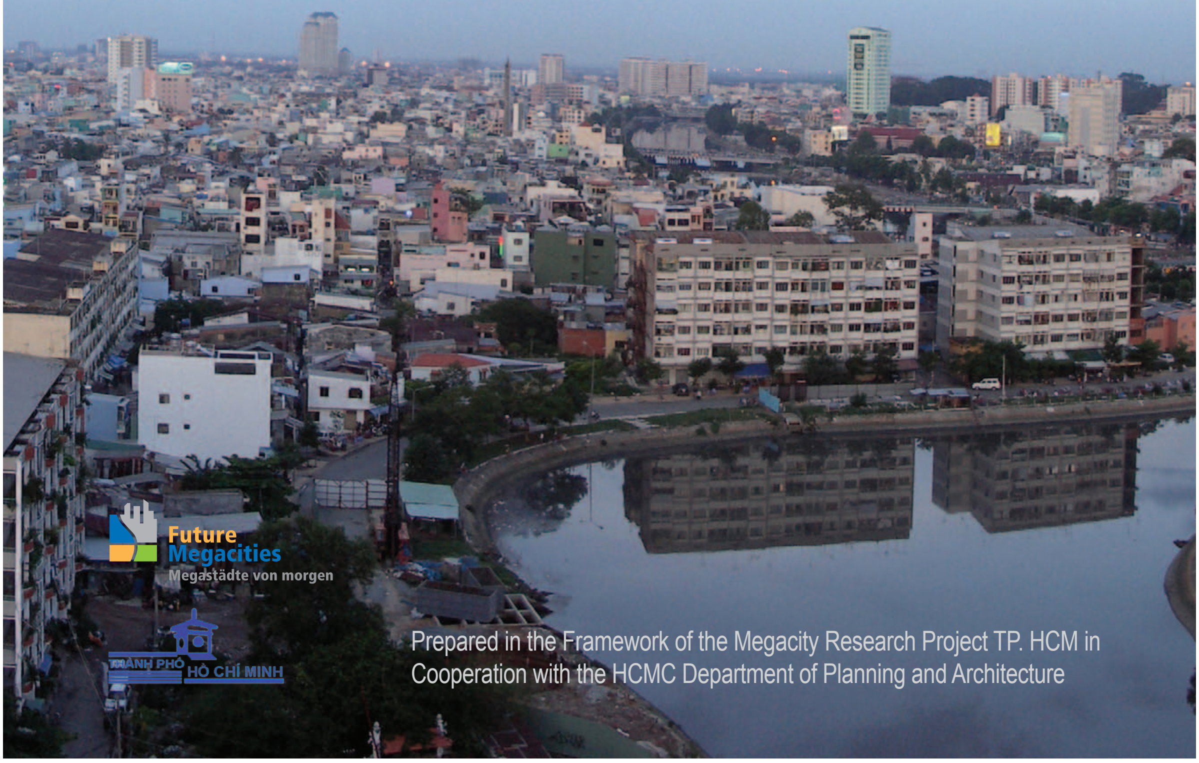
SPONSORED BY THE
Federal Ministry
of Education
and Research

Brandenburg
University of Technology
Cottbus



Adapt - HCMC

Handbook on Climate Change Adapted Urban Planning & Design for Ho Chi Minh City/ Vietnam

Future Megacities
Megastädte von morgen

THÀNH PHỐ HỒ CHÍ MINH

Prepared in the Framework of the Megacity Research Project TP. HCM in Cooperation with the HCMC Department of Planning and Architecture

Adapt-HCMC

Handbook on Climate Change Adapted
Urban Planning & Design
for Ho Chi Minh City/ Vietnam

Future Megacities
Megastädte von morgen

THÀNH PHỐ HỒ CHÍ MINH

Prepared in the Framework of the Megacity Research Project TP. HCM in Cooperation with the HCMC Department of Planning and Architecture

Impressum

© 2013 by Brandenburg University of Technology Cottbus
Department of Urban Planning and Spatial Design
Prof. Frank Schwartze

Konrad - Wachsmann - Allee 4
03046 Cottbus, Germany
Web: www.tu-cottbus.de
Email: ls_stadtplanung@tu-cottbus.de

ISBN 978-3-00-042750-3

Authors

Chau Huynh, Ronald Eckert, Moritz Maikämper, Barbara Horst, Frank Schwartze
Department of Urban Planning and Spatial Design
Brandenburg University of Technology Cottbus

Contributors

Tran Chi Dung, Hoang Tung, Nguyen Anh Tuan, Ly Khanh Tam Thao
Department of Urban Planning and Architecture, Ho Chi Minh City, Vietnam (DPA)

Prof. Lutz Katzschner
Department of Environmental Meteorology, University of Kassel

Robert Atkinson, Antje Katzschner, Hendrik Rujner, Christian Lorenz, Jana Warnatzsch
Department of Environmental Planning, Department of Environmental Geology & Department of Urban Planning and Spatial Design, Brandenburg University of Technology Cottbus

and
Hagen Schwägerl, Maria Feil, Florian Ibold, David Quinque, Robert Lauke
Brandenburg University of Technology Cottbus

Layouts & Illustrations

Ronald Eckert (Layout. Ilustrations at page 9, 74 (above), 76 (above), 84, 115, 117). Chau Huynh (page 12, 16, 17, 20-25, 26 (above), 27-29, 40-44, 46-48, 50, 52, 53 (above), 54-55). Moritz Maikämper (page 72, 73, 74 (below), 75, 87, 88). Maria Feil (page 71, 84, 85, 103 (above), 109 (above)). Florian Ibold (page 76 (below) & 77)

Download addresses

in Vietnamese:
http://www-docs.tu-cottbus.de/megacity-hcmc/public/2013_edition_handbook_on_climate_change_adapted_urban_planning_and_design_VIE.pdf

in English:
http://www-docs.tu-cottbus.de/megacity-hcmc/public/2013_edition_handbook_on_climate_change_adapted_urban_planning_and_design_ENG.pdf

Acknowledgements

This Handbook was designed and prepared within the Work Package 7 - Climate change adapted and energy efficient neighbourhoods, as part of the research project "Integrative Urban and Environmental Planning Framework for the Adaptation of HCMC to Climate Change". The project was funded by the German Federal Ministry of Education and Research in the framework of the research programme "Future Megacities".

Brandenburg University of Technology Cottbus

THÀNH PHỐ HỒ CHÍ MINH

Future Megacities
Megastädte von morgen

SPONSORED BY THE
Federal Ministry of Education and Research

Preface

In a leadership role of the strategic socio-economic polygon in the region, Ho Chi Minh City has become the economic and cultural center of the country. Ho Chi Minh City is the largest port city of Vietnam, a key transportation hub of road, waterway and airway connecting the provinces in the region and also an important international gateway.

The City is located downstream of the Saigon-Dongnai River with a relatively flat terrain; the hydrology of its rivers and canals is highly affected not only by the East Sea tide but also by water reservoirs upstream at the present and in the future.

In the context of global climate change, adaptation to climate change becomes an unavoidable challenge to urban planning and management of the city. In fact, climate change has direct impacts to the life of people in HCMC such as urban flooding, heat island effect and abnormal climate. These fast-growing climate change hazards are becoming key factors in urban planning. In particular, energy efficiency and adaptation to climate change have to be improved.

The Master Plan of Ho Chi Minh City towards 2025 was approved by the Prime Minister Decision No. 24 in 2010. In the current amendment, the master plan has been approached from the hydrological and land conditions towards the directions of socio-economic development of the city. However, to date there are no regulations in place to concentrate the general directives in the city master plan for adaptation to natural condition and climate change.

This Handbook on Climate Change Adapted Urban Planning & Design for Ho Chi Minh City, Vietnam is a first approach to integrate the topic into guidelines and recommendations for the lower levels of urban planning in the city, i.e. zoning and detailed planning.

The present Handbook focuses on adaptation measures in the flooding and urban climate sectors. The two selected case studies in this Handbook also demonstrate how the suggested strategies can be applied in specific locations of HCMC. Together with the Guidelines on Climate Change Adapted Urban Planning & Urban Design, this Handbook helps to integrate different aspects, such as environmental concerns, in the making, assessment and approval of urban plans as well as in the coordination with other sectoral plans.

This Handbook is one of the outcomes of the research in cooperation between Ho Chi Minh City Department of Planning and Architecture and Megacity Research Project Ho Chi Minh City. This is also a contribution of the Department of Planning and Architecture for the Ho Chi Minh City Action Plan to Response to Climate Change, which is part of the National Target Program.

We hope that the content of this Handbook shall be useful for policy makers, city departments and organisations, management authorities, architectural and planning consultants, project developers and the community in the urban planning of the city for a sustainable, climate change adapted development.

Tran Chi Dung, M. Arch.

Director of Ho Chi Minh City Department of Planning and Architecture

PHOTO CREDIT: Chau Huynh

Outline

Introduction

This handbook on Climate Change Adapted Urban Planning and Design for Ho Chi Minh City (HCMC)/ Vietnam presents urban planning and design strategies related to the city's main environmental and climate change risks. The handbook serves as a toolkit for HCMC's administration to support planning decisions and approval processes at the municipal level.

Adaptation and Mitigation in Urban Planning and Design

The higher frequency and severity of environmental problems, particulary flooding, in HCMC have recently started to raise the awareness of climate change. However, the main causal factor is considered to be urban development, rather than climate change. Therefore, urban planning should have a key role for the city's adaptation to these environmental and climate change threats. The urban form of HCMC is the most apparent part of unsustainable urban development. The current urban development hardly considers climate-related risks for the built environment and its inhabitants. The rapid growth of residential areas into the wetland surroundings is one of the city's greatest concerns. Therefore, once research on the environmental aspects of climate change impacts has been initiated, approaches for the integration of adaptation options into the current urban design and planning processes are needed.

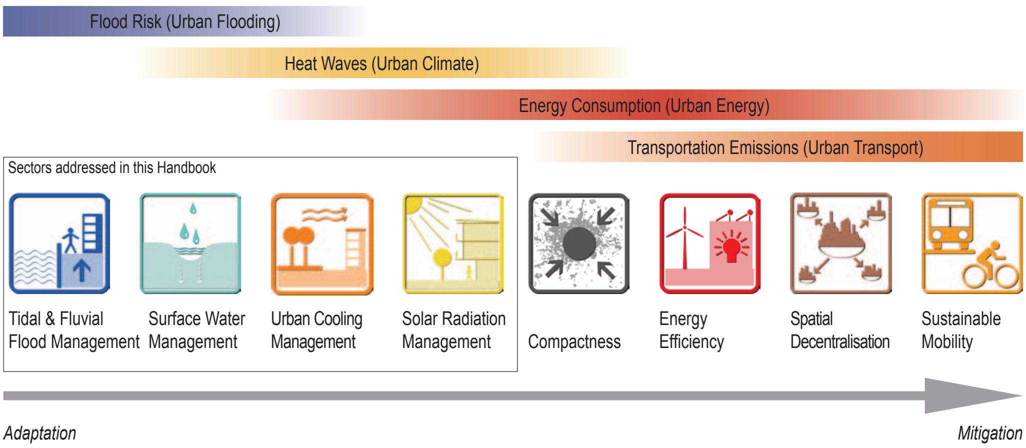
It is widely recognized that urban planning has to play a vital role in adapting to climate change and to move forward towards a low-carbon city. Climate change mitigation and adaptation are strongly influenced by urban form. At high densities, travel distances are minimised and community energy schemes become more viable, with obvious advantages for emission reductions. However, higher densities can conflict with adaptation objectives by intensifying Urban Heat Island effects and reducing urban drainage capacity. Therefore, the concept of the "Mixed-use and Compact City" needs to be combined with concepts of green and blue infrastructure provision since adapting to floods and high temperatures needs more open spaces. An adapted and sustainable urban environment for HCMC makes use of well designed green and blue spaces for ventilation, cooling, water storage capacity, and infiltration of rainfall.

Unfortunately, green space has often been sacrificed in the course of HCMC's rapid urban development. Poorly adapted cities that are not designed to cope with hotter, drier summers will require increased use of mechanical air conditioning. This not only contributes further to climate change, but also increases energy costs. Planners, developers, urban designers and architects must consider the potential conflicts between adaptation and mitigation responses in order to ensure sustainability of future communities.

Purpose of the Handbook

The handbook is intended to raise general awareness of climate change adaptation strategies in the field of urban planning and design among planning authorities as a short-term impact. An improved knowledge about climate change adaptation among several institutional and private stakeholders and a mainstreaming into urban planning are seen as long-term potentials of the handbook. This handbook was designed and prepared within the framework of the research project "Integrative Urban and Environmental Planning Framework for the Adaptation of HCMC

Fig. 1: Main issues for climate change adaptation



to Climate Change". The project is part of the "Sustainable Development of the Megacities of Tomorrow" initiative of the German Ministry of Education and Research. The overall objective of the project is to develop and incorporate climate change adaptation into urban decision-making and planning processes, which will increase resilience to climate-related physical and social vulnerabilities of the urban system in HCMC.

Relationship to Other Documents

The handbook should be used in conjunction with the Adapt-HCMC Guideline Set, on Climate Change Adapted Urban Planning and Design. While the Guideline Set is designed to assist the public authorities to assess the sustainability of urban development projects during the approval process and in establishing binding and non-binding climate change adapted urban planning and design regulations, this handbook can be understood as a source book.

Contents of the Handbook

The main part of the handbook illustrates a menu of adaptation options delivering insights into general adaptation approaches, selected urban planning strategies and best-practice examples. The handbook covers the following areas of adaptation to climate change:

Managing Flood Risk:

- Managing Tidal and Fluvial Flooding
- Managing Surface Water

Managing High Heat Load:

- Managing Urban Cooling
- Managing Solar Radiation

The next part of the handbook contains the description of two case studies to test, demonstrate, and evaluate the applicability of the identified urban design strategies and to downscale the results of a city-wide environmental assessment.

The areas covered by the case studies are:

- The Vo Van Kiet Boulevard
- The Nhon Duc Residential Area

I.
Managing Flood Risk

I. Managing Flood Risk

Flooding has been one of the significant environmental problems in HCMC. The flooding problem in HCMC is not only derived from the topography and climate conditions of the city, but is also strongly related to the impacts of rapid urbanisation. This chapter addresses urban planning and urban design solutions to the flooding problems of HCMC, including the tidal and fluvial inundation, and stormwater flooding.

Problem Background

HCMC is located at the north-eastern fringe of the Mekong Delta and its Sounthern part is connected to the East Sea. The majority of the city is situated on low-lying and marshy lands, elaborated by a complex network of canals and rivers. These topographic and geographic conditions make the city extremely sensitive to various flood sources. The main flood sources include: fluvial floods from upstream the Saigon-Dongnai and Mekong Rivers, semi-diurnal tidal floods, and floods due to surface runoff during rainfalls or tropical cyclones. The impact magnitude of these flood sources is made even more severe and unpredictable due to the effects of rising sea levels as well as other effects by global and regional climate change. Furthermore, these effects increase

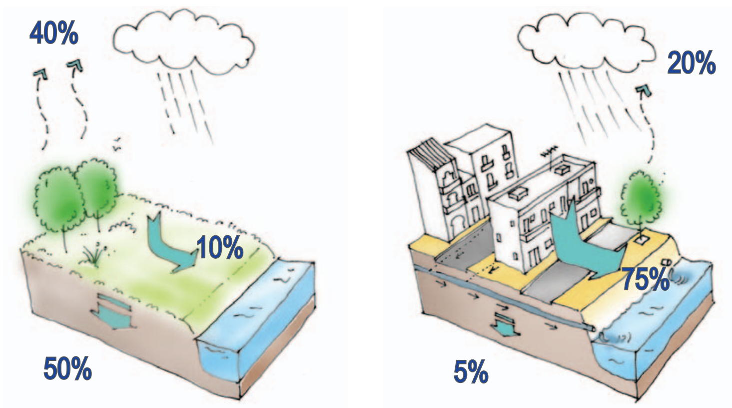
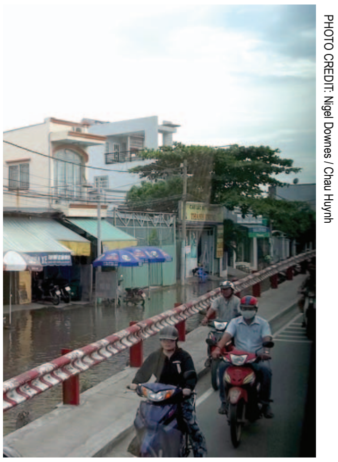


Fig. I.1: Natural water cycle and urban water cycle, illustrating the different rates of surface runoff, infiltration and evaporation.



the likelihood of a combination of flood types occurring simultaneously, greatly exacerbating the issue.

While the geographic location already makes the city highly vulnerable to flooding, rapid urbanisation is compounding the problem. During the 1989 - 2006 urbanisation, the impermeable surface area of HCMC has been doubled (Tran & Ha 2007). Meanwhile, unsealed surfaces such as the forests, the agricultural lands, green spaces and the wetlands in both upstream and downstream areas have been reduced rapidly due to the development of housing and infrastructure. This rapid soil sealing process has strongly contributed to the reduction of infiltration and evaporation capacity and is the main cause of the increased flooding related to surface runoff (Fig. I.2 & I.3).

Beside the notable increase in sealed surface area, many construction activities conducted in low-lying lands and wetlands have also contributed to the loss of natural water retention capacity. Both regulated and unregulated buildings in the city have occupied the riverbeds, narrowed the floodplain areas and altered the natural flow. Hence, the storage capacity of the city's water network has been reduced, floodwater levels in rivers are increasing; and consequently, inundation occurs in neighbourhoods along the waterways.

In addition to the occupation of riverbeds by buildings, one factor that limits the rivers' and canals' capacity is solid waste. Although scientific data on the quantity of solid waste in the city sewer network and open channels is not yet available, solid waste can be observed at the city's stormwater inlets and in the opened drainage channels.

Fig. I.2: Degree of soil sealing in HCMC, showing the high degree of sealing in the city center (Rujner 2011)

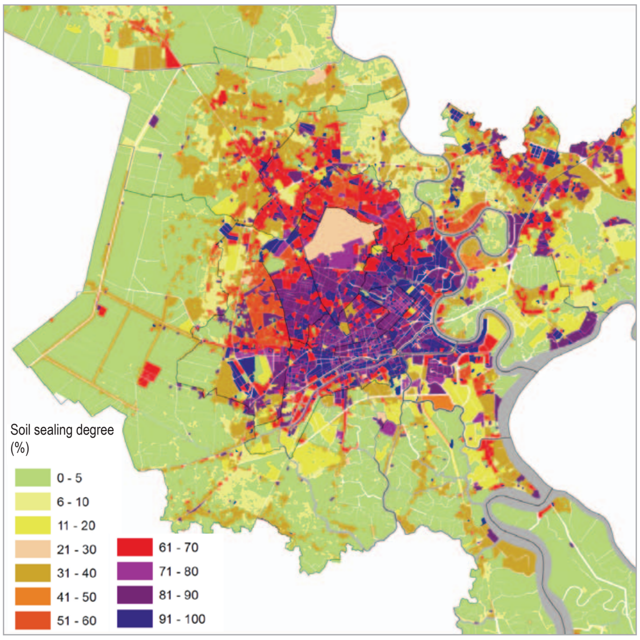


PHOTO CREDIT: Chau Huynh

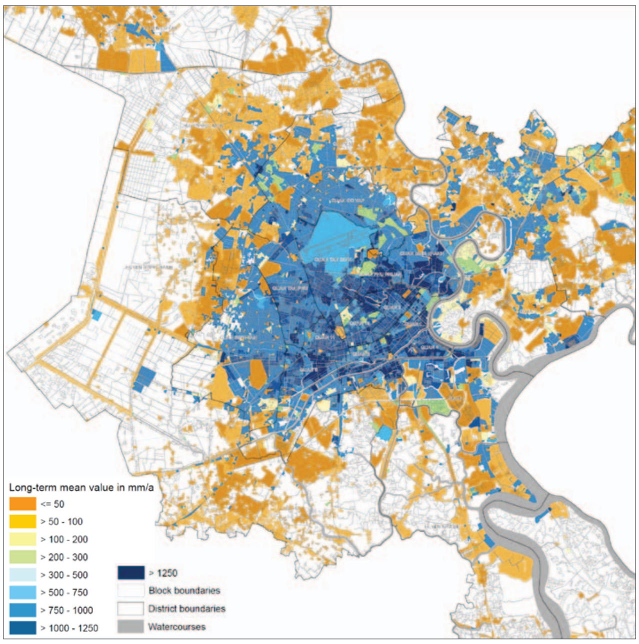
Solid waste, therefore, plays a part in limiting the drainage capacity of the city, leads to flooding. Moreover, it also deteriorates the water quality and pollutes the environment.

The over-use of groundwater in the city also takes part in worsening the flood risk. Since many households use underground water as an alternative water supply, the underground water system has been strongly altered, contributing to soil erosion and land subsidence. Records show that in the city center in HCMC, the land level has reduced in average 4mm per year from 1996 to 2002 (Le & Ho 2009). These areas are especially exposed to fluvial and tidal floods, and floods related to sea level rise.

The city's existing drainage network itself is inadequate to cope with the current urbanisation pace. The poor drainage capacity of the city leads to overloading of the sewer system. Moreover, most of the city drainage is a combined system, combining wastewater and stormwater canalisation. Therefore, the sewer system easily gets overloaded especially during heavy rainfalls, which results not only in flooding but also in a deterioration of water quality.

In conclusion, managing flood risk poses a huge challenge for HCMC, especially when conventional solutions such as applying drainage and dike system in the city are cost and time intensive. This chapter of the handbook therefore does not aim to provide massive structural solutions. It attempts, instead, to start with small scale and low-cost urban planning and urban design solutions, in which all stakeholders in HCMC can take part in reducing the flood risks and improving the environment and the quality of life.

Fig. I.3: Surface runoff resulting from precipitation in HCMC (Rujner 2011)



I-A.
Managing Tidal & Fluvial Floods

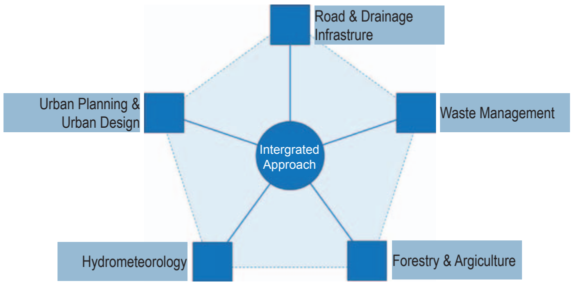


Fig. I-A.3: Intergrated flood management (Adapted from Parkison & Mark 2005)

I-A. Managing Tidal and Fluvial Floods

Tidal and fluvial floods are the two most dangerous flood sources in HCMC. During recent years, these risks have become more severe. Records show that the maximum tide height of HCMC has been increased about 10cm from 2009 to 2012 (Fig. I-A.1). At the same time, fluvial flooding both upstream and downstream of HCMC is becoming more unpredictable due to unexpected sea level rise, heavy rainfalls and tropical cyclones.

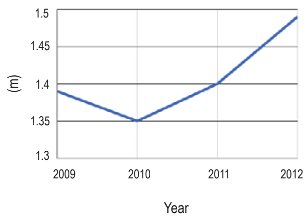


Fig. I-A.1: Maximal tide levels from 2009 to 2012 (SCFC 2012)

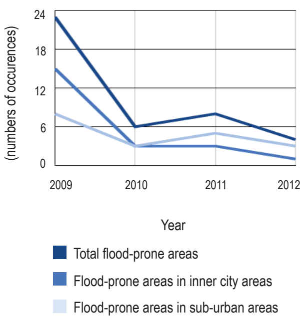


Fig. I-A.2: Numbers of flood-prone areas resulting from tide from 2009 to 2012 (SCFC 2012)

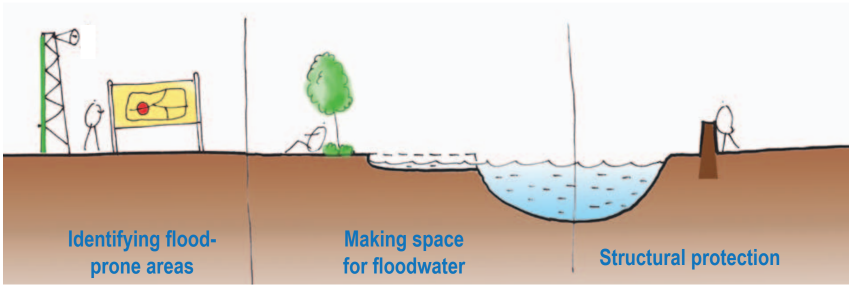
General Approach

Under the management of the Steering Center of the Urban Flood Control Program HCMC (SCFC), many tide protection projects have been implemented. The SCFC's first biannual report on flooding mitigation in 2012 shows that, although areas prone to tidal flooding in the inner city have been reduced indicatively, the risk of flooding in sub-urban areas has increased slightly in 2011 (Fig. I-A.2). The report also stated that the current approach is mainly based on engineering measures such as applying drainage, tide gates, and pumping; and SCFC also admitted that the root cause of the problem has not yet been addressed (SCFC 2012). A more sustainable approach would be a well-integrated flood management system involving different industries and services (Fig. 1-A.3). The solutions should not be based solely on a conventional drainage and infrastructure approach, but also on a wide-range of services (Parkison & Mark 2008). Cross-sectoral and cross-departmental communication should also be strengthened to ensure a good coordination among all stakeholders.

Based on the concept of Integrated Flood Management, this part of the handbook introduces urban planning and urban design approaches to tidal and fluvial flood control, in which a number of structural and non-structural measures for tidal and fluvial flood mitigation and protection are recommended. Here, it is noted that tidal and fluvial flood management is also influenced by planning decisions taken at the hydrological catchments of the Saigon - Dong Nai Rivers and the Mekong Delta (Fig. 1-A.5). However, this handbook focuses only on the urban planning and urban design solutions within the administrative boundary of HCMC.

The general urban planning and urban

Fig. I-A.4: The three-step strategy



design strategies for dealing with tidal and fluvial floods for HCMC can be classified into 3 main steps (Fig. I-A.4):

(1) Identifying flood-prone areas:

It is important that the flood-prone areas, including potential future flood-prone areas are first identified. Based on this identification, all flood management measures and decision making can be established. Information about the flood-prone areas, as well as emergency evacuation plans should be spread to the whole public, with priority given to neighbourhoods situated in flood risk zones.

(2) Making space for floodwater:

The significant encroachment of urban structures into the tidal areas and the floodplains strongly results in the increase of the tide level and the fluvial flood level in HCMC. Hence, in order to mitigate flood risks, more spaces for flood retention should be reclaimed. Through this strategy, floodwater will be kept or diverted, and slowly released to rivers and canals once flood events are over.

(3) Structural protection:

Physical protection structures are also an effective way to avoid floodwater damage to buildings and infrastructure, especially in neighbourhoods already situated in flood risk areas, and where re-location is no longer possible. Structural protection measures also can be applied in urban areas where critical buildings and infrastructures are located.

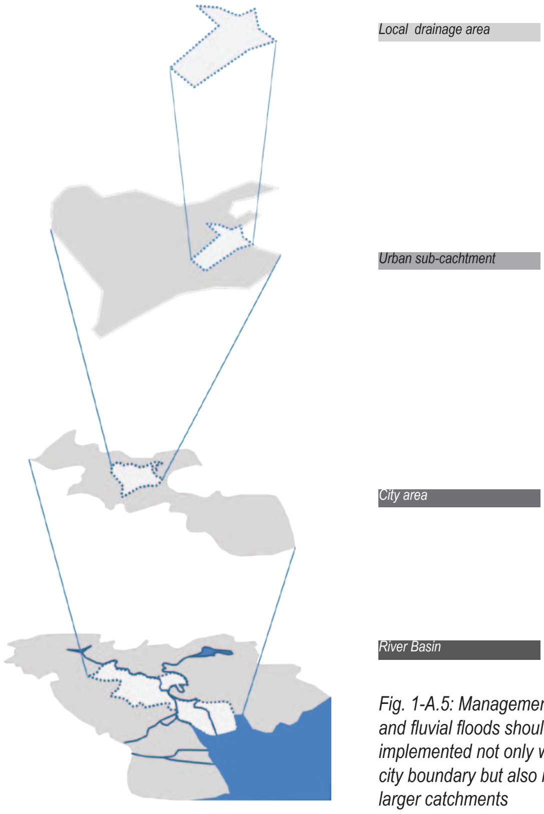


Fig. 1-A.5: Management of tidal and fluvial floods should be implemented not only within the city boundary but also in the larger catchments

Selected Strategies

Identifying Flood-prone Areas

01 Flood Hazard Mapping

Flood hazard mapping refers to the use of maps for communicating flood hazards and flood risks. Flood hazard mapping will facilitate flood plain zoning and other land use planning measures. Flood hazard mapping is not only a supplementary tool for decision makers in both land use and emergency planning, but also a communication tool to inform inhabitants about flood risks, helping to prevent future damage.

