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Adaptation Planning Framework to Climate Change for the Urban Environment in Ho Chi Minh City

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Abstract

The overall objective is to develop and incorporate adaptation into urban decision-making and planning processes with designation criteria and zones that will lead to an increase of resilience to climate-related physical and social vulnerabilities of the urban system of HCMC. Climate Change will likely change current climate conditions and lead to an ongoing sea-level rise and increase in extreme weather events such as heavy rainfall and heat waves etc. These climate related events cause a multitude of potential impacts and risks not only to natural areas but specifically to populations of densely built up metropolitan areas. In foreseeable future they may also cause indirect negative effects such as severe urban floods or disturbances of the energy supply or public transport systems in urban areas. The main task of assessing climate change related impacts in urban areas is to estimate the possible damages that might arise for human-influenced systems by climate change, including extreme weather events. In general there are two elements that define the potential risk: first, the probability of the occurrence of the events and second the "elements" at risk. Events to be included are heat waves, heavy rain, floods etc. "Elements" at risk are not only assets like houses, urban infrastructure services or economic losses, but also human health and livelihood.

1. Spatial Scope: Potential Impacts of Climate Change on Ho Chi Minh City

Similar to other emerging mega-cities in South-East Asia, Ho Chi Minh City (HCMC) is undergoing a rapid process of urbanization accompanied by dramatically land use changes in the surrounding rural areas. It 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. As densely built-up urban area in a flat low lying region, HCMC is historically a region sensitive to climatic effects.

Ho Chi Minh City is located 50 km from the South China Sea and northeast of the Mekong River Delta in an estuarine area of Dong Nai River system with high flow volume. The city is surrounded by marshes on the lower reaches of the Saigon River. 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 tide. The majority of the actual urbanized land is only 2 to 3 meters above sea level. This low elevation of the land and heavy rainfall makes the city susceptible to flooding induced by tidal fluctuations. From October to January when high tide reaches its peak, water level in rivers and canals rise as high as, or more than that the land elevation (Nguyen Huu Nhan 2006/Ho Long Phi 2007). Each year, HCMC suffers many serious floods, not only in rainy season from May to November, where monthly average rainfall is 250 mm, but also during the season with high tide from September to January (Duong Van Truc & Doan Canh 2006).

An additional cause of serious problem of urban flooding is the ongoing rapid urbanization process, 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 imperme-

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able surfaces causing increased surface run-off flow. The future urban expansion of HCMC will take place in peripheral and suburban areas, which will again increase the risk of urban flooding. The number of flooded locations, its frequency and duration has increased continuously (Ho Long Phi 2007).

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.

A regional climate change scenario (SEA START RC 2006) shows that the lower Mekong River basin region tends to get slightly warmer. Summer time in the region will be significantly longer in the future. Hot days will increase by 2-3 weeks and the cool days will reduce also by 2-3 weeks.

Urbanization is an extreme case of land use change. 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 10 ºC) 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).

Vulnerability analysis of these climate-related natural processes and the enhancement of adaptive capacities are major challenges, as the areas prone to potential climate-related impacts vary and overlay with respect to their spatial scope, time, and social environment. As the adverse impacts of climate change will affect the land use structures, the population and natural resources of HCMC, efficient planned adaptation responses must be grounded on site-specific designations within the decision-making processes of urban planning and development in HCMC.

2. Adaptation Response on Urban Planning Scale

The process of adaptation needs a sound adaptation planning framework for incorporating vulnerability and resilience of land-uses into urban policy and decision-making in HCMC. Adaptation planning systems, which are on the one hand, based on specifically selected sustainability indicators and data resources and on the other hand linked to available planning and assessment instruments including strategic environmental assessment represent an important guidance for the governance of global issues in their own right. A higher framework will function as a decision support system for site-specific decisions on locations and design of urban development with the objective to reduce the vulnerability of the urban system in the face of climate change.

Based on the in-depth assessment of the vulnerability of Ho Chi Minh City, the categorized urban environment in form of a spatially explicit information system will act as a matrix for the formulation of appropriate adaptation strategies for future development and redevelopment policies. The mainstreaming of climate change into policy making, the urban planning system and project implementation will be promoted on different spatial scales between the region and the building plot. The resulting Adaptation Planning Framework should form the future basis for spatially-explicit decision-making processes related to sustainable urban planning and development in HCMC.

