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Climate Change and the Resilience of Megacities in South-East-Asia Creating Risk-Based Climate Change Information for Ho Chi Minh City's Settlements

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1 ABSTRACT

The emerging Southeast Asian Megacity of Ho Chi Minh City is experiencing a phase of rapid urbanisation and subsequent changes in city and regional land use patterns. Situated in an intra-tropical and low elevation coastal zone, the developing megacity is vulnerable to many of the adverse impacts of the present and future changes in climate. The paper summarises the impacts climate change will have on urban development in the mega-urban-region of Ho Chi Minh City. In consideration of climate change and urban development interrelations, the research case for adapting to climate change and the risks and opportunities of adaptation are set out. The methodological part of the paper provides generic guidance for using an Urban Structure Type approach to guide urban planning and the development responses to the impacts of climate change. It focuses on how to integrate the need to adapt to climate change into planning policy, the location of development, site layout and building design.

2 INTRODUCTION

Climate change represents one of the greatest challenges facing mega-urban regions in coastal areas of Southeast Asia. To meet this challenge the highly industrialised countries of Europe, North-America and Australia have to reduce their greenhouse gas emissions. Nevertheless all high-risk countries, such as Vietnam, have to recognise that some impacts of global climate change are unavoidable and as such there is an urgent need at present to start adapting these mega-urban-regions to the current impacts of extreme weather events and the predicted impacts of climate change to which they are likely to be confronted in the future. With more than half of Vietnam's population now living in low elevation coastal zones, defined as areas less than ten metres above sea level, coastal urban settlements are becoming increasingly vulnerable to the current and future impacts of climate change.

Climate change is likely to result in rising sea levels, more intense rainfall events and more frequent heat waves. The likely impacts of these on human settlements in emerging countries such as Vietnam include increased damage to housing and infrastructure, an increased energy demand, more vector-borne diseases, and increased stress on storm water management systems. The current urban development trends in Vietnam increase the vulnerability of settlements to climate change in large mega-urban regions. At the same time coastal settlements in the mega-urban regions of Vietnam are important in terms of population growth and investment and are playing a key economic and cultural role.

Most of Vietnam's settlements and infrastructure are concentrated in large mega-urban regions located at the two mega-deltas regions. Over the next decades a significant amount of new urban housing developments will be required in Vietnam, and particularly in the upcoming two megacities Ho Chi Minh City, located north of the southern Mekong river delta and Hanoi, which is located in the Red River delta in northern Vietnam. These new urban developments will shape the spatial pattern of the urban agglomerations for many decades. It is therefore of highest importance to plan in an integrated manner from the outset, how the spatial development direction in general and how buildings and infrastructure in these highly vulnerable regions in detail can be adapted to cope with the climate change related impacts they are likely to be effected over their lifetime.

Similar to other emerging mega-cities in Southeast Asia, Ho Chi Minh City (HCMC) is undergoing a rapid process of urbanisation accompanied by dramatically land use changes in the surrounding rural areas. An integrated Adaptation Planning Framework sets out the climate change adaptation issues that responsible administrative institutions, urban and regional planners and developers should consider and respond at different spatial levels of the urban development process, to ensure that the new urban development and communities are constructed sustainably—so that they remain safe and liveable places for their future lifetime.