Flood hazard maps usually include information on:

- Type of flooding
- Flooded zones
- Depth of flood, velocity and direction of water flow

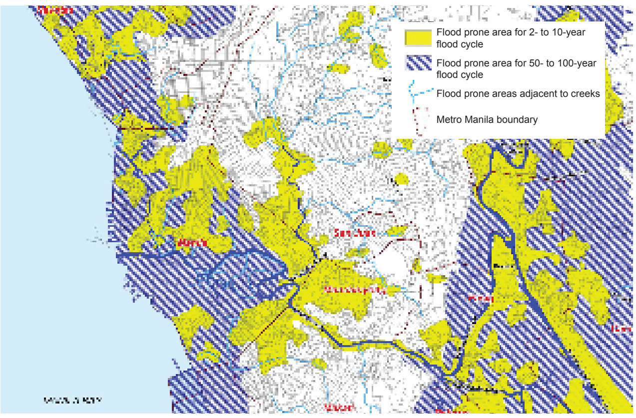


Fig. I-A.6: Flood hazard map of Metro Manila, Philippines, available online (Department of Environment and Nature Philippnes)

Maps are prepared based on specified return periods , for example once per 10 years, once per 25 years, once per 100 years or on less extreme events occurring for example only once in 1000 years (Table I-A.1).

Flood hazard maps should be updated regularly not only with relevant hydrological information, but also with field information such as real estate data, shelter locations, major buildings, road constructions, as well as other relevant data, for example any changes in the flood peak or other data collected from warning stations. Further information such as data on the exposure of assets, current population and population vulnerability may also, on occasion, be included in flood hazard maps (Jha, Bloch & Lamond 2012).

Table I-A.1: Probability threshold

Flood cycle	Probability threshold
1 in 1000 years	Low probability of flood
1 in 1000 years - 1 in 100 years	Medium probability of flooding
1 in 100 years - 1 in 20 years	High probability of flooding
1 in 20 years -	Functional floodplains

(Adapted from World Bank 2012)

Fig. I-A.7: Flood hazard map of Philadelphia, showing shelter locations (City of Philadelphia)

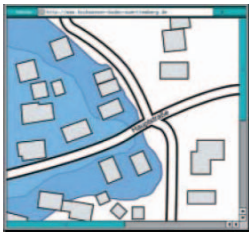
A flood hazard map is typically established in six main steps as described in Table I-A.2. However, it should be noted that uncertainties always exist in flood hazard estimations. There are various sources of uncertainty, such as:

- Model uncertainty
- Parameter uncertainty
- Input uncertainty
- Natural & operational uncertainty (Jha, Bloch & Lamond 2012)

It is important for decision makers and the public to understand that these uncertainties exist. Furthermore, maps should be revised to incorporate any changes in input data, to ensure that future decisions are based on up to date information.

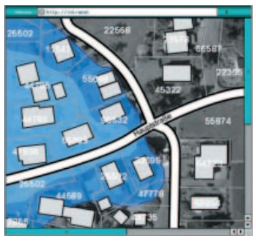
Electronic maps are typically available in GIS raster or vector formats. These maps will have different levels of detail depending on the intended target group, for example local authorities and individual households (Fig. I-A.8). The key purposes of public flood maps are to increase awareness of relevant legal decisions such as the assignment of use, layout and design of an area of land, and to empower individuals to take appropriate preparatory and response measures (FLOODsite 2008).

Fig. I-A.8: Different flood hazard maps for different uses (Ministry of the Environment Baden-Württemberg)



For public uses

For local authorities



For professional departments

Table I-A.2: Methodology to establish a flood hazard map

Step		Descriptions
1	Data collection	Digital terrain, surface models, hydrological data
2	Return-period calculation	Annual maximum flood flow-rate passing a specific location
3	Modelling flood scenario	1D, 2D or 1D2D hydraulic models
4	Model result validation	By means of measuring and surveying actual events to test the performed models
5	Flood maps preparations and distributions	Output data is transfered to a user-friendly format and then distributed to different stakeholders
6	Monitoring and regular updating	Regular updating of maps with field information and hydrological information

(Adapted from Jha, Bloch & Lamond 2012)

Making Space for Floodwater

02 Re-naturalise Rivers and Channels

In many instances, the rivers and channels in HCMC have been significantly narrowed and occupied by housing structures and uncollected solid waste. This results in floodwater blockage and a reduction of flow capacity. Additionally, the embankments in HCMC usually are lined with sealing materials such as stones and concrete. The sealed embankment will partly reduce water infiltration capacity, increase flow velocity to downstream areas and hence, increase downstream floods.

Re-naturalising a river means to bring it near to its original state, enhancing infiltration, reclaiming storage potential, and providing more spaces for floodwater. Moreover, re-naturalisation helps to reduce bank erosion and to enhance the wildlife along the rivers. The four main strategies to re-naturalise rivers are:

(1) Removing obstruction: Obstacles such as solid waste, fallen trees, weirs and impounding constructions in waterways should be removed, in order to increase flood retention capacity and retain the original flow velocity. Removing sediments or deepening and widening the channel should only ever be considered as a last resort and limited to the minimum possible due to the strong impacts to the natural river environment.

(2) Re-meandering river beds to their natural curves: During urbanisation, watercourses are often straightened and canalised. Re-meandering river beds reduces flow rates and erosion, increases bank infiltration, enhances the storage capacity of river plains and delay flood peak.

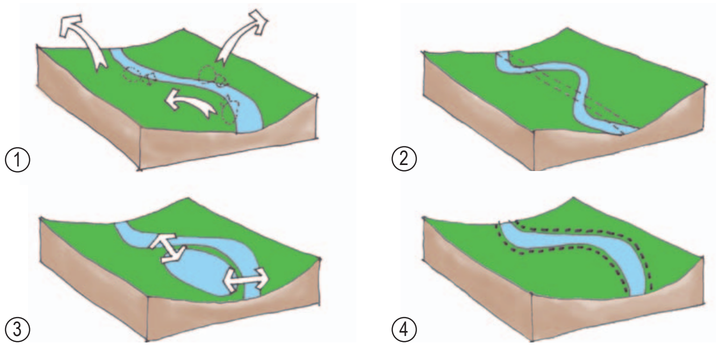


Fig. I-A.9: Measures for re-naturalising rivers and channels

1. Removing obstruction

2. Re-meandering river beds

3. Re-connecting rivers with floodplains

4. Re-naturalising embankments

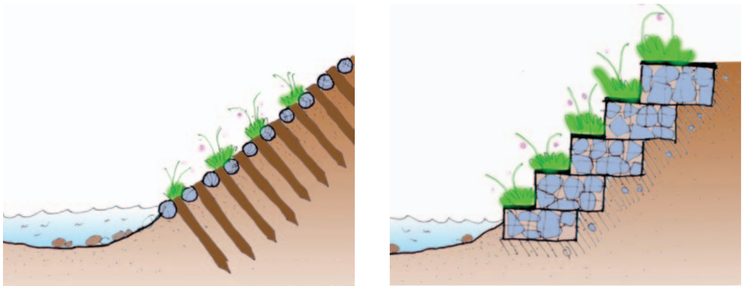


Fig. I-A.10: Examples of technical design of naturalised embankments.

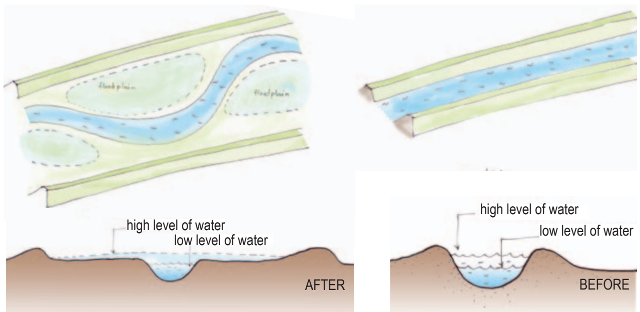
Left: Log cribwall
Right: Planted gabions

(Adapted from PUB 2011)

(3) Re-connecting rivers with floodplains: Connection between the rivers and floodplains usually is interrupted by embankments, backfills and built structures. Re-connecting rivers with floodplains helps to increase storage capacity and transport stormwater away. This can be achieved through: lowering riverbanks, lowering embankments, setting back levees and dikes (Fig. I-A.11), and re-connecting borrowing pits.

(4) Renaturalising embankments: Embankments should only be considered for highly vulnerable stretches of the riverbank, less vulnerable banks should be returned to close to the natural conditions. Where necessary, embankment design should reflect natural conditions, using techniques such as planted gabion or cellular concrete blocks instead of solid concrete lining (Fig. I-A.10, 12). These measures help to protect embankments from erosion, enhance infiltration of floodwater and slow down flow velocity. Additionally, the wider distribution of sediment deposition will provide better conditions for vegetation growth creating wildlife habitat and improving the aesthetics of the rivers and channels.

Fig. I-A.11: Set back levees to extend floodplains and create more flood storage than levees close to the channels (Adapted from MRC 2007)



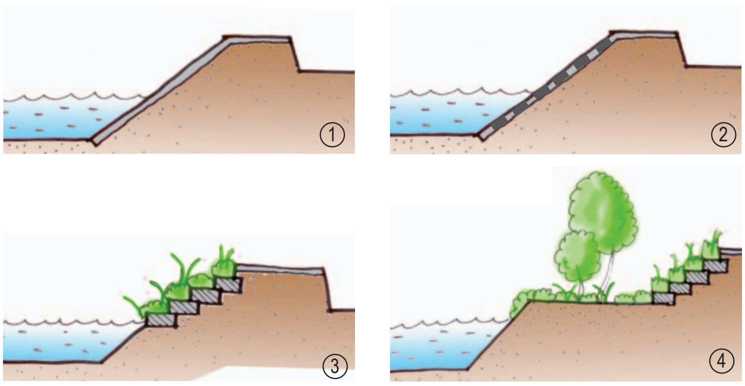


Fig. I-A.12: Re-naturalising rivers and embankments

1. Embankment with solid concrete lining (not recommended)

2. Embankment with cellular concrete blocks

3. Embankment with planted gabion

4. Embankment with planted gabion and a setback

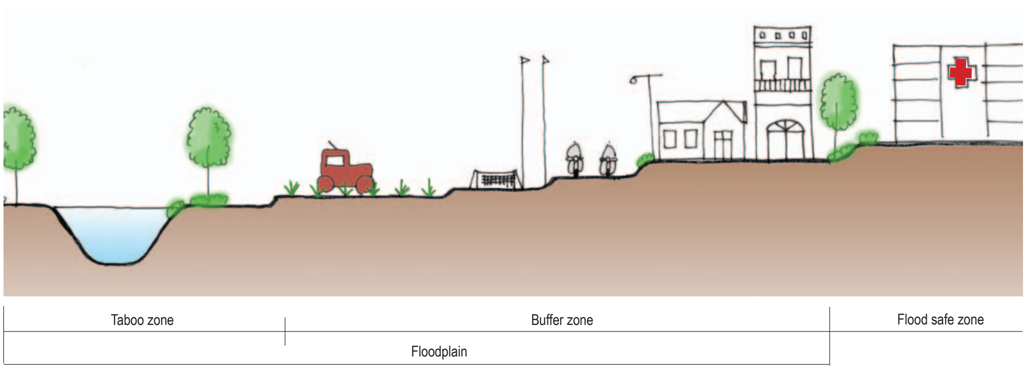
03 Preserve Floodplains

Floodplains are flat areas adjacent to rivers or streams and experience high probable floods such as a 10 or 20 year flood. Natural floodplains provide space for streams and rivers to expand during periods of flooding and dissipate the energy of high peak flows. Hence, they provide a natural flood control and reduce downstream flood risks. Additionally, floodplains also help to reduce non-point source pollution and provide habitat for both flora and fauna (Sipes 2010).

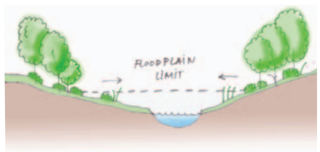
Floodplain zoning should be well thought out in order to utilise land. The periodic flooding of floodplain areas is a key to maintaining important ecosystems, including riparian forests and wetlands. The hydrological functions of natural floodplains can also be preserved by limiting development, or by promoting 'flood-friendly' land uses such as agriculture, playgrounds, sports fields, or flood-proof buildings (DCLG 2006). Floodplains therefore, should be classified into 2 different zones (Fig. I-A.13):

- **Taboo zone:** where the river buffer is used to retain the regular extreme tidal and fluvial floods. In the taboo zones, all building structures will be restricted.
- **Buffer zone:** where experiences seasonal and occasional floods,. These locations are suitable for farming, playing fields, less vulnerable infrastructures, and flood adapted residential buildings and infrastructures.

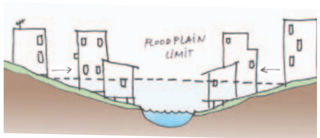
Fig. I-A.13: Floodplain zoning



In the HCMC region, floodplains provide potential development land and are therefore at risk of being raised and occupied by both regulated and unregulated buildings as a result of urbanisation and the high demand for housing. The raising of land in floodplains results in a large reduction in flood storage capacity and creates new flooding areas. It is necessary to protect the existing floodplains, re-connect prior floodplains with the river network, as well as to develop land use specifications for the floodplain areas and to strengthen the land use regulations and urban control in these areas.



BEFORE



AFTER

Fig. I-A.14 : Floodplain before and after being land-elevated and occupied by housing and infrastructures, which leads to an increased flood level.

Table I-A.3: Flood risk vulnerability classification according to land use

Water compatible development	• Flood control and defence infrastructure • Water and sewage transmission infrastructure, pumping stations • Docks, marinas and wharves, shipping and fishing industries • Open space amenity, outdoor sports, water-based recreation • Nature conservation
Less vulnerable	• Shops, restaurants and cafes; financial and office buildings • Storage and distribution facilities • Land and buildings used for agriculture and forestry • Water treatment plants (with adequate pollution control measures)
More vulnerable	• Hospitals, educational establishments. • Residential care homes, children's homes, social services homes, prisons and hostels; dwelling houses, dormitories and hotels • Landfill and sites used for waste management facilities • Sites used for public holiday and events
Highly vulnerable	• Police stations, ambulance stations, fire stations; emergency gathering points • Telecommunications installations • Basement dwellings • Installations requiring hazardous substances consent
Most vulnerable	• Essential transport infrastructure (including mass evacuation routes) • Strategic utility infrastructure, including electricity generating power stations as well as grid and primary substations

(Adapted from DCLG 2006)


PHOTO CREDIT: Ronald Eckert / De Urbanisten

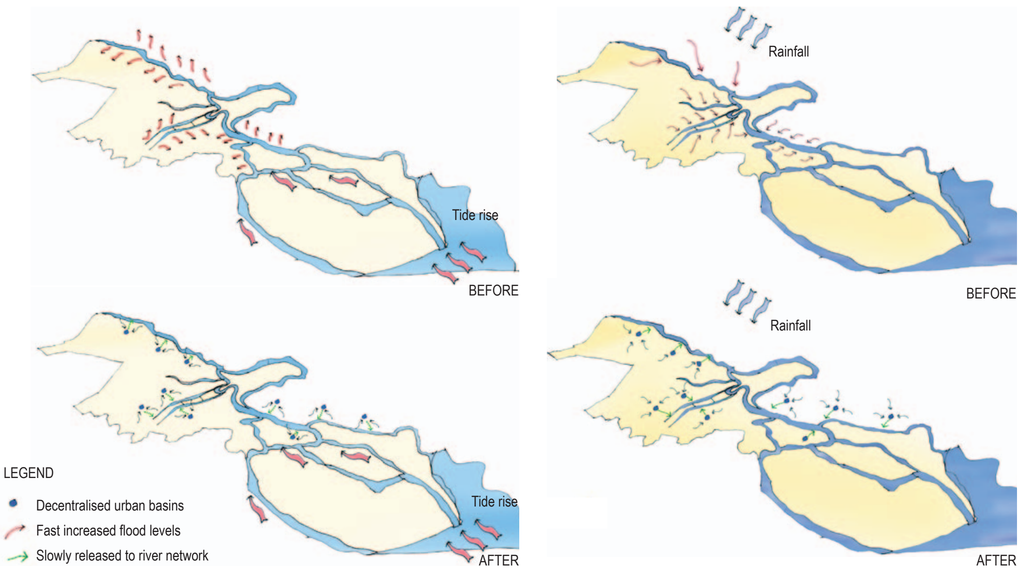
04 Decentralised Urban Basins

Typically, flood events will cause the water level in rivers and channels to rapidly increase, which will lead to inundation due to insufficient storage capacity. It is possible to divert excess floodwater from rivers and channels to the basins into a network of urban basins, where floodwater will slowly be infiltrated into the basin grounds and released back to the water network when flood events are over, or when river capacity is available (Fig. I-A.15).

Alternatively, during rainfall events in which the capacity of the urban drainage system is exceeded, urban surface runoff may be diverted to the basins as 'excess flow' and be released when the drainage system capacity is available.

A decentralised network of urban basins in the city, can therefore play an effective role on reducing both inundation events from rivers and floods due to surface runoff. The existing un-developed areas in HCMC's periphery can be used as potential urban basins and therefore should be kept.

Fig. I-A.15: Before and after applying decentralised detention basin during tide rise and rainfall events



05 Temporary Urban Storage

Depending on the availability of land resources, different sizes of urban basins can be applied. In dense urban areas, urban basins can be set up by making use of areas with other primary functions. They are referred to as temporary urban storage.

Table I-A.4 and I-A.5 cover the main aspects of identifying suitable locations for decentralised urban basins and their estimating storage capacity. There are some basic requirements for the locations:

- They will always be above ground
- The area set aside for storage normally has a different use
- This different use is utilised infrequently and can be interrupted during storage operation (Balmforth, Digman, Butler & Schaffer 2006).

Table I-A.4: Steps for installing a suitable temporary storage

1. Identify suitable locations for urban basins 2. Determine maximum water depth 3. Estimate maximum water capacity and include in a hydraulic model 4. Specify outlet arrangements 5. Consider health and safety issues
(Adapted from Jha, Bloch & Lamond 2012)

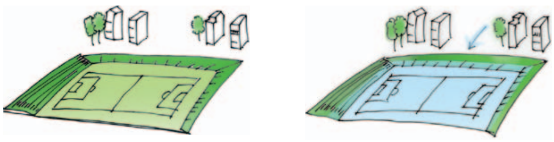
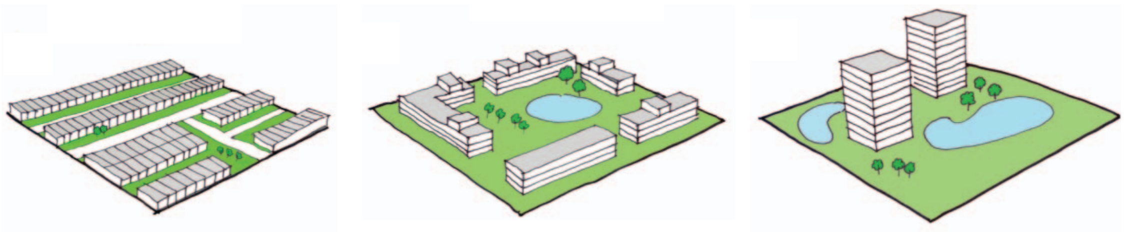


Fig. I-A.16: Playing fields or playgrounds as multifunctional areas: For recreational purposes and for temporary water storage during flood and rainfall events

Table I-A.5: Type of possible temporary urban storage

Type	Description and comment	Max. Depth & Capacity
Car Parks	Depth of water restricted due to potential hazard to vehicles, pedestrians and adjacent property	0.2 m 200 l/m²
Minor Roads	Roads with speed limits up to 50 km/h where depth of water can be controlled by design	0.1 m 100 l/m²
Recreational Areas	Hard surfaces used typically for basketball, mini football and tennis courts	0.5 - 1.0 m 500 - 1.000 l/m²
School fields	Extra care should be taken to ensure safety of the children	0.3 m 300 l/m²
Playing Fields	Set below ground level of the adjacent area and may cover a wide area, offering significant volume	0.5 - 1.0 m 500-1.000 l/m²
Parkland	Care needed to keep floodwater separate and controlled release to prevent downstream flooding	0.5 m - 1.0 m 500-1.000 l/m²
Industrial Areas	Care should be taken as some areas could create significant surface water pollution	0.5 m 500 l/m²
(Adapted from Balmforth, Digman, Butler & Schaffer 2006)		



80% Site coverage | 50% Site coverage | 30% Site coverage

Fig. I-A.17: The same total plot areas and gross floor areas , but different ratios of open spaces and site coverage

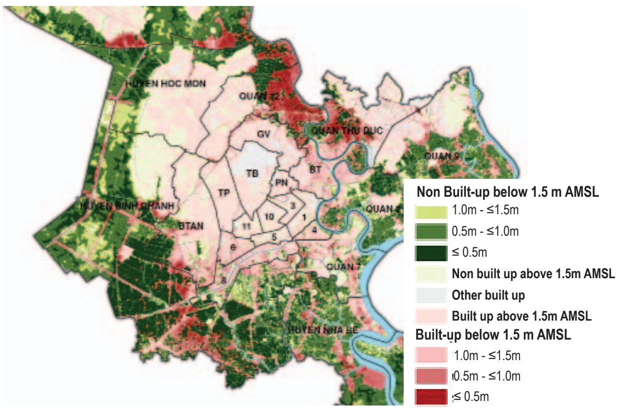
06 High-rise & Compact Urban Form

A high-rise and compact urban form is not only relevant as an adaption to the spatial expansion under the demand of a growing population; it also serves as a measure for the protection of the natural environment. High-rise and compact urban form reduces the urban footprint and therefore reduces the requirement for natural resources. This results for example in the preservation of water bodies, wetlands and green spaces, which protects the natural water retention capacity and therefore reduces flood risk.

To reduce the demands on open space and natural systems, the compact and high-rise urban form is recommended for new developments in HCMC. For existing developments, it is recommended to increase density only where infrastructure is sufficient. Building footprints can be reduced by reaching a suitable compromise between built-up versus non-built surfaces, and total floor areas versus building height. In order to facilitate the compact urban form and preserve open spaces, examples of key urban control measures are listed below:

- Set standards to maintain open spaces and increase densities
- Encourage mixed-use development
- Centralise employment and travel intensive uses at transportation hubs.
- Balance development footprint with conservation gains
- Promote awareness of compactness and environmental preservation

Fig. I-A.18: HCMC's urban form should be the compact form to preserve the low-lying and open lands (Storch & Downes 2012)



Advantages

- Preserve open spaces for water retention and infiltration
- Protect natural water network
- Reduce cost of drainage infrastructure
- Increase efficiency of water supply and treatment

Disadvantages

- Requires strong urban planning and control to limit urban sprawl
- High-rise buildings are contrary to the traditional form of individual living

07 Waterfront Protection Structures

Waterfront in urbanised and crucial areas needs to be protected from floods but also needs to be utilised for public and urban amenities. Waterfront protection structures can be classified into two different catalogues:

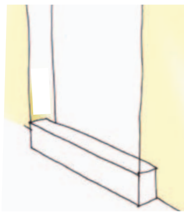
- **Dry flood-protection structures:** fixed and permanent defence structures such as dikes, dams, or levees. They are designed to prevent absolutely the encroachment of floodwater into urban areas.
- **Wet flood-protection structures:** 'softer' structures such as parks, wetlands, or playgrounds that allow waterfronts to accommodate floodwater, instead of walling it off. Floodwater, hence, will be retained on site and slowly released. Additionally, the waterfront areas still can be used as accessible public spaces, by creating activities based on flooding periods. In most instances, wet protection structures also can enhance aesthetics by using water as a landscape design element.

Dry flood-protection structures are usually costly and require high construction and maintenance works. They are most effectively used in areas that are subject to frequent high floods; with many critical structures; and where flood warning time can be insufficient (MRC 2009). Wet flood protection structures are used when dry-flood protection is not necessary or too costly.

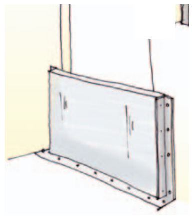
Type		Advantages	Disadvantages
Dry protection	• Dike • Dam • Levee • Sand bags • Flood gates or flood panels	• Prevent absolutely floodwater from entering to the development areas • Utilise lands for facilities and infrastructures	• Costly • Require intensive construction, operation and maintenance works • Can increase downstream floods
Wet protection	• Street • Terrace plaza • River park • Playground • Wetland • Detention pond	• Low cost • Accessible waterfronts • Efficient utilisation of spaces • Can enhance aethetics of the locations	• Only certain land-use types can be applied

Fig. I-A.19: Waterfront terrasses (Adapted from KCA Architects)

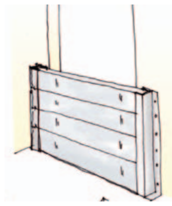
Fig. I-A.20: Flood gates



Simple concrete step



Metal shield



Height adjustable metal shield

08 Building Protection Structures

Buildings and their contents can be directly and indirectly affected by flooding in a range of ways. Direct impacts are the physical damages caused to buildings and their contents. Indirect effects mean the loss of industrial or business processes. A carefully planned building design can reduce the vulnerability of buildings to flood damage. This is especially important for existing buildings, in the flood prone areas which can not be relocated.

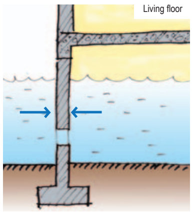
Similarly to the waterfront protection strategies, there are various flood protection strategies for buildings, these can be classified as follows:

- **Wet flood proofing:** Helps to reduce

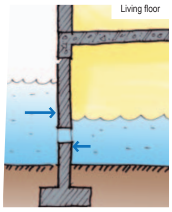
Table I-A.6: Structural flood protection for buildings

Type	Descriptions	Advantages	Disadvantages
Wet flood proofing	• Waterproof materials on both external and internal walls and floors • Flood vent installation • Elevation of vulnerable equipment and electricity lines • Groundfloors or crawlspaces are used with temporary functions	Less costly Reduce flood velocity Reduce flood damage to buildings	Requires adequate warning time to prepare Limited living areas Contamination risks Could require extensive cleanup post flood events
Dry flood proofing	• Temporary flood gates • Waterproof materials only on external walls • Elevated windows • Backflow valve installations	Less costly Keep clean for the internal spaces Reduce physical and emotional impacts of floods on building occupants	Does not reduce flood velocity and potential damage for surrounding neighborhoods
Flood avoidance	• Elevated ground-floor • Buildings on stilts • Land elevating • Relocation	Significantly reduce flood risks to the buildings Reduce physical and emotional strains that accompany floods	Costly, especially when applied to existing buildings Land elevating requires assessment to ensure surrounding neighborhoods are not put under increased flood risk

(Adapted from CLG 2007)



Balance between outside and inside flood levels



Unbalance between outside and inside flood levels, stronger structure is required

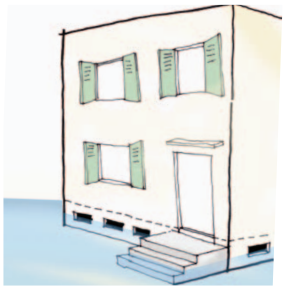


Fig. I-A.21: A crawlspace building and its details (Adapted from FEMA 2008a).

the flood-related damage when let floodwater to enters the building

- **Dry flood proofing:** Seeks to prevent water from entering the building; to reduce damage to the building, and to reduce the effect on occupants
- **Flood avoidance:** Aims at avoiding the floodwater entirely, by elevating buildings above the flood level, or by allowing buildings to rise with the floodwater

The choice of which flood proofing solution is suitable for a building depends on:

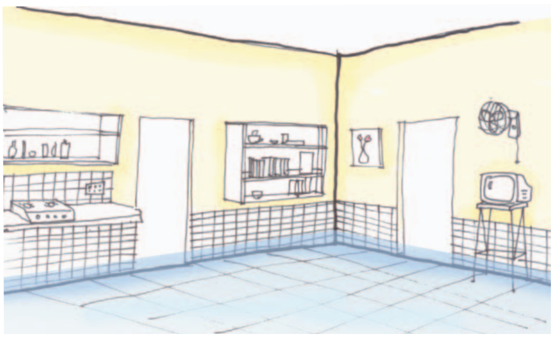
- Potential flood sources
- Depth of floodwater
- Flood duration & frequencies
- Existing environmental conditions, such as the climate, soil conditions, or potential contamination
- Existing building conditions
- Financial capacity

For low income communities living in high risk flood areas, it is recommended to use the above structural measures together with un-structural measures such as fund raising, warning system, evacuation training and self-help construction training.

Table I-A.7: Flood resistant materials

• Concrete, concrete blocks, glazed bricks • Ceramic tiles • Stone, slate or cast stone (with water-proof mortar) • Stainless steel nails and connectors • Metal doors and window frames • Mastic, silicone or polyurethane • Water-resistant glue
(Adapted from FEMA 2008b)

Fig. I-A.22: Wet flood proofing and dry flood proofing buildings

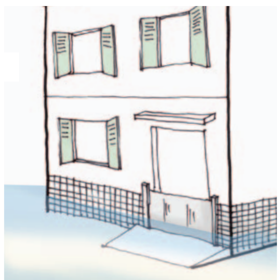


WET PROOFING (Above)

1. Waterproof walls and floor
2. Elevated equipments and electricity lines
3. Opened doors for floodwater to flow in and out

DRY PROOFING (Right)

1. Waterproof external walls
2. Removable flood doors
3. Elevated windows



Best Practice

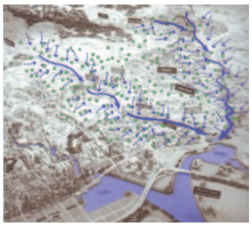


Fig. I-A.23: Singapore's decentralised urban basin network concept (Atelier Dreiseitl 2009)

01 ABC Waters Programme & Bishan Park, Singapore

In 2006, Singapore's national water agency, the Public Utilities Board (PUB) initiated the Active, Beautiful and Clean (ABC) Waters Programme, which aims to transform Singapore's network of functional drains, canals and reservoirs into vibrant and beautiful streams, rivers and lakes with flood mitigation functions.

