Natural Ventilation, Revisited
Edited by Sascha Roesler | Research Module of Territorial Organisation, Prof. Dr Marc Angélil | Future Cities Laboratory

Pioneering a New Climatisation Culture
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When it comes to cooling and heating buildings, many parts of the world are still imitating 20th-century practices. As a discipline, architecture continues to be bound to a paradigm of comfort whose emergence was closely connected with the use of oil. The familiar result—while providing homogeneously air-conditioned rooms and improved technical understanding of climate control—has all too often, however, disregarded sustainable solutions. In Southeast Asia, modernization of the built environment still largely entails a proliferation of air-conditioning units, a preference that simply rejects natural ventilation as an outdated practice.

Against that background, this special issue of FCL Magazine aims to underscore the relevance of natural ventilation within the contemporary urban Asian landscape. Given the current requirements for energy-saving methodologies, a sustainable future will rely on more than mechanical cooling strategies alone. Urgently needed are urban-relevant ventilation concepts that address the interrelationships among climate, territory, and architecture, concepts that give far greater attention to natural ventilation, which, even as an age-old cultural practice, still has relevance to dense urban areas today.

The specific focus of the research we present here then, is on natural ventilation in urban environments. We pose new questions—regarding air pollution, for example—and give insights into the ‘fine art’ of natural ventilation, such as by drying tobacco leaves. The findings are based on both fieldwork and comparative study: We assess the current state of natural ventilation in the cities of Medan (Indonesia) and Singapore by looking at the urban mass housing system, typologies, housing policies, and their implications for the venting systems. In doing so, we identify the critical obstacles and, conversely, the potential inherent in using natural ventilation in an urban context. Our ultimate goal is to pioneer a new climatisation culture in the Southeast Asian region.

This special magazine issue is the product of a collaboration among three architects: Marcel Jäggi, Sascha Roesler, Ani Vihervaara; a landscape architect, Karoline Kostka; and a visual artist, Katja Jug. Its publication marks the completion of the research module ‘Territorial Organisation’ that was conducted from 2010 to 2015 at the Future Cities Laboratory in Singapore.

Marc Angélil
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Natural ventilation represents a significant cultural heritage for Southeast Asia. Largely unrecorded by experts and social elites, this cultural technology awaits an awakening to new life. Historically, the incorporation of natural ventilation in building concepts generated a heritage in Southeast Asia that - as anthropologist Roxana Waterson suggests - can generally be considered ‘the Architecture of Southeast Asia’. The Indonesian architect Topane-petra Pandean, on the other hand, made the summary observation that while the numerous ethnic groups in Indonesia had ‘developed different forms of houses’, these still all had ‘relatively identical characteristics in relation to natural climatisation’, largely owing to the ‘identical climatic circumstances’ in many regions of the country. This trans-ethnic finding can be understood as a common base for contemporary climatic research in architecture in that region of the world, and is, in fact, the point of departure for this research project on ‘man-made weather’. To consider natural ventilation as an inherent part of Southeast Asia’s cultural heritage would not mean, as it would with a temple, to place it under protection; rather, the intention is to actively promote its realisation in contemporary urban building practice.
Man-Made Weather
Toward new climatic research in architecture

Sascha Roesler

Being responsible for 50 per cent of worldwide energy consumption, the building sector is one of the primary causes of CO₂ emissions, and as such, is one of the key drivers of climate change. The concept of ‘man-made weather’ has developed – at least since the turn of the millennium – a second and uncanny meaning, and one which grew out of the first: the control of indoor microclimates by air conditioning and central heating has contributed to the genesis of a new global macroclimate. Increasingly, the climate is becoming a hybrid between nature and culture and can no longer be seen as a variable independent of mankind.

‘Man-made weather’, the working title of this research project on natural ventilation, refers to an expression coined by the supposed inventor of air conditioning for his novel discovery: American engineer Willis Carrier made use of the phrase for decades in order to promote his patented technology. 1 His 1906 patent, A Method for Heating and Humidifying Air 2 , represents a seminal treatise of the 20th century, and its significance is comparable to Sigmund Freud’s The Interpretation of Dreams, a book published in the same period. Just as for Freud, the Interpretation of Dreams represented the key to the unconscious, air conditioning for Carrier was the key to the weather. In both cases, an unromantic attempt was made to bring what is in fact uncontrollable – the unconscious, the weather – under man’s control. In Carrier’s phrase ‘man-made weather’ connotes both the hopes of the engineer and the rainmaker to add artificially created weather to something naturally given. Since Carrier, that artificial creation of weather has meant harnessing four interdependent parameters of an overall system:

1) Controlling temperature
2) Controlling humidity
3) Controlling air circulation and ventilation
4) Cleansing the air 4

Fig. 01 Illustration of Willis Carrier’s patent, ‘A Method for Heating and Humidifying Air,’ 1906
Control as ‘hegemonic model’

One might say with some justification that architectural modernity is the tradition that ultimately brought the (interior) climate to heel. The notion of heating or cooling entire buildings homogenously and independently of their external climatic conditions simply did not exist until around the end of the nineteenth century. Since the middle of the twentieth century, this need for control in both workplace and housing design has been accompanied by an increasing standardisation of indoor temperature, and, meantime, this has emerged as a powerful global standard. We are striving all over the world to maintain air temperature at 20°C and with 50 per cent relative humidity. As architects, we are called upon to develop alternative energy concepts for new building models; we do so with an awareness of where this global standard has brought us over the past hundred years. Today, climate change spurs us once again to address, and in greater depth than hitherto, the complex relationship between architecture and climate, in hopes of achieving a more sustainable way of building.6

My hypothesis is that the concept of ‘control’ represents the centre of gravity in today’s climate-discourse in architecture. ‘Control’ is a paradigm of building services engineering that increasingly dominates the way architecture is considered in relation to climate. I would offer that the control-paradigm’s demand for a homogenous indoor climate7 has caused many other aspects of climate relevant to architecture to be neglected. To cite Bruno Latour, ‘the work of purification’8 in the climate-discourse in architecture correlates outdoor climate again and again (even against better knowledge) with nature, and the indoor climate with culture. Yet the majority of all structures remain excluded from this discourse, inasmuch as nature still governs the interiors of these buildings! Over and beyond the global standard of comfort, numerous other forms of climate, architecture and individuals’ interaction have existed. ‘What used to be diverse, seasonally sensitive, “local” indoor weather patterns accompanied also by local conventions and competences in modifying and varying patterns of activity and clothing, are being replaced by a highly uniform indoor climate, itself an outcome of a universalising mode of scientific enquiry.’9 Architects today would do well to investigate, and more thoroughly, this diversity outside of the cognisance of building physics and building services engineering.

Climatic research in architecture

Today, climate change spurs us once again to address, and in greater depth than hitherto, the complex relationship between architecture and climate, in hopes of achieving a more sustainable way of building. I call this preoccupation the climatic research in architecture (or of architects); and I recently coined the term microclimate ethnography10 for the empirical element of the research. In this research project we have investigated thermal structures, thermal practices and thermal regimes that either support or neglect the use and re-use of natural forms of ventilation. Allow me to set out, in three brief points, my view of how architects could approach contemporary climatic research.

(i) Thermal structures

The first point concerns what I would refer to as thermal structures. Related to the concept that has been termed ‘passiveness’11 since the 1960s, these structures take a place under the heading of vernacular and informal construction. Until the mass proliferation of central heating and air conditioning, built structures always featured an inherent thermal dimension. Reyner Banham rightly speaks of ‘structure as prime controller of environment’.12 Thick walls in a hot-dry climate also serve as thermal reservoirs, absorbing the incident heat and keeping interiors cool. Only since the epistemological divergence of buildings into the separate entities of ‘structure’ on the one hand and ‘building services’ on the other, have structures lost their thermal significance, becoming pure load-bearing entities accompanied by non-load-bearing elements such as thermal, acoustic and other supplementary functions. By investigating approaches that once again conjoin structural and (building services) technological thinking in the construction field, this epistemological separation between structure and building services is likely to be abandoned. Thus, my first point of climatic research in architecture is the investigation of thermal structures.
(2) Thermal practices

The second point concerns what I would call thermal practices. An understanding of climatisation informed by vernacular architecture is based upon the awareness of the constant and inevitable interplay between body and building, between corporeal and building ‘technologies’, between ways of life and ways of building. Thermally relevant activities that take place near and inside buildings are traditionally an integral part of any climatisation culture. An example of thermal practices would be the way people inhabit their houses according to the season or the time of day, or how they vary their manner of dress relative to the changing outdoor temperature. One might concur with architectural theorist James Fitch, who states, ‘our very concepts of warmth and coolness are relative and highly subjective’. 13 Today’s architects have to learn alongside their clients to design buildings whose climate control strategies make a foundation for the thermal practices of their future users. This is my second point of a climatic research in architecture – the investigation of thermal practices.

We are striving all over the world to maintain air temperature at 20°C and with 50 per cent relative humidity.

(3) Thermal regimes

The third point ultimately relates to what I would call thermal regimes. This concept connotes the complex relationship that societies form with their climates in different periods. Indeed, architecture is one fundamental territory of thermal regimes, but certainly not the only one. With increasing frequency, modern thermal regimes are superimposed upon naturally given environmental conditions. Only the reflection of this new artificial climatic order (=thermal regimes) fosters architects’ interrogation of climate-related epistemologies. The relationship between architecture and climate is socially preconditioned, evident when one considers the thermal regimes of diverse societies. How do, for example, thermal regimes in Switzerland compare with those in Singapore? That thermal regimes acquire their political and legal dimensions through governance and norms must be taken into consideration. This is the third point of a climatic research in architecture – the investigation of thermal regimes.

References

Freud, Sigmund (1900) Die Traumdeutung. Franz Deutscie. Leipzig und Wien

Endnotes

2 US Patent 854270.
3 Freud, Sigmund (1900).
What the Climate Is and Was
The monsoon of Southeast Asia

One reason to consider the larger region of Southeast Asia as a whole is its climate. The climate of this Asian sub-region is ‘noticeably uniform, characterised by constant temperatures, high relative humidity, heavy precipitation and regular recurrence of the monsoon winds.’ Southeast Asia’s tropical climate is dominated by the rhythm of an alternating wet season, the ‘summer season’ starting around June with heavy precipitation and a dry season, the ‘winter season’ beginning in December with little rainfall. Over the course of one year, both monsoon seasons are interrupted by an inter-monsoon period. In the recent past, this weather pattern has increasingly lost its stability, such that monsoon in Southeast Asia is significantly less pronounced.

Today, the term ‘Southeast Asia’ refers to those landmasses and archipelagos that are covered by the states of Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. Numerous small islands and island clusters, constituting the Archipelago of Southeast Asia as the world’s largest, dominate the area. The unity of the larger region of Southeast Asia in terms of its common climate suggests a research method that transcends purely local approaches. By referring to ‘nations’ alone, one is not capable of re-imagining the relationship among architecture, territory and climate, without confronting the pitfalls of regionalism. Modern climatic research in architecture, therefore, has to move between different scales (from XL to S) and between different territories. Today, ‘monsoon’ has three major definitions, as listed below.

Fig. 01 | In August, the landmass of the island of Singapore heats up more quickly than the surrounding waters of the Singapore Straits; accordingly, clouds drift over the island, resulting in heavy rainfall
Fig. 02

The area stretching from central West Africa all the way to India, Japan, and Australia in the south is defined as the major global monsoon territory. The major monsoon indicators are defined by criteria such as prevailing winds, surface temperatures, and overall pressure areas along the equator. As a system, the planetary monsoon joins 3 major regions affected (the Northeast-American, the African and the Asian–Australian Monsoon Regions) into one highly vulnerable ‘patch’, and defines 9 other sub-regions, each of which meets the same criteria of monsoon indication.