Potential contributions of various adaptation options to improve the systems' coping capacities focus attention directly on the underlying determinants of adaptive capacity (IPPC 2001). The two main scientific objectives of the research will concentrate on:

1. The improvements of the ability of decision-makers to manage information and the processes by which these decision-makers determine which information is credible, and the credibility of the decision-makers, themselves

2. The evaluation of a range of available technological options for adaptation related to urban planning and design.

2.1 Research Concept of Vulnerability and Adaptive Capacity

Vulnerability and adaptive capacity are two central concepts in climate change research as well as in a number of other research contexts related to the risk assessments of natural hazards. Vulnerability to climate change refers to the impacts to human-environment systems. Scientifically predicted are direct impacts of climate change on human beings (i.e. by urban flooding or heat waves), and indirect effects through impacts on climate-sensitive urban sectors (i.e. housing, energy system or drainage system). Our adaptation planning framework follows the basic definitions of the Intergovernmental Panel on Climate Change (IPPC 2001), because the IPCC definition of vulnerability facilitates to describe the long-term vulnerability to social as well as biophysical systems. Vulnerability according to IPCC is defined by three factors: the regional exposure factor, current sensitivity, and adaptive capacity. If the main interest lies in planned or institutionalised adaptation, carried out for a general public purpose and related to spatial planning, vulnerability is seen a composite of different factors related to place (Cutter, 1996). First, the geographic context gives rise to *biophysical exposure,* which includes factors such as topography and connectivity and can be mediated by technology. Second, the urban fabric of a society underlies patterns of *social sensitivity,* including issues such as population density, levels of income, education and risk awareness and institutional capacity. Combined in different places, biophysical exposure and social sensitivity constitute configurations of *place vulnerability* (Cutter et al. 2003).

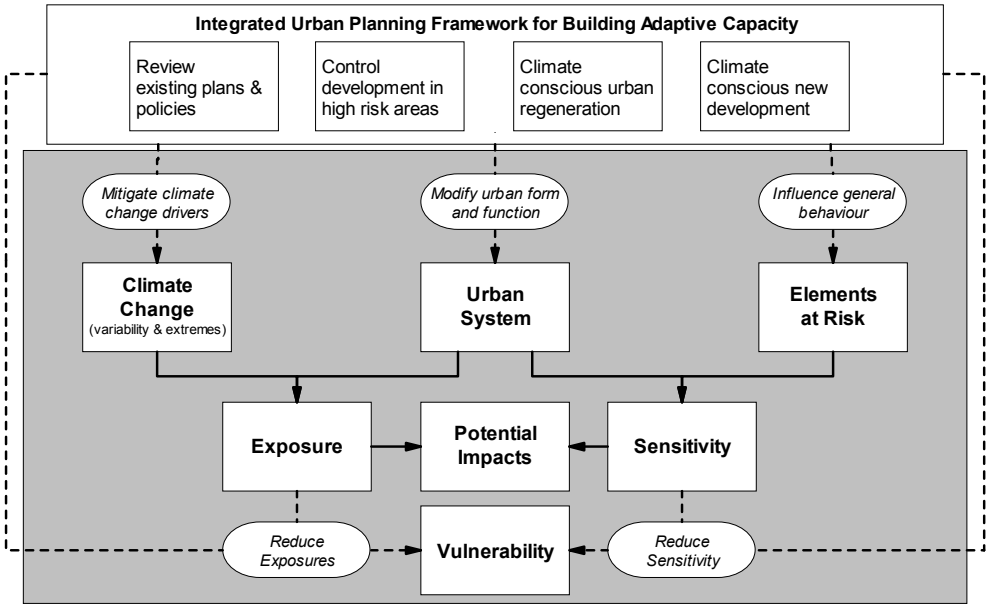

Fig. 1: Integrated Urban Planning Framework for Building Adaptive Capacity

Figure 1 presents the part of the project that deals with analysis and research in different thematic fields highlighted in grey. The upper description fields in white show the approach of adaptation at different urban planning levels, e.g. for flooding areas at spatial level and low energy housing design at neighbourhood level. Measures to enhance the adaptive capacity should be directed towards decreasing exposu-

res on biophysical and social sensitivity from the viewpoint of place vulnerability, taking into account the geographic context of the urban system determining these. Therefore the main objectives are to first of all identify potential impacts in HCMC and then to develop strategies to reduce the vulnerability of affected sites with the help of urban planning decisions. The shift from risk research related to natural hazards to the more integrated view of vulnerability in climate change research has two important aspects. Firstly, vulnerability assessment is focusing on social and not only physical vulnerability. Secondly, it pays more attention to factors related to societal development, institutional organization and administrative decision-making. Because the concept of vulnerability not only relates to the exposure of property and human or to the physical susceptibility of exposed elements, adaptive capacity is strongly related to development issues.