Singapore is an island city state, which, while situated near the equator and hence receiving ample rainfall (3,550 mm per year), is lacking in natural water aquifers. In the 1970's, this situation forced the city to review its water systems earlier than many other cities and to employ a holistic approach to a city-wide water management strategy. Singapore's City-wide Waterscapes

Location	Singapore
Annual Rainfall	3,550 mm
Rainfall Intensity	319 l/s/ha
Area	14,000 ha (Master Plan) 63 ha (Bishan Park)
Canals & Rivers	7,000 km (Master Plan) 3,000 m (Bishan Park)
Client	Public Utilities Board and National Parks Singapore
Design	Atelier Dreiseitl
Planning	2006-2008
Construct.	2009-2010
Strategies	Re-naturalising Rivers, Decentralised Urban Basins, Cleansing Biotopes, Multiple Functions

Fig. I-A.24: Singapore's central watershed and the location of Bishan Park (Atelier Dreiseitl 2009)

Masterplan aims to manage storm and rainwater locally via an integrated and decentralised urban drainage system. A pervasive network of local measures prevents high water loads and reduces the pressure on rivers during peak storm events. Rainwater is collected by a comprehensive network of drains, canals, rivers, and ponds before it is channelled to fresh water reservoirs for storage. This contributes to the target of utilising 2,400 mm of annual rainwater for fresh water supply (PUB 2011).

The renaturation of a former concreted stormwater relief channel in the Bishan Park is one of the pilot projects within the ABC Waters Programme, which aims to meet current and future challenges like the lack of fresh water, an increasing population, water pollution as well as increased rainfall and sea level rise due to climate change. With a fundamentally new approach, the public Bishan Park combines technical solutions with a high quality landscape design, managing rainwater locally by means of infiltration, collection, evaporation and biotic cleansing as well as integrating the potential of changing water levels as design aspects. Supporting measures like the reduction and cleaning of runoff water can be further guaranteed by green roofs and façades, rain gardens, in-house water circles, cleansing biotopes and trash filters within the adjacent neighbourhoods (Dreiseitl & Grau 2009). Flood marks and a warning system have also been installed to alert the community in case of a sudden rise of the water level.

Fig. I-A.25: The Kallang river in Bishan Park before and after re-naturalisation (with low and high water levels) (Atelier Dreiseitl 2009)

Fig. I-A.26: Landscape design for Bishan Park (Atelier Dreiseitl 2009)

PHOTO CREDIT: BACA Architects

Upper Catchment: Let rain slow

Middle Catchment: Let rivers flow

Lower Catchment: Let tides go

Fig. I-A.27: The general principles of LifE Project in managing flood risks at different catchments (BACA Architects 2009)

02 Living with water, LifE-Project, United Kingdom

The LifE project (Long-term Initiatives for Flood-risk Environments) is led by BACA architects and the Building Research Establishment UK. Since 2005, the project has been promoting the use of solutions for the sustainable adaptation to climate change, in particular to flood risks, to the construction industry. LifE's focuses on a non-defensive approach to flood risk referred to as "Living with water". The idea is not to keep water out of an area, but to design new urban areas in the way that allows floodwater and rainwater move over or around the sites in a controlled and predetermined manner.

The project focused first on three pilot projects in the three different catchments: Hackbridge in the upper catchment, Peterborough in the middle catchment and Littlehampton in the lower catchment. All the three locations are in danger of future floods. In these case studies, different riverside masterplans have been developed based on the general principles of LifE (Fig. I-A.27). Flood management, then is integrated within the development sites. This integrated approach seeks to use land and water assets for multiple functions, such as

Location	United Kingdom (UK)
Annual Rainfall	650 mm
Area	24,000 ha (the whole pilot projects) 800 ha (Hackbridge project)
Client Design	Defra Research Project, UK BACA, Building Research Establishment, Halcrow, Fulcrum Consulting
Planning Construct.	2009 Under construction
Strategies	Re-create Floodplain, Preserve Floodplain, Re-naturalising Rivers, Multiple Functions.

selective development, recreation, renewable energy production, local food production, water storage and flood alleviation.

The Hackbridge project is located in the London Borough of Sutton, South East of England, on the upper catchment of the river Wandle. Sutton is expected to accommodate 40% of the Borough´s planned housing growth. However, 5% of the land area in Sutton has a medium risk of fluvial flooding, and a further 5% of the land area is located in high flood risk areas or on functional floodplains. Therefore, this is an ideal location for a pilot LifE project for mitigating flood

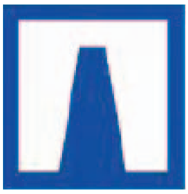
risks in the upper catchment.

A central amenity space, the so-called "Village Blue and Green" is designed as an open space to accommodate flood-water during flood events. When the flood event is over, water is released back to the river, and the space is used as a community playground and sport facility. Together with the Village Blue and Green, there are also many built around courtyard gardens, functioning as rainwater collection from housing to store and infiltrate into the soils. Throughout the site, a vegetated swale network is used to convey overflow water from the river to the wetlands in the Village Blue. Urban structures are also designed to have maximal open and permeable surfaces. Buildings situated near the rivers are of a dry-flood-proof design. Solar panel roofs are used to generate electricity during flood periods.

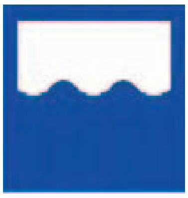
Fig. I-A.28: Aerial view of Hackbridge project and the „Village Blue" (in the blue arrow), where floodwater is accomodated (BACA Architects 2009).

Fig. I-A.29: Detailed design of Hackbridge project, showing different amenity spaces are integrated with flood retention and detention functions (BACA Architects2009)

Evacuation Shelter



Levee



Flood Water Depth

Fig. I-A.30: Flooding information pictogram (MLIT 2004)

03 Hazard Mapping Project, Japan

As a response to heavy damages from the typhoon "Tokage" in 2003, the Ministry of Land, Infrastructure and Transport Japan (MLIT) started the "Emergency flood control project from 2004 to 2014" with a total budget of 90 billion Yen. From 2004 to 2005 the main structural measures, such as rehabilitation of break points in embankments and the heightening of levees were implemented. Subsequently, the project shifted to non-structural measure, the most important "Ubiquitous hazard mapping project". Flood hazard maps of each city have been drawn at an appropriate scale based on the results of preliminary, city-specific flood risk assessments. The maps cover the following flooding scenarios:

Location	Tokyo city, Japan
Annual Rainfall	2,065 mm
Area	697 km^2
Client	Ministry of Land, Infrastructure and Transport, Japan (MLIT)
Design	MLIT
Planning	2003
Construct	2004-2014
Strategies	Flood Hazard Mapping, Flood Disaster Informing

A) Low probability (1:1000, once in 1000 years)

B) Intermediate probability (1:100, once in 100 years)

C) High probability (1:20, once in 20 years)

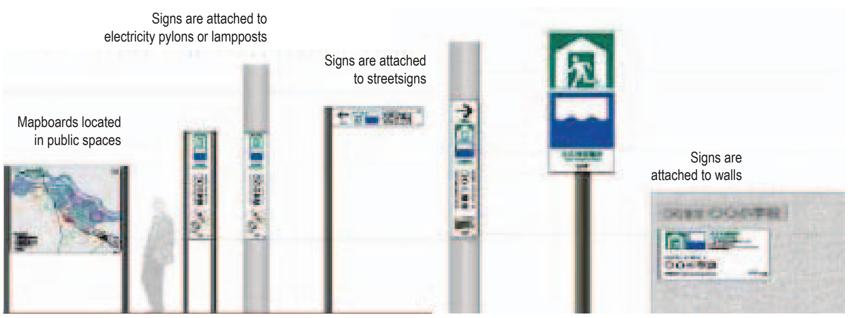


Fig. I-A.31: Potential flood disaster sign locations (MLIT 2004)

PHOTO CREDIT: MLIT Japan

The resulting maps were then distributed to different target groups including local residents and local authorities. Afterward, surveys were conducted to assess residents´ understanding of the flood hazard maps in order to improve the map quality.

Beside the establishment of flood hazard maps, MLIT also started a campaign to set up disaster information signs in urban flood risk areas. These include different information such as disaster history, previous flood water depth, assumed water depth, and locations of the nearest flood evacuation shelters (Fig. I-A.32). These signs help not only inhabitants but also tourists in the case of an evacuation. The results have been published in the "Guidance for Ubiquitous Hazard Mapping Project", as a guide for river administrations and municipalities.

Following the success of the project the three flood disaster signs of "Flood water depth", "Flood evacuation shelters" and "Leeve"; were standardised and introduced across the nation (Fig. I-A.30).

Fig. I-A.32: An example of an information signboard at Kinosaki community center (MLIT 2004)

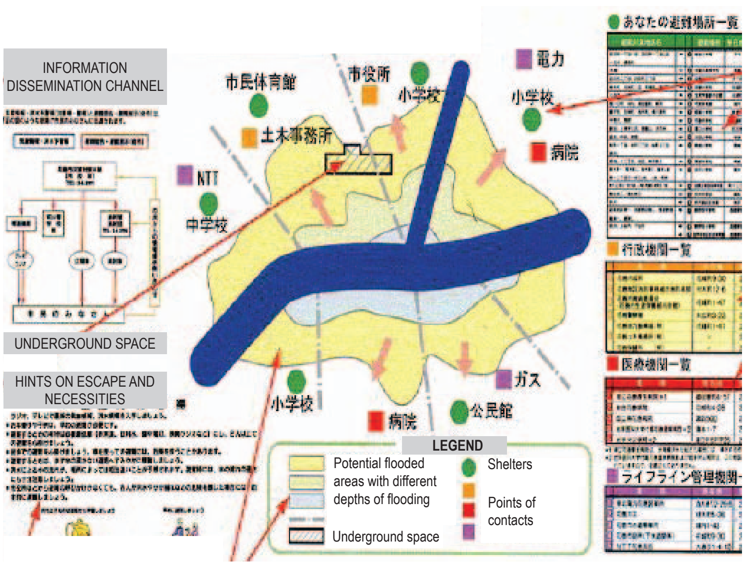


Fig. I-A.33: A conceptual flood hazard map for a city (MLIT 2004)

References & Resources

Balmforth, D., Digman, C.J., Butler, D. & Schaffer, P. (2006). Defra Integrated Urban Drainage Pilots Scoping Study.

Communities and Local Government (2007). Improving the Flood Performance of New Buildings. Flood Resilient Construction. Department for Communities and Local Government: London.

Department of Communities and Local Government. (2006). Planning Policy Statement 25: Development and flood risk – Practice Guide. London. Retrieved from https://www.gov.uk/government/uploads/system/uploadsv/attachment_data/file/7772/pps25guideupdate.pdf

Dreiseitl H. & Grau D. (Eds) (2009). Recent Waterscapes - Planning, Building and Designing with Water.

FEMA (2008a). Below Elevated Buildings in Special Flood Hazard Areas Technical Bulletin 1. National Flood Insurance Program. August 2008

FEMA (2008b). Flood Damage-Resistant Materials Requirements. Technical Bulletin 2. National Flood Insurance Program. August 2008

FLOODsite Consortium (2008). Review of Flood Hazard Mapping. Sixth Framework Programme for European Research and Technological Development (2002-2006).

Jha, A.K., Bloch, R., Lamond, J. (2012). Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century. The World Bank: Global Facility for Disaster Reduction and Recovery. Retrieved from https://www.gfdrr.org/sites/gfdrr.org/files/publication/World_Bank_Cities_and_Flooding_Guidebook.pdf

Le, V.T. & Ho, T.M.D. (2009). Monitoring Land Deformation Using Permanent Scatterer INSAR Techniques - case study : Ho Chi Minh City. Hanoi: 7th FIG Regional Conference Spatial Data Serving People: Land Governance and the Environment – Building the Capacity, 19-22.

Mekong Region Commission (2007). River Awareness Kit. Retrieved from http://ns1.mrcmekong.org/RAK/html/1.12.4c_methods_rehabilitation.html. Accessed date: 20.05.2013

Mekong Region Commission (2009). Best practice guidelines for structural measures and flood proofing. The flood management and mitigation programme component 2: Structural measures and flood proofing. Retrieved from http://ns1.mrcmekong.org/download/fmmp-reports/3C_BPG_SM_FP_21Dec09.pdf

Parkison, J. and Mark, O. (2005). Urban Stormwater Management in Developing Countries. IWA Publishing: London

Public Utilities Board Singapore (2011): ABC Waters Design Guidelines. Singapore.

Rujner, H. (2011) Investigation of the effects of urban growth and soil sealing on the water balance of Ho Chi Minh City, Vietnam - GIS-supported modelling utilising the software ABIMO. Diplom Thesis. Brandenburg University of Technology Cottbus: Germany.

Sipes, J. L. (2010). Sustainable Solutions for Water Resources : Policies, Planning, Design, and Implementation. Hoboken, N.J.: John Wiley & Son.

Steering Center of Urban Flooding Control Program HCMC (2012). Biannual report on flooding mitigation in 2012. Retrieved from http://www.ttcn.hochiminhcity.gov.vn/chuong-trinh-du-an-chong-ngap/-/ext/articleview/article/64476/10182

Storch, H. and Downes, N. (Eds.) (2012) Land-use Planning Recommendations. Adaptation Strategies for a changing climate in Ho Chi Minh City. Summary for Decision-Makers. Upon request of the Planning Division, Department of Natural Resources and Environment Ho Chi Minh City, December 2012. DONRE-HCMC & BTU-Cottbus.

Tran, T.V., & Ha, D.X.B. (2007). Urban land cover change through development of imperviousness in HCMC. Asian Conference on Remote Sensing (ACRS) 2007 proceeding. Retrieved from http://www.a-a-r-s.org/acrs/proceeding/ACRS2007/Papers/TS7.4.pdf

Best-practice projects

01 ABC Waters Programme & Bishan Park, Singapore.

Public Ultilities Board Singapore. 2008. Master Plans: Objectives of ABC Programme Retrieved from http://www.pub.gov.sg/abcwaters/abcwatermasterplan/Pages/default.aspx.

Public Utilities Board Singapore (2011). ABC Waters Design Guidelines, Singapore: PUB. Retrieved from http://www.pub.gov.sg/abcwaters/ABCcertified/Documents/ABC_Guidelines_090616.pdf

Lai, C.M.L. & Vaishali, K., 2009. CASE STUDY "Active, Beautiful and Clean" waters programme in Singapore, Singapore.

02 Living with water, LiFe-Project, United Kingdom

www.baca.uk.com/

03 Hazard Mapping Project, Japan

Ministry of Land, Infrastructure and Transport Japan. (2003). Flood hazard mapping for technology transfer. International training program on total disaster risk management. Retrieved from www.adrc.asia/publications/TDRM2003June/26hazardmap1.pdf

International flood network. (2007). Best Practice of Flood Hazard Map in Japan. Retrieved from http://www.internationalfloodnetwork.org/common/070806FHM%20Best%20Practice_Final.pdf

I-B.
Managing Surface Water

I-B. Managing Surface Water

During the rapid urbanization of HCMC, the impermeable surface area has been doubled during 17 years, from 1989 to 2006 (Tran & Ha 2007); and this has resulted in a corresponding increase in surface runoff. At the same time, the rainfall volume in the city has increased significantly (Fig. I-B.1), mainly due to urban heat island effects and climate change. These facts pose a huge challenge to surface water management.

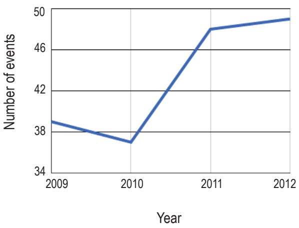


Fig. I-B.1: Occurences of extreme rainfall events in HCMC from 2009 to 2012 (SCFC 2012)

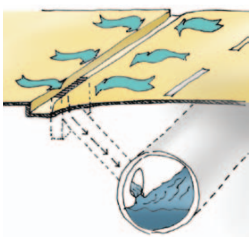


Fig. I-B.2: Conventional drainage system of HCMC using the combined sewer system.

General Approach

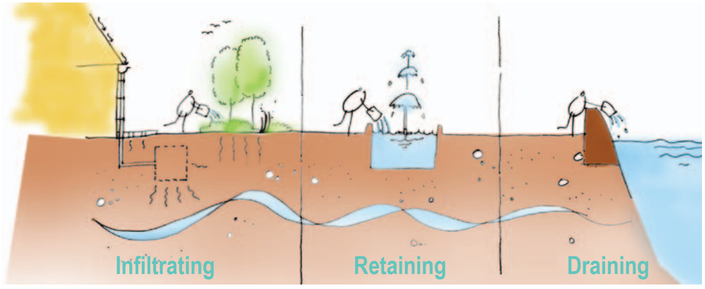
The main aim of water management in urban areas with a high degree of impervious surfaces is to drain excess water as quickly as possible. On a small scale, rapid draining can be a good solution, but this generally means that the problem is simply displaced to an area situated downstream. In addition, a system geared toward rapid draining also promotes dropping water-tables. As a result, problems associated with water shortages and salinisation will occur more easily during times when water is scarce, which is expected to occur more frequently (MoTPWWM 2000).

A holistic water management approach should prevent the passing on of water-related problems and safety issues to downstream regions. To achieve this goal, the so-called **'Three-step strategy'** has been developed (Fig. I-B.3). The three-step strategy of infiltrating, retaining, and draining is the guiding principle for the surface water management of catchment areas. This means that precipitation should be held as long as possible in the catchment area where it falls in a natural way or by built water storage areas. Excess water is drained only when these options have been used to their full potential. This sub-chapter introduces the measures available for the implementation of such a water management system. These measures can be categorised based on the three step strategy as follows (Fig. I-B.3):

- Infiltration & Permeability
- Retention & Storage
- Drainage & Conveyance.

As previously mentioned, water should be held as long as possible, even during dry and normal conditions. The objective here is to prevent local and nearby depletion of water table levels, and to limit the influx of "non-local"

Fig. I-B.3: Three-step strategy to avoid passing on water-related problems



water. The strategy of 'not passing on responsibility' demands regionally-tailored efforts. In detailing such a strategy, objectives for preventing water table level drop and salinisation as well as for improving water quality must be incorporated (MoTPWWM 2000).

There are several approaches and names for an integrative stormwater management at an urban scale. The concept of Sustainable Urban Drainage Systems (SUDS) developed in the UK is probably the best known (CIRIA 2007). For the Asia-Pacific Region the concept of Water Sensitive Urban Design (WSUD), which originated in Australia, is more common. WSUD can be best explained as the interactions between the urban built form (including urban landscapes) and the urban water cycle as defined by the three urban water streams of potable water, wastewater, and stormwater. The guiding principles of WSUD are centred on achieving integrated water cycle management solutions for new urban release areas and urban renewal developments. These principles are aimed at:

- Reducing potable water demand through water efficient fittings and appliances, rainwater harvesting and wastewater reuse.
- Minimising wastewater generation and treatment of wastewater to a standard suitable for effluent reuse opportunities and/or to release to receiving waters.
- Treating stormwater to meet water quality objectives for reuse and/or discharge to receiving waters.
- Using stormwater in the urban landscape to maximise the visual and recreational amenity of developments (PUB 2011).

Fig. I-B.4: Typical cross- section of a SUDS system for a residential area

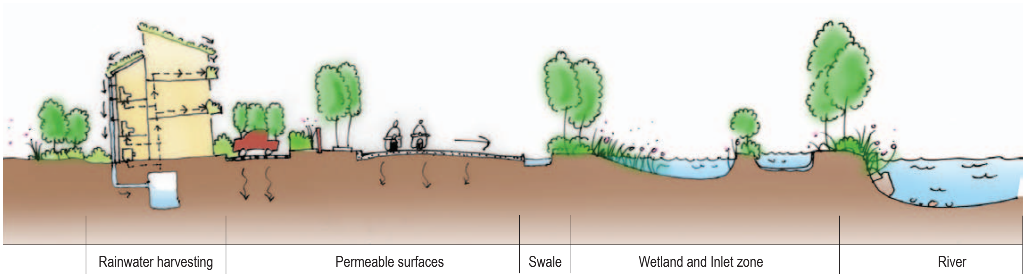


PHOTO CREDIT: Chau Huynh / Ronald Eckert / Chau Huynh

Selected Strategies

Infiltration & Permeability

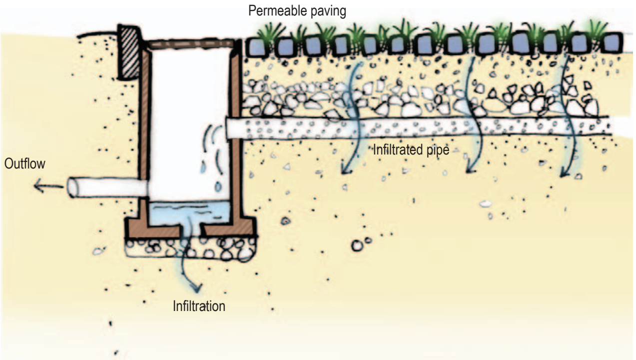
09 Permeable Pavements

Runoff from paved surfaces can be reduced by replacing impervious soil coverage with permeable pavers and un-sealed surfaces. Permeable paving creates a surface that allows infiltration, either because it is porous, or because specific openings have been provided (for example, the spaces between paving blocks). Permeable paving can be applied on areas with light (or no) vehicle traffic such as driveways, shoulders of roadways, sidewalks, overflow parking areas.

The sub-base provides storage for rainwater, typically in the voids between granular particles. The collected water may then be allowed to infiltrate into the ground. Alternatively, in cases where it is important to protect groundwater from pollution, the base and sides may be sealed, with water allowed to flow to a piped outlet, but far more slowly than it would in a conventional drain (Fig. I-B.5). The only serious restriction on infiltration in urban areas is when there may be a risk of polluting groundwater that is used as a water resource (World Bank 2011).

Typical construction of a porous paving system includes several layers (Fig. I-B.6). The top layer is the pervious pavement layer, which can range between 10-15 cm thick. In this layer sand particles with a diameter of less than 2 mm are removed, creating a void space in the pavement of 18-20%. Below the surface layer is a choker course layer created with c.a. 2 cm diameter crushed stone, followed by the filter course and filter blanket layers consisting of fine filter materials such as sand and gravel. Below the filter blanket material is a reservoir course layer, which can include a subdrain if needed. Below this layer would be the native materials. An optional impervious layer could be installed between the reservoir course layer and the native materials if infiltration is undesirable in the area, allowing for the system to function as a reservoir with the runoff exiting through the drainage pipe (Novotny et al. 2010).

Fig. I-B.5: Combination of a permeable pavement and a sub-surface drainage connected to a soakaway



There are a number of benefits to the use of porous pavements, the primary benefit being a reduction of up to 30% of surface runoff from an otherwise impervious area. If the pavement is designed properly, 30% of the runoff can be stored and subsequently allowed to infiltrate into the natural ground. The resulting aquifer recharge can be seen as the second important benefit. The final benefits are the reduced need for storm drainage, and the removal of contaminants from the runoff through the filtration of the water through the soils (Novotny et al. 2010).

Where pervious pavement systems are designed for infiltration, the seasonally high groundwater table must be more than 1 m below the base of the structure (CIRIA 2007). Pervious pavement is therefore only effective where the groundwater table is low in HCMC.

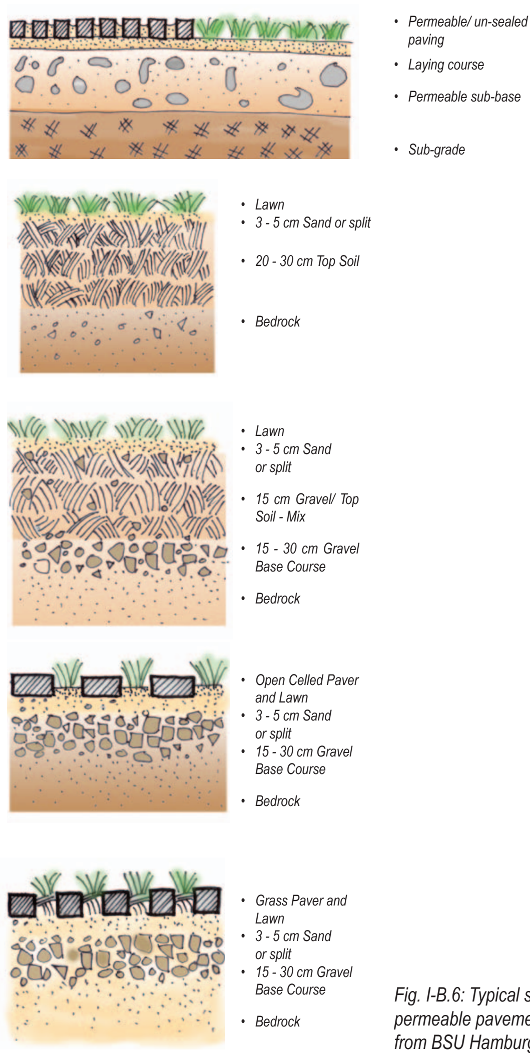


Fig. I-B.6: Typical structures of permeable pavements (Adapted from BSU Hamburg)

PHOTO CREDIT: Ronald Eckert

10 Absorbent Landscape

Most landscape types, either natural or manmade, act like a sponge to soak up and store rainfall. In the natural conditions without paving and roof development, most of the rainfall volume that lands on natural watersheds never becomes runoff, but is either soaked into the soils or evapotranspirated. The trees, shrubs, grasses, surface organic matter, and soils all play a role in this absorbent landscape.

Scientific studies have shown that a significant amount of gross precipitation is intercepted (i.e., never reaches the ground) by tree crowns. Plants provide a stormwater detention function, slowing down rain before it hits the ground surface. Although some precipitation is able to fall through the canopy without restriction as throughfall, a significant portion lands either on leaves or on twigs where it is delayed prior to creating a canopy drip. Some of this rainfall flows down twigs and branches to become stem-flow at the tree trunk (Lanarc Consultants 2005).

Soils are the most significant landscape mechanism for stormwater storage. Landscape soils typically

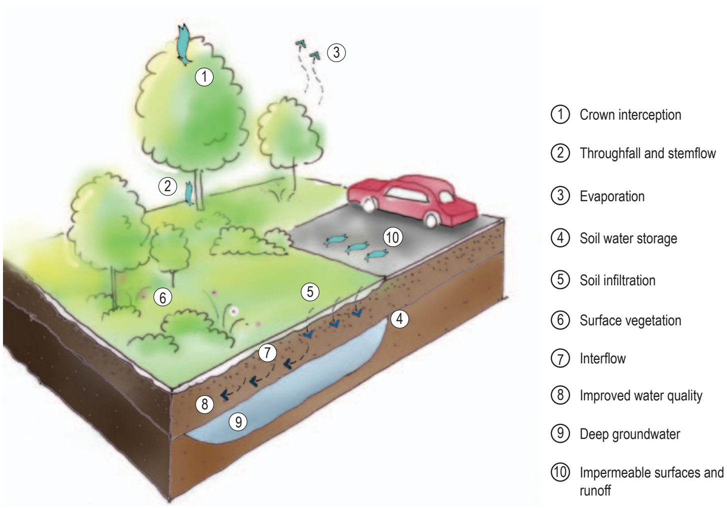
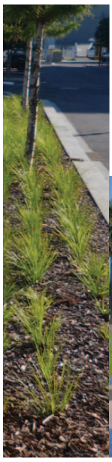


Fig. I-B.7: Stormwater variables of absorbent landscape



store from 7% (sand) to 18% (loam) of their volume. Surface soil structure plays a fundamental role in stormwater management. Under natural conditions, surface plants provide a layer of organic matter, which is stirred into soil by populations of earthworms and microbes. Vegetation and organic matter improve soil structure and contribute to macropore development. This is essential for promoting and maintaining infiltration and transpiration potential. To optimise infiltration, the surface absorbent soil layer should have high organic content (about 10 to 25%). Surface vegetation should be either herbaceous with a thickly matted root zone (shrubs or grass), deciduous trees with high leaf density, or mixed growth forests.

Runoff from landscaped areas can be reduced up to 50% by providing a 300mm layer of landscaped absorbent soil, even under very wet conditions where the hydraulic conductivity of the underlying soil is low (Lanarc Consultants 2005).

Reducing impervious areas is also a strategy to increase the absorbent landscape. Based on the current urban design layouts for new residential areas in HCMC, reducing impervious coverage can be achieved by strategies such as:

- Reducing the building footprint
- Reducing road widths
- Reducing parking standards and the amount of surface parking
- Reducing impervious surface materials for recreational open spaces.