Within the planetary monsoon system, the Southeast Asia Monsoon is a sub-region in the Asian–Australian Monsoon Zone.
Monsoon definitions

(1) Prevailing surface winds
The Indian Monsoon is the most pronounced and, at same time, the one credited with the word’s origin. ‘Monsoon’ derives from the Arabic ‘mausim’, the word for ‘season’. The term was first used in British India and neighbouring countries to refer to the heavy seasonal winds blowing in from the Bay of Bengal and the Arabian Sea in the southwest, both of which brought heavy rainfall to the area. Primarily, the term refers to very direction-stable regional winds, in conjunction with a two-time reversal of the most common wind direction over southern Asia and the Indian Ocean in the course of a year. Monsoon winds are accompanied by regular heavy precipitation occurrences, caused by those seasonal changes in lower atmospheric circulation that is typically associated with the asymmetric heating of land and sea.

(2) Global climate system
More and more, ‘monsoons’ refer to very large-scale wind circulations that can simultaneously affect – and be affected by – global climate. They are notorious weather incidents with annual ‘metronomic’ regularity. The monsoons (reversal surface winds) are mainly caused by a) the migration of the zenith position of the sun between the tropics of Cancer 23.5° N and Capricorn 23.5° S; b) different heating and cooling properties of water and land; and c) corresponding windage. The chain reactions affecting weather patterns throughout the world are collectively known as ‘global tele-connection’. The global tele-connection explains causes by other geographic events in the area of trade winds. More recently proposed, the ‘global monsoon’ hypothesis interprets monsoon systems as part of one global-scale atmospheric overturning circulation, implying a connection between the regional monsoon systems and an in-phase behaviour of all northern hemispheric monsoons on annual timescales.

(3) Geographical area
Finally, the phenomenon ‘monsoon’ is often equated with the geographical description of monsoon regions. Regional monsoons are described over six sectors: Africa, Asia-Australia, North America, South America, Pacific and Atlantic oceans, thereby collectively configuring the global monsoon system. The two major monsoon sub-systems of the world are the West African and Asian-Australian monsoons. Within these two systems, common climate conditions determine the different monsoon regions and their tropical ecology, the landscape of each region having a specific and unique identity.

‘Monsoons’ refer to very large-scale wind circulations that can simultaneously affect – and be affected by – global climate.
Southeast Asian monsoon

The Southeast Asian monsoon region is located in the centre of the Asian-Australian monsoon system. Asian-Australian monsoon affects East Asia, Southeast Asia, South Asia, the Australasian islands and northern Australia. According to climate types, Southeast Asian monsoon is a ‘Tropical Monsoon Climate’ (Am) and a ‘Tropical Wet / Rainforest Climate’ (Af). Throughout the year average temperatures exceed 18°C, while the mean precipitation ranges from 1500 to 2500 mm; three times the world’s average rainfall. For the most part, monsoon tropical areas are situated within the realm of developing countries. Since many of their societies rely on rain-fed agriculture, prediction of the amount, timing and location of monsoon winds and rains is crucial to their communities’ interest. Although some 60 per cent of the region’s population still lives under rural conditions, the Asian-Australian monsoon system also affects some of the world’s largest cities. This raises the need to understand monsoon as an urban design phenomenon, and one that must be treated in the context of ‘city climate’ theory.

Monsoon prediction and climate change

Current spatial strategies in the context of climate change in Southeast Asia embrace risk-based land-use planning initiatives. These include the role of green spaces and environmental buffers such as large-scale mangrove planting for protection against eroding coasts and future sea-level rise. In 2009 the United Nations’ Intergovernmental Panel on Climate Change identified the regions most vulnerable to climate change impacts by overlaying climate hazard (called ‘Climate Change Vulnerability Mapping for Southeast Asia’). Climate hazards are thus defined as the frequency of droughts, floods, and cyclones over about 20 years (1980–2000), physical exposure to landslides, and inundation zones of a five-meter sea level rise. Based on this mapping assessment, the most vulnerable regions in Southeast Asia include:

- Cambodia (almost all regions)
- Indonesia (West and East Java): exposure to droughts, floods, landslides, sea level rise
- Indonesia (West and South Sumatra): exposure to droughts, floods, landslides, sea level rise
- Lao PDR (North and East regions)
- Philippines (all the regions): exposure to tropical cyclones, landslides, floods, droughts
- Thailand (Bangkok region): exposure to sea level rise, floods
- Vietnam (Mekong River Delta): exposure to sea level rise
- Vietnam (Eastern coastal areas): exposure to tropical cyclones, droughts

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Fig. 05 Average annual rainfall in Sumatra (map published 1981)

Fig. 06 Overview of the winds in Sumatra
Since the 1950s, the presence of El Niño (or El Niño Southern Oscillation) has intensified. From East Africa to the United States, droughts and floods have increased in number markedly, and represent phenomena that could start a chain reaction throughout the atmosphere, causing stronger lows and heavier rain. By acknowledging the global monsoon system, the overall planetary influence on wind, rain, temperature, vegetation and air circulation became an important focus in climate understanding. With the rising water level caused by climate change, the temperatures of ocean water increase, resulting in a decrease of temperature difference (as regards land and ocean surface). At the same time the overall pressure areas lose their intensity, resulting in lower equilibrium forces and weaker winds. For some years, monsoon in Southeast Asia has been significantly less pronounced.

For some years, monsoon in Southeast Asia has been significantly less pronounced.

References


Endnotes

2 Source: asean.org [accessed 11.08.2015].
4 Wang, B and Q Ding (2008).
5 See Wang and Ding (2008) and Trenberth et al. (2000).
7 East Asia with mountain ranges, plateaux and basins; South Asia with lower mountain ranges, deltas and river plains; and Southeast Asia with mainly archipelagos and seas. Monsoon regions are determined by ‘Prevailing wind shifts by a minimum 120° between July and January’; ‘Average frequency of prevailing wind direction in January and July that exceeds 40 %’; ‘Mean resultant wind at least one of the months exceeds 3 m sec-1’; Fewer than one cyclone-anticyclone alternation occurs every two years in either month in a 5° latitude-longitude rectangle’. See Ramage, C (1971), p. 6.
8 de.slideshare.net/lschmidt1170/chapter7-10793606 [accessed 21.05.2015].
9 On the basis of moisture regime and temperature, the humid tropics are also termed ‘warm humid tropics’. Exceptions within this zone are the highlands of this geographical area. The Köppen and Geiger climate classification uses temperature, precipitation and elevation information to indicate high altitude climate types and links additionally to natural vegetation patterns. See Kottek, M et al. (2006), p. 259-263.

Image Credits

Fig. 06: Royal Tropical Institute (KIT), University of Leiden.
Fig. 07: Roxana Waterson, The Living House.
Fig. 08: Ministry of Interior, Republic of Indonesia, Land Use Planning Directorate and General Agrarian Directorate.
Fig. 09: Rosane Waterson, The Living House.
Indigenous, or more generally spoken, vernacular building can be understood as the evolutionary result of precise – albeit pre-scientific – observations of the environment. Research into vernacular architecture has amassed a tremendous amount of evidence that indicates a close correlation between climate, culture, and construction. In vernacular cognition, architecture relies on climate, and climate is perceived by means of architecture and construction. Natural ventilation is set up at the intersection of climate, tropical ecology, and architecture.

James Fleming and Vladimir Jankovic have recently argued that there are ‘index- and agency-based readings of climate.’ From their point of view, the ‘definition of climate’ as a ‘statistical index’ is a relatively new phenomenon. By conceiving of it as an index, ‘climate has been eroded to an abstract three-dimensional geophysical system, rather than an intimate ground-level experience.’ Historically, ‘climate has more often been defined as what it does rather than what it is. This means that climate has not usually been seen as an indicator of weather trends, but as a force – and a resource – informing social habits, economic welfare, health, diet, and even the total “energy of nations”. In these domains of social life, climate as agency has helped translate matters of concern into matters of fact. [...] Early modern scholars [...] saw climate prescriptively as the norm that connected environmental features with social potentials. In this sense, climate literally produced seasons and endemic disease, vegetation and diet, soil and vernacular architecture, customs and political organisation. Climate was considered as agency organising social experience as a result of the material circumstances of life.’
Monsoon landscapes

During the six-year journey he took through the Malaysian archipelago between 1854 and 1862, Alfred Russel Wallace kept a diary, in which, among many other things, he describes the island of Singapore. His descriptions give the modern reader insights into how the flora and fauna, as well as the climate of Singapore, presented themselves to a European traveller. Wallace describes a forested island, one still significantly shaped by its natural parameters: The island of Singapore consists of a multitude of small hills, three or four hundred feet high, the summits of many of which are still covered with virgin forest. The mission-house at Bukit-tima was surrounded by several of these wood-topped hills, which were much frequented by woodcutters and sawyers, and offered me an excellent collecting ground for insects. [...] Several hours in the middle of every fine day were spent in these patches of forest, which were delightfully cool and shady by contrast with the bare open country we had to walk over to reach them. The vegetation was most luxuriant, comprising enormous forest trees, as well as a variety of ferns, caladiums, and other undergrowth, and abundance of climbing rattan palms.5

The tropical rain-forest is the climax vegetation of the humid tropics. A wide range of vegetation types grows in the humid tropics, with numerous tree species of varying height, canopy structure, and biomass. Three types of forest can be distinguished: tropical rain-forests in the lowlands, moist deciduous forests in regions with a pronounced dry season, and montane forests in the highlands. The tropical rain-forest vegetation is diverse and complex and characterized by the following: high biodiversity (comprising 40–50 per cent of Earth’s five to ten million species); high plant biomass (ranging from 200 to 400 Mg/ha, with most of the biomass accumulating in the first eight to ten years); a concentration of a large proportion of the total nutrient capital within the plant biomass; a rapid rate of nutrient recycling; a multi-storey canopy of mature tropical rainforest containing numerous species in different strata; and a virtually closed ecosystem for most nutrients and water within the mature or high (tropical) rainforest.5

Although the long-term planetary climate has shaped the landscapes of the Southeast Asian monsoon region, these landscapes are both object and subject, both effect and cause of climatic phenomena. Over time, and with their distinct characteristics, they became the visible indicator of extreme climate and temporary weather conditions. Southeast Asia’s landscape consists of disproportional solids and fluids with different heating and cooling properties, voids and barriers for wind circulation and dense high vegetation that creates wind-friction, but at the same time, enables wind velocity and bundles moisture and humidity. The islands and archipelagos are determined by three major characteristics that can only be identified as the monsoon landscape of Southeast Asia:

1) land-water relation of vast sea with relatively large islands and long coastlines
2) islands with high altitudes in relation to the sea water level and
3) tropical rainforest vegetation on volcanic soils.
Monsoon landscapes of Southeast Asia are determined by three major landscape elements: topography, vegetation, and soil types.

**Fig. 08 Topography**
In Southeast Asia, the area covered by the sea is approximately four times the land area. Over 90% (approx. 2 million km²) of the total land area is islands, but less than 25% of the total archipelago area (approx. 8 million km²) is land. This disproportion of (island–ocean distribution, with big islands and high altitudes, sets a regional foundation for an extremely pronounced monsoon climate.

**Fig. 09 Vegetation**
The tropical rainforests (TRF) is the climax vegetation of these soils. Many lamas (woody vines) and herbaceous epiphyles (air plants), such as orchids, are present. Monsoon forests' evergreen forests are especially well developed all over Southeast Asia, and are typified by tall teak trees and thickets of bamboo.

**Fig. 10 Soil types**
Similar to vegetation, the soils of the humid tropics are also diverse and highly variable. The predominant soil types are the groups of Ultisols and Oxisols, soils that occur in regions without a marked dry season. They are primarily loaded with clay minerals with or without plinthite or laterite. Air-dried laterite (lat. ‘brick’) is used as brick in the regional construction industry.

**Monsoon Climate: What the Climate Does**

The principles of stilt house construction and permeability comprise the two central climate-related constructional approaches in the indigenous architecture of Southeast Asia.