3 IMPACTS OF LOCAL AND GLOBAL CLIMATE CHANGE ON HO CHI MINH CITY

As a densely built-up urban area in a flat low lying region, Ho Chi Minh City (HCMC) is historically a region sensitive to climatic effects, mainly due to its location, 50 km from the South China Sea and northeast of the Mekong River Delta in an estuarine area of the Dong Nai River system with a high flow volume. The city is surrounded by marshes on the lower reaches of the embedded river system. The Saigon River, Dong Nai River, Nha Be River and Long Tau River flow through the city, and the rivers and canals form a complex network that is affected by the tide. The majority of the actual urbanised land is only 2 to 3 meters above the current sea level. This low elevation and heavy rainfall makes the city susceptible to flooding induced by tidal fluctuations. From October to January when high tide reaches its peak (1.5 meters), the water level in rivers and canals rise as high as, or more than that of the land elevation (Nguyen Huu Nhan 2006/Ho Long Phi, 2007). Each year, HCMC suffers many serious floods, not only in the rainy season from May though to November, where monthly average rainfall is 250 mm, but also during the season with high tide from September though to January (Duong Van Truc & Doan Canh, 2006). The number of flooded locations, their frequency and their duration has been seen to increase continuously (Ho Long Phi 2007). An additional cause for the serious problem of urban flooding is the process of ongoing rapid urbanisation, which has changed the land-use pattern of the metropolitan region. Natural streams, channels, lakes, wetlands and vegetation structures that can maintain the urban water balance have been replaced by impermeable surfaces causing increased surface run-off.

A regional climate change scenario (SEA START RC 2006) has showed that the lower Mekong River basin region will tends to get slightly warmer. Summer time in the region will be significantly longer in duration in the future. Hot days will increase by 2-3 weeks and the cool days will reduce also by 2-3 weeks. Rapid and dense urban expansion in HCMC has direct impact at the local scale by changing the urban climate. The additional impacts of future rises in temperature due to climate change, together with the observable increases in temperature due to urban heat-island (UHI) effects make Asian cities more vulnerable to higher temperatures (Kalnay & Cai 2003; Patz et al. 2005). The UHI-effect reveals the warming of the inner-core of HCMC that is significantly higher (up to 10ºC higher) than typical temperatures in vegetated urban areas or the surrounding rural areas (Tran Thi Van 2004; Ho Tong Minh Dinh et al., 2006/ Le Van Trung et al., 2006). Due to its geographic location this flood-prone metropolitan area will always face natural hazards. However, vulnerabilities of lives and livelihood to climate-related environmental processes are primarily the result of inadequate and unsustainable urban planning practices, associated with complex natural settings and societal structures. This combination accumulates to a high average level of physical and social vulnerability in most parts of HCMC.

4 DOWNSCALING CLIMATE CHANGE IMPACTS ON URBAN SCALE

Ho Chi Minh City's (HCMC) settlements are integrated in an urban system that is affected by a number of internal and external pressures and therefore the impacts of climate change on the city, its settlements and infrastructure should be assessed in the context of this complexity. Vulnerability to climate change will vary considerably from settlement to settlement and even within settlements. The location, urban structure, dominant building type, socio-economic characteristics and institutional capacity are key factors that affect vulnerability and adaptive capacity of a settlement in the mega-urban region.

HCMC is characterised by urban structures of both planned and informal expansions of the urban morphology which are both degrading valuable natural areas in the hinterland, and are increasing the vulnerability of these areas to climate-related environmental changes or hazards. Additionally exposure to and sensitivity for climate change related risks and impacts are a result of physical processes, such as the building construction, urban planning, infrastructure provision or the transportation, creating these hazards, and the human processes, such as lifestyle choices, that lead to these vulnerabilities (Clark et al. 1998).

The main task in downscaling climate change assessments on urban level is that every region has its own urban development issues and possible adaptation options. In general, there is a methodological gap between the regional climate change model and urban development scenarios, which are limiting effective impact assessment (see figure 1). Knowing future temperature, precipitation and flooding trends without knowing the general urban development path, limits the assessment of vulnerabilities of the future urban structures in relation to the future climate conditions in a regional context.

For regional climate change projections, extreme events are more important than average events and it will be difficult to predict simultaneously increases in magnitude and in frequency of events. For urban development scenarios a higher degree of flexibility is required but a rigorous approach is essential to produce spatially explicit and comparable results.