Table I-B.1: Typical infiltration coefficients by soil type

Soil Type	Typical Infiltration Coefficients (m/ h)
Good Infiltration Media	
Gravel	10 - 1000
Sand	0.1 - 100
Loamy Sand	0.01 - 1
Sandy Loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt Loam	0.0005 - 0.05
Chalk	0.001 - 100
Sandy Clay Loam	0.001 - 0.1
Poor Infiltration Media	
Silty Clay Loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 0.1

(Adapted from CIRIA 2007)

PHOTO CREDIT: NCSU-BAE / Atlanta Regional Commission / NCSU-BAE

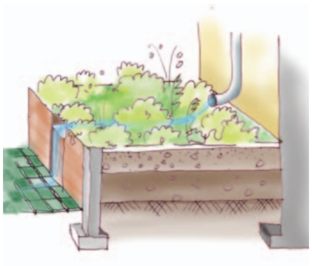


Fig. I-B.8: A small-scale rain garden

Fig. I-B.9: Typical cross-section of a wet pond (Adapted from US. Environment protection agency)

11 Infiltration Basins

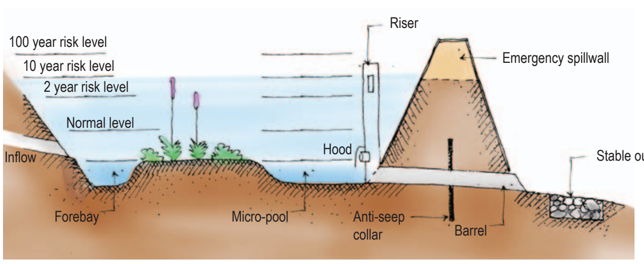
Infiltration basins are shallow impoundment which store surface water runoff and allow it to gradually infiltrate through the soil of the basin floors. This practice also provides efficient removal of pollutants and helps to recharge groundwater to balance water resources. An infiltration basin design however, depends largely on soil type and the adequacy of available space.

An emergency overflow can be provided for extreme rainfall events, when the storage capacity of the basin is exceeded. It should be noticed that infiltration basins differ from swales, in that they may have any shape while swales are linear features.

In general, infiltration basins can be classified into:

- **Wet ponds:** permanently wet ponds with rooted and aquatic vegetation, mainly around the edge (Fig I-B.9). The retention time of several days provides better settlement conditions than offered by wet extended detention ponds as well as a degree of biological treatment. Baffles may be used within the design of retention ponds in the form of islands, promontories and submerged shoals. Such baffles provide visual interest and variation in habitat.

- **Dry ponds:** a shallow dry impoundment, designed to allow stormwater infiltration into the soils. These differ from wet ponds, in that they remain empty over an adequate time period in all seasons and are only filled with water temporarily during and immediately following storm events (Fig I-B.10). Dry ponds are designed to accommodate stormwater for a period of 6 to 12 hours after a storm, or 12 to 48 hours in the case of the extended dry pond. This factor makes dry ponds more preferable than wet ponds, as dry ponds do not allow mosquitoes to breed.



Dry ponds are usually planted with species of vegetation which can survive both in dry or wet conditions for a long period. Together with the basin's porous soil, the root systems of the vegetation enhance infiltration, maintain soil permeability and encourage diverse

microbial populations. In general, dry ponds and wet ponds are best suited to smaller drainage areas of less than 4ha.

- **Rain gardens:** a smaller scale of dry ponds which are suitable to be integrated in private gardens. Rain gardens are designed to treat stormwater on site, such as runoff from parking lots, roofs, and driveways. Rain gardens are usually located near a building´s roof drain pipe. The type of vegetation used in rain gardens are not only selected to aid infiltration but also for aesthetic purposes. Native plants are recommended in order to reduce maintenance cost and attract local wildlife (Fig. I-B.11).

Designing an infiltration basin requires careful consideration of site location. The infiltration rate is less efficient in locations with higher groundwater levels, typically less than 1.5m below the infiltration surface. An Infiltration rate between 2 and 5 cm/hours is considered suitable. The soils should have less than 20% clay content and less than 40% fine sand content (MDE, 2000). The floor of a basin should be as level as possible to improve infiltration rates. The locations of an infiltration basin should be far from drinking water wells to avoid the risk of contamination.

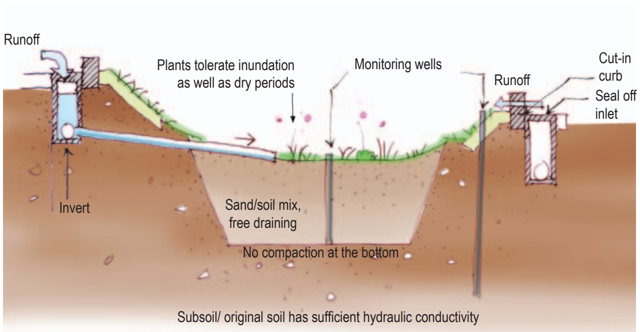


Fig. I-B.10: Typical cross-section of a dry pond

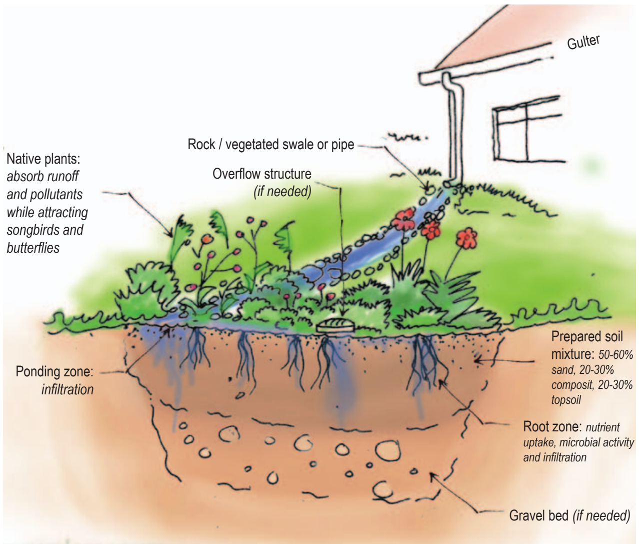


Fig. I-B.11: Typical cross-section of a rain garden


PHOTO CREDIT: HYPSOS / DH Evironmetal Consulting / www.wsud.org / Ronald Eckert

Retention & Storage

12 Constructed Wetlands

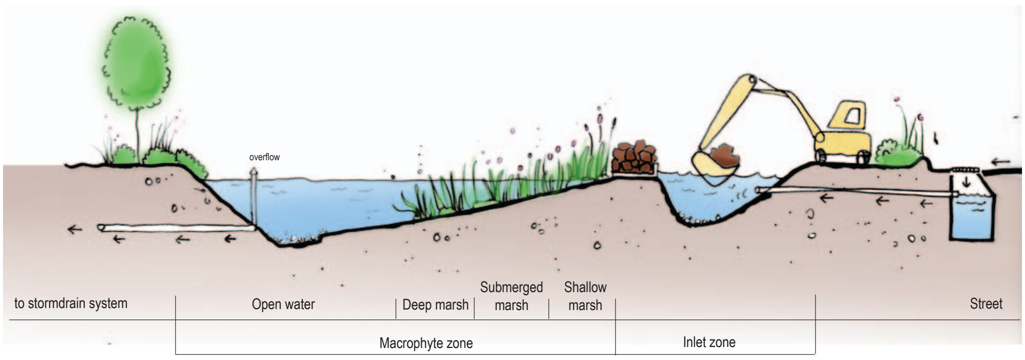
The wetlands in the south and east of HCMC play a key role in maintaining the city's natural water balance and hydrology. They retain large volumes of water, and promote recharge of the interflow zone and evapotranspiration from wetland vegetation (BC MoWLAP 2002).

The use of constructed (artificial) wetlands for urban stormwater quality improvement is widely adopted in many urban environments, many of which have been successfully incorporated into the urban landscape. Constructed wetland systems are shallow, extensively vegetated water bodies that use enhanced sedimentation, fine filtration and pollutant uptake processes to remove pollutants from stormwater.

Wetlands generally consist of an inlet zone (sedimentation basin to remove coarse sediments), a macrophyte zone (a shallow heavily vegetated area to remove fine particulates) and a high flow bypass (to protect the macrophyte zone). They are designed to remove stormwater pollutants associated with fine to colloidal particulates and dissolved contaminants (Fig. I-B.12).

Constructed wetlands are often located within accessible open space areas and can become interesting community features. Landscape design aims to ensure that marsh planting fulfils the intended stormwater treatment function and successfully integrates with the surroundings. There are opportunities to enhance public amenity and safety by integrate wetlands with city parks,

Fig. I-B.12: A cross-section of a constructed surface flow wetland



viewing areas, pathway links, picnic nodes, sport runways, etc.

In general, wetlands can be categorised into three types:

- **Surface flow wetland**

This wetland comprises marsh planting, with the water level kept at a constant depth. The marsh planting helps to remove impurities in the water.

- **Floating wetland**

The floating wetland is an enginieered system that employs plants growing on a floating mat on the surface of the water and used to purify contanminated water bodies. The method is cheaper than other engineering purification methods.

Sub-surface flow wetland

In this wetland, no water can be seen as it is flowing through filter media below the surface, which retains suspended solids (PUB 2011).

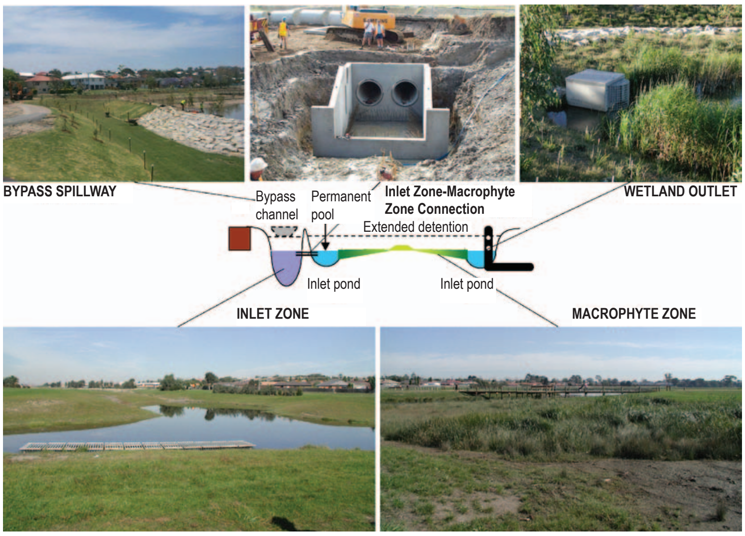


Fig. I-B.13: Structure and construction of wetland inlets and outlets (PUB 2011)

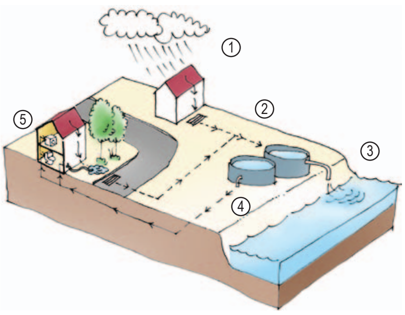
PHOTO CREDIT: Kristin Goldbach / NCSU-BAE

13 Rainwater Harvesting & Reuse

Rainwater harvesting is a green and sustainable option for increasing the supply of water in areas of water scarcity, where the conventional water supply has failed to meet the demand. This system has been a widely used technology for water supply in Vietnam's rural areas for centuries (Nguyen 2007). However in many cases, it has declined in importance, partly due to the lack of needs as piped water supplies improve and because of the perception that rainwater is an unsanitary water source.

Nevertheless, it is now recognised that rainwater harvesting can also prove to be an important technique for handling peak rainfall over a wide area; it involves diverting the water using sewers or rivers which create a line of conveyance. The "areal" approach of managing rainwater at source within a watershed, especially in urban areas, by collecting and then storing the water in numerous tanks and storage structures, can reduce peak runoff (Jha, Bloch & Lamond 2012).

In such systems, the methods of storage need to be appropriate for different reuse types. Simple home-based systems can be water barrels, while larger systems can be roof tanks, surface tanks and sub-surface tanks. The initial cost of applying a rainwater harvesting and infiltration device can be relatively high. Hence, it is recommended for HCMC to apply large rainwater collection systems in first priority in public buildings and buildings which have large roof surfaces. Residential buildings are then reccommended to apply simple home-based systems as small water barrels or roof tanks.



1 Rainwater is harvested from building roofs

2 Rainwater is collected and transported into storage system

3 Overflow is drained into rivers

4 Rainwater is treated and delivered for re-using

5 Re-using rainwater for garden watering, toilet flushing or washing.

Fig. I-B.14: Above-ground rainwater storage with overflow and reuse options

The stored rainwater thus can be used for non-drinking purposes such as garden watering, toilet flushing or machine washing, resulting in water conservation. It can also be used for drinking purposes if proper purification measures can be installed. Treatment is necessary before use in domestic water services or before infiltration into the ground if runoff does not meet quality standards. Reasonable treatment schemes allowing reuse of reclaimed rainwater for cooking and drinking are:

- **Physical treatment:** by sand or microfiltration followed by reverse osmosis and ultraviolet disinfection (Fig. I-B.15). This scheme can be successfully used for both household scale or in a controlled environment such as an urban cluster.
- **Biological treatment:** in subsurface flow wetlands followed by filtration and, if needed, by disinfection. Bioretention, biotopes, and gravel or sand filters are corresponding options for stormwater treatment (Hoyer et al. 2011).

It is recommended to install gutter screens, leaf screens or roof washers to first remove particulates before rainwater runs to the filter system.

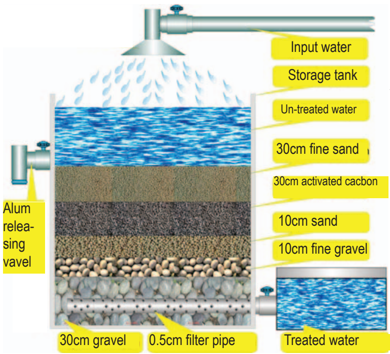


Fig. I-B.15: Cross-section of a home-based reverse osmosis system. (Adapted from GE Applicants)

Table I-B.2: Installation and operation factors for rainwater systems

Step	Detached, Semi-detached Houses	Multi-residential
1. Sources of rainwater	Potential depends on available space for storage and on building topography	
2. Collection and distribution	Collection points close to points of use	Dispersed collection points and centralised processing use
3. Design and installation	Proprietary solutions with possible DIY fitting of main system	Professionally designed and installed
4. Application	Relatively easy to retrofit	Easily integrated into new build. Difficult to retrofit
5. Maintenance	Routine tasks	Regular maintenance by trained personnel

(Adapted from Environment Agency 2004)

PHOTO CREDIT: Chau Huynh/ Moritz Maikämper

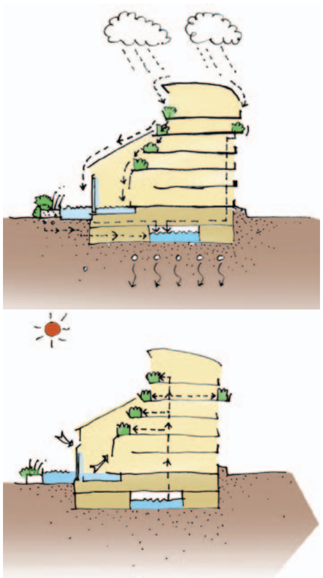


Fig. I-B.16: Irrigation of rain gardens and collection of rainwater during the rainy season (Above)

Evaporation and irrigation of plants with stored water during the dry season (Below)

14 Green Roofs & Façades

Green roofs are designed to limit the impact of impervious surfaces of the city, useful for collecting rainwater, at the same time, they can be used for building cooling and insulation.

Green roofs are a type of environmental system designed to help mimic the predevelopment hydrology of an urban development by incorporating vegetation and soils on top of an impervious roof top. There are various green roof types which can be used on any property size, although large areas of roof are generally more cost-effective. Green roofs put no additional space requirements on a development, therefore, they are, well suited to urban city centre settings where there is limited space for other techniques. Green roofs can be retrofitted easily providing that there is sufficient structural capacity in the roof to support them. With careful choice of materials, light-weight systems can be designed to suit most buildings (CIRIA 2007).

There are three types of green roof:

- **Extensive green roofs:** These cover the entire roof area with low growing, low maintenance plants. They are only accessed for maintenance and can be flat or sloping. Extensive green roofs typically comprise a 25 - 125 mm thick growing medium in which a variety of hardy, drought tolerant, low-level plants are grown. Vegetation normally consists of mosses, herbs or grasses and is intended to be self-sustaining. They are lightweight and cost effective.
- **Simple intensive green roofs:** These are vegetated with lawns or ground covering plants. This

Advantages	Disadvantages
• Effectively remove pollutants • Suitable for high density developments • Ecological, aesthetic and amenity benefits • No land consumption necessary • Air quality and micro-climate improvement (cooling) • Provide building insulation • Sound absorbers	• More expensive than traditional runoff • Not suitable for steep roofs • Roof vegetation needs maintenance • Waterproofing vital as roof acts as a sink • Stable building and roof construction needed

(Adapted from Livingroofs.org Ltd. 2012)

vegetation requires regular maintenance, including irrigation, feeding and cutting. However, demands on building structures are moderate and the roof system will be less expensive.

- **Intensive green roofs:** These are landscaped environments with high amenity benefits, which include planters or trees and are usually accessible. They may also include water features and storage of rainwater for irrigation. Intensive roofs generally impose much greater loads on the roof structure and require significant ongoing maintenance (CIRIA 2007).

These above green roof types usually consist of a vegetation layer, a substrate layer used to retain water and anchor the vegetation, a drainage layer to transport excess water off the roof, and specialised waterproofing and root-resistant material between the green roof system and the structural support of the building (Mentensetal 2003) (Fig. I-B.18). However, for HCMC, green roofs also can be installed simply with seperated and movable vegetated pots on roofs or roof terraces, which are cost efficient and easy to maintain.

Green façades are made up of climbing plants either growing directly on a wall or on specially designed supporting structures. The plant shoot system grows up the side of the building while being rooted in the ground. With a living wall, the modular panels are often made of stainless steel containers, geotextiles, and irrigation systems. Based on the panels vegetation can be grown.

Fig. I-B.17: Green roofs reduces impact of unavoidable paved surfaces

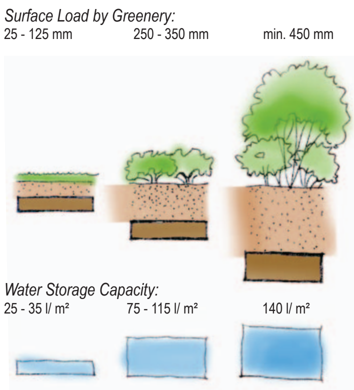
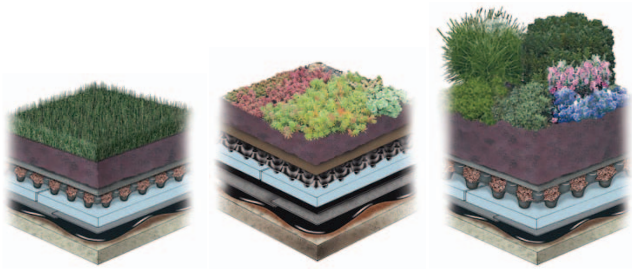


Fig. I-B.18: Medium water storage capacity reliant on greenery surface capacity of green roof (Left) and structure of constructed green roofs (Below) (Adapted from American Hydrotech Inc.and English Nature)



Extensive green roofs | Simple intensive green roofs | Intensive green roofs

PHOTO CREDIT: Hendrik Rujner

Drainage & Conveyance

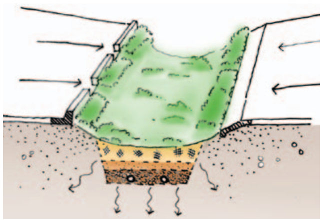


Fig. I-B.19: A cross-section of a grassed filter strip

15 Infiltration Drainage

Infiltration drainage is different from conventional conveyance because it transfers water and infiltrates water at the same time, therefore , can physically reduce the volume of drained runoff. This is the most desirable solution to runoff management because it restores the natural hydrologic processes. However, infiltration rates vary with soil type and condition, antecedent conditions, and with time. Where there is no risk of contamination, the process can be used to recharge underlying groundwater sources and feed the baseflows of local watercourses. Infiltration can not be used in areas where groundwater sources are vulnerable (CIRIA 2007). There are situations where infiltration drainage is not appropriate:

- where poor runoff water quality may pose a pollution threat to groundwater resources
- where the infiltration capacity of the ground is low
- where groundwater levels are high
- where the stability of foundations may be at risk.

There are different infiltration techniques:

- **Swales**

Shallow un-sealed linear channels that are designed to convey runoff and remove pollutants. Due to the physical linear feature, swales have significant pollutant-removal potential

Table I-B.3: Guidelines for grass filter strip design

Design Parameter	Design Criteria
Filter width	Minimum width 15 - 23 m, plus additional 1.2 m for each 1% slope
Flow depth	5 - 10 cm
Filter slope	Maximum slope of 5%
Flow velocity	Maximum flow velocity of 0.75 m/s
Grass height	Optimum grass height of 15 - 30 cm
Flow distribution	Should include a flow spreader at the upstream end to facilitate sheet flow across the filter

(Adapted from Novotny et al. 2010)

when the stormwater flows through. They are particularly suitable for diffuse collection of surface water runoff from small residential or commercial developments, paved areas and roads. Swales can also be used for runoff attenuation, disposal treatment (by settlement or filtration through the vegetation, or allowing infiltration through the base of the swale).

- **Grassed filter strips**

Wide, relatively gently sloping areas of grass or other dense vegetation that treat runoff from adjacent areas. The design criteria for grassed filter strips are shown in Table I-B.3.

- **Filter Drains**

A filter drain comprises a perforated or porous pipe in a trench surrounded with a suitable filter material, granular material or lightweight aggregate fill. The fill may be exposed at ground surface or covered with turf, topsoil or other suitable capping. Filter drains collect and convey runoff from the edge of paved areas, they also provide limited temporary storage.

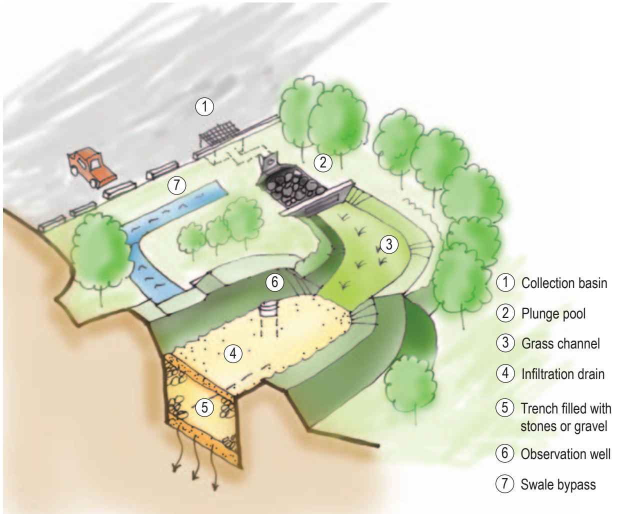


Fig. I-B.20: A filter drain system (Adapted from Blairremy Architects)

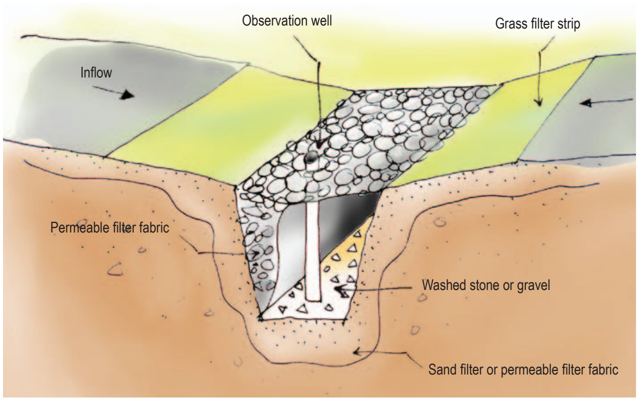


Fig. I-B.21: Details of a filter drain (Adapted from Eulie 2010)

Best Practice

01 Telecom Park, Taipei (Taiwan)

As a new urban vision for Taipei, the Telecom Park Project represents a future-orientated approach to combine a liveable public realm with the requirements of sustainable water management in densely built-up urban areas. The project‘s main objectives deal with the management of typhoon rains, the provision of alternative water sources for daily and recreational purposes as well as the supply with fresh and clean water for an enjoyable landscape.

A compound network of drainage canals, subsurface cisterns and retention areas allows the management of at least 50% of rainfall on-site and the accommodation of a 100-year flood event without any extensive damage. Green roofs and porous paving contribute to the reduction of stormwater runoff. To reduce the amount of drinking water consumed by

Fig. I-B.22: Landscape design and integrated stormwater management for the Telecom Park (Atelier Dreiseitl 2009)

Location	Taipei, Taiwan
Annual Rainfall	2,100 mm
Rainfall Intensity	387 l/ s/ ha
Area	24 ha
Canals & Rivers	8,100 m² (Water Surface)
Client	Far Eastern Resource Development Co. Ltd.
Design	Atelier Dreiseitl
Planning	2007-2008
Construct.	2009-2010
Strategies	Detention Basins, Cleansing Biotopes, Infiltration Drainage, Stormwater Storage, Green Roofs

non-potable uses, collected rainwater is for example reused for toilet flushing and green space irrigation (Giesler 2011). As a main feature, the central park guarantees access to water for recreational purposes and comprises cleansing biotopes to contribute clean water to the water system. Green roofs and the generous planting of trees promote fresh air and a pleasant microclimate.

For a successful implementation of the overall water management strategy, design guidelines have been prepared jointly by the property developer and the local planning authority. These guidelines are binding requirements for all buildings and plots on the site (Dreiseitl & Grau 2009).

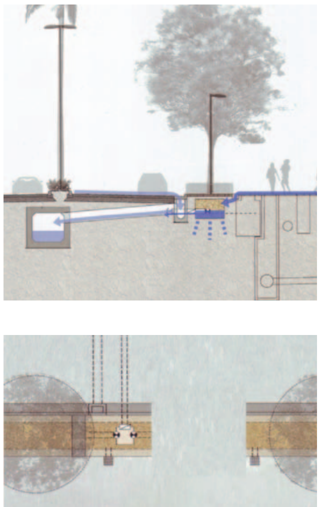


Fig. I-B.23: Stormwater concept for streets integrating infiltration devices and classical drainage (Atelier Dreiseitl 2009)

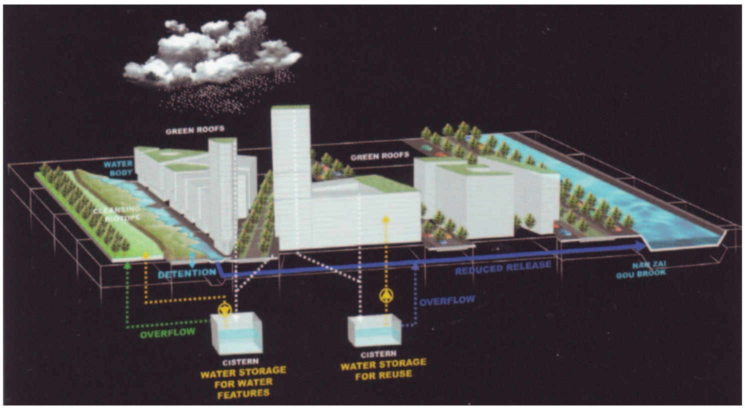


Fig. I-B.24: Planned water cycle in the Telecom Park Project (Atelier Dreiseitl 2009)

PHOTO CREDIT: Atelier Dreiseitl

Fig. I-B.25: Zhangjiawo New Town Comprehensive Plan and location of „Society Hill" (Atelier Dreiseitl 2009)

02 Zhangjiawo New Town, Tianjin (PR China)

The residential community "Society Hill" is part of the Zhangjiawo New Town near Tianjin in the northern part of China. In contrast to HCMC, this region faces water shortage and droughts most of the year; although urban areas are flooded regularly in summer as two-thirds of the annual rainfall occurs in July and August only. Therefore, rainwater harvesting as well as rainwater drainage was a challenge for the landscape design of this brownfield development.

Before the transformation, the site was a wasted farm land with a river that was highly polluted by solid and liquid industrial waste. For the "Society Hill Community", the landscape architects developed human scale ecological solutions that respected the cultural and social fabric of the city. The historical irrigation channels of the former farm

Fig. I-B.26: Urban and landscape design concept for the Society Hill (Atelier Dreiseitl 2009)

Location	Tianjin, PR China
Annual Rainfall	550 mm
Area	180 ha (Master Plan) 20 ha (Site)tv
Canals & Rivers	1,000 m
Client	Shanghai Wisepool Real Estate Co. Ltd.
Design	Atelier Dreiseitl
Planning	2005-2008
Construct.	2006-2009
Strategies	Cleansing Biotopes, Infiltration Drainage, Detention Basins, Rainwater Harvesting & Resue

land are found within the decentralised stormwater management system. Bioswales, channels, and other water features allow rainwater to be cleansed and infiltrated into the groundwater. The restored river combined with the surrounding stormwater features create a manmade hydrological system, which interconnects with the natural one while offering residents a great public recreational place (Xia 2011).