Numerous observations can be found in Pelzer's notes that offer information on how construction - before the beginnings of modern architecture - dealt with climatic factors in the region. The tropical, hot-humid conditions had (for reasons easily grasped) led to filigree models: air-permeable and elevated building structures. Indeed, the principles of stilt house construction and permeability comprise the two central climate-related constructional approaches in the indigenous architecture of Southeast Asia. Pelzer summarises the constructional peculiarity, shaped by timber building techniques, of this larger region as follows: "This whole study is a study of construction without nails. When there are nails, there is already Western influence - except possibly Chinese influence, Chinese Nails." Timber, bamboo and natural fibres were the materials most suited for use under such adverse conditions. Pelzer describes, for instance, how the central element of the ridge of the roof was chosen: to find the necessary material meant having to go find it in the forest. She writes, "Ridge: Construction of ridge very important. Judge quality of house by it. From djior wood (Indonesian: djuhar). One piece. Its length limits size of house."

**Built heritage**

Exactly 100 years after Wallace, the American architect Dorothy Pelzer travelled through the Malaysian archipelago with no less a systematic approach. In contrast to Wallace, however, who had set out to study the natural history of the region, Pelzer documented the vernacular architecture of Southeast Asia - just before sweeping transformations in it took effect. In the eight years following 1963, Pelzer travelled alone and even under adverse socio-political conditions through Laos, Burma, Cambodia, Thailand, Vietnam, Malaysia, Singapore, Indonesia and the Philippines. She wrote that her ‘project was a book on traditional house types of Southeast Asia, to be recorded in photographs and measured drawings. The most interesting of these houses everywhere were fast becoming lost - built as they were in perishable wood, bamboo, and thatch, in a physical climate taking heavy toll on such materials, and in a mental climate fast abandoning old forms in the rush for imported “progress”.'

Climate (and with it, the tropical ecology) was a transcendent variable, to which humans were subordinate, and they had to adapt as precisely as possible to it by means of their architecture. Yet the gods had been granted the ability to manipulate the climate according to their own interests. The godly Hindu king of the Batak ethnic group in Sumatra, Singa Mangaradja, for example, possessed ‘no secular power, but was seen as someone who held sway over the weather’; his power to rule the climate was an expression of his godly status.
Urban traditions of natural ventilation

The governing question of this research project is how the cultural heritage of natural ventilation might today – under conditions of widespread social and environmental change and advancing urbanisation – be renewed and reintroduced into the urban architecture of Southeast Asia. How to gear, for instance, the (horizontal) vernacular architecture of the shophouse towards the (vertical) high-rise building? Beside the indigenous filigree construction techniques of the villages (stilt buildings), the urban heritage of the Chinese massive construction (shophouses), and the colonial and postcolonial style known as Tropical Architecture are the historical points of contact for today’s concepts of natural ventilation. An urban practice of climate control, familiar throughout Southeast Asia since the 11th century, was established by Chinese settlers. Shophouses are courtyard houses in a hot-humid climatic zone, which fundamentally influenced urbanisation in Southeast Asia.\(^1\) We can distinguish two basic principles of natural ventilation at work in courtyard houses; both kinds are also of the greatest relevance for the natural ventilation of high-rise buildings today:

‘The architectural design can ensure such natural air movement through two principles. In the first, differences in wind velocity produce a pressure differential that results in air flowing from the higher to the lower air pressure region. In the second, air is warmed, causing convection, with the warm air rising and being replaced by cooler air.’\(^2\)
Medan and Singapore

An urban culture of natural ventilation brings together the aforementioned heritage and the demands of modernisation. For reasons of sustainability and cost, the question arises today as to how natural forms of ventilation could once again be considered an option more often for the Southeast Asian housing sector. The two case studies following address the underlying mechanisms of ‘man-made weather’ in the cities of Medan (Indonesia) and Singapore, and also explore how the city’s macroclimate and the individual microclimate interact. To reconsider natural ventilation in these cities means to acknowledge the interdependency of the various scales. In contrast to (horizontal) Medan, with its unregulated mass housing sector, (vertical) Singapore is strongly regulated. Singapore’s housing agency HDB is responsible for 85% of all housing units on the island, while in Medan, almost two-thirds of all buildings are erected without any governmental regulation. In the Indonesian city’s residential sector, this is largely attributable to informal building industries and profit-oriented developers. Medan’s urban mass housing is economy-driven, whereas Singapore’s urban mass housing is based on a rigid political program that was set up as early as in the 1960s.

While the monsoon climate in the two cities is almost identical, their urban developments and – relative to that – their urban climates are dissimilar. Medan and Singapore each attach a different status and connotation to natural ventilation. A comparison of the two locations, in fact, reveals fundamental differences in the dynamics of their climate, culture and methods of construction. While natural ventilation in Medan is challenged by the conditions of poverty and high air pollution, natural ventilation in Singapore is confronted by the unprecedented victory of air-conditioning and the abundance of sheer energy. Whereas Singapore’s energy-intensive modern lifestyle dictates a new housing policy of diversified cooling concepts, Medan’s response has been simply to ensure a basic demand of comfort for large parts of the population.
References


Holdridge L R (1967), Life Zone Ecology, San Jose, Costa Rica: Tropical Science Center.


Marsden, William (1784) The History of Sumatra: Containing an Account of the Government, Laws, Customs and Manners of the Native Inhabitants, with a Description of the Natural Productions, and a Relation of the Ancient Political State of That, London.


Endnotes

1 Flemming, James R/Jankovic, Vladimir (2011), p. 3.
4 Wallace was no mere traveller, but rather one of the most important naturalists of the 19th century, independently conceiving the theory of evolution alongside Charles Darwin. See Wallace, Alfred Russel (2010 [1869]), p. 20.
6 Holdridge, 1967; Lanly, 1982; Whitmore, 1984; Brown et al., 1989; Grainger, 1991
7 (Holdridge, 1967)
11 Or with words of the early British-colonial orientalist William Marsden: ‘In their buildings neither stone, brick, nor clay, are ever made use of, which is the case in most countries where timber abounds, and where the warmth of the climate renders the free admission of air a matter rather to be desired, than guarded against.’ See: Marsden, William (1784).
12 Institute for Southeast Asian Studies: Dorothy Pelzer Collection, DP 1b, Common Factors.
13 Institute for Southeast Asian Studies: Dorothy Pelzer Collection, DP 1b, Common Factors.

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Fig. 01, 03, 05, 16: Sascha Roesler.
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Fig. 19: Sumatran Heritage Trust, Medan.
Fig. 21, 22: Sascha Roesler.

Page 32: Ani Vihervaara. Sources: About Medan – The advent of a North Sumatran Modern City, Johannes Villedo, 2011; Enziklopedi Umum, Penerbitan Jajasan Kanisius, 1973; NEA, Records of Climate Station Alas; Singapore Ministry of Environment and Resources, Key Environment Statistics, Air Quality, 2015; The World Bank, World Development Indicators; WHO; Wikipedia; www.salaryexplorer.com

Fig 23: Arina Nasution.
Fig 24: Ani Vihervaara.
CASE STUDY MEDAN

Medan is infamous for being the Southeast Asian city with the highest air pollution levels, and whose air quality is tainted by traffic, manufacturing, and plantation industries. The middle and upper classes want to be shielded from the environmental reality of smog, haze and dust by inhabiting and working in air-conditioned buildings. In this case study we will explore aspects of a fundamental climate dilemma triggered by rapid economic development and the public’s desire for enhanced living conditions; a serious and multi-faceted issue that requires long-term study. Nowadays, natural ventilation has a vanishingly low profile when it comes to the design of cooling techniques and ventilation systems in newly erected buildings. Air pollution not only alters expectations of housing, but also contributes to the vulnerable dependency of urban mass housing on the regional electrical infrastructure. The various scales of the city are interconnected: processes occurring at one scale have unexpected effects at other scales which cannot be ignored. Looking at Medan’s urban development one has to question traditional epistemologies of climate and consider adjustments of natural ventilation strategies.
Emergence of New Building Industries
From wood to soil-based construction

Extensive deforestation has led to the scarcity of what was once Southeast Asia’s most important building material, so nowadays, other construction materials are being substituted for timber. Bricks are obviously cheaper, while large-scale use of valuable timber is frequently prohibited in the effort to protect the remaining forests. Anthropologist Christian Pelras sums up this fundamental development in the construction sector of Southeast Asia – from timber to bricks – with the view that “the main architectural change occurring nowadays [...] is not evolution but technical change.” Accordingly, the knowledge of how to construct a wooden house is slowly fading away, such knowledge that would include skills for cooling a building without mechanical means, for example.
In the mid-19th century, the east coast of Sumatra was still ‘an unknown and inhospitable jungle of no economic significance’. Fifty years later, however, the so-called plantation belt along the east coast had become a global centre of colonial extraction of raw materials: ‘rubber, tobacco, oil palm, tea, and fiber became the five most important plantation crops in East Sumatra, both in regard to export value and the acreage they covered.’ Yet over the past century North Sumatra has been the site of one of the most intensive and successful pursuits of foreign agricultural enterprise in the Third World’, writes the American anthropologist Ann Laura Stoler. After the first tobacco plantations in the mid-1860s the landscape of East Sumatra underwent a radical transformation. According to Stoler, the territory today has a specific ‘colonial imprint’ that is shaped by the juxtaposition of trees and factories and the settlements on the edges of plantations. Subsistence farming and wage labour are part of a single economic system. Century-old agricultural technologies (such as ‘shifting cultivation, swidden agriculture, or slash-and-burn cultivation’) exist alongside the intensive industrial use of the land, or are even integrated within it. Nowadays, the rainforests are mere remnants between settlements, transport infrastructures and plantations. In the last 30 years Sumatra has lost over 50 per cent of its natural forest through deforestation.

Knowledge of and expertise in constructing with wood and using natural ventilation practices is becoming obsolete.
From timber ...

The spatial extension of the plantation belt into a plantation carpet covering the entire Sumatran lowlands triggered the disappearance of domestic trees such as *Jati* (teak), *Damar, Nyatoh, Merbau* and *Meranti*, proper kinds of timber having almost disappeared from the forests or becoming too expensive. As a result, the shortage of affordable good quality timber has created a highly competitive niche market in second-hand timber (*kayu bekas*). Many of Medan’s remaining small-scale carpenters around Jalan Brigjen Katomso or Jalan Sentosa Lama source their raw material in demolished, colonial buildings around the downtown. Alternatively, often illegally logged timber is imported to Medan and the North Sumatra Province from remaining Indonesian forests. Not surprisingly, this limited supply of timber has driven up the price and narrowed the options of materials for most building developers and architects. Further, these restrictions have accelerated the decline in the use of traditional building materials; for a vast majority of Medan’s growing middle class, materials such as bamboo and wood are increasingly associated with either retrogressive building practices or poverty. In the urban context of Medan timber remains in use in low-income households and is assembled from industrially produced wood-based panels (and other inexpensive building materials and components). Yet knowledge of and expertise in constructing with wood and using natural ventilation practices is becoming obsolete.
... to brick

Introduced by the Dutch, bricks (batu bata) have become the most important building material for Medan’s construction industries. Since the post-independence boom of the 1970s Indonesian economy, the use of bricks in construction has become inextricably linked to a modern lifestyle – a status symbol on par with air conditioners. Compared to timber structures, brick buildings are faster and easier to build and are more affordable. As the exploitation of the rich local clay soils on the eastern outskirts of Medan has increased, small plantation villages – Lubuk Pekam and Perbaungan, for example – have turned into veritable brick cities, where almost everyone seems to be involved in brick production. Clay-carrying trucks, semi-formal factories, smoking kilns, and open-air drying fields dominate these suburbs, while the clay itself is sourced nearby, from plots in between the palm oil plantations. From a socio-economic point of view, the minimal initial investment needs, coupled with rudimentary mechanisation, lower the bar to entry for even small-scale family-run companies. Moreover, brick production relies on manual work, which translates to a high number of jobs for low-skilled workers in the region.14

What happens to the practice of natural ventilation if the former preconditions – regularity of weather patterns, tropical ecology, filigree building materials, constructional skills etc. – vanish? Although the causalities are hard to identify, the outcomes of this thorough transformation are clear in the case of Medan. The city’s urbanisation leaves an epistemological void in its wake: the traditional interplay among climate, culture and construction is no longer in force; and a new consistent thermal regime hasn’t yet take the place of the old. The traditional model of adaptation is no longer suited to providing solutions for how the largely populated areas could be better adjusted to tropical conditions. The transformation of East Sumatra is a perfect example of how intensive production and modernisation necessitate the adaptation of traditional concepts of the natural.15 Climate in particular is greatly affected by this – it no longer suffices to conceive of it as an external influencing variable. Rather, climate represents a hybrid relational object, part of a system made up of natural and social agents.
Fig. 15 Industrial-scale kiln building, on the outskirts of Lubukpekam. The quality of the bricks depends on the following parameters: type of firewood (rubber wood or palm oil fruits), type and amount of clay used, type of drying (air or fire), exposure to rain, mechanical or manual work (standardisation). A single brick in Medan costs ca. 300 INR (= 0.3 SGD).