Our research will focus on the development of an *adaptation planning framework* on urban level as well as *community based adaptation schemes* on neighbourhood. The project will also seek to provide a scientifically profound understanding and research to guide the implementation of innovative demonstration projects, which can serve as models for climate-conscious urban planning and energy-efficient urban spatial typologies.

2.2 Urban Environmental Planning Information System

The urban environmental information system represents the central instrument to integrate the requirements and measures for adaptation to climate change supported by the urban sustainability indicator framework. 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 first main result of the 1st phase of our research in HCMC has been an indicator concept which represents an interpretative method to integrate the physical aspect of housing developments with the socio-economic and environmental-related information of built-up areas, based on the concept of urban typologies (Storch & Schmidt 2006). The typology-based approach allows a (scientific) trans-disciplinary identification of core indicators for the spatial information system. It appears to be consensus that a useful urban typology must combine a range of different indicators. This has led to a multi-layered typological approach in which urban typologies highlighting the major aspects of sustainable urban development can be identified. To assess the sustainability of urban settlement developments (Storch & Eckert 2007), four different layers must be analysed:

1. The physical structure – how the settlement with its form of the built environment is related with the different parts of the city, responds to the topographic situation and is integrated within the natural environment.
2. The urban environmental land-use patterns – spatial environmental sensitivity indicators offer the capacity to assist the identification of areas where housing-related development impacts require careful consideration.
3. The use patterns – are described by the public provision of urban infrastructure and services, which defines the way the settlement uses its resources and the impacts on the urban and regional natural environment.
4. The social system – how the settlement provides opportunities for an acceptable quality of life to their residents.

The second main result of the 1st phase of our research in HCMC related to the field of spatial information management in the urban environment of HCMC has been the development of a commonly accepted framework to structure HCM City into comparable types of spatial areas ("urban typology framework"). 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).

Trans-disciplinarity is essential in dealing with the inherent complexity of the urban environment in Asian Megacities. This common spatial framework based on urban morphology, supports the evaluation of the urban environment by bridging the gap between the physical methods of urban planning and the environmental concerns of urban development planning (Pauleit & Duhme 1998). The spatial classification and subdivision of HCMC's urban form according to urban typological principles, derived from urban and environmental planning, offers a coherent structure to support cross-scale investigations across household, neighbourhood, district and urban-scale. In this respect, the developed urban typology 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 typological classification 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 typological unit. Thus, the urban typology framework contains a whole set of physical indicators (Banzhaf et al. 2007) to characterize state and dynamics of the urban development in space and time and to foster planning strategies for adaptive urban development to Climate Change.

3. Outlook and Summary - Adaptation Planning Framework

The objective of the adaptation planning framework with an *integrated vulnerability assessment* is to inform decision-makers and the general public about climate change risks, and to increase their capacity to implement necessary adaptation measures and to strengthen the resilience of the urban system of HCMC.
The following questions will be explored for climate-related impacts on the urban environment of HCMC:

1. Where and how does urban development change the land use pattern of the metropolitan area of HCMC, and to what extent does this affect the exposure or sensitivity of the urban environment to climate change related impacts?
2. Which urban structure types can be distinguished, and what is the relation between their characteristics and the assessed level of vulnerability against climate change impacts?
3. Which vulnerable areas can be identified in the context of the predominant impacts of climate change (including current variability and extremes) in HCMC (in the research fields of urban flooding, urban climate, energy and transport systems)?
4. Which indicators are suitable for urban planning and land use management to assess vulnerability and classify adaptation measures on the urban scale in HCMC?
5. Which methods are suitable for impact and vulnerability assessment and urban environmental monitoring on the urban scale in HCMC?
6. How adequate are the existing land use planning and urban-environmental management approaches to the relevant governance structures; to what extent do they contribute to an urban development that takes climate-related vulnerabilities into account?

The concept of Vulnerability and Adaptive Capacity aims to provide the basis for an integrated assessment of climate-related impacts and possible adaptation options in the urban environment of HCMC. The integrative concept is used to structure the work steps of the four selected thematic fields of application of 'Urban Flooding', 'Urban Climate', 'Urban Energy' and 'Urban Transport'.