Rainwater harvesting is managed in a two-step approach. Individual plot-based storage facilities store most of the water. In case of overflow the water is channelled to decentralised detention ponds, cleansed and reused for irrigation in the public green space. (Dreiseitl & Grau 2009).

Fig. I-B.27: Bird's eye perspective on the New Town Zhangjiawo (Atelier Dreiseitl 2009)

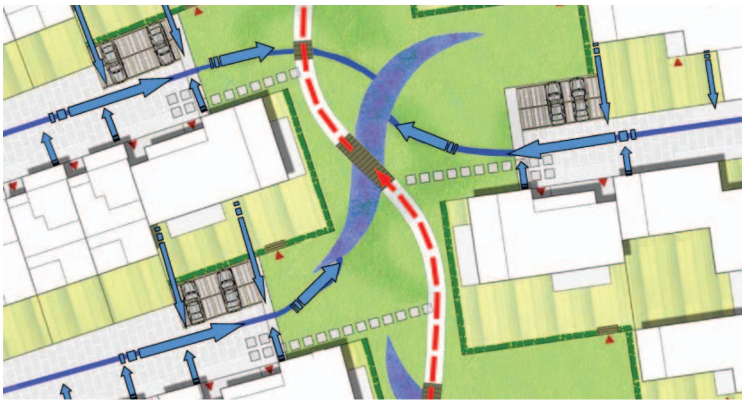


Fig. I-B.28: Rainwater collection, retention and infiltration concept for residential areas (Atelier Dreiseitl 2009)

References & Resources

Balmforth, D.; Digman, C.; Kellagher, R. and Butler, D. (2006): Designing for Exceedance in Urban Drainage – Good Practice. CIRIA Report C635. London: CIRIA.

Behörde für Stadtentwicklung und Umwelt (2006): Dezentrale naturnahe Regenwasserbewirtschaftung. Ein Leitfaden für Planer, Architekten, Ingenieure und Bauunternehmer. Hamburg: BSU.

Butler, D. and Davies, J. W. (2004): Urban Drainage. London: Spon Press.

Environment Agency UK and South East England Regional Assembly (SEERA); Eds. (2005): A Toolkit for Delivering Water Management Climate Change Adaptation Through the Planning System. ESPACE - European Spatial Planning: Adapting to Climate Events.

Environment Agency UK; Ed. (2006): Building a Better Environment. A Guide for Developers. Almondsbury: Environment Agency UK.

Fiselier, J. and Oosterberg, W. (2004): A quick Scan of Spatial Measures and Instruments for Flood Risk Reduction in selected EU Countries. RIZA Institute for Inland Water Management and Waste Water Treatment.

France, R. L.; Ed. (2002): Handbook of Water Sensitive Planning and Design. Integrative Studies in Water Management and Land Development 1. Boca Raton: Lewis Publishers, CRC Press Company.

Grant, G.; Engleback, L. and Nicholson, B. (2003): Green Roofs: Their existing Status and Potential for Conserving Biodiversity in Urban Areas. English Nature Research Reports 498. Peterborough: English Nature.

Hoyer, J.; Dickhaut, W.; Kronawitter, L. and Weber, B. (2011): Water Sensitive Urban Design. Principles and Inspiration for Sustainable Stormwater Management in the City of the Future. Berlin: Jovis.

Jha, A. K.; Bloch, R. and Lamond, J. (2011): Cities and Flooding. A Guide to Integrated Urban Flood Risk Management for the 21st Century. Washington: World Bank.

König, K. W. (1996): Regenwasser in der Architektur. Ökologische Konzepte. Staufen: Ökobuch Verlag.

Lanarc Consultants Ltd.; Kerr Wood Leidal Associates Ltd. and Goya Ngan (2005): Stormwater Source Control Design Guidelines. British Columbia: Greater Vancouver Regional District.

Land Use Consultants; CAG Consultants; Collingwood Environmental Planning and Wilbraham & Co. (2005): A Toolkit for Delivering Water Management Climate Change Adaptation

Through the Planning System. London: Environment Agency.

Ministry of Transport, Public Works and Water Management (2000): A Different Approach to Water. Water Management Policy in the 21st Century. The Hague: MoTPWWM.

Nguyen Viet Thang (2007): Promoting Rainwaters Harvesting in Vietnam Urban Areas. In: Atkinson, A.; Graetz, M. and Karsch, D.; Eds.: Techniques and Technologies for Sustainability. Proceedings: International Conference and Summer School 2007. TU Berlin.

Novotny, V.; Ahern, J. and Brown, P. (2010): Water Centric Sustainable Communities. Planning, Retrofitting, and Building the Next Urban Environment. Hoboken: John Wiley & Sons.

Public Utilities Board Singapore (2011): ABC Waters Design Guidelines. Singapore: PUB.

Roaf, S.; Crichton, D. and Nicol, F. (2005): Adapting Buildings and Cities for Climate Change. A 21st Century Survival Guide. Oxford: Elsevier; Architectural Press.

Stephens, K. A.; Graham, P. and Reid, D. (2002): Stormwater Planning. A Guidebook for British Columbia. British Columbia Ministry of Water, Land and Air Protection.

SRV, Socialist Republic of Vietnam (2009): Law on Urban Planning, No.32/2009/QH12. Hanoi.

Waterboard Rivierenland; Ministry of Public Housing, Spatial Development and the Environment and Province of Gelderland; Eds. (2004): Guiding Models for Water Storage. Possibilities for Water Storage and Multiple Space Use in the Dutch River Area. ESPACE - European Spatial Planning: Adapting to Climate Events. Nijmegen/ Oosterbeek.

Woods-Ballard, B.; Kellagher, R.; Martin, P.; Jefferies, C.; Bray, R. and Shaffer, P. (2007): The SUDS Manual. CIRIA Report C697. London: CIRIA.

Best-Practice Projects

01 Telecom Park, Taipei (Taiwan)
Dreiseitl, H. and Grau, D. (2009): Recent Waterscapes. Planning, Building and Designing with Water. Basel, Boston, Berlin: Birkhäuser Verlag.

02 Zhangjiawo New Town, Tianjin (PR China)
Giesler, U.; Ed. (2011): Water - Curse or Blessing?! Encouraging Architectural Projects in Asia-Pacific. Exhibition Catalogue, 9 September - 21 October 2011. Berlin: Aedes Am Pfefferberg.

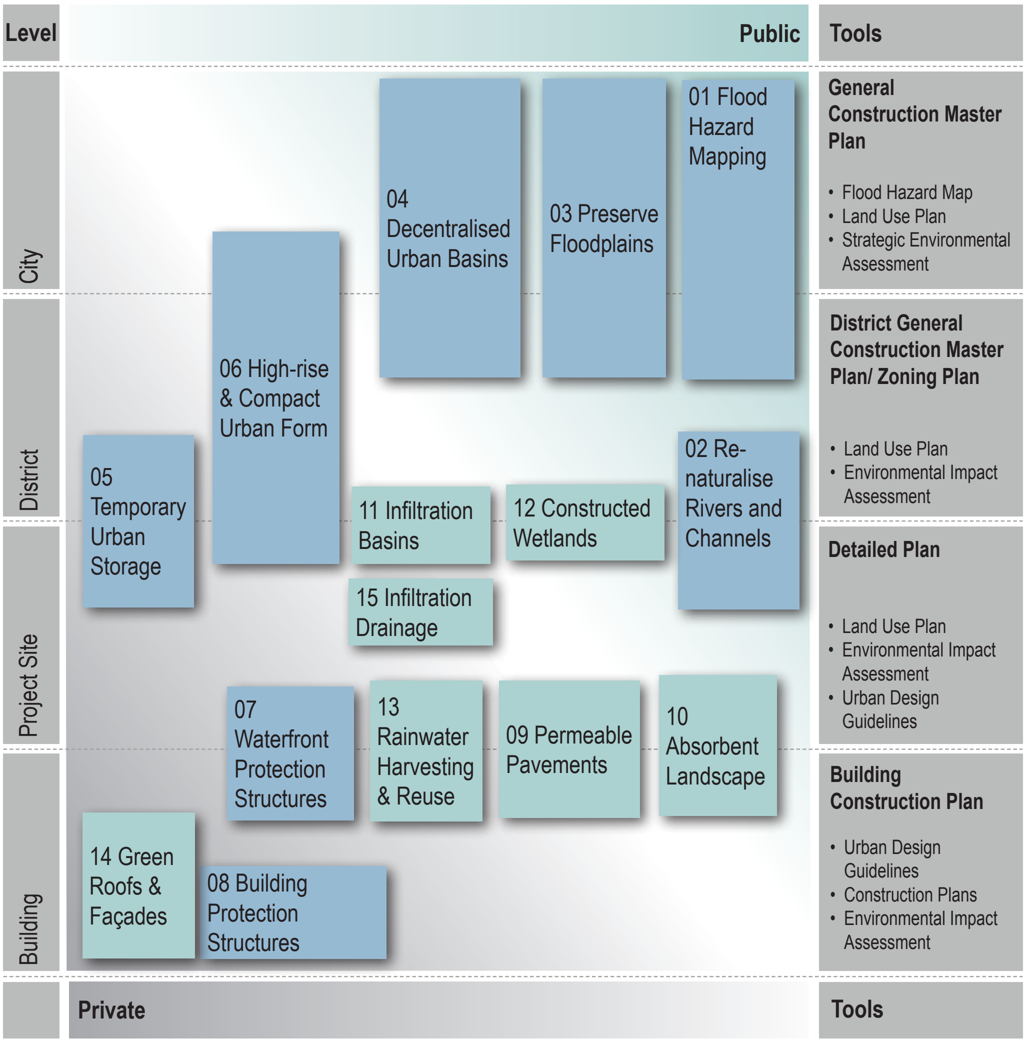
Additional Internet Resources

www.rainharvesting.co.uk
www.eartheasy.com
www.freewateruk.co.uk
www.ecoplay-system.com
www.underground-tanks.co.uk
www.h20-recycling.co.uk
www.aqualogic-wc.com
www.catchrainwater.com
www.thegreendirectory.com
www.bracsystems.com
www.harvesth2o.com
www.greywater.com

I-A. Managing Tidal and Fluvial Floods

I-B. Managing Surface Water

Outlook of the Selected Strategies



II.
Managing High Heat Load

II. Managing High Heat Load

For HCMC, the urban heat island effect will become one of the most pressing urban planning issues. The city's growth leads to further sealing of surfaces and increasing building volumes and at the same time to less air ventilation and cooling opportunities. It is therefore crucial for the city's prosperity to pay attention to the climatic impact of current and future urban developments and to find strategies to manage the high heat load.

Problem Background

Growing cities in tropical areas are seriously affected by high temperatures: On the one hand, inner-city areas are warmer than the rural surrounding – in the case of HCMC the difference of the surface temperature is up to 10°C (Tran & Ha 2008). On the other hand, the global climate change is an increasing burden, especially in the tropics (Storch et al 2009). High heat load does not only lead to thermal stress in terms of personal wellbeing (or a lack thereof) but also enhances the air pollution and thus seriously threatens the health of people and the environment.

Generally, there is no single simple strategy or arrangement to counteract these effects, rather an integrated planning approach is needed.

To manage high urban heat load, information about different aspects is necessary, including:

- the main drivers of high heat load
- the specific local conditions on different spatial levels in terms of both natural and built environment
- strategies and tools to react to different challenges related to high heat load.

To be able to integrate climate aspects into zoning plans, urban climate maps are a necessary prerequisite to understand the climatic specifics of each city. Up to now this information, as with many other cities worldwide, has not been available for HCMC. Within the framework of the research project "Megacity HCMC", an urban climate map for HCMC has been developed (Fig. II.2). This map is an important basis to be able to organise both mitigation of and adaptation strategies to urban thermal stress. This chapter provides some basic strategies to deal with high urban heat load. It is structured in two parts:

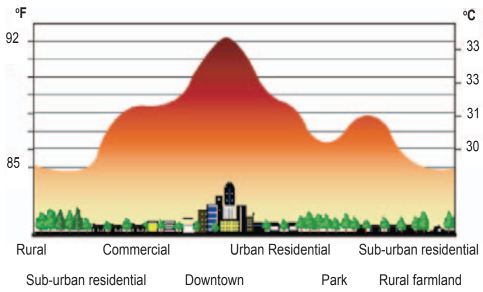


Fig. II.1: Late afternoon temperature in an urban area (Adapted from Prof. Tim Oke)

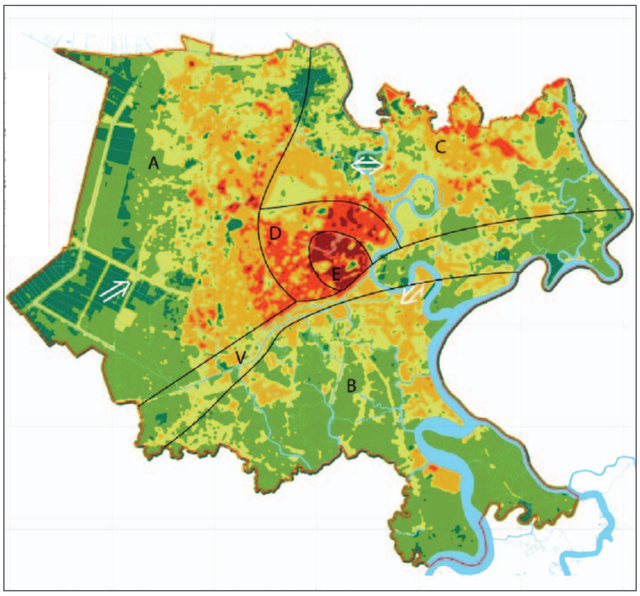
- Managing urban cooling
- Managing solar radiation.

In these sub-chapters several approaches and strategies are presented on how to face both current and future challenges. Both sub-chapters are strongly linked to each other and can hardly be addressed separately. It is therefore crucial to be concerned with all different aspects to be able to choose the best approach and strategy for a specific site development. An Urban Climate Map, developed for the specific situation and interpreted by experts can contribute to substantiated decisions.

Urban Climate Map

"The Urban Climate Map combines various climatic parameters like wind directions and speeds, solar radiation, air temperature with information about the city topography, landscape, building bulks, street grids and so on. The UC-AnMap can tell how the streets are ventilated, where the more comfortable spots are, where the problematic areas are, and how the buildings affect the city wind environment. With information like these, planners and designers have a better climatic basis of decision making."

(Prof. Lutz Katzschner, Uni Kassel)



		Descriptions	Evaluation
1	Fresh & cool air production zones	Open areas with significant climatic activity, cool and fresh air production; Climatically active open sites in direct relation to housing area; Very high nocturnal heat degradation	Very important, need to be preserved & protected. High sensitivity with respect to intervention which changes in land use.
2	Cool air production zone	Open areas with less significant climatic activity; Cool & fresh air with effects to neigbourhoods; Areas without any emissions; High nocturnal heat degradation	Important, need to be preserved & protected. Redevelopments should be allowed only in exception case, which is supported by detailed assessment
3	Mixed & transitional climate zone	Strong daily variation through income radiation, but good cooling effect; Areas with high percentage of vegetation; Low & discontinous emissions; Buffer zones between different climatopes; Moderate/good nocturnal heat degradation	Important linkage areas, foresee the orientation and density, surface roughness cannot be increased due to a reduction in ventilation with the effect on neighborhoods.
4	Moderate urban heat	Some heat storage, but mainly buffered through greeneries and wind; Dominated constructions areas with lots of vegetation in the open spaces; Low nocturnal heat degradation	Thermally vulnerable area, promote porous building design. Generally redevelopment is possible if they take care about ventilation
5	Remarkable urban heat island	Heat storage remarkable, but still some wind effects and cooling potentials; Density development with little vegetation in open spaces; Very low nocturnal heat degredation	Risk of future heat stress due to the neighboring green areas. The areas should be maintained or improved, and not worsen
6	Urban heat island maximum	Heat storage high; Low potentials and low ventilation; Heavily compressed and sealed inner city areas; No/very low nocturnal heat degredation	In need of renewal for urban climate. No more development in this zone is allowed. Improving air exchange & shadow providing design are recommendations

Regional ventilation   Regional circulation

Fig. II.2: Urban climate map of HCMC (Katzschner, L. 2011)

II-A.

Managing Urban Cooling

PHOTO CREDIT: Moritz Maikämper

II-A. Managing Urban Cooling

Urban cooling has to be managed in terms of both mitigation of and adaptation to high urban heat load. Urban planning, in particular by zoning, has to assure an appropriate level of linked green open space which may serve as cooler spots and having a certain size even as cold-air production areas. Further, sufficient air ventilation will be provided. Urban cooling, hence, is an important factor to improve urban comfort and quality of living.

General Approach

There are different tools which can be used to manage urban cooling. Some of them have a high impact on the micro-level whereas others have to be planned and implemented on the urban scale, in particular the location of main fresh air flow corridors. This means that climate adaptation strategies have to be embedded into general planning and other planning levels (Gill et al. 2009).

In a megacity as HCMC, the additional cost of air conditioning for buildings for an increased 1°C will come to millions of dollars (Storch et al. 2009). Therefore, it is important to research and apply mitigation and adaptation strategies to reduce urban heat. Although the specific air temperature depends on several local and micro level parameters there are some general rules:

- The bigger the ratio of green areas, the cooler the surrounding and the bigger the decrease of temperature over-night.
- The more ventilation opportunities exist, the bigger the cooling effect.
- The more moist green surfaces, the bigger the cooling effect.
- Open water surfaces support cooling effects.
- The more the above-mentioned conditions are combined, the more urban cooling can be managed and achieved.

However, besides these synergies a number of conflicts have to be considered. For example, tree planting helps to reduce temperature by shadowing and the evaporation process, nevertheless the kind of tree has to be considered as wide crowns and too dense planting can lead to a decrease in air circulation. This is followed by an increase of thermal stress as well as a possible increase of air pollution.

These conflicts are presented together

with selected strategies on the following pages. In supplement, map sections of different scenarios are shown which indicate the temperature changes expected. The comparisons among different simulated models of the strategies will assume the efficiency of each strategy and will support the appropriate selections. In addition, the technical feasibility and cost-efficiencies of these strategies also have to be taken into consideration.

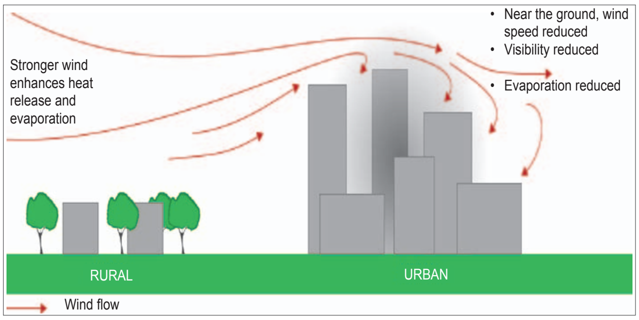


Fig. II-A.1: Urbanisation effects on the low level wind flow over the urban area, compared to a rural area (Adapted from Hong Kong Observatory)

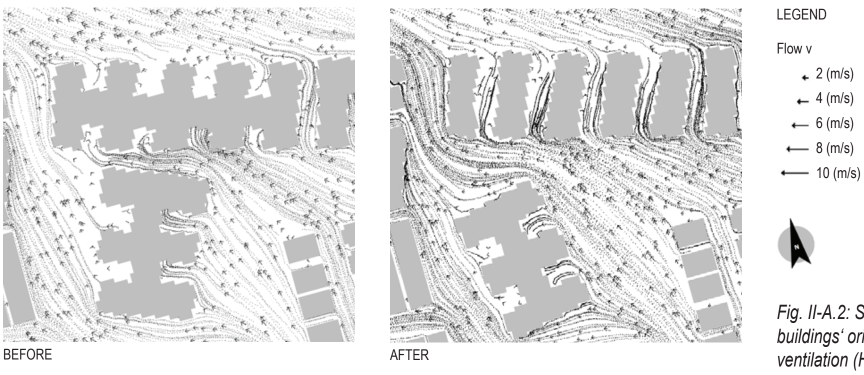


Fig. II-A.2: Simulations on how buildings' orientation can influence ventilation (Huynh & Eckert)


PHOTO CREDIT: Moritz Maikämper

Selected Strategies

01 Fresh-air Flow Corridors

Fresh-air flow corridors are connections of large open spaces next to dense settled areas, which serve as transporters of cold and fresh air. Their importance consists of both cooling down urban areas and providing fresh air for stressed zones. That is why they have to be clearly defined and regulated on the level of the whole city.

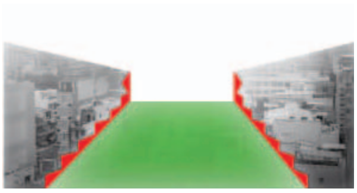
The lower the exchange of air in a specific area is, the more important is the existence of adequate fresh air flow corridors (MKULNV NRW 2010). Since there is limited macro air movement in the tropics, fresh air flow corridors are crucial for a tropical megacity like HCMC. Another determining factor in tropical areas is the change of wind directions among the seasons (Emmanuel 2005). Prevailing wind directions in both dry and rainy seasons have to be taken into consideration.

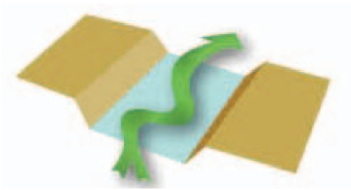
In undeveloped areas, wind flow is mainly influenced by topography and large water bodies (ib.). On the urban scale, buildings and trees are the main elements that alter wind flow. The bigger and denser a city is, the more important is the existence of large open spaces within the city or in the near surrounding (MKULNV NRW 2010). Any development in these fresh air flow corridors should be limited and the borders of the corridors should be clearly defined in zoning plans. In Germany, for example, the fresh air flow corridors could be regulated by binding land-use plans.

The main fresh air flow corridor of HCMC is along the Tau Hu canal, from the southwest to the northeast as can be seen from the urban climate map (Fig. II-A.4).

In addition to keeping the main fresh air corridors of the city, smaller corridors on

Fig. II-A.3: Fresh air flow corridors have to be kept free from any development. Borders have to be defined.





district level also should be defined and kept free from development. Generally, it can be stated that a disturbance on a district level only affects parts of the city, whereas damage to the main fresh air flow corridor has a massive negative impact on the climate of the whole city.

Large open and linear spaces can funnel winds into the city, too. Airports, highways as well as linear parks and canals are suited to serve as such wind channels; therefore they should be oriented to divert wind from desired direction into and through the city (Watson, Plattus & Shibley 2002).

Those canyons, hence, should be designed to promote ventilation by: widening the street width, stepping buildings back from the street, integrate open spaces along the canyon, create different building heights, and designing intersections to deflect winds (ib.).

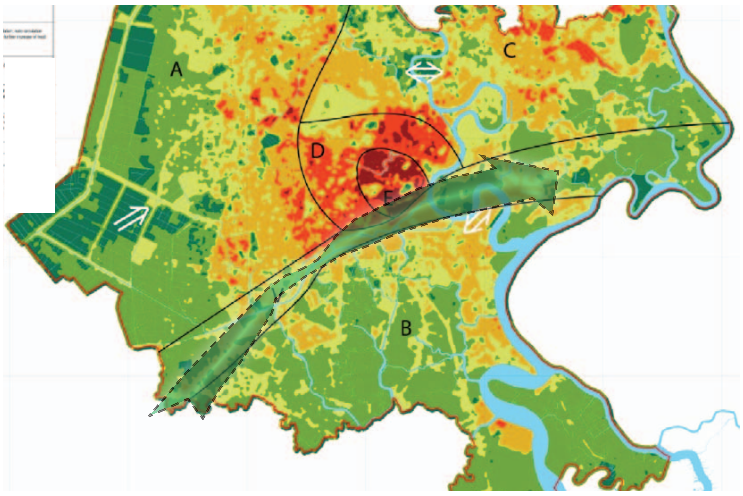


Fig. II-A.4: The main fresh air flow corridor in HCMC (Adapted from Katzschner, L. 2011)

PHOTO CREDIT: Moritz Maikämper/ Chau Huynh

02 Orientation to Prevailing Winds

To assure fresh air supply within city quarters, both street pattern and single houses should be oriented to prevailing winds. As wind directions change in the tropics the most reasonable orientation for HCMC is the one along the monsoonal winds (Fig. II-A.5). Streets should either be parallel to the wind flow or angled by 30 degrees (Emmanuel 2005). Further, the road cross-sections must be wide enough and should not be blocked by buildings or trees.

When planning the orientation to the prevailing winds, the orientation to direct sun should be considered as well as, e.g narrow streets can help an increase in shading. However, streets should still be designed in a way allowing the wind to pass through, and on the contrary not produce a funnel effect.

Due to surrounding building forms, wind direction and velocity can be altered and therefore be different from the city's main wind. Therefore, a developed design should not be stereotyped in the one orientation, but should be based on site-specific wind direction and micro-climate (Huynh & Eckert 2012).

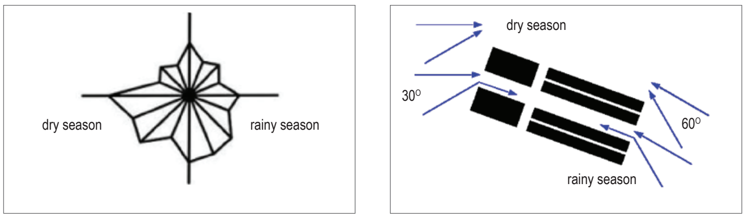


Fig. II-A.5: Main wind directions in HCMC, buildings should either be parallel to the wind or angled by maximal 30°

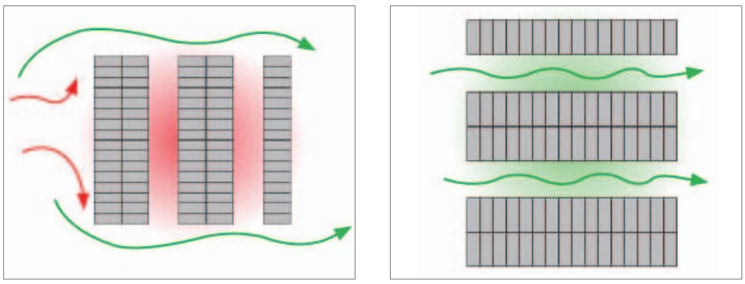


Fig. II-A.6: Benefits of re-orientated buildings to the main wind direction (Adapted from Ng 2010)

03 Avoidance of Wind Blocking Effects

High-rise buildings in HCMC are often based on a podium which is 5-6 storeys high. Thus, wind-flow could be prevented from circulating at a pedestrian level. It is therefore important to assure sufficiently dimensioned corridors between podia in building laws (Ng 2010).

Huge building blocks should generally be avoided. They cause wind blocking effects as urban wind blockage walls, but can benefit as funnel effects. Particularly for buildings along water fronts, it is crucial to create enough corridors for the wind to flow using the cool air from the water body.

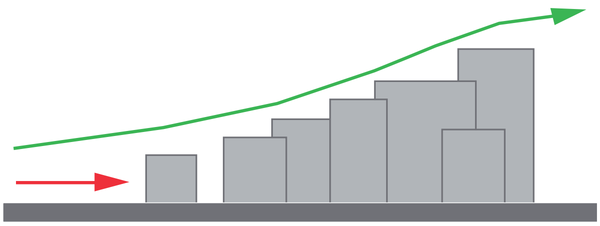
Table II-A.1: Design elements with the biggest influence on wind flow
• The overall density of the urban area • Size and height of individual buildings • Existence of high-rise buildings • Street orientation • Availability, size and distribution of open areas and green belts
(Adapted from Emmanuel 2005 & Givoni 1989)

04 „Downwash Effect“ of Different Building Heights

Tall buildings are able to catch wind blowing at a higher level and to downwash it. This means fresh air can be redirected toward the ground.

Buildings with different heights cause different wind speeds between them and therefore improve the ventilation (Ng 2010). The buildings located downwind should be the lowest (Fig. II-A.7). Downwash effects have to be organised on the district level and applied in the design of single building blocks.

Fig. II-A.7: The closer to the area, from which the prevailing wind comes, the lower the buildings should be.



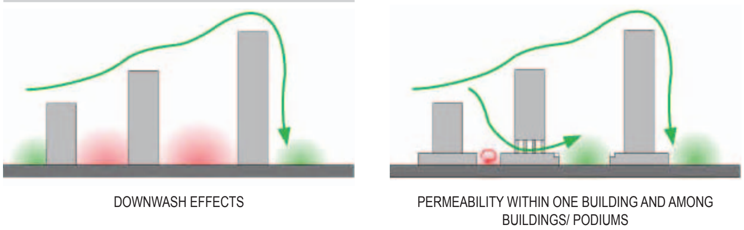


Fig. II-A.8: Urban permeability and downwash effects from high-rise buildings to enhance urban cooling (Adapted from Ng 2010)

PHOTO CREDIT: Moritz Maikämper /Ronald Eckert

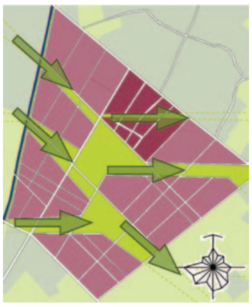


Fig. II-A.9: A network of vegetated green surfaces should follow the prevailing winds to enhance urban ventilation

05 High Ratio of Vegetated Green Surfaces

Urban quarters can benefit from green surfaces in different ways. Corresponding to the positive effects of large green open spaces outside of a city, parks and green areas in the city can provide fresh and cool air to adjacent blocks of houses.