Fig. 16 Open-air drying field with bricks covered by plastic at a small-medium scale brick factory in Jalan Pondok Kuala Namu. It takes some 2 weeks to produce a ready to use brick stone.

Fig. 17 Drying hall, part of the brick factory at Jalan Kebun Sayu, Lubukpekam. Brick factories are often double as multi-generation social spaces, since workers live with their families in rudimentary housing on site.

Fig. 12 Trucks waiting for a clay load in a palm oil plantation near a clay pit in Penara, which is close to Kuala Namu International Airport. Due to its rich clay sources, Lubukpekam (25 km from Medan) and Perbaungan have become regional centers for clay sourcing and brick production in the Medan area.

Fig. 13 Motorised compression mould and brick cutting equipment at the 'Kilang Batu' brick factory, Lubukpekam.

Fig. 14 Small-scale wood-fired kiln building at Pasar 5 Kebun Kelapa, on the outskirts of Lubukpekam. The illustrated 'Kayu Karet' (rubber) firewood comes from a nearby plantation. It requires roughly 9m3 of wood to fire 10,000 bricks (one week’s production). Generally said, roughly twice as much wood is needed to fire the bricks for a brick house than is needed to build a wooden house.

Fig. 15 Industrial-scale kiln building, on the outskirts of Lubukpekam. The quality of the bricks depends on the following parameters: type of firewood (rubber wood or palm oil fruits), type and amount of clay used, type of drying (air or fire), exposure to rain, mechanical or manual work (standardisation). A single brick in Medan costs ca. 300 INR (= 0.3 SGD).
References


Geertz, Clifford (1963) Agriculture and Involution: The Processes of Ecological Change in Indonesia, University of California Press.


Endnotes


2 This text is a modified and shortened version of an article originally published in Scapegoat, edition 08, Weather, p. 70–80, 2015.


8 Thwe Kian-Wie (1977), p. 3.

9 earthenginepartners.appspot.com/science-2013-global-forest [accessed 01.02.2013].

10 From interview conducted by Marcel Jäggi with Ms. Juliana, PR manager of PT Sumatera Timberindo, Medan, 30 May 2014.


12 From interview conducted by Marcel Jäggi with Mr. Dede, managing director of Fuel’s Carpentry, Medan, 30 May 2014.

13 From interview conducted by Marcel Jäggi with Taep Kurnadi Mustafa, chairman of board of education and Indonesian Institute of Architects, and member of the Sumatra Heritage Trust, Medan, 4 June 2014.

14 See Röhling, S et al. (2009).


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Fig. 19: Dirk Buiskool.
Fig. 20: Ani Vihervaara, Marcel Jäggi.

Fig. 18 The spatial presence of the ‘Plantation Belt’ in the North Sumatran lowlands around Medan today

Fig. 19 Growth of Medan – from linear city to urban sprawl

Fig. 20 Building industries in Medan area – brick and concrete have become the predominant building materials in North Sumatra
Almost without any kind of restrictions, developers, specu-
lators and the informal construction sector are currently
reshaping the city of Medan. The city hardly adheres
to any institutionalised climate adaption plan for guidance
alongside the growth of its urban fabric. As Chao Ren et al.
have suggested, the development of urban climatic guidelines
and the implementation of mitigation measures (such as
increasing greenery, creating air paths, controlling building
morphologies, etc.) are vital, especially in the rapidly
expanding cities of developing and emerging countries and
regions in the global South. Nevertheless, if any proposed
solution reduces Medan’s urban climate issues to a mere
technical problem, then the issue’s complexity will have been
gately misunderstood."
The anthropologist Christian Pelras defines a very real gap in the modern adaptation of Indonesian housing to climatic requirements, and he addresses the domain of the architect quite directly: ‘Suffice it to say that [today’s houses] often have features that are much less well suited to the climate than those of the former wooden houses. For instance, instead of having elevated floors, they are built at ground level, and often have no crawl space and may even lack a foundation. Because they are frequently located in areas susceptible to flooding, many of them are flooded every year during the rainy season. Likewise, instead of having natural ventilation, they are hermetically sealed by windows that are seldom opened, so that the air inside is often stifling. Unfortunately, little if any effort has been made to adapt this new kind of architecture to local conditions and lifestyles, or to come up with satisfactory solutions by adapting time-honoured techniques to the new situation.’

In the heat of tropical nights, people take their mattresses out into the open, no longer able to bear being inside. The general shift in construction from timber and bamboo to brick and concrete has had a profound influence on the microclimate in the buildings and the comfort of any who live in them.

Shop houses

The disregard of climate (and other natural agencies) is reflected in the widespread climatic inadequacies of the houses large parts of the population live in. Like elsewhere in Southeast Asia, the contemporary incarnation of the Chinese shop house, traditionally equipped with a central courtyard used for air circulation, dominates the city. However, the increasing demands of urban density had eroded this specific natural ventilation feature by the early 1970s. Now, these easy-to-build, walkable, three-to-four-storey, long *rumah toko* (literally ‘house shop’) are almost exclusively built with brick-infilled concrete frames to form walls according to a ‘one-brick lengthways’ method of construction. The simplicity of this method does not require sophisticated experience in bricklaying and is fuelling Medan’s real-estate boom as a result. The old interplay of macro- and microclimates has been replaced by a new self-referential thermal regime. Speculative developers are producing half-abandoned spaces (as most shop houses are often only used on the street level).
Electricity blackouts

Given Medan's tropical environment, air-conditioning has become one of the most desirable assets in the real-estate market. While these devices add to the property value, they boost ever-increasing energy consumption, as well. As such, a major threat to the cooled and refreshed spaces is the security of the country's energy supply. The recently coined Indonesian term biarpet describes the repeated turning on-and-off of electricity supply by the local power plants due to supply shortages. Often occurring daily, the six-hour (or longer) rolling blackouts in Medan cause problems of all kinds, switching on the air-conditioner being just one. The blackouts also contribute to the rising number of house fires in the city, as many residents rely on candles as light sources, and the use of private diesel generators is on the rise. According to the BPS Indonesia (the Department of Statistics), only 16.18 per cent of North Sumatran households with an air conditioner turn their devices off when the temperature outside drops below 25° Celsius. Not surprisingly, when paired with dysfunctional building stock, the failure of existing centralised, state-owned electrical infrastructures and technological systems has ultimately created a forbidding environment in which to live. Since the rising energy demands of the local industrial and building sector have not been met, many people are left trapped in buildings with unbearably hot, humid and stagnant air. Using private electricity generators to keep the machines running or sleeping on the veranda (rather than inside the house) are simply short-term solutions to the problem. Today, many buildings in Medan have become microclimate traps, providing no real shelter from hazardous man-made weather for a large portion of the population. Access to air-conditioning has become a symbol of class division and cultural homogenisation, as in many regions in the global South.

It is not surprising, that today's shop houses contribute to a large extent to an estimated 60 per cent of the buildings erected without any prior approval by a designated authority in Medan. Meanwhile, the advisory role of architects and academics in this overheated and rapidly developing city has decreased to a minimum. Only a few nominal efforts at technical innovation and the implementation of air-quality standards have been made to better adapt shop houses and other relatively new building typologies such as the Perumahan Nasional (a state-run mass housing program) to local conditions and lifestyles.

The recently coined Indonesian term biarpet describes the repeated turning on-and-off of electricity supply by the local power plants due to supply shortages.
Air pollution (interconnecting Sumatra and Singapore)

Over the last few decades, in the times of prevailing winds of the Southwest Monsoon between May and October, coupled with dry seasons and poor precipitation, conditions have made the arrival of haze in cities a regular occurrence. In June 2013, large parts of Southeast Asia were shrouded in a cloud of record-breaking haze pollution. In Singapore, the haze exceeded the hazardous limit for air quality close to threefold. The National Environment Agency Singapore (NEA) stated that in 2012, low- and middle-income countries in Southeast Asia and the Western Pacific Regions suffered a total of 3.3 million deaths that were linked to indoor air pollution, while cross-border smoke from forest fires in the region (namely Sumatra and Borneo) is another major problem that impacts air quality and escalates the greenhouse effect. A total of 3,270 confirmed fire hotspots in June 2013, most of them concentrated in the Riau province on the east coast of Sumatra, were caused largely by slash-and-burn land-clearing practices for profit-driven agricultural use. The province is Indonesia’s most productive palm-oil producer, accountable for 1/6 of the country’s total annual production. Major parts of the land affected belong to Malaysian- and Singaporean-owned palm-oil conglomerates, circumstances that lead to mutual allegations of causation between Indonesia and its neighbouring countries. 

Medan is infamous for being the Southeast Asian city with the highest amount of air pollution in terms of particulate matter. Air emissions from industrial production and motor vehicles are the key sources of air pollution, while cross-border smoke from forest fires in the region (namely Sumatra and Borneo) is another major problem that impacts air quality and escalates the greenhouse effect. A total of 3,270 confirmed fire hotspots in June 2013, most of them concentrated in the Riau province on the east coast of Sumatra, were caused largely by slash-and-burn land-clearing practices for profit-driven agricultural use. The province is Indonesia’s most productive palm-oil producer, accountable for 1/6 of the country’s total annual production. Major parts of the land affected belong to Malaysian- and Singaporean-owned palm-oil conglomerates, circumstances that lead to mutual allegations of causation between Indonesia and its neighbouring countries.

References


Endnotes

1 This text is a modified and shortened version of an article originally published in Seargeotop, edition 08, Weather, p. 70–80, 2016.


3 From an informal interview conducted by Marcel Jäggi with representatives of the Department of Spatial Planning and Buildings of Medan (Dinas tata ruang dan bangunan), Medan, 4 June 2014.

4 From an interview conducted by Marcel Jäggi with Tanja Kumradi Mustafa, Chairman of the Board of Education and Indonesian Institute of Architects, and member of the Sumatra Heritage Trust, Medan, 4 June 2014.


7 Gunawan, Apradi (2010).

8 National Environment Agency Singapore (NEA).


11 Ekadina, Andrew et al. (2013).

12 Teng, Amelia (2013).

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Fig. 06, 07: Sascha Roesler.
Fig. 11: www.harianandalas.com.
Fig. 12: NASA Satellite Images.
Fig. 13: Joe Nair, Memphis West.
Cyclic Venting Systems
Large scale drying barns

Tobacco barns are large-scale drying equipment that is designed to enable the curing of tobacco leaves by modifying microclimatic conditions. Based on fieldwork conducted in the plantation belt around the city of Medan, the article describes the structure and mechanisms of these passive houses. By making use of the local monsoon winds, tobacco barns are architectural symbols of a climate control system based on natural ventilation. Four intersecting cycles are providing the set-up of a successful venting system (five years, one year, half a month, one day). The study of tobacco barns might inspire greater consideration of passive house concepts and the attendant passive climate control mechanisms that involve both natural and cultural agents.