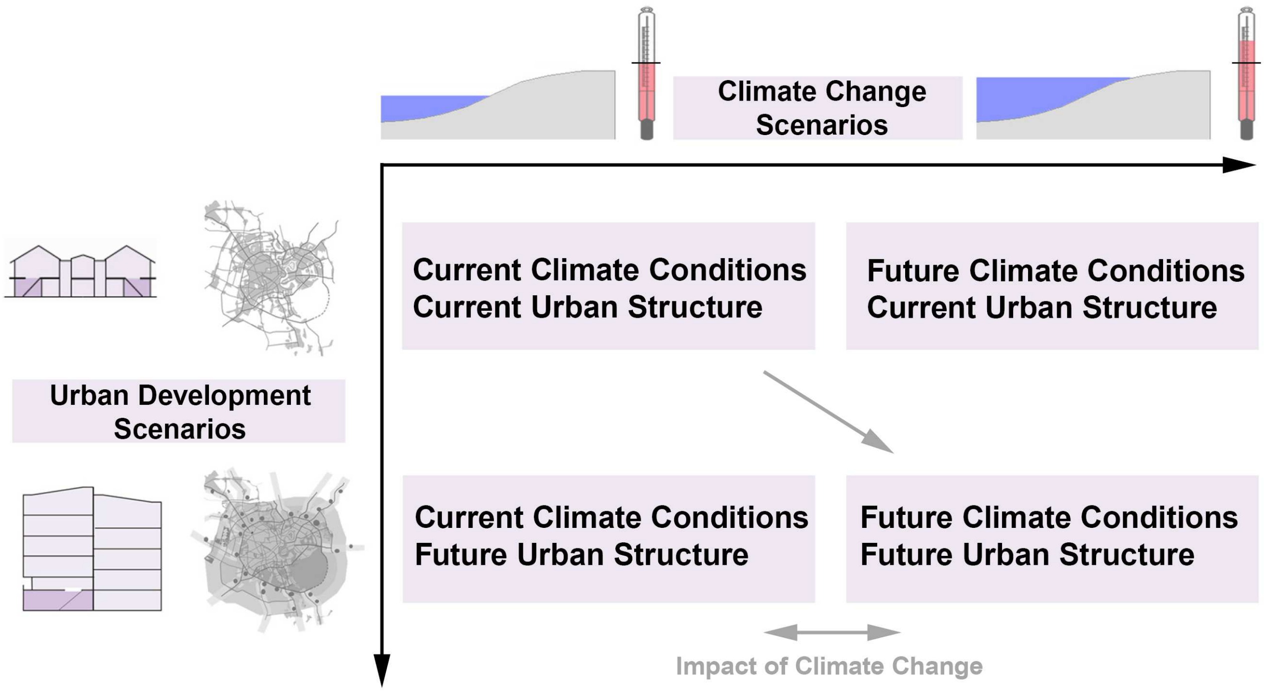


Fig. 1: Vulnerabilty Assessment of Climate Change Impacts for Mega-Urban-Regions

4.1 Spatial Adaptation Planning Framework

The urban environmental planning information system represents the central instrument to integrate the requirements and measures for adaptation to climate change supported by the urban structure type approach. A comprehensive analysis of results from previous project phases and additional existent planning tools, methods and processes will be the basis for the coordination and cooperation. The main function of the urban structure type approach is to spatially link an indicator concept which represents an interpretative method to integrate the biophysical aspect of the 'Exposure' to climate change related effects with the socio-economic aspect of assessing the 'Sensitivity' of people and places and environmental-related information. The urban structure type approach thus allows a multi-disciplinary identification of core indicators for spatially explicit 'vulnerability assessment´ procedures.