Centralised and huge park areas are able to provide fresh air to the city and the surrounding neighbourhoods. However, a network of decentralised smaller green surfaces also has the same effects, and provides spaces for leisure and recreation activities (MKULNV NRW 2010).

Additionally, these green surfaces also have flood storage capabilities, and therefore they have beneficial impacts on ecological quality and mitigating flood risks (Shaw et al. 2007).

Green belts for isolating heavy industrial zones or motorways from housing areas are to hinder the transport of polluted air and contribute to the removal of pollutants.

In residential areas, green open spaces should be orientated to the prevailing winds to enhance their capacity to distribute fresh air in the surrounding.

When planning vegetated green surfaces, the affordability and maintenance costs of caring and artificial irrigation should be considered, especially in the dry season. Therefore it is advisable to keep the need for watering of any open space in the development as low as possible. Possible measures can be re-using the abudant rainwater in the rainy season of HCMC, or re-using the gray water for plant and tree irrigation. Additionally, the selection of local native trees and plants can help to keep the water consumption of green spaces lower.

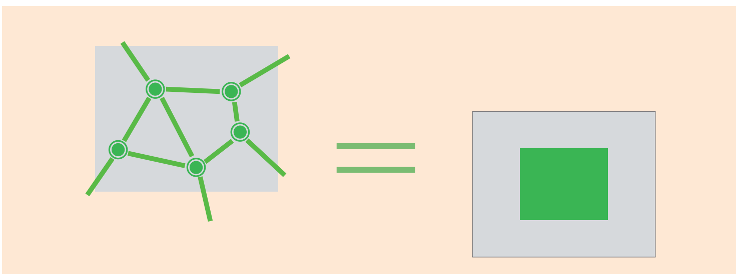


Fig. II-A.10: A network of small green spaces is as benefitting as one single big green surface.

06 Open Water Surfaces

Big open water surfaces generally affect the air temperature of their surrounding in a positive way by reducing the temperature and enhancing ventilation. Moving water has a larger benefit then standing water (MKULNV NRW 2010).

It is noted that, only large water surfaces like lakes have a measurable impact on the urban scale. However, on a small scale air cooling opportunities, small water sufaces can be used to enhance the evaporation and reduce heat storage. Regarding this measure one has to consider that the used water surfaces has to be open in order to not cause heat accumulation. Moreover, the containers of these water surfaces should not be in bright colours, to advoid the radiation storage effect within the water bodies.

The biggest water surface based cooling effect on city quarters in HCMC can be reached by open water surfaces located northeast and/or southwest of a certain area, where the main wind flows.

Water surfaces and nearby open spaces can be surrounded by trees to buffer the heat of the sun (Emmanuel 2005). A joint implementation of these strategies can create liveable and enjoyable open spaces.

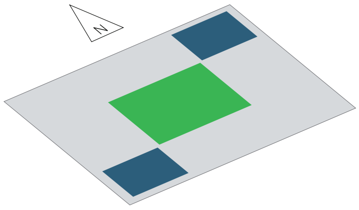


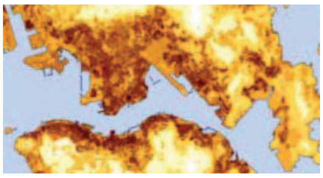
Fig. II-A.11: Water surfaces located in the southwest and northeastern corner bring more cooling benefits.

Fig. II-A.12: Trees around a water surface buffer the heat of the sun (Photo: Maikämper M.)

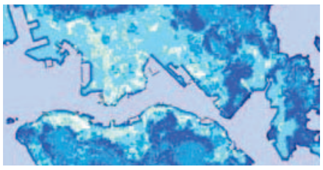
Fig. II-A.13: A moving water body will bring more cooling effects than a stable one (Photo: Eckert R.)

PHOTO CREDIT: Marcus Tschaut/ Jana Wamatzsch

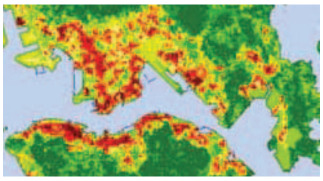
Best Practice



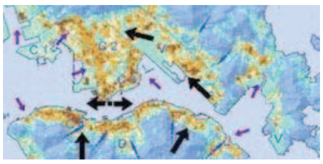
MAP 1: High thermal load throughout the urban core



MAP 2: Low dynamic potential for adaption throughout the urban core



MAP 3: Intending different needs for adaption to air ventilation improvement



MAP 4: Urban climatic planning recommendation

Fig. II-A.14: Urban Climate Maps of Hong Kong (Planning Department Hongkong)

01 Urban Climate Assessement & Recommendations, Hong Kong

In 2003, the Hong Kong Planning Department initiated the "Feasibility Study for Establishment of Air Ventilation Assessment (AVA) System". The study aimed to assess Hong Kong's existing urban climate conditions and to elaborate recommendations as regards to climate adaption by urban design. The urban climate assessment addresses the thermal load and the dynamic adaption potential of urban areas. Derived from that, urban areas are classified according to their need for climatic improvement and differentiated into equivalent zones of emphasised actions (Recommendation Map).

Due to Hong Kong's congested urban conditions, the AVA was implemented as a guideline for planning practice to deal with the thermal discomfort and the improvement of air ventilation. Arising from that, specific requirements and recommendations for a climate adapted urban design could be identified. The overall urban design approach is the preservation, or respectively creation, of urban permeability on city, district and building levels with the application of different principles. The preservation of breezeways and a street grid that corresponds to major prevailing wind directions are the main principles. The

Location	Hong Kong
Tempera-ture	max.: 32 °C (July) min.: 14 °C (January)
Wind direction	Southeast, Southwest; East-west (harbour)
Area	1,100 km²
Client	Hong Kong Planning Department
Planner	ARUP, Hongkong university of Science & Technology, PlanArch Consultants Ltd., Kassel University
Planning	2003 - 2010
Strategies	Urban Climate Assessment, Planning Recommend and Urban Design Guidelines

fresh air corridors need to be kept free from obstruction like tall buildings or elevated road structures. Particularly, waterfront sites require special attention in terms of allowing sea breezes to enter the urban areas as far as possible. The disposition of building blocks and differences in building heights contribute to the capture and deflection of wind and to the generation of air turbulence. The podiums of buildings should be open and

terraced to direct downstream airflow to street level. Gaps in buildings help to enable air to flow even in high-density areas. By reducing the buildings' ground coverage, open spaces are generated and linked together. Throughout the city, green spaces need to be provided to increase the thermal comfort and to support micro-scale wind flows. The usage of light materials can achieve a cooling effect by reducing the absorption of solar radiation.

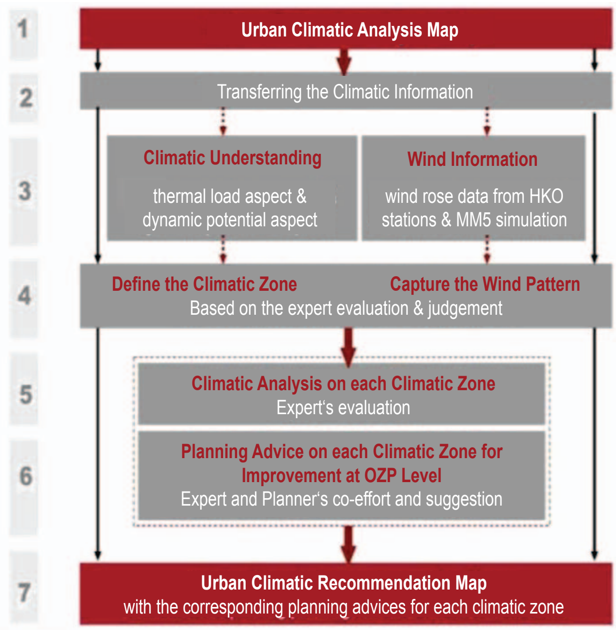
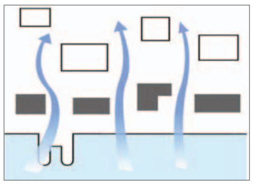
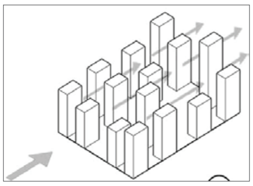


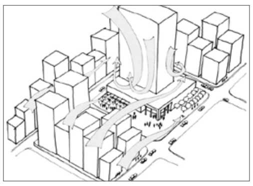
Fig. II-A.15: Methodology to establish an Urban Climatic Recommendation Map (Planning Department Hong Kong)



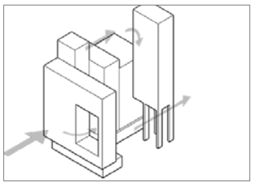
Sea breezes entering the urban areas



Correspondance of building mass orientation and wind direction



Different building heights for wind flow and defelection



Building permeability to allow wind flows to enter high-density areas

Fig. II-A.16: Climate adapted design guideline for Hong Kong (Planning Department Hong Kong)

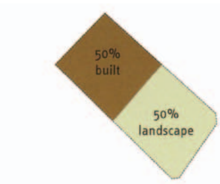
PHOTO CREDIT: X-Achitects & SMAQ

Fig. II-A.17: Climate relevant conception of the urban design (SMAQ)

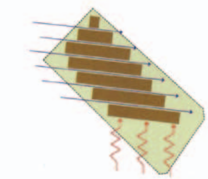
02 Xeritown, Dubai

The proposed vision of this desert city is aimed at the creation of pleasant living conditions while repsecting the specific surrounding. Harmonically embedded into the natural environment, the urban setting reflects Arabic urban design traditions to ensure natural ventilation and urban cooling. The project's primary objectives deal with the preservation of ventilation corridors and the shading of public spaces. The ventilation is based on the orientation and placement of building blocks, forming unoccupied corridors which correspond to the prevailing westerly winds and enable cool sea breezes to blow between the built-up areas.

Location	Dubai, UAE
Tempera-ture	max.: 45 °C (July) min.: 27 °C (January)
Sun hours	8 - 11 hours / day
Wind direction	West, South
Area	59 ha
Client	Dubai Properties
Design	SMAQ - Architecture Urbanism Research
Planning	Conceptual
Strategies	Wind Corridors, Providing Shade by Buildings, High Density and Compacted Urban Form

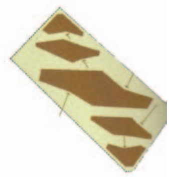


Giving shade
(Compact urban form)

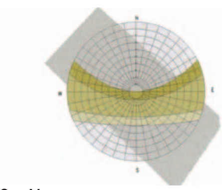


Ventilation by cool winds
(Built cut into strips for cool wind chanelling)

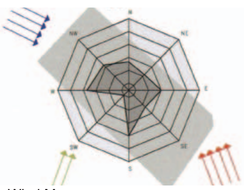
Benefit from existing humidity
(Strips positioned to preserved existing water)



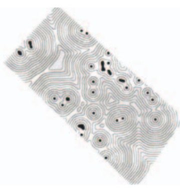
Integration in the dunescape (Strips shaped to recal a dunescape)



Sun Map



Wind Map



Humidity Map

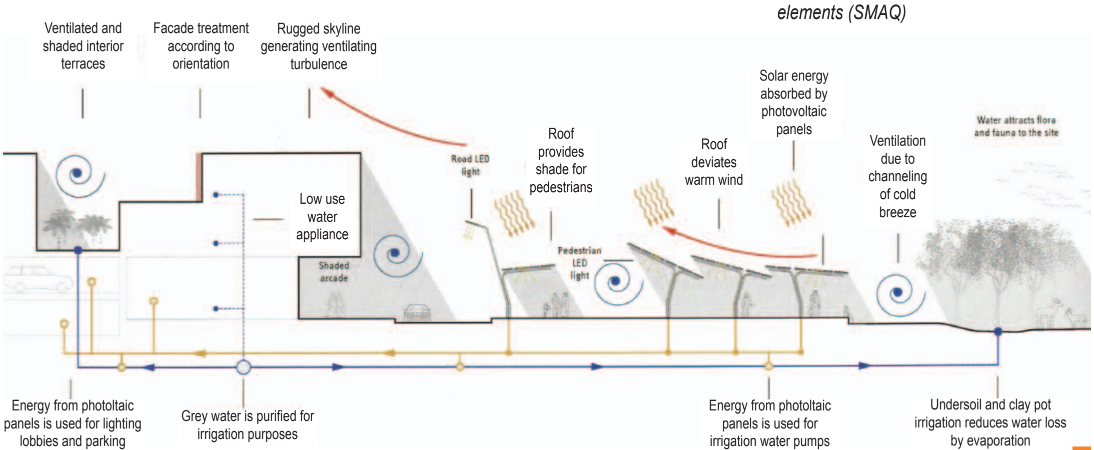
Dune Map

Differences in building heights allow the diversion of air flows and the generation of wind turbulence. As an additive urban design, further developments could encourage the enlargement of ventilation corridors by retaining their orientation keeping them free from development.

The shading of public spaces is meant to be achieved by a highly condensed urban fabric that is self-shading due to its narrow street profile and different building heights as well as protrusions, forming deep arcades. Thereby, the warming effect of high solar radiation is reduced to a minimum. Due to the unsuitability for the desert conditions, tree shading has been omitted in favour of solar panels, which simultaneously provide shading and generate electricity. That being said, natural ground water aquifers allow for green spaces between the built-up areas, which contribute to the generation of fresh and cool air. This supports the generation of air flows and increases the wind speeds. Measures for ventilation and shading are also implemented at the building level by means of facades and natural wind towers that support the influx of cool air, while releasing warm air.

Fig. II-A.18 (Above): View and functionality of a wind tower (SMAQ)

Fig. II-A.19: (Below) Cross-sectional scheme showing the concurrence of climate relevant elements (SMAQ)



References & Resources

Emmanuel, M. R. (2005). An Urban Approach to Climate-Sensitive Design. Stategies for the tropics. Abingdon, Oxon: Spon Press.

Gill, S., Handley, J., Ennos, R., Nolan, P. (2009). Planning for Green Infrastructure: Adapting to Climate Change. In: Davoudi, S., Crawford, J., Mehmood A. (ed.): Planning for Climate Change. London: Earthscan Ltd. P. 249-261.

Huynh, C. and Eckert, R. (2012). Reducing Heat and Improving Thermal Comfort through Urban Design – A Case Study in Ho Chi Minh City. In: International Journal of Environmental Science and Development, Vol. 3, No. 5, pp. 480-485.

Katzschner, L. 2011. Urban Climate Strategies Against Future Heat Stress Conditions, in: K. Otto-Zimmermann (ed.), Resilient Cities: Cities and Adaptation to Climate Change - Proceedings of the Global Forum 2010, Local Sustainability 1, DOI 10.1007/978-94-007-0785-6_8, © Springer Science+Business Media B.V. p 79 – 91, 2011

MKULNV NRW (Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz des Landes Nordrhein-Westfalen) (2010). Handbuch Stadtklima. Maßnahmen und Handlungskonzepte für Städte und Ballungsräume zur Anpassung an den Klimawandel. Düsseldorf. [In German]

Ng, E. (ed.) (2010). Designing High-Density Cities for Social and Environmental Sustainability. London: Earthscan Ltd.

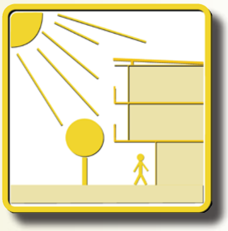
Shaw, R., Colley, M., and Connell, R. (2007). Climate Change Adaptation by Design: A Guide for Sustainable Communities. London: TCPA.

Storch, H., Downes, N., Nguyen Xuan Thinh, Thamm, H.-P., Ho Long Phi, Tran Thuc, Nguyen Thi Hien Thuan, Emberger, G., Goedecke, M., Welsch, J., Schmidt, M. (2009). Adaptation Planning Framework to Climate Change for the Urban Area of Ho Chi Minh City, Vietnam. In: Worldbank (Eds.) (2009) Fifth Urban Research Symposium "Cities and Climate Change: Responding to an Urgent Agenda" Marseille, France, June 28-30, 2009, Session: Adaptation of Cities to Climate Change: Case Studies of Local Plans, Online-Proceedings www.urs2009.net, 24 pp.

Best-practice Projects

01 Urban Climate Assessement & Recommendations, Hong Kong
Planning Department Hong Kong (2011) Urban Climatic Map and Standards for Wind Enviroment - Feasibility Study. Stakeholders Engagement Digest. Available at: http://www.pland.gov.hk/pland_en/p_study/prog_s/ucmapweb/ucmap_project/content/main/PublicEngagement/Digest_Eng.pdf

02 Xeritown, Dubai
Heinrich Böll Foundation. Urban Futures 2030. Urban Development and Urban Lifestyles of the Future. Available at: http://www.boell.de/downloads/ecology_5_-_urban_futures_2030.pdf



II-B.
Managing Solar Radiation

PHOTO CREDIT: Moritz Maikämper

II-B. Managing Solar Radiation

The management of solar radiation is an important tool to adapt to climate change on both city quarter and building levels. The use of reflective materials can lower micro-climate temperatures while shaded open spaces enhance human comfort and therefore they can contribute to a liveable city. The impact of many small scale solar radiation mitigation measures can provide a significant contribution toward the heat mitigating aim at the city level.

General Approach

In contrast to urban cooling, solar radiation mitigation strategies are mainly applied at smaller scales of urban quarter and building levels. However, the impacts can be achieved not only on the micro-climate but also can contribute to the whole city. This part of the handbook offers strategies on managing solar radiation to increase reflectivity, and reduce radiation absorbent, heat storage, and heat releasing during night.

Based on the suggested strategies, an effective public policy may either promote the use of specific strategies or demand proof from developers that they have implemented certain tools to avoid high heat load. The selection of appropriate strategies and tools to manage solar radiation can be easily left to the developer of a specific area.

In general, the main aims and tools of managing solar radiation are:

- an enhanced solar reflectivity of

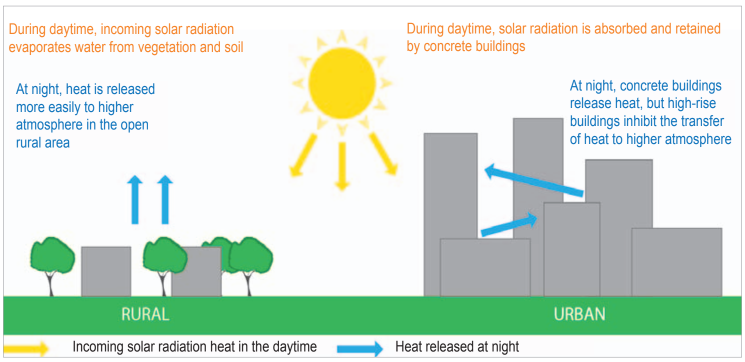


Fig. II-B.1: Solar radiation absorbency and exchange during day-time and night-time of an urban area, compared to a rural area (Adapted from Hong Kong Observatory)

affected building and paving materials;

- an enhanced solar avoidance by providing shading for buildings and public spaces.

Some principal statements can be made about solar radiation management strategies, these are:

- The lighter colour a material is, the more it is able to reflect solar radiation, and the cooler it therefore stays.
- The more direct solar radiation can be avoided, the cooler an area or part of a building is.
- The more integrated with ventilating effects the strategies can be, the more benefits the strategies can reach.
- Although the solar radiation mitigation strategies mostly are applied at the building and urban quarter scale, the impacts on the city level still can be achieved.

In addition to the provided strategies, in this part of the handbook, climatic simulations of different scenarios are shown to further explain which effects can be achieved by specific arrangements. It is also noted that most of the proposed tools can be adopted not only for new development but also in an existing built environment.

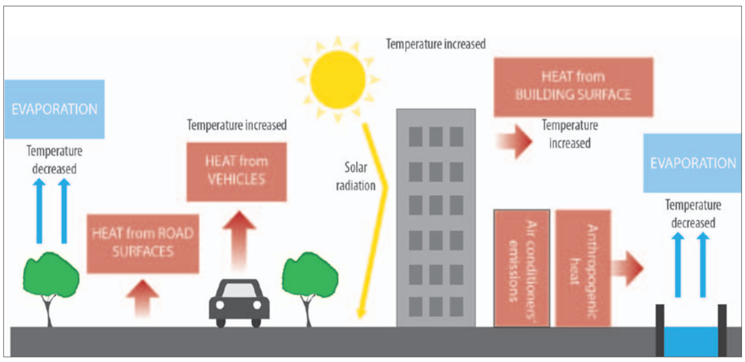


Fig. II-B.2: Built structures absorb solar radiation and emit it, in addition, other heat load is released from urban emissions (Osaka city official website).

PHOTO CREDIT: Moritz Maikämper

Selected Strategies

07 Light-coloured and Reflective Roofs and Façades

Roofs and building façades are the exposed surfaces to sunlight and hence in high need to be protected from the solar radiation. The use of reflective and brightly coloured building materials has a long tradition in tropical and sub-tropical regions (MKULNV NRW 2010). It helps to lower indoor temperature of the applied buildings and enhance the micro-climate conditions. The main positive properties of those materials are:

- a high solar reflectance
- a high thermal emittance (Gartland 2010) (Fig. II-B.3).

In addition to lowering indoor temperatures, reflective and light-coloured building materials also help to reduce the cooling energy consumption and save cost from cooling equipments.

Other materials which can be warmed up to a large extent when exposed to direct solar radiation, such as glass and steel, should be limitedly used as façades material. Generally, the combination of reflective, light-coloured materials and shadowing elements is commendable.

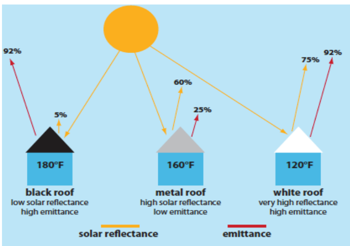
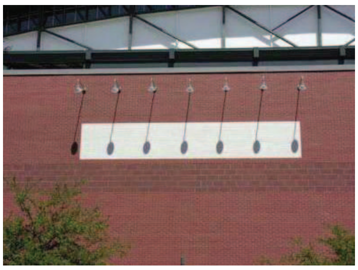


Fig. II-B.3: Cool roofs reflect up to 60-75% solar radiant help to reduce cooling electricity consumption, increase cost savings from downsizing cooling equipment (Energy Coordinating Agency, Philadelphia)



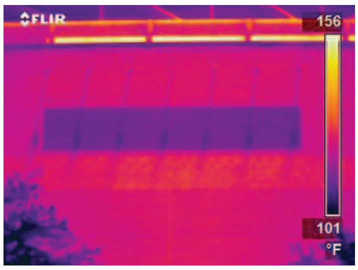


Fig. II-B.4: Albedo alone can significantly influence surface temperature, with the white stripe on the brick wall about 5 to 10°F (3-5°C) cooler than the surrounding, darker areas (ASU National Center of Excellence).

08 Light-coloured and Reflective Paving Materials

Up to the half of urban surfaces consist of pavement (Gartland 2010). That is why, it is crucial to make careful consideration about the materials which are widely used.

Reflective and bright surface materials are able to reflect more shortwave solar radiation than dark coloured ones. Therefore, they can contribute to a reduction of the urban heat island effect. To achieve noteworthy effects, the larger a paved surface is, the more necessarily the light-coloured materials should be used.

Here, it is noted that, not only the colour but also material properties such as the thermal conductivity influence the cooling effect of the pavement (MKULNV NRW 2010). Simulations have shown that: with porous asphalt roads and light-coloured brick pavements, the surface temperature in HCMC, can be decreased by 2 to 6°C compared to traditional basalt asphalt and cement pavements (Huynh & Eckert 2012) (Fig. II-B.6).

There are several possibilities to enhance the reflective properties of paving materials: for instance, light-coloured aggregates can lighten up asphalt and bright cement can brighten concrete (Gartland 2010). In rainy seasons, porous and permeable paving materials can be cooled by evaporation and hence, heat storage of these materials is reduced. It is therefore recommended that the paving materials should not only be light and reflective but porous as well. This can improve the rain water infiltration capacity of the ground as a side benefit.

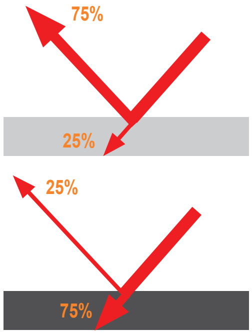
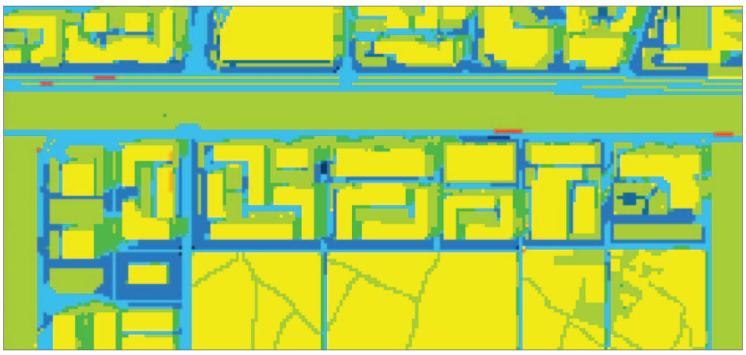


Fig. II-B.5: Light colours reflect more solar radiation than dark ones. This can help to keep both roofs and pavements cool.



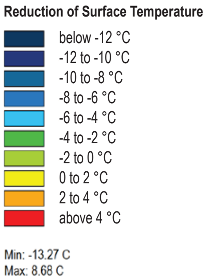


Fig. II-B.6: Reduction of surface temperatures when changing HCMC's conventional paving materials (cement and non-porous asphalt) to cool paving materials (porous asphalt and light coloured permeable bricks). Map is simulated by ENVI-met 04 under the climatic conditions of HCMC (Huynh & Eckert).

PHOTO CREDIT: Moritz Maikämper

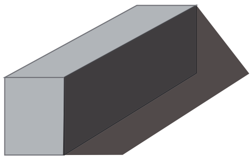


Fig. II-B.7: Buildings can shade open spaces.

09 Providing Shade in Public Spaces by Trees and Buildings

Another strategy to reduce heat load is to avoid direct sunlight by providing shade in public spaces by trees or buildings. Large tree canopies are generally recommended for urban areas in the tropics to protect both open spaces and buildings from direct solar radiation; thereby they are limiting the rise of air temperature during the daytime as well as providing an attractive ambience.

However, trees can cause negative side effects as they can cause wind blockage or contribute to a higher humidity level by evaporation; hence, they can increase human discomfort, especially during hours with light winds. Therefore, trees should not be planted too densely in terrains which lack of fresh air supply. Selected trees and plants should be native and suit to the tropical climate thus requiring less irrigation. Irrigation water should be treated gray water or harvested rainwater in order not to interfere with the general water supply of the city.

Public spaces and streets can also be shaded by surrounding buildings. As the cubature of buildings cannot be changed easily afterwards, the arrangement should be planned carefully. Depending on the function and main time of use of an open space, different building heights arround the open space need to be considered. To provide shade for a public square in the afternoon, for instance, the building on the Southern and Western sides should to be the tallest. Narrow streets with aside attached buildings also help to provide shade. Buildings designed to shade public spaces in this way are called a shadow umbrella (Emmanuel 2005).

Physical equivalent temperature

- below 23 °C
- 23 to 29 °C
- 29 to 35 °C
- 35 to 41 °C
- above 41 °C

Min: 27.75 °C
Max: 79.59 °C

Special layer

- Buildings
- Trees

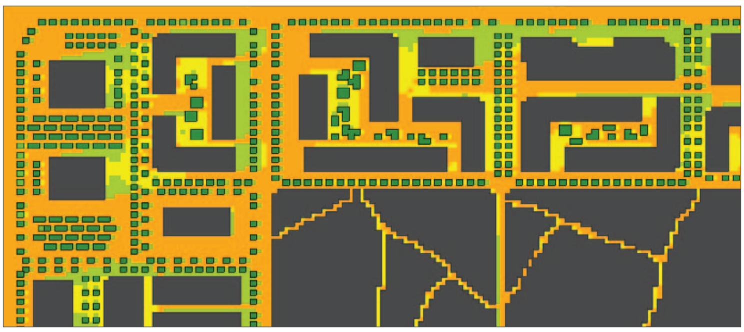


Fig. II-B.8: Climatic simulation map of an urban quarter within the Vo Van Kiet Boulevard project at 2pm, showing areas with greenery and under shadows have 6-12°C physical equivalent temperature less than the sun-exposed areas (Huynh & Eckert).




10 Buildings' Shading Elements

The less building surfaces are exposed to direct solar radiation, the lower the energy needed for air conditioning is. Therefore, shading elements for facades or parts thereof are effective tools for lowering buildings' energy consumption. There are several design elements which can contribute to an effective solar protection of facades, such as overhanging roofs, balconies, patio and arcades. All of these have been used in tropical architecture for many decades and can easily be combined with other shading arrangements.