The region around ‘the plantation city’ of Medan is shaped by storage structures where harvested plants are temporarily stored, refined or processed. Among the many different types of storage structures, the so-called tobacco barn represents a particularly distinctive building type in which tobacco leaves are hung to dry. The leaves undergo curing, a biochemical refinement process in which water and farina are drawn out of them in a drying procedure of between 17 and 21 days. Tobacco barns enable this process by capturing and modifying the monsoon winds. The key factor in setting up the desired climatic condition inside of the barn is the control of the winds. Without exception, all tobacco barns have the same orientation, one that follows the angle of incidence of the Southeast Asian monsoon winds (NE – SW). The barns are at once subjects and objects of natural conditions, simultaneously representatives and victims of the winds, and are made permeable in order to collect, channel and moderate the winds. By the end of its life cycle, however, the physiognomy of a barn has undergone a thorough transformation, being battered or even partially destroyed by the constant monsoon winds.
Tobacco is prepared from the leaves of the tobacco plant in a process of curing which lasts from 17–21 days. The tobacco barns main purpose is to produce a relatively uniform climatic condition for those leaves during that drying process. The three main climatic parameters – air temperature, relative humidity and wind velocity – must be brought under control.

Distances
Positioned at a right angle with respect to the plot, any single barn is more than 100m from its nearest neighbour, a placement which enables wind velocity.

Orientation
The barn is rotated 45° to the north. This orientation of the façade allows optimum handling of the monsoon winds from the northeast and the southwest. Caretakers who open and close the front window, control the incoming winds manually, depending on the monsoon strength.

Disposition
The barns are always situated along a major network of single rows so as to avoid wind shadows.

Ratio
Each barn measures 25 × 70 m (height 13 m). The harvest of four standard-sized fields (100 × 100 m) can be dried in one large tobacco barn.

Circulation
With a life cycle of five years, the barn plot becomes a productive field over time. By using a slash-and-burn methodology, the organic material of the barn becomes fertiliser for the tobacco production. Another formerly productive field becomes a plot, whereby the movement of architecture creates a distinctive landscape cluster.

The life cycle of these large barns reaches its stress limit after a maximum of 5 years. Within a time frame of 3 months, and using only manpower and basic tools, a new barn is constructed. The structure of each tobacco barn is at once typical (thus repeatable) and singular (thus non-repeatable). Without regular maintenance, the delicate construction might threaten to collapse.
the end of the 19th century, an extensive corpus of colonial tropical literature has been published on the topic of drying tobacco. The research report *Over het drug van tobacco* (On the Drying of Tobacco), for example, published in 1929 by a Dutch laboratory in Medan (Sumatra), clearly illustrates the climate regulating capacities of tobacco barns. In one of the examples given, the conditions in the exterior and interior of a barn were measured and compared. While the humidity and the temperature outside varied widely during the day – between 23.6°C and 92% relative humidity (at 3 a.m.) and 32.1°C and 64% relative humidity (at 3 p.m.) – the temperature and humidity inside the barn remained relatively uniform: 28.8°C and 76% relative humidity (at 3 a.m.) and 29°C and 79% relative humidity (at 3 p.m.). These data show the tempering effects of large-scale tobacco barns. This tempering capacity is achieved by considering six basic principles (in order of decreasing significance): 1.) Orientation of the building, 2.) Structure of the building, 3.) Volume of the building, 4.) Materialisation of the facade 5.) Windows of the façade, and 6.) Fireplaces within the building.

To uniform climatic conditions

To understand the complexity of the curing process adequately, it might be helpful to consider Michel Foucault’s concept of ‘dispositive’ or ‘apparatus’. These terms can be brought to bear when using specialised knowledge about the interlocking of agricultural science, architecture, local human practices and natural conditions that determine the success of the tobacco leaves’ curing process. The curing has to be understood as an apparatus in and of itself, of which tobacco barns are a part; indeed, the air curing of the leaves meets the desired quality standards only if the requisite climatic conditions inside the barns are maintained. Therefore, tobacco barns’ main objectives are the production and maintenance of relatively uniform climatic conditions inside. As such, tobacco producers must bring the three principal climatic parameters – air temperature, relative humidity and wind velocity – under control. A successful curing process protects the leaves from larger fluctuations among these three parameters. Since

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Tobacco barns are built entirely from the natural materials of teak (trunks), bamboo (rods) and sago palm (leaves). Their main tectonic characteristics – as rod-based, wind permeable, organically comprised, re-locatable systems – make them an ingenious and exemplary type of Southeast Asian architecture. As archaic as the buildings appear with their sago palm shutters, their sheer scale (the great number of buildings and the size of the halls) points to their industrial standards. The dimension of the tobacco barns are significant: an acreage of 25 × 70 m and a ridge height of 13 m speak to the demanding harvest rates, which this building type must accommodate.

**A cyclic logic**

Fig. 18, 19 The structural design is a superimposition of two structures: A teak frame serves as the primary weight-bearing support for the roof, and a bamboo-grid forms the secondary support structure that is used for hanging the tobacco leaves. The axonometric view illustrates the three basic components of each lattice structure.

Fig. 15 Flaps and shutters on the front façades provide cross ventilation, and regulate temperature and humidity.

Fig. 16 The fragile bamboo structure serves as a hanger for the tobacco leaves.

Fig. 17 Simple ropes are used to connect the suspension rods to the supporting structure.

Fig. 15 The fragile bamboo structure serves as a hanger for the tobacco leaves.

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Fig. 15 The fragile bamboo structure serves as a hanger for the tobacco leaves.
A single barn can be constructed in two months; two to four weeks are required for the construction of the teak structure and four weeks for the construction of the bamboo structure. During the construction of the teak and bamboo structure, the shutters and the other wall elements are crafted on-site. Approximately four weeks are needed for the roofing, the installation of the shutters and the cladding of the exterior walls. The entire surface of the building is composed of woven palm fronds of the sago palm that are freshly braided and installed on site where they are dried. No machinery and very few tools are used. Instead, only human labour is employed to construct the barns along with a few locally available tools: wire, pliers, saws, knives and machetes, as required.

Whereas this building type as such has survived all social, economic, political, cultural and natural changes in Sumatra in this time as largely unchanged itself, the individual (realised) building is erected for flexibility and to facilitate change. The crop rotation system of the plantations requires variable buildings that can be temporarily erected and rebuilt a few years later elsewhere. Today’s tobacco fields must be prepared annually and have their new seedlings sown twice a year. After one year of tobacco cultivation, any field must lay idle for five years. Intermediate crops serve – by slash-and-burn cultivation – as fertiliser and they grade up the soil as black anthrosol. After a maximum of five years, tobacco barns reach their stress limit and are replaced by new buildings in a new location. Without regular maintenance, the delicate constructions may collapse even earlier.

The rhythm of the tobacco crop and the construction of the large barns is ultimately ‘tailored’ to the annual climate conditions and periods. Time frames for maintenance work on the barn, planting and harvesting, and the requirement for the tobacco growth and yielding are optimally used. The harvesting period starts either around April or October during the inter-monsoon season, and right before the advent of fierce monsoon showers.
Besides the tobacco fields, other annually rotating changing crops (such as sugar cane) or multi-annual crops (such as rubber and coconut palms) make up the well-used and regular landscape carpet. Within this patchwork, the alignment and barn orientation to a northeast-southwest direction is significant.

Although barns change position within the course of a life cycle (5 years), their orientation remains. There are changes, however, in land use and planting. The illustration shows the varying land use stages of 2009, 2011, and 2014.
The venting system has both a physical (building) component and a practical (user-driven) component. Structures and thermal practices of the users are mutually reinforcing. The curing process requires a knowledge and intuition on the part of those who hang and monitor the tobacco leaves. These ‘caretakers’ have the necessary know-how to adjust the temperature and amount of moisture when required. Accordingly, they operate the shutters depending on fundamental changes in the weather. Despite the thermodynamic inertia of the barns, the shutters enable the caretakers to respond quickly to ever-fluctuating conditions. A shutter system with a total of 110 flaps (approximately 30 along the longitudinal facades and roughly 25 along the front facades) offers the possibility of regulating temperature and humidity levels through cross ventilation. The flaps of the two front facades can be opened at a 60° angle by pulling bamboo rods. By and large, the overall success of the curing process owes much to the ‘skill and instinct of these tobacco caretakers.’ The 24-hour monitoring requirement of the tobacco leaves means that the caretakers must actually stay on site and inhabit the tobacco barns, which is reflected in the wide range of facilities: the measured tobacco barn contains a bedframe, tables, benches, racks for kitchen utensils (all constructed of bamboo) and a cooking hearth. A lavatory and washing area are located outside the barn. A garden is also provided. During the on-site research, the caretaker’s wife, their daughter and three children all lived in the tobacco barn. Throughout the day, visitors came either for a quick chat or for a longer stay. In this respect, tobacco barns are remarkable places of cohabitation.

Despite the thermodynamic inertia of the barns, the shutters enable the caretakers to respond quickly to ever-fluctuating conditions.
labour conditions and skills of the local construction worker- and building traditions of Indonesia. And if Pierre Bourdieu introduced the idea of a binary, gender-based spatial order of indigenous building and housing with his concept of the ‘Kabyle House’\(^1\), then the tobacco barn, again in contrast, must be described as a building enabling fluid transitions. Specifically, this implies transitions between inside and outside, between building process and building, between labour and home, between humans and non-humans (plants, animals). In this sense, tobacco barns confirm Ann Laura Stoler’s dictum of the Sumatran ‘plantations’ as ‘virtual laboratories for technical and social experimentation’.\(^{12}\) One could cite the formation of a new cross-cultural body of knowledge, the venting system of tobacco barns in Sumatra offering a model for devising resilient passive house systems in other contexts. These tobacco barns are born of change and are designed to bear change through their very architecture, and as such, are of timely relevance to current debates about sustainable methods of construction.

Cross-cultural body of knowledge

A first impression of these structures can be misleading. Sumatran tobacco barns are not simply ‘vernacular’. On closer inspection these structures reveal just as many architectural features that are of modern European provenance. If Claude Lévi-Strauss depicts ‘bricolage’\(^10\) as the tobacco barns are not simply ‘vernacular’. On closer inspection these concepts and interconnects the two distinct dispositions of the engineer and the savage-layman. Indeed, while the static structure of tobacco barn derives from a fluid rationality that mediates between logic and fuzzy logic concepts and interconnects the two distinct dispositions of the engineer and the savage-layman. Indeed, while the static structure of tobacco barns is optimised by the skills of the civil engineer, it is also adapted to the

References


De tabakscultuur Deli (1889) Amsterdam: J H de Bussy.


Rowaan, P A (1929) Over het drogen van tabak. Mededelingen van het Deli proefstation te Medan – Sumatra, Tweede Serie No. LXII.


Westerman, Willem (1901) De tabakscultuur op Sumeatra’s oostkust, met medewerking van dakundigen. Amsterdam: J H de Bussy.

Endnotes

1 In May 2013 and April 2014.

2 This text is a modified and shortened version of an article originally published in the newspaper Spaces of Change, edited by Marc Angélil. See: Roesler, Sascha (2014).


4 Foucault described a dispositif/apparatus as ‘a decidedly heterogeneous ensemble, that comprises discourses, institutions, architectural facilities, regulating decisions, laws, administrative measures, scientific statements, philosophical, moral and phil-anthropic propositions, in short: it includes what is said as well as unsaid’. Translation by the author: See: Michel Foucault (1978): p. 119.

5 In striving for controlled, uniform indoor conditions, tobacco producers in the late 19th century developed a climate control system that anticipated the 20th century architecture and engineering paradigm for control of homogenous interior climates.

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Fig. 02: Picture library ETH Zurich.

Fig. 03: Rowaan, P A (1929). Over het drogen van tabak.
A Monument for Natural Ventilation
Re-presenting the tangible and intangible heritage of natural ventilation

With the exhibition ‘For Sumatra (Man-made Weather)’ a monument for the venting system of the Sumatran tobacco barn shall be erected. The monument comprises three parts – a model, a manual, and a film. The brass model shows the timber structure, the projected manual the making, and the film the use of the tobacco barns. The monument for natural ventilation was a contribution to the Swiss Art Award Exhibition. The Swiss Art Awards offer insight into current art and architecture making in Switzerland. 2014, one of the nominated architects was Sascha Roesler, researcher at FCL. Based on fieldwork in the former Swiss colonial plantation ‘Helvetia’, in the outskirts of the city of Medan, the exhibition presents the structure and the mechanisms of these passively ventilated houses.

