry, 19th February 2013)

Jardin, Paul, former Hydrology Engineer, SOGREAH (Grenoble, 26th December 2012)

Manin, Olivier, Engineer and Project leader, SYMBHI (Grenoble, 19th December 2012)

Pinhas, Michel, Director Association des Digues Isère-Drac-Romanche (telephone interview, Zürich/Grenoble, 14th may 2013)

Isar-Plan, Germany

Engelmayer, Oliver, project leader, Irene Burckhardt Landschaftarchitekt (Munich, 24th june 2013)

Mahida, Nivedita, Management and communication, Water Board of Bavaria, State of Bavaria (Munich, 26th june 2013)

Schaufuß, Daniela, Director Water Works, City of Munich (Munich, 25th june 2013)

Thalgott, Christiane, former head of Urban Planning Department, City of Munich (Munich, 25th june 2013)

Third Rhone Correction, Switzerland

Gross, Damien, Planner, Department of Architecture and Urban Planning, City of Sion (Sion, 24th July 2013)

Mettan, Nicolas, Planner, Department of Roads and Rivers, Direction Rhone 3, Canton of Valais, (Sion, 23th july 2013)

Michelet, Paul, Department of Agriculture, Canton of Valais (Sion, 24th july 2013)

Largey, Thierry, Secretary Pro Natura Valais (telephone interview, Zürich/Sion, 13th august 2013)

Tille, Didier, Engineer hydrologist, Project leader Central Valais, Direction Rhone 3, Department of Roads and Rivers, Canton of Valais. (Sion, 17th april 2014)

Room for the river, the Netherlands

De Bont, Jos, historian, former farmer and inhabitant Overdiepse Polder (Waspik, 23th september 2013)

De Jonge, Jannemarie, Landscape Architect, guest lecturer at Wageningen University (Wageningen, 22 March 2013)

De Koning, Robbert, Landscape Architect Noordwaard (Arnhem, 24th april 2013)

Houwing, Erik-Jan, Technical Manager Room for the River / Noordwaard, Group West (Werkendam, 26 november 2012)

Sijmons, Dirk, former chairman of the Q-Team Room for the River (15th September 2015, Delft, and 20 October 2015, Amsterdam)

Van der Grift, Jan and Der Nederlanden, Hermine, experts Spatial Quality, Department of Knowledge Management, Rijkswaterstaat, Room for the River.(Utrecht, 13 august 2013)

Meerstad-Groningen, the Netherlands

Leverman, Robert, Project Manager, and De Vries, Aldert, Civil engineering, Bureau Meerstad (Harkstede, 12th march 2013)

Rolvink, Remco, Project leader and former partner, Alle Hosper Landschapsarchitectuur (Haarlem, 12th december 2012)

Van de Bospoort, Jan, landscape architect, City of Groningen (Groningen, 11th march 2013)

Van Hall, Albert, Chairman, and Küpers, Harm, Director-Secretary, Water Board Hunze-en-Aa's (Veendam, 13th march 2013)

Hille von Seggern

Data and statistical sources

Federal Office of Topography, Swiss Topo, Wabern. http://www.geo.admin.ch

Geodata Visualization and Interactive Training Environment (GeoVITe), Institute of Cartography and Geoinformation, ETH Zürich. https://geodata.ethz.ch

Statistiques Suisse de la superficie (AREA), OFS - Edition: 2013-08-09 <http://www.bfs.admin.ch/bfs/portal/fr/index/themen/02/03/blank/key.html>; accessed on 12 feb 2014

http://www.muenchen.de/rathaus/Stadtinfos/Statistik/Bev-lkerung/Bev-lkerungsbestand.html

http://www.muenchen.de/rathaus/dms/Home/Stadtinfos/Statistik/wahlen/jz/121103/jt121103.pdf. Accessed on 14.07.2013

http://www.muenchen.de/rathaus/Stadtverwaltung/baureferat/mse/Baden-in-der-Isar.html. Accessed on 16.07.2013

Bayerisches Landesamt fürStatistik und Datenverarbeitung. Accessed on 14.07.2013. http://www.wahlen.bayern.de/lw/lt0gesst.htm

Bayerisches Landesamt für Vermessung und Geoinformation, Munich, digital terrain model Munich and surroundings.

AHN Nederland, Amersfoort. ahn.nl

PDOK, Publieke Dienstverlening Op de Kaart, Apeldoorn. www.pdok.nl

Institut Géographique National. ign.fr

Open street map. http://www.openstreetmap.org

Eurogeographics.org

Google Earth

Previous publications

Parts of this thesis are based on earlier publications by the author:

Rossano, Frédéric (2010), 'Le Fleuve Captif', in Frédéric Rossano (ed.), Sion-sur-Rhône. Un nouveau paysage pour la vallée du Rhône à Sion/Eine neue Landschaft für das Rhonetal in Sion (Pamphlet 13; Zürich: GTA).

Rossano, Frédéric (2012), 'Dynamic Designs for Fluctuating Landscapes', in Frédéric Rossano (ed.), Rising Waters, Shifting Lands. (Pamphlet 16; Zurich: GTA).

Rossano, Frédéric (2013), 'Designing with flood risk. Water management beyond technicism.', Urbanism after Urbanism. VII International PhD Seminar Urbanism & Urbanization (Paris).

Hobeica, Liliane and Rossano, Frédéric (2014), 'Design as a Negotiation Platform: New Deals and Spatial Adaptation in Flood-prone Areas', in D. Proverbs and C.A. Brebbia (eds.), Flood Recovery, Innovation and Response IV (Witpress).

Rossano, Frédéric (2015) From absolute protection to controlled disaster: New perspectives on flood management in times of climate change, Journal of Landscape Architecture, 10:1, 16-25.

ERRATA

Errors in the doctoral thesis were discovered by the author of the report after its approval and acceptance by Department Conference:

- Section II, page 114, second paragraph

The second sentence should read:
“The Room for the River program elaborated in the nineties concerns the Rhine Delta and its various branches (Meuse, Lek, Ijssel, Waal), a total of about 450 kilometers.“

- Section II, page 116, table Key facts for the Third Rhône Correction and the Room for the River programs

The value for the stream length concerned by the Room for the River program should read: 450 km.

- Section II, page 257, table Mitigation/flood deviation areas in four projects

The value for the stream length concerned by the Room for the River program should read: 450 km.