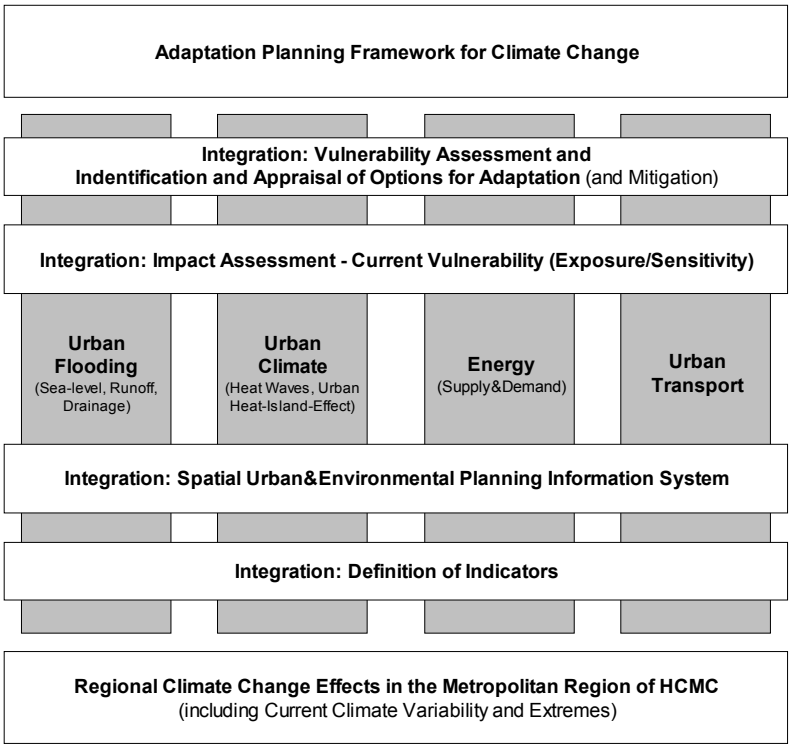

Fig. 2: Research concept: Adaptation Planning Framework for the Urban Environment in HCMC

Figure 2 presents the iterative network of the adaptation planning framework with its modules linking the four research fields of urban flooding, urban climate, urban energy and urban transport in a cooperative and interdisciplinary way. These shall promote vertical and horizontal feedback and loops between the integrative modules. For instance the thematic fields of urban energy and transport will require first essential results from the analysis of the thematic fields of flooding and urban climate, to derive adaptation strategies. An adapted urban planning system would deal more effectively with future challenges of climate change. Spatial planning must not only take into account land use activities, but the social, economic and environmental well-being of communities. An adapted flexible system has therefore the capacity to promote real changes in how development is implemented to support targets for CO2 emission reductions and to facilitate the growth of the low carbon and renewable energy sectors, enabling change, not only through development, but through delivery mechanisms as well (Cambell 2006). The thematic fields of energy and transport are interrelated with urban flooding and climate.

This spatial concept is the base for the framework to assess the *Vulnerability* of the urban environment in HCMC by reflecting *Exposure* and *Sensitivity* on spatial defined urban structures between the micro- and macro-scale of the city (Haggag & Ayad 2002). Vulnerability assessment is a new field of applications for the model of urban structure types such as their exposure to climate-related impacts. Therefore the modules Urban Flooding, Urban Climate and Urban Energy will use this common spatial framework for the spatial definition of their more application oriented exposure and sensitivity units. In this context the urban structure types are analysed with respect to their vulnerability to these impacts. Their physical vulnerability results in a multitude of environmental and social changes in the urban quality of life. All modules are using this common representation of spatial exposure to climate-related impacts in the urban

environment of HCMC, an integrated assessment of combined exposure factors will be facilitated. Creating the framework for this tool will be one of the outputs of the first phase:

- a commonly agreed sustainability indicator system especially for topics, relevant for vulnerability assessment methodologies based on spatial information management;
- a common spatial planning information system for these indicators and other relevant issues;
- a proposal for a spatially consistent adaptation strategy for urban planning in HCMC;
- a spatial planning information system that fits in the administrative structure of HCMC;
- a refined spatial concept based on urban structure types, to facilitate the transfer to other Asian cities.

The adaptation planning framework represents the central instrument of environmental planning. It will integrate requirements and measures for adaptation to climate change from the four thematic modules and support the development of a sustainability indicator framework, the spatial urban and environmental information system, the vulnerability assessment. 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.

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