39 Slides: 2.4 × 3.6 cm format
Brass Model: 70 × 25 × 13 cm
Video: HD-Film 3’ Loop

image credit: Sascha Roesler
Fig. 02  Plans of the monument for natural ventilation, horizontal sections

image credit: Sascha Roesler

Fig. 03  Plans of the monument for natural ventilation, vertical sections

image credit: Sascha Roesler

1. Brass model
2. Diascope projection
3. Loudspeaker
4. Video projection
5. Tobacco leaves
Fig. 04 | Casting of the brass model in the foundry ‘Kunstgiesserei St. Gallen’, Switzerland 

Fig. 05 | Views of the Swiss Art Award exhibition in Basel. Mix media (brass model, diascopic projector, Loudspeaker, mdf) 

Image credit: Sascha Roesler, Kunstgiesserei St. Gallen, Switzerland.
Fig. 06  Cured tobacco leaves  image credit: Sascha Roesler

Fig. 07  Model and film  image credit: Sascha Roesler
The gap in Singapore’s housing policy generates ‘wicked problems’ (Horst Rittel) – design-wise, problems that are increasingly difficult for planners and architects to solve on their own. How to design flats pertaining to urban mass housing, where one might enjoy spending time, while outside temperatures of 32°C and 80% humidity prevail?

While for almost 50 years, Singapore’s government has promoted natural ventilation in public housing, some 80% of today’s inhabitants have access to air-conditioning, and that percentage is increasing. In this case study we will initially reconstruct the natural ventilation system of HDB and the emergence of residential air-conditioning. In a second step we will analyse the architectural contradictions that evolve from the entanglement of these two venting systems. Finally, we will examine the implications of housing policy and address the architecture of HDB. At the very centre of our analysis is the conceptual gap between housing provided by the state and flats that are owned by residents. Our thesis is that for an understanding of current ventilation practice in Singapore’s HDB settlements, this conceptual gap between the state and the resident-owners is crucial. By privatising the flats, HDB concedes responsibility for large parts of the energy supply to the residents.
The vast majority of the approximately 11,000 public housing buildings of Singapore’s housing sector are organised into 23 New Towns across the country. Ventilation was certainly not the only factor that determined the layouts of the public spaces and flats of these new satellite cities. But ventilation was certainly a crucial parameter for the design of the buildings and neighbourhoods, inasmuch as the tropical climate of Singapore is rarely bearable in badly ventilated flats. Over the years, a New Town-specific popular culture of natural ventilation emerged, inheriting and transforming vernacular ventilation practices of both the Malay Archipelago and China.

In Singapore, the state plays a key role as ‘provider’ and ‘social engineer’ in the field of public housing. By combining all such housing efforts under one single authority – the so-called Housing Development Board (HDB) – the highest possible degree of authority over all the dimensions of the social housing sector was attained. Historically, social housing was ‘the prime mover in the formulation of a national identity’, a phenomenon that can be readily observed by traveling across the Singaporean territory, which is laced with HDB settlements. The visual appearance of this city-state is, in fact, marked by its mass housing programme. Science fiction author William Gibson has cited that in Singapore, ‘somehow it’s all infrastructure’ – which is to be understood against the backdrop of these New Town facilities’ sheer presence. According to the city’s Annual Report 2013, 63 per cent of the resident population lives in HDB apartments and some 95 per cent own the flat they occupy.
In the development of the HDB settlements, four main parameters can be identified: a) economic parameters (such as low-cost housing etc.), b) constructional parameters (such as prefabrication etc.), c) sociocultural parameters (such as individualisation etc.), and d) climatic parameters (such as orientation etc.). Even up to the present, HDB flats are officially ‘designed to be naturally ventilated’, a basic assumption that has a far-reaching impact on the architectural envelopes and the city’s level of energy consumption. Two aspects are crucial to consider in designing naturally ventilated blocks:

1) Their climate-related typologies, comprising both architecture and green spaces

2) Thermal practices of the residents, including both seasonal and daily behaviours

Even up to the present, HDB flats are officially ‘designed to be naturally ventilated’, a basic assumption that has a far-reaching impact on the architectural envelopes and the city’s level of energy consumption.

HDB New Towns are designed based on the New Town Structural Model. In addition to defining a programmatic layout, the structural model defines: the overall density, the relationship between built and open areas, the layout of main arteries and the general orientation of buildings as well as the distances between buildings – all of which have a significant impact on the microclimatic conditions at the urban scale. (Source: Housing a Nation. 25 Years of Public Housing in Singapore)

Typologies

There are certainly general modifiers of HDB indoor microclimates on an urban design scale, including the greenery between buildings, double-sided buildings; the height and the orientation of the buildings; the distances between the buildings; the void decks. And on a building design scale there are modifiers such as the façade design; construction materials; window size; shading, or the volume and layout of the flats.

New Towns dating from different periods, however, have distinctive characteristics in the arrangement of the blocks. These in part relate to different bio-climatic design strategies and, more generally, to varying sensibilities regarding climate and natural ventilation. It is important to note that there has been no linear development from sufficiently to insufficiently or from insatisfactorily to satisfactorily ventilated HDB blocks and flats.

‘From the 1960s to 1980s the nation was built almost only in the East-West direction’. 1960s estates were ‘composed only by linear slab blocks (corridor style) in most common heights of 10 storeys’. 1970s generation estates were dominated by ‘big slab blocks in most common heights of 12 to 16 storeys and ‘point blocks of 20 and 25 storeys’. 1980s generation estates were ‘composed by slab blocks in most common heights’ of 10 to 16 storeys, ‘plus 25-storey point blocks’. ‘Compared with previous decades, 1980s block corners were bent to give […] a sense of enclosure’. Estates built since the 1990s reflect the growing demand for privacy and individuality. There are no corridor-facing units after 2004. The new blocks ‘tend to be around 40-storeys high’. Today, HDB blocks “amalgamate the point and slab block designs, featuring taller blocks.” The Pinnacle@Duxton is the highest HDB settlement in Singapore ‘with seven connected 50-storey towers.’ 4

Practices

A whole range of HDB elements potentially affect the microclimate in the settlements. Thought these elements are partly provided by HDB and designed by architects, the thermal effects largely depend on usage by the residents. To mention just a few of these microclimatic hybrids, comprising objects and practices: a) Doors with metal grids allow to keep the entrance door to the apartments open in order to benefit from entering breezes. b) The access corridor is a widely-distributed bio-climatic element that provides shade for the residential units. c) Plants along the access corridor absorb the heat and provide additional shade. d) Adjustable louvres ‘to stay open for ventilation without undue loss of privacy.’ e) Clothes-drying pole holders provide shade by the garments hanging and cool the air by evaporating water.

The task to ventilate large-scale blocks of urban mass housing by natural means is not an easy one, and fundamentally differs from practice in rural settlements. The high-density population of mass housing leads savvy designers to recurrent trade-offs between privacy and cross-ventilation requirements. Many HDB flats have difficulties in coping with noise problems, privacy necessities and thermal comfort for different activities. The access to units along the single-loaded building mass, for example, results in reduced privacy since the windows open out to the common corridor. Especially the bedrooms lack any cross-ventilation as doors are usually closed during the night to protect people’s privacy.
Completed HDB dwelling units by year

Source: HDB Annual Reports, 1960–2013
1927–1960
Singapore Improvement Trust

1960–1970
HDB 1st and 2nd 5-year plan

1970–1975
HDB 3rd 5-year plan

1975–1985
HDB 4th 5-year plan

2013
Completed HDB flats by 2013

1975–1985
HDB 4th 5-year plan

2013
Completed HDB flats by 2013


1965–1970
Construction of Toa Payoh, HDB’s first New Town, started in 1965.
- Queenstown (SIT)
- Toa Payoh

1970–1975
In early 1970s four New Towns were started:
- Bedok
- Marine Parade
- Marsiling
- Tukok Blangah

1975–1980
In the second half of 1970s construction commenced for:
- Ang Mo Kio
- Clementi/West Coast
- Hougang

1980–1985
In the early 1980s seven New Towns were started:
- Bukit Batok
- Hougang
- Jurong
- Serangoon
- Tampines
- Woodlands
- Yishun

1985–1990
In the late 1980 four more New Towns were started:
- Bishan
- Bukit Panjang
- Choa Chu Kang
- Punggol

1988–1996
In the early 1990s seven New Towns were started:
- Pasir Ris
- Senkang

1990 (ongoing)
- Pasir Ris
- Senkang

2000 (ongoing)
- Punggol


Evolution of Toa Payoh (1967–1976)

1967

1968

1970

1971

1976

Evolution of Toa Payoh (1967–1976)
Evolution of HDB building types throughout the years

1960-1966 1-room Emergency

1960-1967 3-room Standard

1960-1969 2-room Standard

1960-1962 2-room Emergency

1960-1966 1-room Emergency

1960-1967 3-room Standard

1966-1974 1-room Improved

1969, 1972-1975 2-room Improved

1967-1975 3-room Improved

1967-1975 4-room Improved

1974-79, 1980- 3-room New Generation

1979-1981 4-room Model ‘A’

1969-1981 4-room New Generation

1979-1981 4-room Model ‘A’

1967-1975 Executive apartment point block

1969-1990 Executive apartment

1993-1994 Executive maisonette

1984- Executive maisonette/Executive apartment

1993-1994 Executive maisonette

1984- Executive maisonette/Executive apartment

1995-1996 Executive/ executive maisonette

2000 onwards generic HDB building type

2000 onwards generic HDB building type

The evolution HDB building types presents an array of public housing adapted to tropical climate conditions, demonstrating the interplay between economic, sociocultural and construction parameters. All HDB buildings are officially designed for cross-ventilation. HDB buildings typically consist of only one or two different unit types per building. After the double-loaded corridor (as used in the early HDB generation emergency units) was found to be ineffective in terms of both ventilation and noise problems, HDB switched to single-loaded slab blocks with a common access corridor.

Since the 2001 introduction of BTO (Built-to-Order) HDBs, no corridor-facing units have been constructed. Cross-ventilation often tends to be compromised in these units – especially in the bedrooms (largely due to privacy concerns). The recent HDB typologies tend to follow the slab-point block hybrid typology.
The average daily mean temperature throughout the year is 26.98°C, with yearly average high and low temperatures ranging between 31.0°C and 24.1°C. There is a high humidity through the whole year, with the average yearly humidity of 84.2%, humidity and abundant rainfall throughout the year. Surface wind speeds are generally low in Singapore. The long term annual mean wind speed is 2 m/s.
From 1960’s to 1980’s the nation was built almost only in the East-West direction in order to minimise the solar gain of the facades.

1960s estates were composed only by linear slab blocks with a shared-access corridor, commonly at the height of 10 storeys.

1970s generation estates were dominated by large, linear slab blocks, commonly at the height of 12 to 16 stories and point blocks of 20 and 25 storeys.

1980s generation estates were composed of slab blocks in most common heights of 10 to 16 storeys, plus 25-storey point blocks.

Compared with previous decades, 1980s block corners were bent to give a sense of enclosure. Bending the block corners affects the ventilation properties negatively on the block scale.

The estates since the 1990s reflect the growing demand for privacy and individuality. The so-called point-slab hybrid blocks start to evolve and blocks tend to continue the enclosed block design.

2000 estates are built increasingly taller with varying layouts of point-slab hybrid blocks. The majority of blocks are built in the height of 16 storeys, such as in Punggol. Multi-storey car parks are built within the blocks.
Evolution of the building heights and the basic building typology

The single-loaded slab block replaced the double-loaded building type in the 1970’s due to insufficient ventilation and noise problems in the double-loaded emergency units (even despite the fact that the double-loaded is the most economical typology). The open ground floor emerged in the 1970’s and has remained a general HDB building design principle to this day. Later, with the emergence of the point-slab hybrid block, the double-loaded typology is making a comeback - now with a more permeable building mass and no corridor-facing units for privacy. Due to economic reasons, the overall height of New Towns, such as in Punggol, has stayed around 16 storeys. However, the tallest HDB projects reach up to 40-50 storeys.