The second main function of the urban structure type approach is the definition of a commonly accepted framework to structure HCMC into comparable types of spatial areas. This concept has been developed in cooperation with the partners of the field of urban planning as a practicable and appropriate method for the urban and environmental integration of our research in HCMC (Storch & Eckert 2007). The concept of neighbourhood can be seen in many ways by different scientific disciplines in an urban development context. Nevertheless, urban planning and especially planning information systems always have the need for the definition of an explicit physical reality (Wickop 1998). The concept of urban structure types is offering a multi-disciplinarily approach, which is essential in dealing with the inherent complexity of the urban environment in Asian Megacities. This common spatial framework based on urban structure and morphology, supports the necessary downscaling of climate change related impacts on urban areas and is in the case of vulnerability assessment procedures bridging the gap between the spatial scale and physical methods of urban environmental planning and the concerns of regionalised climate change research practices (Pauleit & Duhme 1998). The spatial classification and subdivision of HCMC's urban form according to urban typological principles, derived from urban environmental indicators, offers a coherent structure to support cross-scale investigations across household, neighbourhood, district and urban-scale. In this respect, the developed urban structure type framework defines urban areas with homogenous characters, which integrate similar urban environmental conditions, and can provide a classification method of the morphological situation and the characteristics that can be expected in different areas. The urban structure type method integrates valuable urban indicators with regard to environmental, housing, and population aspects (Storch & Schmidt, 2006). Features of built-up areas, impervious surfaces, land use, housing types, and building density, population density and social status of urban areas can be related for every urban structural unit. Thus, the urban structure type framework contains a whole set of biophysical and socio-economic indicators (Banzhaf et al., 2007) to characterise the state and dynamics of the urban development in space and time as well as to foster planning strategies for adaptive urban development to climate change.

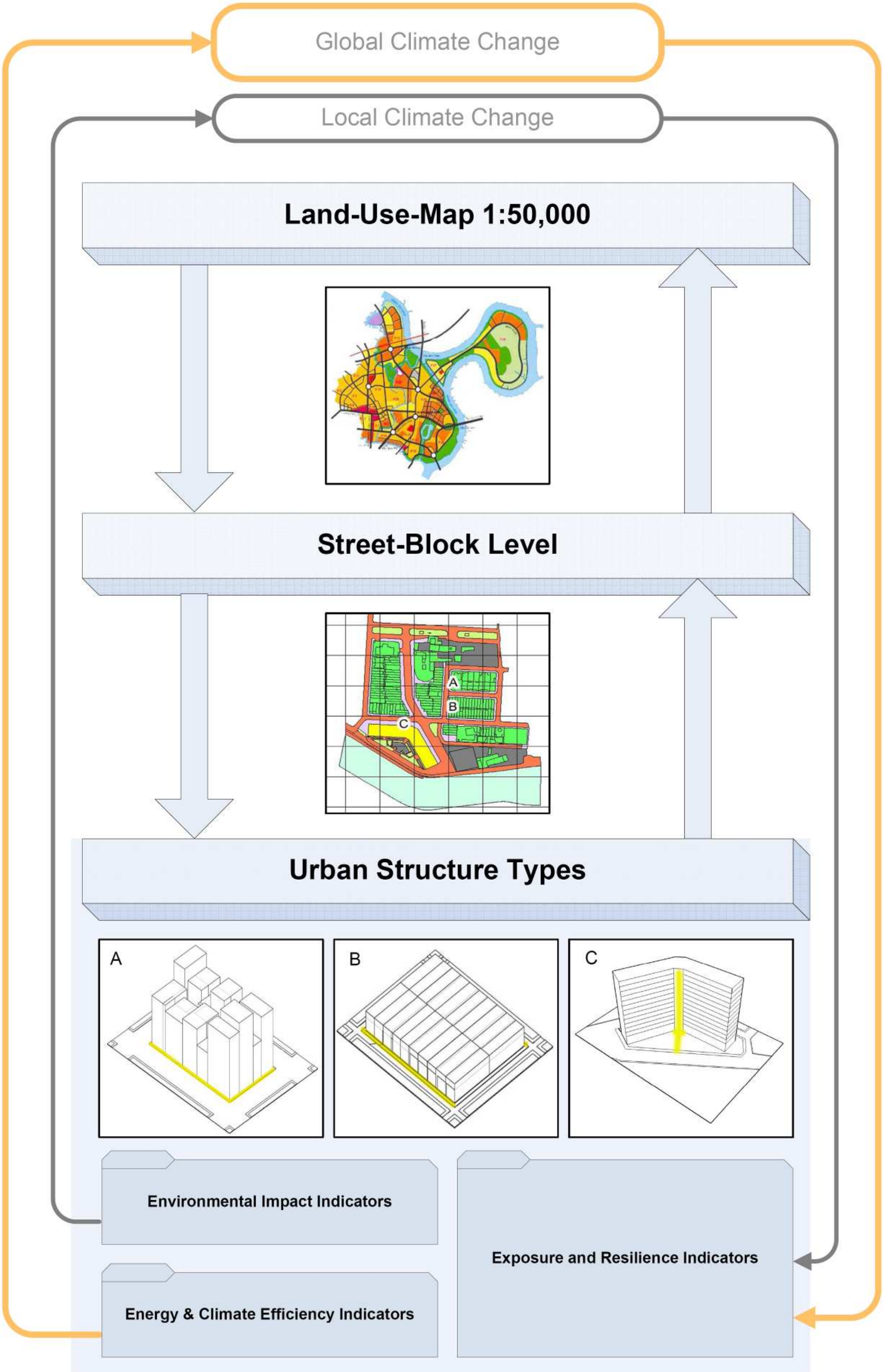
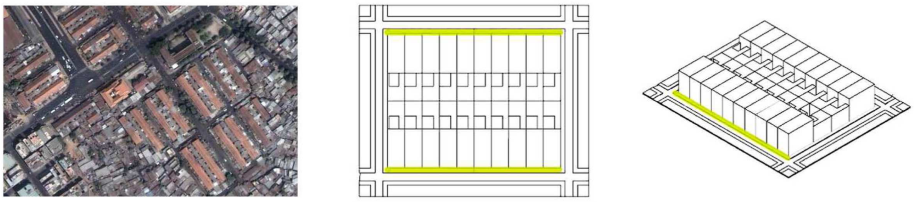