While facades to the south and north can be shaded by horizontal elements, vertical elements are necessary for eastern and western facades to avoid stronger direct sunlight (Emmanuel 2005). Usually, these design elements can be added to existing buildings and are therefore suited for both urban renewal and new development projects.

Although the offered strategies are mainly on the house level, a network of arcades can enhance the attractiveness for pedestrians by modifying the extremes of sunlight, wind, and temperature and hence, can provide a comfortable space.

11 Artifical Shading Elements in Public Spaces

When planting trees in public spaces is not suitable, artificial shading structures can be applied. Pavilions, tents or large sun umbrellas can be used to provide shade for urban open spaces. Additionally, there are several construction techniques allowing them to be used for short periods such as for festivities or in the rainy season where they can be removed on a daily basis. Taken together, there are shading opportunities for almost every open space.


Fig. II-B.9: Above: Overhanging roofs and arcades at the Gallery of Art in HCMC.

Below: Combination of tree shading and shaded arcades.

PHOTO CREDIT: http://masdarcity.ae/

Best Practice

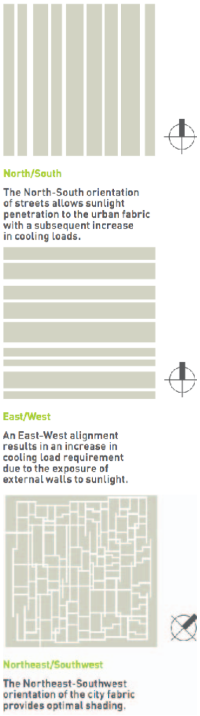
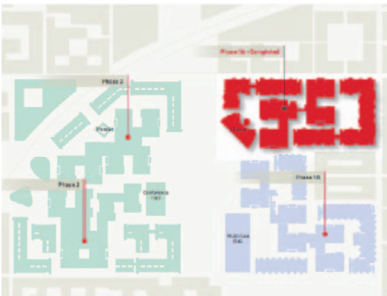


Fig. II-B.10: Concept of building orientation (Masdar City)

01 Masdar Institute, Masdar City, Abu Dhabi, UAE

The Masdar Institute is a major part of the future development of the emerging global clean-technology cluster Masdaar City and is located within the first phase of the project. The urban form of the institute is a microcosm of the fabric of the city as a whole. It is bisected by a linear park, and has an environment-intelligent building orientation, which optimises the outdoor thermal comfort of the public realm. The walkways throughout the city are always shaded through overhangs and narrow streets. The building heights and orientation have been designed in relationship and aim to minimise solar heat gain within the local environment, which has a direct impact on both the immediate environment and the amount of energy consumed by air conditioning. A wind-

Location	Abu Dhabi, UAE
Tempera-ture	max.: 42 °C (July) min.: 11,8 °C (January)
Sun hours	10-11 hours/ day
Wind direction	Northwest
Area	700 ha (Master plan) 4000 m² (project site)
Client	Mubadala Development Company
Planner/ Designer	Foster and Partners, Adams Kara Taylor, PHA Consult
Planning Construc-tion	2007 2009-2010
Strategies	Shading by buildings, building elements and trees, Building orientation, Building cool materials, Wind-tower



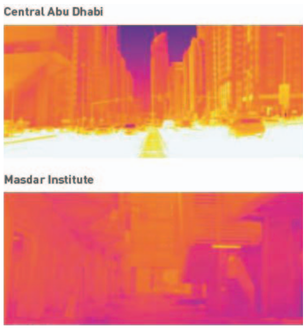
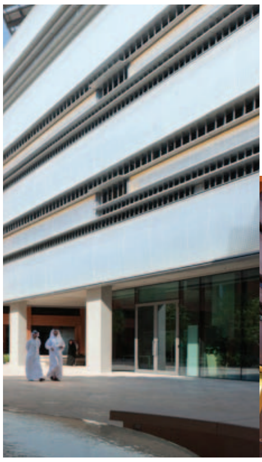


Fig. II-B.11: Proposed masterplan for the Masdar Institute Campus (left) and a thermal analysis of Masdar Institute, compared to a central Abu Dhabi (right) (Masdar City)



tower is integrated in the structure. This is a re-interpretation of a traditional Arabic structure, which redirects wind flow toward the courtyard. The design features of the Masdar Institue generate lower radiant temperatures: compared to a typical Abu Dhabi street, the difference of up to 20°C is an achievement (Fig. II-B.13).

Pedestrian activity at the street level is connected and encouraged by the creation of shaded space. Therefore colonnades are integrated into the design of all buildings within the institute. Passive cooling of the colonnades is achieved by the use of high thermal mass materials for soffits, walls and ceilings. A reduction in air temperature is reached by use of shading by buildings and vegetation. The use of native plants links the design to its immediate context and provides additional benefits including reduced air temperature in the public space. The strategically located water features provide indirect cooling and contribute to the creation of a relaxing environment. The facades of the buildings have been developed to passively mitigate heat transfer and incorporate materials with a low thermal mass which cool down quickly at night to avoid radiant heating of the public realm. Materials with high thermal mass, if strategically used in shaded location, can help store "coolth" to shaded colonnades.

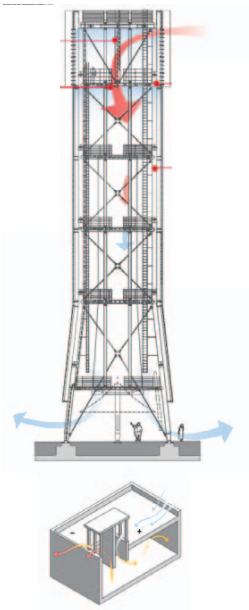


Fig. II-B.12: A conceptual wind tower, 45m high, can capture the cooler upper level winds and direct them to the open air public square at its base (above); and a traditional Arabian windtower (below) (Masdar City)

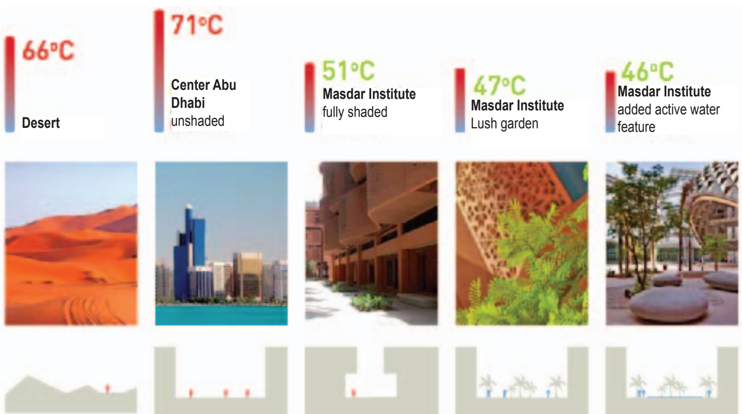


Fig. II-B.13: Concept of percieved temperature in different open spaces (Masdar City)

PHOTO CREDIT: Ronald Eckert

02 Gardens by the Bay, Singapore

The developed masterplan for Marina South is part of Singapore`s new Garden by the Bay Project, which aims to create a new destination in the city and which has been designed as a network of distinct ecosystems with maximum environmental efficiency.

At the garden at Marina South, some of the most spectacular structures are located: a grove of “supertrees” with a height of 5-25 metres and two cooled conservatories, which represent the largest climate-controlled glasshouses in the world.

To increase accessibility and connectivity between the gardens and its surrounding landscape, different

Location	Singapore
Tempera-ture	max.: 31 °C (July) min.: 23 °C (January)
Sun hours	4,5 - 6,5 hours/day
Wind direction	Southeast, Northeast, Southwest
Area	101 ha (Master Plan)
Client	National Parks Board Singapore
Design	Grant Associates
Planning	2006-2012
Strategies	Supertrees, Shading elements, Reflective pavement

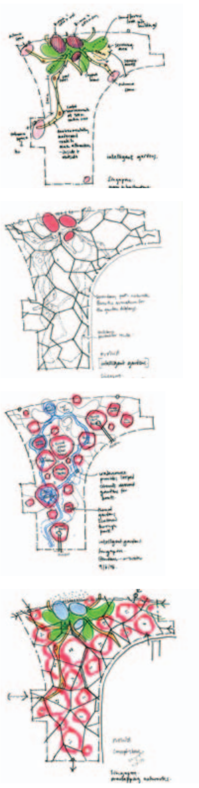


Fig. II-B.14: Design development

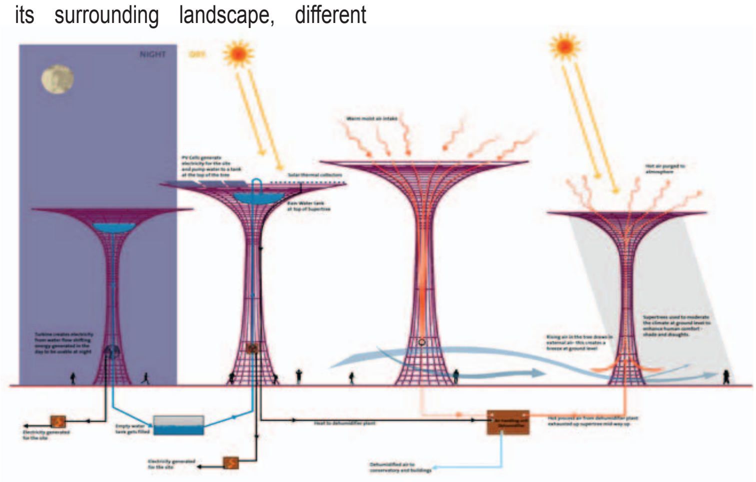


Fig. II-B.15: Supertrees

plans for the pedestrian and vehicular linkages from the surrounding developments and public transport stations have been planned. The landscape design proposes landforms that, based on the prevailing winds, will create spaces with gentle breezes. At the same time tree canopies, plant trellises and other structures such as the cooled conservatories and supertrees will provide shade and shelter in most parts of the gardens.

Keeping the environment in mind the gardens are designed to adopt environmentally sustainable technologies. Integrated into the design, a lake system takes into account the aesthetics and hydrology within the gardens catchment. It serves to capture runoff from within the gardens and acts as a natural “Eco-filter” that cleans the water using aquatic plants.

The so called supertrees are tree-like structures dominating the gardens landscape. They are planned as vertical gardens that fulfill a multitude of functions, as for example space for planting, shading and different ecological and environmental functions for the gardens . The Supertrees also serve as air intake and exhaust functions as part of the conservatories' cooling systems.

In addition to the supertrees, canopies and natural planted trees, other measures to cool down open spaces include greened and shading arcades or pavements with reflective materials are also used.

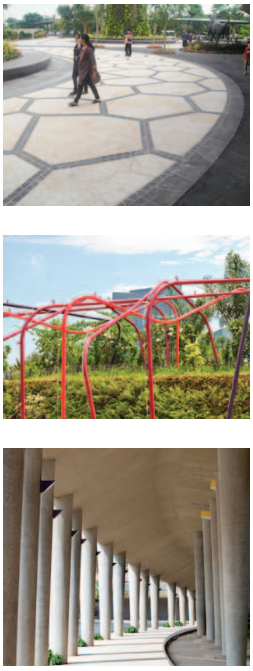


Fig. II-B.16: Concept measures for shading and reflective pavement

Fig. II-B.17: To cool down open spaces several measures are used in singapore as for example arcades to shade pedestrian pathways, canopies and artifical trees on squares as well as fans inside of roofed public spaces. (Photo: Eckert R.)

References & Resources

Emmanuel, M. R. (2005). An Urban Approach to Climate-Sensitive Design. Stategies for the Tropics. Abingdon, Oxon: Spon Press.

Huynh, C. and Eckert, R. (2012). Reducing Heat and Improving Thermal Comfort through Urban Design – A Case Study in Ho Chi Minh City. In: International Journal of Environmental Science and Development, Vol. 3, No. 5, pp. 480-485.

Gartland, L. (2010). Heat Islands. Understanding and Mitigating Heat in Urban Areas. London: Earthscan Ltd.

MKULNV NRW (Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz des Landes Nordrhein-Westfalen), Ed. (2010). Handbuch Stadtklima. Maßnahmen und Handlungskonzepte für Städte und Ballungsräume zur Anpassung an den Klimawandel. Düsseldorf: MKULNV NRW.

Shaw, R., Colley, M., and Connell, R. (2007). Climate Change Adaptation by Design: A Guide for Sustainable Communities. London: TCPA.

Best-practice Projects

01 Masdar Institute, Masdar City, UAE, Abu Dhabi

Masdar City. Exploring the Masdar Institute Campus. Available at: http://www.masdar.ac.ae/data/grkwx8r2t752.pdf

Foster and Partners. Projects Masdar Institute, Abu Dhabi, United Arab Emirates 2007-2010. Available at http://www.fosterandpartners.com/projects/masdar-institute/

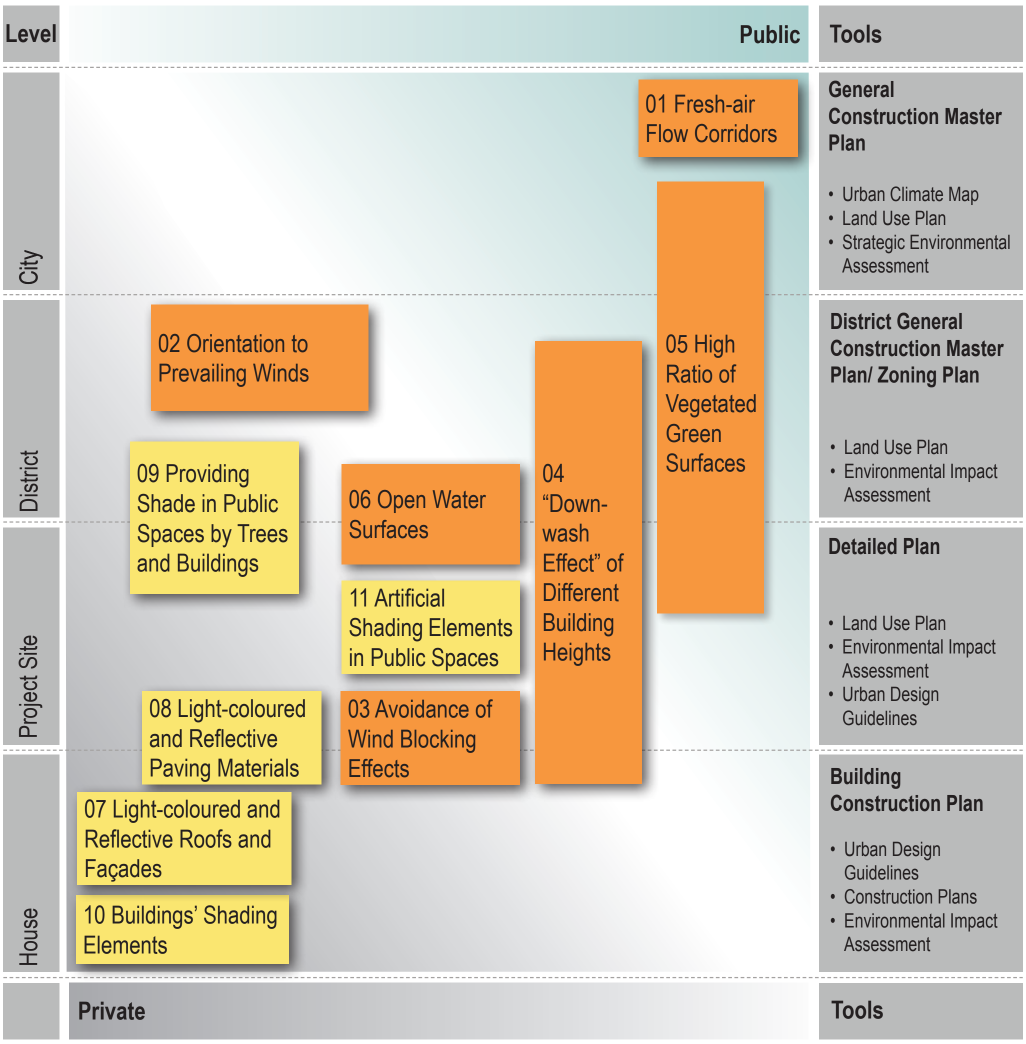
02 Gardens by the bay, Singapore

Grant Associates. Project Garden by Bay, Singapore. Available at: http://www.grant-associates.uk.com/projects/85-gardens-by-the-bay/4777-gardens-by-the-bay.aspx

II-A. Managing urban cooling

II-B. Managing solar radiation

Outlook of the Selected Strategies



III.
Case Studies

Methodology

Two study sites were selected within the HCMC administrative area to test, demonstrate, and evaluate the applicability of the proposed urban design strategies on specific sites. All of the sites are representative current urban development in HCMC.

Based on the existing situations of the two sites and the urban design schemes, which were proposed by a private developer and a local authority, the alternative urban design scenarios, the so-called alternative scenarios, were conducted, aiming at improving the climate change adaptation abilities of the two sites to flood risks and high heat load. The new urban designs, hence, offer opportunities to compare the existing scenario with the planned scenario for each site, and to evaluate the proposed strategies (Fig. III.1).

The new alternative urban designs were proposed with the same gross floor areas with the planned, but were adopted and integrated with the selected urban design strategies as proposed in Chapter I & II with different building forms, orientations, site coverage, vegetation models, and façade & building materials. The alternative urban design, hence will demonstrate how the selected strategies in Chapter I & II can be applied to specific locations.

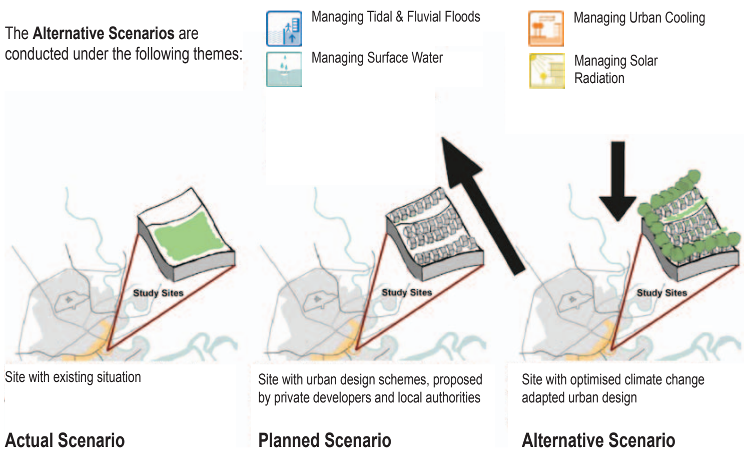


Fig. III.1: Methodology to assess the case studies

General Introduction to the Case Studies

The selected two case studies are Vo Van Kiet Boulevard and Nhon Duc Residential project. Both of them are particularly representative for the current urban development and redevelopment of HCMC.

The Vo Van Kiet Bourlevard is a mixed-used and high-rise development project, located in the inner city in between district 6 and 8, which is historically subject to flood risks. Meanwhile, the Nhon Duc Residential Area is located on a empty wetland area, outskirt of the city, and represents the urbanisation into low-lying areas of HCMC.

Both case studies are under high risks of flooding and urban heat island effects. However, current planned scenarios have not been under considerations to these risks. Hence, the alternative design schemes are conducted to optimise adaptation abilities of the two sites to the future climate change risks.


VO VAN KIET BOULEVARD


NHON DUC RESIDENTIAL AREA

Fig. III.2: Locations of the two case studies (Based map: Storch & Downes 2012)

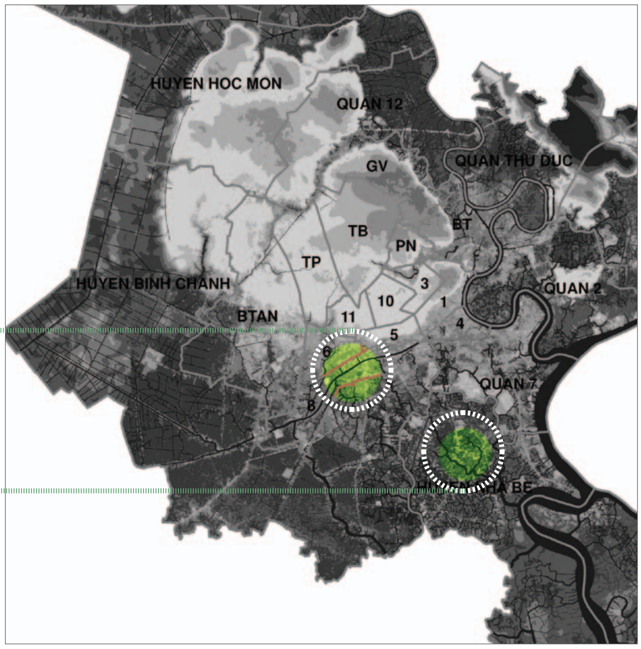


PHOTO CREDIT: Ronald Eckert

Site 1: Vo Van Kiet Boulevard

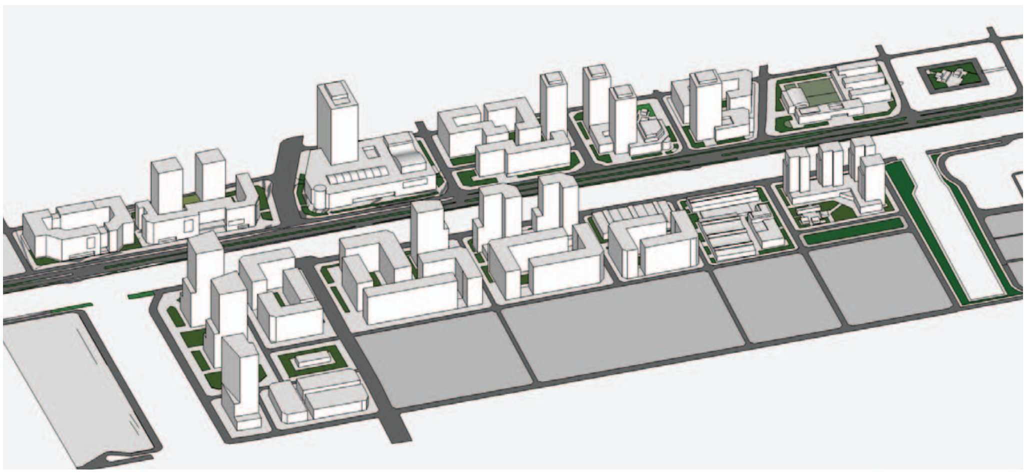
The first site is a 60 hectare inner-city area, located between the Districts 6 and 8. This is part of a larger urban design study by the Department of Planning and Architecture HCMC (DPA), which examines the potential and limits for a higher utilisation of urban land along the newly opened 'East-West-Highway' ('Vo Van Kiet Boulevard'). The objective of this project is to regulate the future urban development and form through a urban design guideline set, which controls building densities, floor area ratios, building heights.

The selected area is currently dominated by smaller industrial sites at the waterfront, partly abandoned warehouses and small-scale housing areas with row houses and narrow street patern. It will be subject to a transformation into a newly developed high-density and high-rise housing and commercial and office area, according to DPA's draft plans.

This area is located on low-lying land within the 'Tau Hu – Ben Nghe Canal Basin' and faces regular urban flooding. Additionally, the site is part of a city-wide ventilation corridor which provides fresh air to several inner-city districts.

The existing building materials mostly are brick walls and concrete or metal roofs. Most of the surfaces are sealed with asphalt, concrete and cement. The existing greenery are scattered along the

Fig. III.3: Planned urban design along the Vo Van Kiet Boulevard (Adapted from DPA)

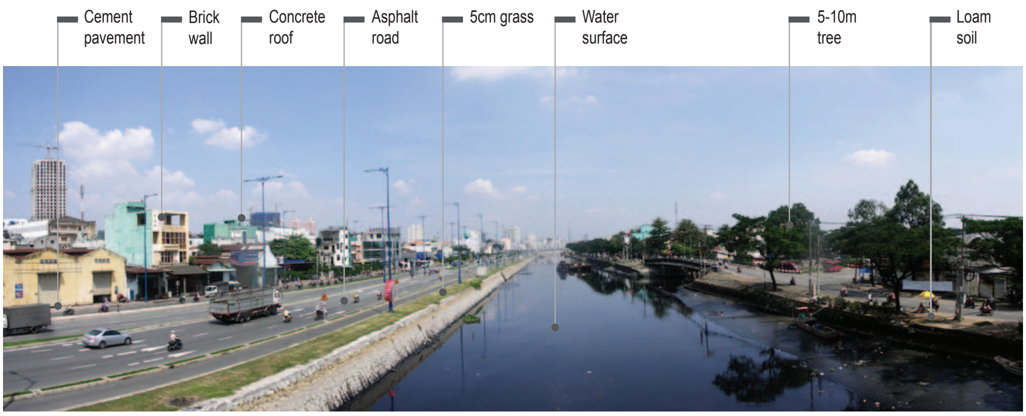


Vo Van Kiet Boulevard	
Location	10°44'N, 106°38'E
Wind speed	2 m/s
Wind direction	30° (along the canal)
Existing Materials and Greenery	
Pavement	Cement
Streets	Non-porous Asphalt
Building roofs	Concrete & Metal
Building walls	Brick
Soils	Loam
Street greenery	5-10m trees
Ground greenery	5cm grass
Building greenery	None

streets with 5-10m height trees, and the current green coverage is approximately just 2% of the total site area.

The research on this planning area should assess among other questions, whether higher building densities and building heights will influence the ventilation function of the 'Tau Hu Canal', how the planned urban form could be optimized to decrease possible negative effects on the ventilation or which measures and strategies could be incorporated into the planned urban design to provide a local flood protection.

Fig. III.4: Existing situation along the Vo Van Kiet Boulevard (Photo credit: Eckert R.)

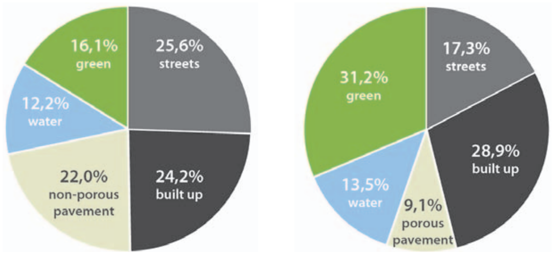


Comparision of the Three Scenarios

Fig. III.5: (Right) Actual scenario (Adapted from Google Earth 2012)

Fig. III.6: (Below) Planned scenario (DPA)

Fig. III.7: Comparision of surface coverage



PLANNED SCENARIO

ALTERNATIVE SCENARIO

The Planned Scenario is shown with the below insufficiencies concerning climate adaptation:

Insufficiencies regarding flood risks:

- insufficient flood protection and adaptation to buildings
- paved surfaces will increase the risk of surface runoff
- no retention areas for floodwater and rainwater.

Insufficiencies regarding high heat load:

- paved surfaces will cause the high solar radiation abosorbent
- building orientations are regardless to main wind direction, and will cause wind blockage effects
- Building heights are regardless to the main wind direction.

The Alternative Scenario is designed to adapt to the micro-climate conditions and to protect itself from flood-risks. By adjusting the building orientations and building heights, the design attempts to enhance the natural ventilation into the area. Additionally, most of the sealed surfaces are replaced with green surfaces, which will be used as open public spaces and flood rentention areas. Detailed applied measures are shown in the following pages.

Fig. III.8: Alternative scenario

Waterfront Protection Structures („Wet“ protection)

- let the waterfronts accommodate flood-water, instead of walling it off
- waterfront spaces are used as public spaces such as terrace plazas or river parks

COMPLEMENT

Preserve Floodplains

- protect the flat areas adjacent to river in order to give space for floodwater
- buffer zone is ulitised with flood-friendly land uses such as playgrounds, sports fields, agriculture lands.