1960s estates composed only by linear slab blocks (corridor style) in most common height of 10 storeys and usually with 12 units per floor, but several blocks were very long.

Minimal distance between facades was not regulated, usually 15–30 metres.

1970s generation estates were dominated by big slab block in most common heights of 12, 13 or 16 stories and usually with 14 or 18 units per floor, most were over 100 metres long, plus point blocks of 20 and 25 storeys.

Minimal distance between facades was 30 metres.

1980s generation estates are composed by slab blocks in most common heights of 10, 12, 16 storeys, usually with 10 or 12 units per floor, plus the well known 25-storey point blocks which dominate skyline.

By unknown reasons, after 1985 only few blocks were built with more than 12 storeys.

Minimal distance between facades was 24 metres.

The single-loaded slab block replaced the double-loaded building type in the 1970’s due to insufficient ventilation and noise problems in the double-loaded emergency units (even despite the fact that the double-loaded is the most economical typology). The open ground floor emerged in the 1970’s and has remained a general HDB building design principle to this day. Later, with the emergence of the point-slab hybrid block, the double-loaded typology is making a comeback - now with a more permeable building mass and no corridor-facing units for privacy. Due to economic reasons, the overall height of New Towns, such as in Punggol, has stayed around 16 storeys. However, the tallest HDB projects reach up to 40-50 storeys.
Variety of different HDB unit types throughout the years

All units are planned for passive cross-ventilation. The units follow a similar programmatic and organisational logic. The living room and one of the bedrooms are typically located adjacent to the access corridor. Here, a trade-off is established between the need for ventilation required and need for privacy. The kitchen, bathrooms and, occasionally, a yard are located on the other side of the unit. The second bedroom is often pulled deeper within the building mass.
Wind topographies of typical blocks from HDB New Towns

**Toa Payoh**
(late 1960s, early 1970s)
Seen from the SSE

10:00 a.m. morning sun, at summer equinox, June 21

Summer Monsoon winds from prevailing wind direction from southwest winds at a wind speed of 2 m/s

2-room standard unit slab blocks, ground fl. void + 10 stores
3-room Improved slab blocks, ground fl. void + 10 stores

**Bukit Batok**
(1980s)
Seen from the SSE

10:00 a.m. morning sun, at summer equinox, June 21

Summer Monsoon winds from prevailing wind direction from southwest winds at a wind speed of 2 m/s

4/5-room Model ‘A’ composite block
13, 9, 4 and 25, 4 stores
4-room New Generation slab block, ground fl. void deck + 12 stores
3-room New Generation slab blocks, ground fl. void deck + 12 stores

**Marine Parade**
(late 1970s)
Seen from the SSE

10:00 a.m. morning sun, at summer equinox, June 21

Summer Monsoon winds from prevailing wind direction from southwest winds at a wind speed of 2 m/s

5-room point blocks, ground fl. void deck + 25 stores
4-room New Generation slab blocks, ground fl. void deck + 13 stores

**Punggol**
(late 1970s)
Seen from the SSE

10:00 a.m. morning sun, at summer equinox, June 21

Summer Monsoon winds from prevailing wind direction from southwest winds at a wind speed of 2 m/s

5-room hybrid point-slab blocks, ground fl. void deck + 16 stores
6-storey multistorey carparks
Wind flow is simulated from the prevailing wind direction during summer – a SSW wind brought by the Sumatras monsoon. The air tends to move and gain speed along the roads, and along paths of larger openings. Notice how the wind tends to follow the circular road network in Toa Payoh.
Marine Parade New Town was the first residential project to be built on reclaimed land. Its location next to the sea and East Coast Park makes it one of the breeziest (and most popular) HDB New Towns in Singapore. Marine Parade consists of 12-storey slab blocks and 25-storey tower blocks. Slab blocks are mainly oriented east-west for the ideal solar angle. With the prevailing wind direction from the SSW - NNE or NNE - SSW, the slab blocks are oriented perpendicular to the wind direction.
In principle, it is advantageous to lay main roads parallel to the main wind direction (in Singapore this would dictate a SSW or NNE orientation) and secondary roads perpendicular to the wind. It is also highly recommended to create corridors for the wind, taking advantage of long continuous patches of greenery, water bodies or open fields to make highways for the wind.
Punggol New Town is the newest of all 22 New Towns in Singapore. Most buildings are 16-storey hybrid tower-slab blocks. Punggol is denser in comparison to many previous New Towns and features large, multistorey parking garages in the centre of the quarter. The blocks are laid out in a NW-SE orientation, in contrast to the earlier HDBs which aligned with the ideal solar orientation of east-west. It can be observed from the wind simulation that the main roads function as air corridors for the majority of air flow. However, the large, dense building clusters block the winds from entering inside the courtyards. Turning the building clusters 90 degrees and leaving the block ends open would be a more favourable orientation, enabling the prevailing wind to enter the courtyards.
References


Wong, Aline K/Yeh, Stephen (ed.) (1985), Housing a Nation. 25 Years of Public Housing in Singapore, Maruzen Asia for Housing & Development Board.

Yuen, Belinda (2005), Squatters no more: Singapore Social Housing, in Third Urban Research Symposium (Land Development, Urban Policy and Poverty Reduction, April 4-6 2005, Brazil).


Endnotes

1 Seng, Eunice (2014), abstract.
5 All information given according to: www.teoalida.com/singapore/hdbfloorplans [accessed 08.12.2014].
6 All information given according to: en.wikipedia.org/wiki/Public_housing_in_Singapore [accessed 08.12.2014].
7 Liu Thai Ker (1975), p. 137.
9 Tenorio, Rosangela (2007).
Between 1978 and 2008, the number of Singaporean apartments fitted with air conditioning grew by 70 per cent, a convention that laid the foundation for a broad societal coverage with this technology. As air conditioning has increasingly infiltrated not only workspaces in factories and offices, but has also become something like ‘domestic furniture’ in private dwellings, an all-encompassing man-made weather has, in recent years, begun to take the place of what was a diversity in microclimates. Since the paradigm of control of (indoor) climate has ousted the traditional adaptation towards (outside) climate, a new thermal regime – made in Singapore – has emerged.

Residential air conditioning is a very young phenomenon in Singapore. In the decades following the founding of the state, architects were still asked to consider the thermal relevance of floor plan design and the inhabitants’ various modes of behaviour as they planned new housing. Architects could expect that residents would know how to make use of the architectural offering of cross ventilation. By the proliferation of residential air conditioning however, new cultural patterns of cooling have emerged and with them, new sociocultural norms of comfort. Against the widespread dichotomy of ‘natural ventilation’ versus ‘air conditioning’, or low tech versus high tech, architects and planners have to approach ‘cooling’ as complex cultural systems that involve a variety of agents, each of which has huge potential for experimentation. Nowadays however, two aspects are in the very centre of the debates around residential air-conditioning:

1) The population’s productivity
2) Growing energy consumption
The humble air-conditioner has changed the lives of people in the tropical regions. [...] Before air-con, mental concentration and with it the quality of work deteriorated as the day got hotter and more humid... Historically, advanced civilisations have flourished in the cooler climates. Now, lifestyles have become comparable to those in temperate zones and civilisation in the cooler climates. ‘The humble air-conditioner has changed the lives of people in the tropical regions. [...] Before air-con, mental concentration and with it the quality of work deteriorated as the day got hotter and more humid... Historically, advanced civilisations have flourished in the cooler climates. Now, lifestyles have become comparable to those in temperate zones and civilisation in the tropical regions need no longer lag behind.’


**Fig. 02 ‘Singapore, The Air-Conditioned Nation’ by Cherian George**

### (1) Productivity

The integration of climate in what Michel Foucault termed ‘governmentality’ denotes the way modern societies deal with their climate. In a Foucauldian reading, mastering the climate means hot-wiring a nation’s weather with its political economy. Air-conditioning is a ‘way of losing less, or making more, money’, by ‘increased productivity’ on the part of the population. In this respect, air-conditioning is not only the result of growing income levels but one of the preconditions for them. For Lee Kuan Yew, the first prime minister of Singapore, air-conditioning was the most important invention of the 20th century. Along with other opinion-makers, he saw the productive capacity of labour in great interdependence from climatic conditions. ‘The humble air-conditioner has changed the lives of people in the tropical regions. [...] Before air-con, mental concentration and with it the quality of work deteriorated as the day got hotter and more humid... Historically, advanced civilisations have flourished in the cooler climates. Now, lifestyles have become comparable to those in temperate zones and civilisation in the tropical zones need no longer lag behind.’ The Singaporean journalist Cherian George saw the widespread proliferation of residential air-conditioning as a political metaphor for ‘comfort and control’, and cited Singapore as ‘the air-conditioned nation’.

### (2) Energy consumption

According to McNeil and Letschert, there is a continuous ‘trade-off between climate, and financial considerations’ in developing countries. Although recent history has shown that air conditioner ownership can grow more rapidly than economic growth, comparative data from developing countries suggest an availability rate below 20 per cent until such time as the GDP reaches USD 3,300 on average. As soon as this level of wealth has been reached, the availability rate of air conditioning correspondingly ‘climbs steeply’ and development and sustainability begin to diverge. The growing energy consumption that the proliferation of air conditioning causes is the flip side of economic development and low prices for energy, however. Over the last years the high demand in the use of air conditioning [...] in the residential sector has contributed to the increase in energy consumption levels. This is basically due to the low costs of electricity and household A/C systems allied to a social lifestyle change, demanding better comfort levels. Sales of A/C equipment have increased considerably over the past few years [...] especially small packaged A/C systems that can be easily installed by homeowners. Due to the proliferation of air-conditioning, Singapore is among the countries with the highest per capita energy consumption worldwide.

### End-use Electricity Consumption in Singapore

- **Air-Conditioner units**: 36.7%
- **Refrigerator + Freezer**: 36.5%
- **Computers & Peripherals + Modern Router**: 5.0%
- **Lighting**: 4.3%
- **Electric air-pump**: 4.0%
- **Dishwasher**: 2.3%
- **Rice**: 1.9%
- **TV set top box + Entertainment console**: 1.9%
- **Microwave oven + Electric oven**: 1.6%
- **Clothes Dryer**: 1.1%
- **Fan**: < 1%

**Source**: Singapore Energy Statistics 2014, Research and Statistics Unit, Energy Market Authority, Singapore

### Residential Final energy consumption in 2012 in Singapore

- **Electricity**: 89%
- **Natural Gas**: 8%
- **Others**: 3%

The triumphant success of mechanical cooling in Singapore is typically correlated with the growing GDP, without any reference to popular culture. However, the proliferation of residential air-conditioning has a major impact on this nation’s popular culture. ‘Over the past […] years, extraordinarily varied methods of living with heat, of calibrating clothing, of adjusting social and seasonal rhythms and fine tuning the built environment have been eroded and increasingly replaced by a resource-intensive […] culture of mechanical cooling’. Today’s residents, but also the responsible authorities and the designing architects, are all unlearning these former thermal practices. The American historian Raymond Arsenault speaks of an ‘air-cooled privatism’, or the notion of keeping people inside their flats. By entering the privacy of the living space, air-conditioning transformed the public discourse from efficient production to human comfort once again. Further, with the increasing affordability of residential air-conditioning units, the technology changed its character from an amenity to a necessity. Arsenault’s statement about the United States applies meanwhile also to Singapore: ‘In varying degrees virtually all […] have been affected, directly or indirectly, by the technology of climate control. Air conditioning has changed […] the way of life, influencing everything from architecture to sleeping habits’. Although the residential sector’s contribution to the growing energy consumption of Singapore is only secondary, housing is indeed the most important experimental field where the scope and the diversity of contemporary and future cooling practices are tested. Therefore planners and architects should consider venting systems, not just as a mere technological problem to solve, but much more as a cultural potential with which to experiment.

References

Endnotes
3 Foucault, Michel (1978).
7 George, Cherian (2000).