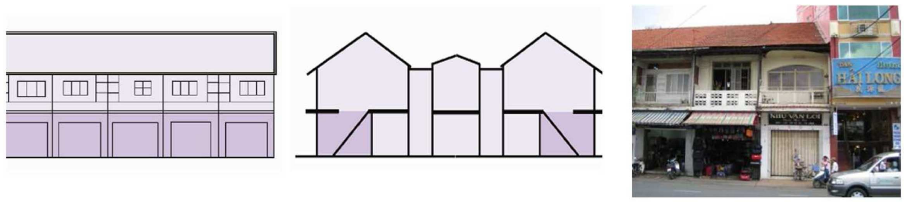
Fig. 2: Downscaling Climate Change Impacts On Urban Scale

4.2 Common Spatial Framework based on Urban Structure Types on Street-Block Level

Adaptation planning to Climate Change in an urban development context requires different strategies for different settlement types, because spatial planning concepts are very dependent on the particular local urban context. Different settlement types will have different implications for achieving the 'vulnerability' of different settlement and housing structures. Different discipline-specific methodological approaches to the 'urban environment' require a commonly accepted spatial working basis, which can ensure that the resulting heterogeneous investigations can be trans-disciplinarily integrated by using an adequate spatially explicit classification. The urban structure approach is providing a uniform methodological and spatial framework for the different tasks within the interdisciplinary network of the research project. Housing-related urban development decisions require a rational characterisation of urban structural landscapes according to structural indicators reflecting the degree of resilience and vulnerability of housing areas in HCMC. The typology approach ensures that data integration of different sources (remotely sensed, field-based, survey-based and map-based) with their original specific spatial/temporal resolutions and thematic contents can be operationally integrated in the GIS environment of the research project.



Name: Shop House / Code: 01j
Oldest form of Shop house, scattered in the old town: two floors



Location	Inner-City (old town)
Street Network	Regular
Layout	Back to Back
Access	Street
Block size	Small (100*40)
Height (floors)	1-2
Built up Ratio	Low
Housing Mix (types)	Low
Usage Mix (res/public/com)	Medium (Shops in the outside borders)
Utilisation	Ground floor Front :Shop Ground floor back: Residence Upper floor: Residence
Material	Brickwork, wood
B/D Width	2.5-6m
B/D Length	12-16m
Facade	
Age	
Additional Features	Sloping roof

No. 1 Shop house

No. 2 Shop house

No. 3 Villa

No. 4 High Density APT

Fig. 3: Urban Struture Types – Example of one Definition Card

Settlement and housing types in HCMC are not uniform. Understanding these different types in HCMC therefore becomes crucial to the urban planning debate in the field of adaptation to climate change for this metropolitan region. It is therefore not the primary goal to develop a general definition of settlement and housing typologies in HCMC. Rather, an analysis of the resilience and sensitivity of urban typologies in a relatively representative model of different settlement and housing types is needed to assess the adaptive capacity of different urban settlement and housing structures. Urban typologies can provide a tool for the structured and representative analysis of settlements in HCMC with its different components, of which the concept of 'Vulnerability' is in the context of adaptation planning to Climate Change an important one.