I-A.07

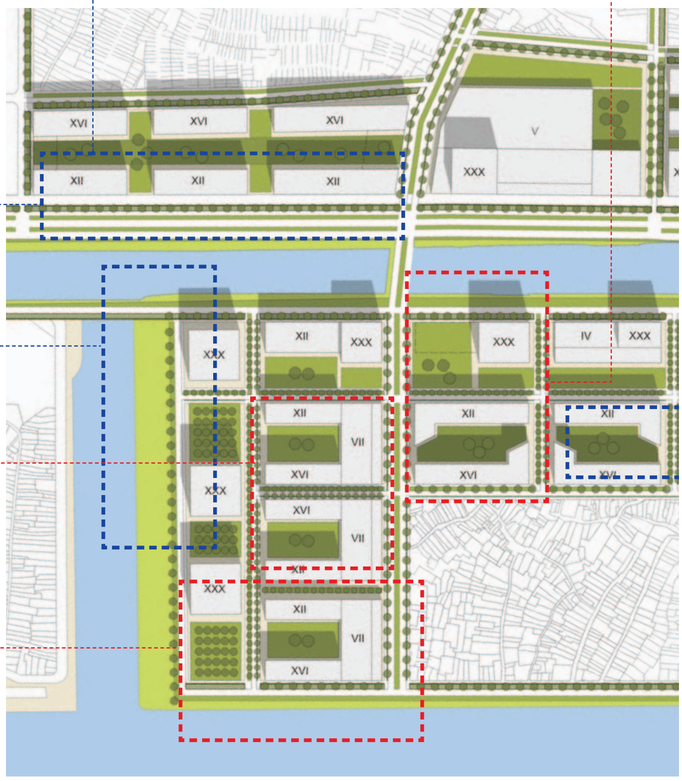
I-A.08

Building Protection Structures

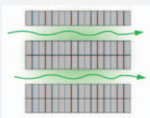
- waterproof materials on walls and floors
- elevating vulnerable equipments/electricity
- elevated ground-floor

II-A.04

I-A.03



Orientation to Prevailing Winds



- assure fresh air supply, building orientation should consider wind directions, avoidance of wind blockers like smaller buildings or trees
- streets must be wide enough

CONSIDERATION

Providing Shade in Public Spaces by Trees and Buildings

- trees along streets protect buildings and streets from direct solar radiation
- shade from trees and buildings improve thermal comfort in open spaces

II-A.02

II-B.09

Light-coloured and Reflective Paving Materials, Roofs & Façades

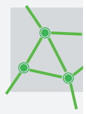
- light-coloured& reflective building and paving materials will reduce solar radiation absorbency
- not only colour but also material properties influence heat absorbency

II-B.07

II-B.08

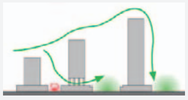
II-A.05

High Ratio



- green surfa tion absorb
- scatter gree same effec

„Downwash effect“ of Different Building Heights

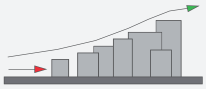


- different building heights to enhance ventilation
- creat building permeabilities for winds to flow through

COMPLEMENT

II-A.03

Avoidance of Wind-blocking Effects



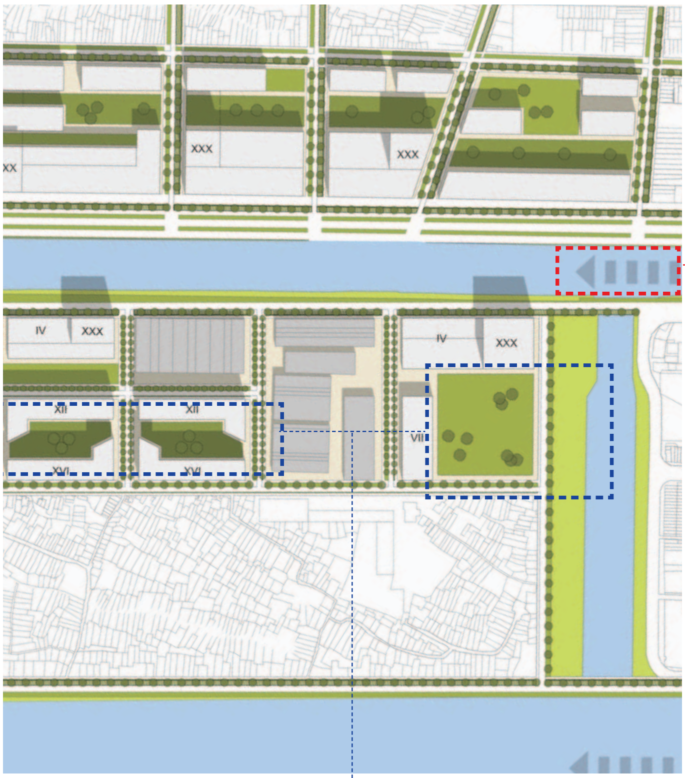
- buildings along water front and located downwind should be the lowest

CONSIDERATION

I-A.06

Highrise & Compact Urban Form

- minimize built up area to maximize green spaces and water retention areas



II-A.01

Fresh-air Flow Corridor

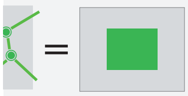
- preserve windflow corridor at the citywide level
- help to enhance ventilation and supply fresh air into the city
- can be combined with large streets, canals or green corridors

VO VAN KIET BOULEVARD

ALTERNATIVE SCENARIO

0 50 10 200

of Vegetated Green Surfaces



ces helps to reduce solar radia-
ency
n spaces have almost the
as a centralised green space

COMPLEMENT

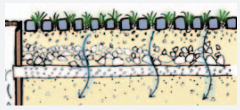
I-A.05
I-B.15

Temporary Urban Storage Infiltration Drainage

- open spaces such as neighbourhood parks or sport fields can be multi-used used as floodwater storage basins
- vegetated swales are designed in between the building blocks to convery run-off and infiltrate stormwater into the grounds to remove pollutants

I-B.09

Permeable Pavements



- replace impervious pavements with permeable pavements to allow infiltration and reduce runoff

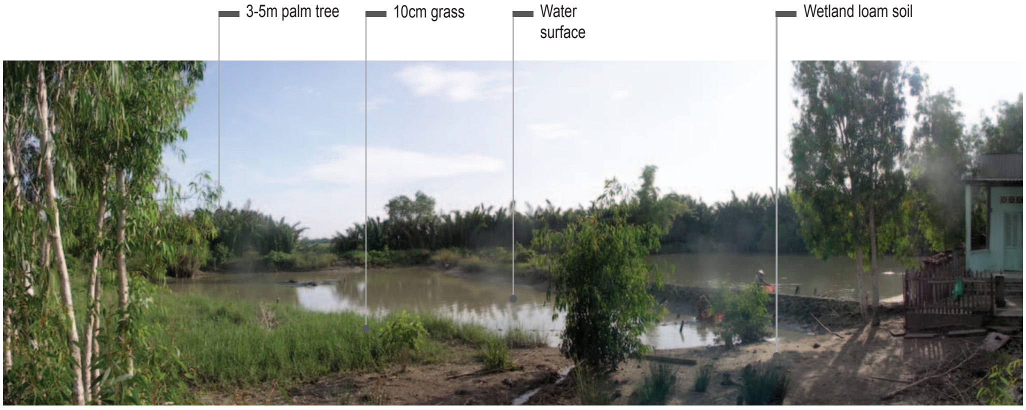
Site 2:
Nhon Duc Residential Area

The second site is a 40 hectare area in the southern wetlands of HCMC in District 'Nha Be', Ward 'Nhon Duc'. This is a new medium-scale housing neighbourhood is planned by a private developer. The existing entire area is very low-elevated and marshy, partly used for shrimp-farming and mostly not accessible. A construction of buildings or infrastructure without any land elevating would be impossible.

Existing housing structure is just a few temporary houses, which will be re-located in the future under the pressure of the new development project. The land is occupied mostly by 3-5m palm trees and many small lakes and streams. Most of the surfaces are un-sealed and open surfaces, covered by grass and water.

Nhon Duc Residential Area	
Location	10°40'N, 106°41'E
Wind speed	3 m/s
Wind direction	135° (to the North)
Existing Materials and Greenery	
Building materials	Temporary wooden houses
Soils	Wetland, loam
Ground greenery	10cm grass 3-5m palm trees

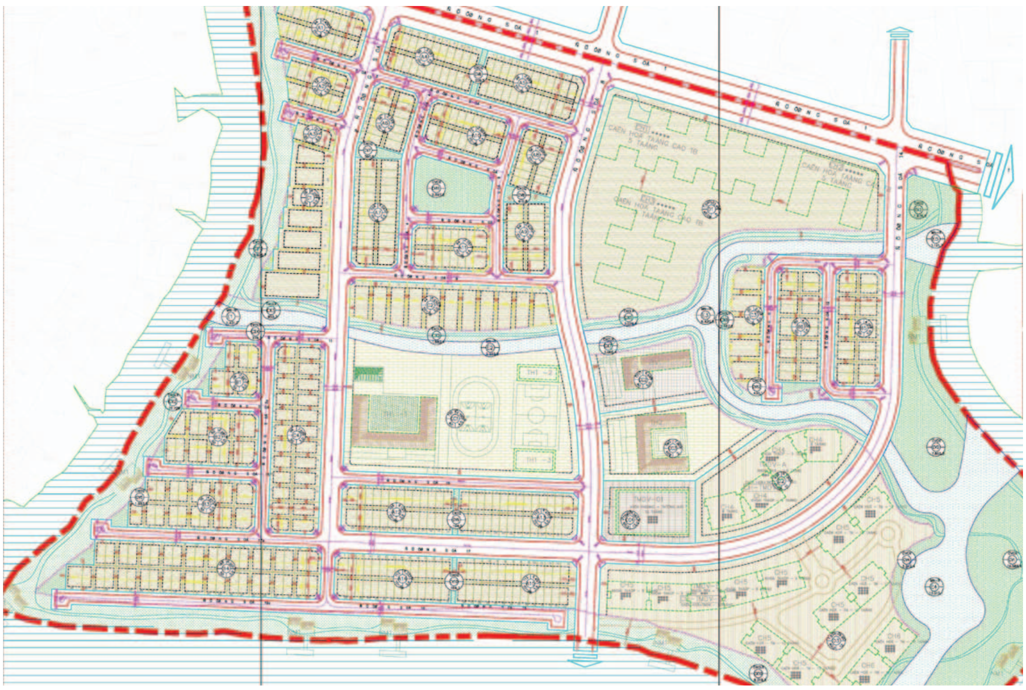
Fig. III.9: Current situation at the Nhon Duc Residential Area (Photo credit: Eckert R.)



The planned development project is a low-rise residential neighbourhood, including 3-4 storey row-houses, 5-11 storey apartments, some 10-11 storey apartments, one office and commercial building, and one primary school and a kindergarten.

This residential development project is symptomatic for the still on-going process of formal urbanisation in the southern and eastern flood-prone periphery of HCMC. However, similar to many urban designs in HCMC's flood-prone areas, this proposed urban design has not yet been integrated to flood adapted strategies, instead, it is a typical design for any location in HCMC.

Fig. III.10: Planned urban design for the Nhon Duc Residential Area (Nha Be People Committee)

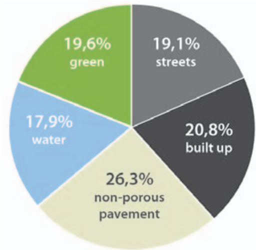


Comparision of the Three Scenarios

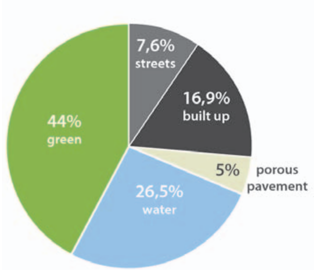
Fig. III.11: Actual scenario (Adapted from Google Earth 2013)

Fig. III.12: Planned scenario (Nha Be People Committee)

Fig. III.13: Comparision of surface coverage



PLANNED SCENARIO



ALTERNATIVE SCENARIO

The Planned Scenario is shown with the below insufficiencies concerning climate adaptation:

Insufficiencies regarding flood risks:
- no consideration of integration of flood adaptation although the site is located on a low-lying land
- strong channelising and landfill is destructing natural absorbent landscape

Insufficiencies regarding high heat load:
- high rate of paved surfaces lowers cooling effect of urban greenery
- some building blocks not adapted to main wind direction and cause wind-blockage effect.

The Alternative Scenario is designed to mitigate and adapt to flood-risks and the micro-climate conditions. The taboo zones and buffer zones allow certain building density but respect and consider absorbent function of natural riverbanks. Small scale solutions for rainwater harvesting and reuse will contribute to a decrease of surface runoff and lower water consumption of households. The building forms are adjusted to create more permeabilities and enhance ventilation.

Fig. III.14: Alternative scenario

II-B.07& 08

Light-coloured and Reflective Paving Materials, Roofs and Façades

- light-coloured& reflective building and paving materials will reduce solar radiation absorbency
- not only colour but also material properties influence heat absorbency

II-B.09

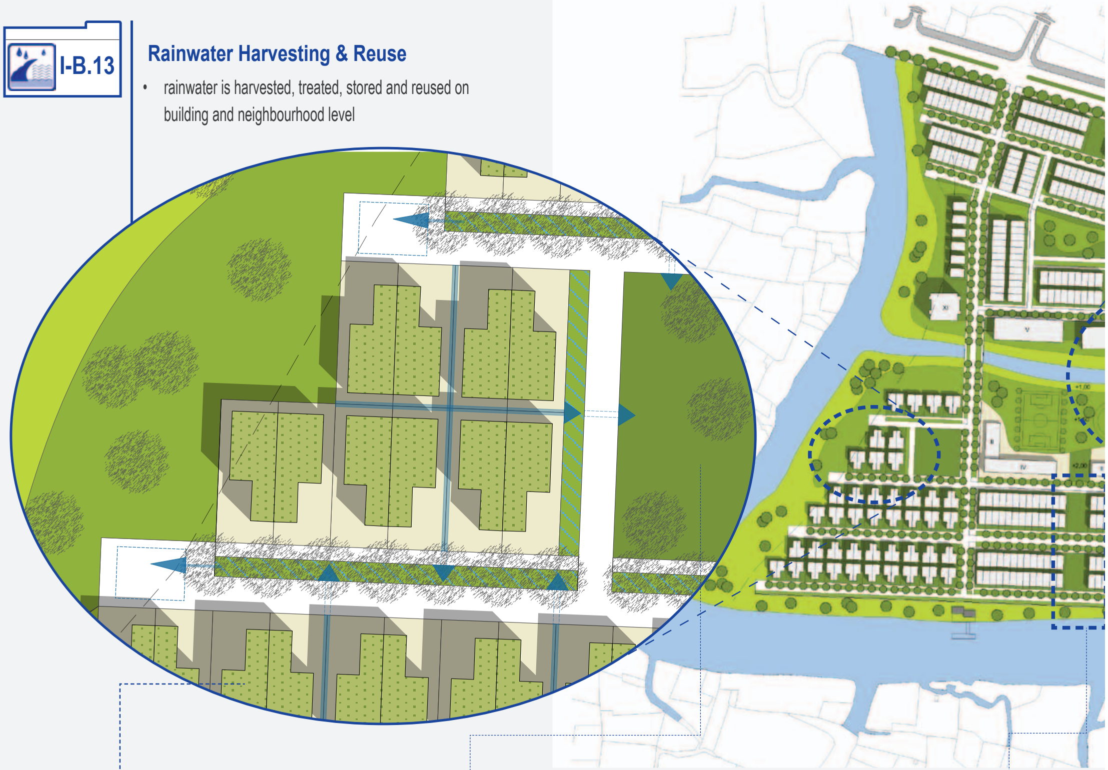
Providing Shade in Public Spaces by Trees and Buildings

- trees along streets protect buildings and streets from direct solar radiation
- shade from trees and buildings improve thermal comfort in open spaces

I-B.13

Rainwater Harvesting & Reuse

- rainwater is harvested, treated, stored and reused on building and neighbourhood level



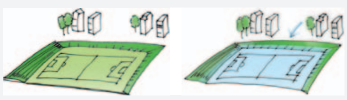
I-B.14

Green Roofs & Façades

- limiting the impervious surfaces of the city

I-A.05

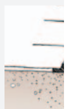
Temporary Urban Storage



- open spaces such as neighbourhood parks or sport fields can be multi-used used as floodwater storage basins
- floodwater is temporary stored in these urban temporary basins and released back to the river network when floodevents are over

I-B.15

Infiltrati

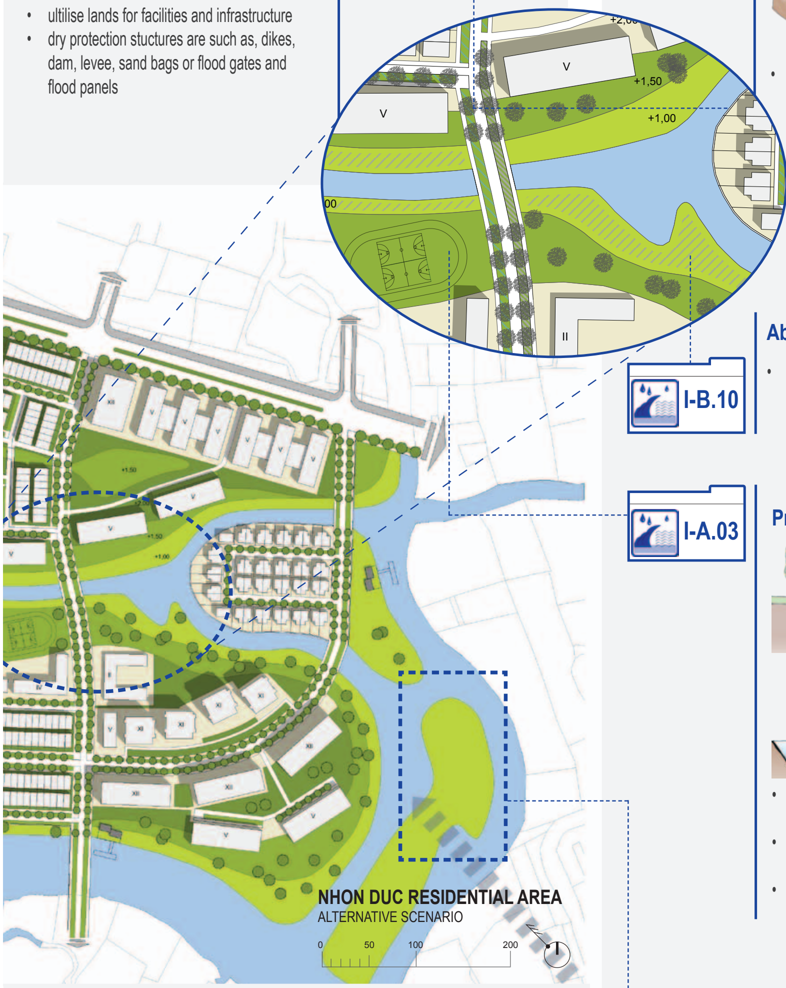


- vegeta blocks ground
- only ef the de

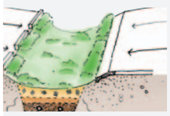
Waterfront Protection Structures („Dry“ Protection)

- prevent absolutely the encroachment of floodwater into urban areas
- ultilise lands for facilities and infrastructure
- dry protection stuctures are such as, dikes, dam, levee, sand bags or flood gates and flood panels

I-A.07



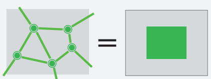
on Drainage



- ed swales are designed in between the building to convery run-off and infiltrate stormwater into the s to remove pollutants
- ective when groundwater table is less than 1m below igned surface

II-A.05

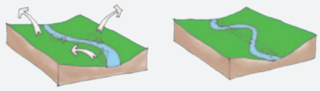
High Ratio of Vegetated Green Surfaces



- green surfaces helps to reduce solar radiation absorbency
- scatter green spaces have almost the same effect as a centralised green space

I-A.02

Re-naturalise Rivers and Channels



- un-sealed and natural embankment will enhance water infiltration capacity, reduce flow velocity and reduce downstream floods

COMPLEMENT

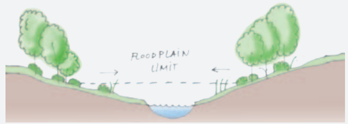
I-B.10

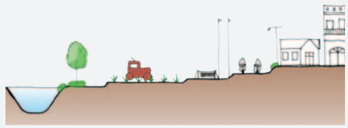
Absorbent Landscape

- natural designed / naturalised landscape with local trees, shrubs, grasses, surface organic matter.

I-A.03

Preserve Floodplains





- protect the flat areas adjacent to river in order to give space for floodwater
- buffer zone is ulitised with flood-friendly land uses such as playgrounds, sports fields, agriculture lands.
- flood resilient open space allowing temporary flooding on streets and open spaces without extensive damage

COMPLEMENT

I-B.12

Constructed Wetlands

- landscape design has to ensure that marsh planting fulfils the intended stormwater treatment function
- accessible as open space areas with viewing areas, pathway links, picnic nodes,..

Conclusion

Conclusions

HCMC should be urbanised and re-urbanised in priority on the high-elevated lands, which are minimum 2m higher than the average mean sea level. The approriate urban form should be high-rise and compact urban form, and integrated sufficiently with technical infrastructure as well as green and blue infrastructure. The current urban policies, standards and laws need be updated to promote this urban form.

Recommendations for an Optimised Urban Design

Generally, a further urbanisation of HCMC's wetlands, if can not be completely avoidable, should be concentrated in elevated areas or already raised transportation corridors to prevent further excessive land reclamation and large-scale land elevating. As the presented case studies reveal, a climate-compliant urban structure with the same density as the current is not impossible. Open spaces must be designed not only for recreational purposes but also as climate functional areas. Of course, the designation of connected green spaces, ventilation corridors, and areas for stormwater retention reduces built-up coverage.

The integration of climate change adaptation measures is crucial for a sustainable and resilient HCMC. Although the current urban design hardly provides capacity for a higher building density, new adopted typologies such as a stacked shop house with two housing units upon each other or multi-level residential buildings could allow for higher population densities. For existing building structures, there are renovation measures to enhance their resilience to climate chnages, such as green roofs and green or light coloured façades to mitigate solar heat and contribute to the water retention capacity.

Due to the high housing demand and the lack of high-elevated lands of HCMC, the urban sprawl into the low-lying lands seems to be difficult to advoid. However, rising temperatures and the need to manage heavy rain events and high tides call for a contrary urban form. The mixed-use and compact city form, therefore, integrating green and blue infrastructure will be the approriate urban form for HCMC. With this urban form, open spaces will be protected and preserved, hence it helps to enhance the city's adaptation ability by decreasing the soil coverage and introducing fresh air corridors and water bodies.

Generally, climate responsive neighbourhoods for HCMC call for a modified ratio of built and nonbuilt surfaces. Compared to current housing demand, the building density has to be increased on built surfaces, while open spaces have to be designed as climate functional areas. Particular emphasis should be placed on the orientation of buildings to enhance local ventilation; the provision of sufficient vegetation to increase evaporative cooling and shading effects; and the integration of on-site rain water infiltration and harvesting. Additionally, it should be noted that urban greenery has a remarkable impact on not only enhancing urban thermal comfort and reducing air temperature, but also create opportunities for floodwater storage and reducing surface runoff.

Fig. 2: Integration of guidelines into national laws and codes

Scale	**Planning Level** according to Urban Planning Law/ Construction Law		**Statutory Planning Tools**	**Codes, Standards, Laws**	**Applicable Sectors**
City	Regulations at **General Construction Planning Level**	SEA*, Land Use Plan, Infrastructure Plan	General Construction Master Plan (1:50.000, 1:25.000)	Building Code for Regional and Urban Planning and Rural Residental Planning (04/2008/QĐ-BXD)	**Level 1 Guidelines**
District			District General Construction Plan (1:10.000,1:5.000)	Urban Planning Law 2009 (30/2009/QH12)	
Neighbourhood	Regulations at **Zoning Planning Level**	EIA**, Land Use Plan, Infrastructure Plan	Zoning Plan (1:5.000, 1:2.000)	Decree for SEA in Construction and Urban Planning (29/2011/NĐ-CP)	**Level 2 Guidelines**
Single Project	Regulations at **Detailed Planning Level**	EIA, Land Use Plan, Urban Design Guidelines	Detailed Plan (1:500)	Decree for EIA in urban planning (01/2011/TT-BXD); Master Plan of HCMC to 2025 (24/QĐ-TTg)	
Single Building	Regulations at **Building Level**	EIA, Construction Plan, Urban Design Guidelines	Building Construction Plan (1:100, 1:50)	Building Code (QCXDVN 01:2008) Energy efficiency code (40/2005/QĐ-BXD)	**Level 3 Guidelines**

* SEA: Strategic Environmental Assessment

** EIA: Environmental Assessment Impact

Sectors addressed in this Handbook

Tidal & Fluvial Flood Management; Surface Water Management; Urban Cooling Management; Solar Radiation Management; Compactness; Energy Efficiency; Spatial Decentralisation; Sustainable Mobility

Integration of New Planning Strategies & Instruments into the Planning System

The improvement and adaptation of current urban design and construction practices require the integration of new planning strategies, regulations and measures into the existing planning processes.

The overall aim of these regulations is to limit and prevent negative impacts to the inhabitants and damage to buildings and infrastructure caused by climate change. However, it has become evident that a low extent of planning regulations is symptomatic for the Vietnamese planning system, in which plan-making processes and construction projects are regulated by only a few legal provisions and compliance is almost never observed. In this context, binding guidelines were identified as one suitable instrument to transfer adaptation and mitigation measures into the relevant plan making and political decision making processes. There is consent that increased regulation not only raises general environmental and quality standards, it can also serve as an effective approach to mainstreaming climate change adaptation into urban planning (Eckert, 2011).

In order to mainstream climate change response into the urban planning system and to improve response capacity, a dual strategy is promoted. On the one hand, a formal “top-down” oriented approach is being followed, in which goal is a readjustment of the legal foundation that frames lower order decisions and decision making processes. On the other hand, a bottom-up strategy is adopted, which aims to improve local response capacity in the urban planning and construction sector by applying a diverse set of un-structural and structural measures at the communiy level.

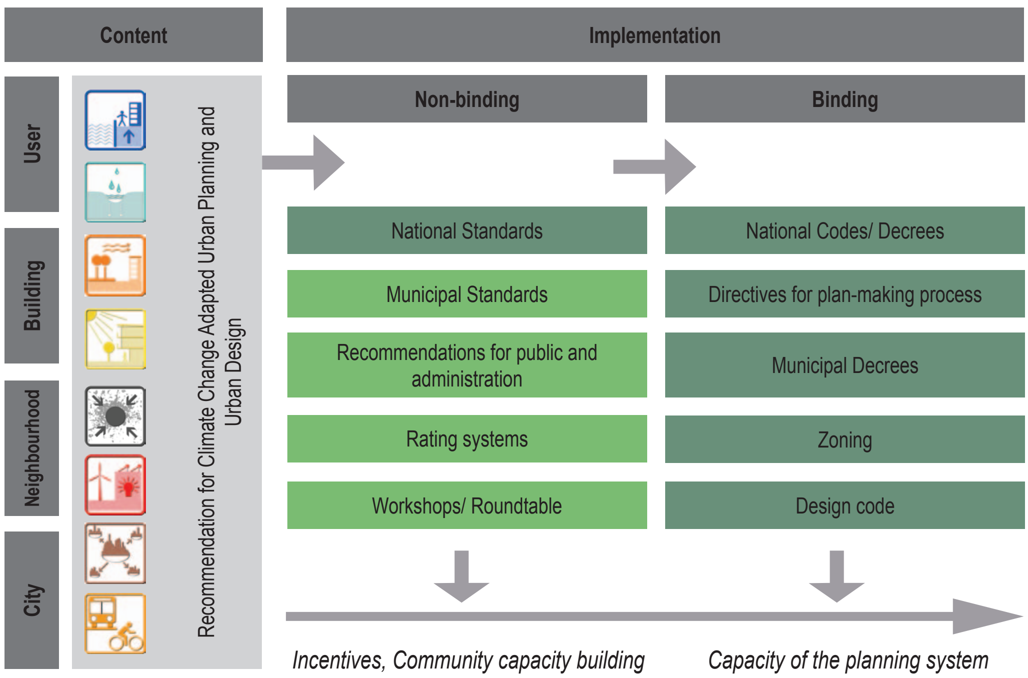
The top-down oriented, regulatory approach is applied firstly in response to a lack of regulation regarding climate change response. In order to fill this gap, new instruments like Urban design guidelines, Zoning plans and Strategic environmental assessments have to be incorporate into the planning system. Analyses of the formal planning system of HCMC show that opportunities for the legal integration are still identified. The development and incorporation of guidelines is a great chance to mainstream climate change response across various levels and localities.

However, the fundamental problem of the Vietnamese planning system seems to lie not only in the lack of formal regulations, but rather in the correct application and implementation of such. With this in mind, the top-down approach is complemented by a bottom-up strategy. The latter implies a diversified approach including the implementation of community participation schemes, the dissemination of knowledge through Handbooks, Manuals and Toolkits and climate change related Incentive Programs. Also, capacity building activities are regarded as a valuable tool to spread knowledge and to discuss challenges related to climate change and the promotion of sustainable urban development in Vietnam.

Fig. 3: Existing and proposed (binding and non-binding) planning instruments/ approaches for climate change integration

New approach, needs to be strengthened

Exiting approach, needs to be improved



References & Resources

Eckert, R. (2012): How Climate Changes Urban Design. Challenges and Consequences for the Urban Fabric of Ho Chi Minh City/ Vietnam. Online-Proceedings of the 10th International Urban Planning and Environment Association Symposium (UPE 10). Sydney: UPE.

Eckert, R. (2011): Designing Climate-Compliant and Compact Urban Structures for Ho Chi Minh City. A Contradiction in Terms? In: Gauthier, P. and Gilliland, J. Eds. Urban Morphology and the Post-Carbon City. Proceedings of the 18th International Seminar on Urban Form. Montreal: ISUF.

Brandenburg University of Technology Cottbus/ Germany
Department of Urban Planning and Spatial Design

Ho Chi Minh City
Department of Urban Planning and Architecture (DPA)

Prepared in the Framework of the
Megacity Research Project TP. HCM

Part of the Future Megacities Initiative funded by the
German Federal Ministry of Education and Research

© 2013 by Brandenburg University of Technology Cottbus

ISBN 978-3-00-042750-3

PHOTO CREDIT: Ronald Eckert

Brandenburg
University of Technology
Cottbus

Federal Ministry
of Education
and Research

Future Megacities
Megastädte von morgen

© 2013 by Brandenburg University of Technology Cottbus

ISBN 978-3-00-042750-3