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Fig. 01: Ani Vihervaara.
Fig. 02: Cherian George.
Entangled Venting Systems
The superimposition of natural ventilation and air conditioning

Sascha Roesler

Natural ventilation and air conditioning presuppose two completely different design strategies: In theory, air-conditioned buildings require airtight envelopes whereas naturally ventilated buildings require permeable ones. In HDB flats, however, rather than two separate systems of climate control, there are only entangled and hybrid ones. Increasingly natural ventilation and air conditioning are superimposed on one another. The question of how to lower energy consumption cannot be solved by optimisation of the mechanical cooling systems alone. As such, there is a need to rethink the architectural envelope newly.

The ways a passively ventilated and a mechanically cooled building operate their energy balances differ widely. A passively ventilated building in the tropics wants as much atmospheric exchange with its surrounding environment as is possible, while the mechanically cooled building aims at creating and maintaining a temperature difference. Maintaining this temperature difference between the inside and the outside requires either insulation or a constant input of energy. Interestingly, though, for naturally ventilated buildings in Singapore, there are no clear façade design guidelines.
Semi-permeable envelope

We refer to the current architectural answer to the superimposition of the two climate control systems (natural ventilation and air conditioning) as the ‘semi-permeable envelope’. Architecturally, the semi-permeable envelope reflects the contradictions between the two climate control systems. In terms of regulations, the semi-permeable envelope is stipulated by approving high U-Values. The ‘U-value’ is ‘the overall heat transfer coefficient that describes how well a building element conducts heat [...] across the structure.’ In Singapore there are no regulations for the thermal transmittance of passively ventilated buildings. HDB buildings are still supposed to be naturally ventilated despite the fact that around 80 per cent of households now have access to air-conditioning. The only specification for non-air-conditioned buildings is that its walls should not exceed an U-value of 3.5 W/m²K. This regulatory value is one completely unheard of in Europe. The majority of regulatory values in Europe range between 0.25 and 0.40. Compared to Singapore’s, the European U-values are 8 to 14 times lower. The current u-value regulation explains and legitimises the growing energy consumption of HDB flats. In housing policies, natural ventilation continues to be the state’s concept, and air-conditioning the venting system of the single owner. It is up to the owner to install air-conditioning units under HDB guidelines. Only very recently has the HDB started to provide ledges for window units, an acknowledgement of the reality in itself.
Wicked problems

In 1973, design theorists Horst Rittel and Melvin Webber coined the term ‘wicked problems’ in the context of ‘social policy planning’. A wicked problem is ‘a problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize.’ The term “wicked” is used to denote resistance to resolution.

Ventilation in Singapore’s mass housing today is typical example of a wicked problem. In HDBs, the two entangled climate control systems are riddled with contradictions, gliding transitions and mutual references which can no longer be resolved by conventional bio-climatic design. Instead, approaches both by the social sciences and cultural studies are needed to shed light on the current venting practices. There’s a ‘scholarly neglect’ in ethnographic description and architectural analysis of the entangled venting system of today’s HDBs. Such a description and analysis of the current state of ventilation would be the precondition for future architectural concepts and new building regulations. Still outstanding are the innovative concepts that would determine how naturally and artificially ventilated blocks can be realised in a more sustainable combination.

The state and the resident-owner

Keeping the complexity of the (wicked) problem in mind, we’d like to end with two short tips that point to the connecting factor for sustainable cooling strategies in public housing: 1. Relative to Building regulations, the conceptual gap between the state and the resident-owner has to be at the very centre of a contemporary analysis of the two entangled climate control systems. Energy consumption in HDB flats can no longer be a privatised issue. Sustainability is a public endeavour which requires political and public decisions based on suitable housing policies and building regulations, and not only for Singapore. But especially there, the government should acknowledge its responsibility to rethink a sustainable venting system for urban mass housing. 2. Relative to Architecture, it’s time to question the concept of the semi-permeable envelope. Passively and actively ventilated spatial areas must be disconnected to more often than has been done hitherto. Disentangling entangled climate control systems by a clear separation of active and passive venting systems make a case for partial insulation of air-conditioned rooms, centralisation of air-conditioning in HDB buildings and above all: a conscious mixed-mode use of active and passive venting systems. Today’s urban ventilation culture should anchor itself within the different ventilation traditions of Southeast Asia – noting that air-conditioning is also part of Singapore’s cultural heritage.
In this manual we are showing thermal renovation strategies for an HDB building consisting of 3-room New Generation units. That’s a single loaded slab block typology and one of the most common HDB unit types in Singapore. Although we are showing the example of just one unit type, the same principles of renovating can be applied on all HDB single loaded slab block building types, as other unit types most often repeat a similar logic of spatial organisation.

We are suggesting renovation as an option instead of tearing down and building new HDB buildings to replace. Balconies on both sides of the building provide shading and lower the indoor temperature; accordingly temperature inside the unit stays cooler than the outside temperature. The centrally (chilled water) air-conditioned bedroom core is insulated with 100 mm insulation.
Two Options for …

Option A  Added new private balcony

Option B  Old access balcony converted into private balcony, new access balcony

Before the renovation the public space access space is the only outdoor space connected to the units. Its use is limited as it is a fully public circulation space. The living room and the one of the bedrooms open to this public side. All the service spaces are located on the other facade side of the building. There is no shading on this side no contact to the outdoor, although this side is naturally more private. In the tropics, one is dreaming of a big balcony!

Keeping the circulation on the access balcony as it is but shifting the service spaces on this more public side and the living spaces more towards the private side of the building. (Only the common room still faces the access balcony)

Attaching a prefabricated 3m wide private balcony and opening the living room to the balcony with large sliding windows

Turning the access balcony into a private balconies for each unit, makes the outdoor space usable. Privacy is increased in the bedrooms as neither of the bedroom is no longer located along a public corridor. Thus the bedroom windows can be more easily kept open, improving both privacy and possibility for natural ventilation. The 2m wide new access balcony is taken 1m off the facade to improve the privacy of the units. The new access balcony provides shading for the facade and improves the energy balance of the building.

Balconies on both sides of the building provide shading and lower the indoor temperature. The centrally (chilled water) air-conditioned bedroom core is insulated with 100 mm insulation.

Different temperature zones inside the units

Option A  Added new private balcony

Option B  Old access balcony converted into private balcony, new access balcony
Design option A

Renovation of 3-room New Generation 67 m² + balcony
- A new private balcony is added
- The old access balcony stays as is
- The living spaces and the service spaces switch places, so that the living room can open to the new private balcony

Added private balcony

By rearranging the spatial organisation of the unit it is possible to open the living spaces to a newly installed private balcony

Added private balcony

A new shaft to improve ventilation

10 mm insulation around an air-conditioned bedroom core

Central chilled water air-conditioning

The old access balcony stays as is

Design option B

Renovation of 3-room New Generation 67 m² + balcony
- Access balcony turned into private balcony
- New access balcony provides shading to the building and creates a private living room and bedrooms

Added new access balcony

The old access balcony is turned into a private balcony

Turning the common access balconies into private balconies and adding a new access balcony improves the organisational logic of the unit and opens the unit to the outdoor

An new access balcony

A green facade for shading

A new shaft to improve ventilation

10 mm insulation around an air-conditioned bedroom core

Central chilled water air-conditioning

The old access balcony converted into a private balcony

Large openings/sliding doors opening to the balcony

Perforated brick wall between balconies

Large openings/sliding doors

Semipermeable louvre

Sliding adjustable shading

Large openings/sliding doors

Central chilled water air-conditioning

10 mm insulation around an air-conditioned bedroom core

Perforated interior brick wall

Central chilled water air-conditioning
Programmatic and organisational logic of the original HDB 3-room New Generation unit

Original 3-room New Generation unit

Option A: Added new private balcony

Option B: Old access balcony converted into private balcony, new access balcony

Air-conditioned bedroom cores and the location of ducts for the central chilled water cooling system

Original 3-room New Generation unit

Option A: Added new private balcony

Option B: Old access balcony converted into private balcony, new access balcony

Air-conconditioned volume for 12 storeys:

Volume a: \( V = 32.5 \times 2.7 = 89 \text{ m}^3 \)

Volume b: \( V = 25 \times 2.7 = 67.5 \text{ m}^3 \)

Option A:

Volume a × 12 Storeys: \( 12 \times 32.5 \times 2.7 = 1068 \text{ m}^3 \)

Core 12 Storeys: \( V = 1068 \text{ m}^3 \)

Option B:

Volume b × 12 Storeys: \( 2 \times 12 \times 25 \times 2.7 = 1620 \text{ m}^3 \)

Core 12 Storeys: \( V = 1620 \text{ m}^3 \)

Total Air Conditioned Volume:

Volume a × 12 Storeys: \( 12 \times 32.5 \times 2.7 = 1068 \text{ m}^3 \)

Volume b × 12 Storeys: \( 2 \times 12 \times 25 \times 2.7 = 1620 \text{ m}^3 \)

Total Air Conditioned Volume:

\( 1068 + 1620 = 2688 \text{ m}^3 \)

Option A:

Volume a × 12 Storeys: \( 12 \times 32.5 \times 2.7 = 1068 \text{ m}^3 \)

Core 12 Storeys: \( V = 1068 \text{ m}^3 \)

Option B:

Volume b × 12 Storeys: \( 2 \times 12 \times 25 \times 2.7 = 1620 \text{ m}^3 \)

Core 12 Storeys: \( V = 1620 \text{ m}^3 \)

Total Air Conditioned Volume:

\( 1068 + 1620 = 2688 \text{ m}^3 \)
Central chilled water cooling system installation in 3-room New Generation building

Typically, a separate, split type air-conditioner unit is installed for each room, mounted on the façade outside. We replace those numerous and inefficient units with a central chilled water system, doubling the energy efficiency of the air-conditioning and reducing the globally installed cooling capacity. By cooling only the now insulated bedrooms, the cooling demand is reduced so that the pipework can easily fit into dedicated risers.

Image Credits

Page 162, 163: Sascha Roseler, Ani Vihervaara, Marcel Bruelisauer, Zulandi Adzi.

Technical installations of central chilled water air-conditioning for HDB 3-room New Generation

Assumptions for calculations

Cooling capacity 125 W/m² (35% lower than typical HDB installation)
Cooling capacity per bedroom 16–2 kW (as comparison, Kent Vale Condo has 3–5 kW for normal/master bedroom)

Cooling capacity could be further reduced if changing to different usage patterns that require lower peak loads

Central chilled water system 5.9/12°C chilled water temperatures for fan-coil units

Vertical piping installations

<table>
<thead>
<tr>
<th>Vertical piping installations</th>
<th>Installations on rooftop</th>
</tr>
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<tbody>
<tr>
<td>DIN</td>
<td>Cooling towers</td>
</tr>
<tr>
<td>1  3 × 40 mm plus insulation</td>
<td>2 × 4 × 2 × 3 m (part-load and redundancy)</td>
</tr>
<tr>
<td>2  3 × 50 mm plus insulation</td>
<td>Chiller</td>
</tr>
<tr>
<td>3  3 × 32 mm plus insulation</td>
<td>3 × 350 kW (part-load and redundancy)</td>
</tr>
<tr>
<td>4  3 × 32 mm plus insulation</td>
<td>Pump</td>
</tr>
<tr>
<td>5  3 × 50 mm plus insulation</td>
<td>Main distribution pipes</td>
</tr>
<tr>
<td>6  3 × 50 mm plus insulation</td>
<td>2 × DIN 100 plus insulation</td>
</tr>
<tr>
<td>7  3 × 32 mm plus insulation</td>
<td></td>
</tr>
<tr>
<td>8  3 × 50 mm plus insulation</td>
<td></td>
</tr>
<tr>
<td>9  3 × 50 mm plus insulation</td>
<td></td>
</tr>
<tr>
<td>10 3 × 40 mm plus insulation</td>
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</tbody>
</table>

Central chilled water air-conditioning system installed to cool an insulated bedroom core

Installation of a central chilled water air-conditioning

Section of the 3-room new generation building type after the transformation

1. Cooling Tower
2. Pump
3. Central Chiller
4. Fan-Coiled Unit
5. 10 mm insulation around an air-conditioned bedroom core
6. A new shaft to improve ventilation
7. Vertical piping installations
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as they appear in the magazine

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