4.3 Definition of Urban Structure Types

Beginning with the basic housing archetypes in HCMC, each of these were conceptually divided into subtypes to generate urban structure types that are reflecting different biophysical exposure or impact indicators. Examples of the stepwise ordered selection rules are given in Figure 4.

Nr.	Type name	Description	Location	Street Network	Layout	Access	Block size	Height Floors	Built up Ratio	Housing Mix (Types)	Usage Mix (Res/public/Com)
	Shop house										
	Planned Grid Structure			regular							
1	01b_Shop house	large blocks with small inner road netwoks and pedestrian pathways	old Inner-City	regular	Back to Back	Street / both sides	medium-large 180*200	2-4	high	low	high
2	01c_Shop house	Small-sized blocks, every house plot is connected to a street	Inner-City	regular	Back to Back	Street	small 120*40	2-3	medium	low	medium (basically residential use)
3	01j_Shop house	Oldest form of Shophouse,scattered in the old town 2 floors	old Inner-City (old town)	regular		street	small 120*40	2	low	low	medium (Shops on the block periphery)
4	01i_Shop house	Orthogonal shophouse pattern in the city periphery	Outer Districts periphery	regular		street	small 100*40	1-2	low	low	medium (basically residential use)
5	01e_Shop house	Redevelopment site with shophouse typology for middle- to high- income groups, one/two family houses	new Redevelopment Area in Inner-City & New Development area	regular	New plots	Street	small 100*40	4-5	high	low	low
	Informal Structure			irregular							
6	01a_Shop house	Shop houses on the periphery (street-orientated) of an informal settlement area	old Inner-City	irregular		Street	very large	2-3	medium	medium	medium (Shops on the peripherey outside borders)
7	01a2_Shop house	Dense informal settlements along the canal one/two floors	Along the canals	irregular	Street-canal	Street & canal	no blocks	1-2	low	low	low
8	01g_Shop house	linear street orientated elongated Sprawl	Outer Districts periph	irregular	linear street orientated	Street / side	no blocks	1-2	low-medium	medium	medium
	Shop based Clearly mixed			regular							
9	01d_Hotel house	High-density tourist area with hotels, restaurants,services in shophouses	Inner-City, Dist. 1	regular	Back to Back or detached	Street	small 140*30m	2-8	very high	medium	high (basically commercial use, limited residential use)
10	01h_Town Rowhouse	Redevelopment site with shophouse typology for middle- to high- income groups (Rowhouse)	Newly developed areas	regular	Back to Back or detached	Street (often from 2 sides)	small 100*40m	4-5	high	low	low
11	01k_Shop Large unit (APT)	New Development a previously informal settlement area	Redevelopment Area in Inner-City & Newly developed areas	regular	one unit	Streets	small 140*30	4-6	high	low	medium (Shopson the outside peripherey borders)

Legend

Street Network
irregular
regular

Block size	Height Floors	Built up Ratio	Housing Mix (Types)	Usage Mix (Res/public/Com)
very large	>20 Floors	very high		very high
large	8 Floors <	high	rich	high
medium	4-7 Floors	medium	medium	medium
small	1-3 Floors	low	low	low

Fig. 4: Urban Structure Types – Example of Indicator-based Definition Rules

The most complicated structure in HCMC is represented by the shophouse structure, which was divided into more specific subtypes to reflect the broad variety of these predominant settlement structures occurring often in the inner-districts of HCMC. Examples of the physical building-specific indicators which were used to define the final housing typologies are given in Figure 3.

Each example study site represents one housing typology found within the settlement pattern of HCMC. First, these study sites were spatially defined through examination of high-resolution satellite images and later verified by ground recognition of pre-selected archetypes. Example sites were selected following two primary criteria: archetypical representation of the urban structure type and correlation to pre-existing statistical and spatial data sources. Each structure type is selected to represent one housing typology found within the neighbourhood pattern on the district level. The physical boundaries of the housing typologies are defined by street blocks. The study site is embedded within the surrounding urban fabric of the neighbourhood pattern. Data collected from the study sites for the representing housing typology will be used to formulate scores for physical resilience and exposure of the building structure based on descriptive indicators. The neighbourhood pattern is represented as a puzzle, in which the separate urban structural units fit together to form the complete picture of settlement developments in HCMC.

Clearly, the structure and arrangement of housing areas are factors influencing exposure and resilience to impacts of climate change in an urban spatial context. Recognition of this connection makes it possible to re-evaluate the housing development pattern as one fundamental determinant in the formation of urban vulnerability to climate change, because, if replicated on multiple sites, the housing development pattern becomes an integral part of the urban fabric of HCMC. The exposure and resilience pattern of each housing development helps to determine the ultimate vulnerability for climate change risks of the urban region. In the times of climate change urban resilience and exposure are strongly influenced by the choices that are made about which housing types to build (Storch & Schmidt 2008).

5 SUMMARY AND OUTLOOK

Future urban development scenarios for the mega-urban-region of HCMC are closely interrelated with climate change adaptation. The consequences of climate change will be influenced by the economic, social and technological conditions, which will for HCMC be very different from those of today. These conditions will have an effect on the vulnerability of HCMC´s future settlement structure to climate change impacts, by influencing the future 'adaptive capacity' – the ability of the biophysical urban structure to adapt to climate change impacts by increasing their resilience to climate change effects.

The small-scale spatial variability and heterogeneity of the urban landscapes of HCMC define a spatial pattern of vulnerability and risk. The basic concept of urban structure types is therefore the integrating approach for the assessment of vulnerability of the urban area of HCMC. Defined by the street network, the building-layers are presented as central information basis using the urban structure type approach. A further indicator-based classification of these structures enables the correlation of resilience with urban structures.

The most important adaptation strategy will be based on two options. First, the prevention of effects through combined structural and technological measures (e.g. construction of resilient buildings and housing structures, increase in the water storage capacity of new urban developments) and second, prevention of effects through legislative, regulatory and policy measures (e.g. planning policies that take account of climate change; amending design standards for more resilient building structures and (re)location of housing away from high risk areas.

As an initial result, the following recommendations can be formulated for decision making on regional and urban levels in the metropolitan region of HCMC:

1. the progressive biophysical effects and impacts of climate change need to be consequently mitigated at the urban regional scale;

2. spatially explicit vulnerability assessment procedures should contribute to an improved coordination of regional planning scenarios and target setting for adaptation of land use to climate change and mitigation of greenhouse gas emissions;

3. urban land uses of importance for adaptation to climate change should be more strongly weighted in urban development and land use planning;

4. urban structure types with potential for mitigation of carbon should be more strongly realised in scenarios for urban redevelopment;

5. institutional responsibilities at urban planning and regional activity levels for analysis and supply of information and data on spatial effects of climate change, exposure, sensitivities and vulnerabilities of the urban environmental structural components and the formulation of adaptation strategies should be precisely clarified and coordinated more efficiently;

6. cross-sectoral cooperation between land use planning and sector planning at the urban scale should be further improved for the development of common strategies for adaptation of Ho Chi Minh City to climate change.

Urban environmental planning needs to clarify its responsibilities for contributing to long-term achievements of regional adaptation objectives. Its procedural elements, which are directly linked to the vulnerability assessment process based on spatial information of the planning information system, should be strengthened and its objectives and area designations should be well integrated into regional and urban planning. Spatial planning bodies of the mega-urban region should take over increasing responsibility to voluntarily coordinate their activities with other sector planning authorities, in order to set common targets for adaptation of the region's area management to climate change.

6 ACKNOWLEGEMENT

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