Urban Sustainability in Times of Changing Climate: The Case of Ho Chi Minh City, Vietnam

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1. Introduction

The impacts of climate change are predicted to be unevenly distributed, with many of the greatest challenges to be faced by the mega urban regions situated in the intra-tropical low elevation coastal zones of Southeast Asia. To these regions, which exhibit significant climate related hazard exposure, portfolios are additionally associated with specific development and socio-economic issues that exacerbate this exposure. While on the other hand, climate change can be seen to magnify the inherent development issues. For Vietnam, a country of the Global South, there is broad agreement that if left unaddressed, the effects and consequences of climate change will present significant threats to the achievement of Millennium Development Goals and the country´s sustainable development. More than half of Vietnam's population presently resides in inter-tropical low elevation coastal zones, the majority of which are settled in the two densely populated mega river deltas around, the northern capital city of Hanoi and the red river delta and the southern economic hub of Ho Chi Minh City and the Mekong delta to the south. The city of Ho Chi Minh City (HCMC) is the country's largest and a rapidly emerging megacity, contributes a dominate share to the national GDP. However the concentration of population and economic activity make HCMC particularly vulnerable to fast-paced unsustainable development and the impacts of climate change. These impacts are altering the traditional context of urban land-use planning and are shaping the priorities of sustainability. The environmental dimension of spatial planning in emerging megacities such as HCMC, has become a strong rationale for coordinating spatially well defined adaptation actions and responses and integrating mitigation policies (Storch 2009).

This paper describes the initial research results in the development of geographical information system (GIS) based climate change vulnerability and urban sustainability indicators, based upon a common spatial framework using an urban structure type approach for HCMC. The proposed system represents a thematic integrative method where ultimately domain specific GIS applications, analytical models and thematic assessment methods, including climate change resilience and exposure indicators, will be used to generate spatial sector-specific risk and vulnerability analyses. Through the utilisation of planning recommendation maps, the comprehensive aim is to develop, designate, and incorporate climate change mitigation and non-structural adaptation potentials into the urban decision-making and planning processes. The research is envisaged to contribute to and promote an increase in the city's resilience to climate-related vulnerabilities and the sustainability of structures. The main objective of the integrated adaptation planning framework is to advance and disseminate knowledge and inform decision-makers and the general public about the climate change risks, increasing capacities to respond to climatic stress, to implement necessary adaptation measures and to strengthen the sustainable responsive capacity of the urban system.

2. Urban Sustainability and Climate Change

Since its founding, HCMC has historically exhibited sensitivities to natural hazards. Its location in an estuarine area of the Dong Nau River system, with a high discharge, fifty kilometres from the South China Sea and northeast of the Mekong River Delta have all but added to this sensitivity. It's highly flood prone metropolitan area is surrounded by low-lying

marshes on the embedded lower reaches of a complex tidal fluvial system and currently affected by an extensive urban heat island (UHI). The Sai Gon River, Dong Nai River, Nha Be River and Long Tau River all flow through the city and its suburbs. For HCMC, climate change will likely lead to ongoing sea level rise and an increase in the occurrence of extreme weather events, such as heavy rainfall and heat waves (Ho Long Phi 2007; Storch 2009). In the foreseeable future it is envisaged that these events will also cause a multitude of indirect, cumulative and synergistic adverse impacts of a severe nature not only to natural areas, but specifically to the exposed population of this densely urbanised metropolitan area, with further urban flooding or disturbances to the urban energy supply and public infrastructure.

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 to initiate adapting mega-urban regions to the current impacts of extreme weather events and the predicted impacts of climate change. However, over the next decades, to keep pace with envisaged growth a significant amount of new urban residential, commercial and infrastructural developments will be required. These new urban developments will shape the spatial pattern of HCMC for many decades. It is therefore of utmost importance to plan in an integrated manner from the outset. Major questions on how the spatial development direction in general can be steered and how buildings and infrastructure in these highly vulnerable regions can be adapted to cope with the climate change related impacts they are likely to experience during their lifetime, are yet to be answered. Due to its geographic location, this flood prone metropolitan area will always face natural hazards. However, the vulnerabilities of lives and livelihoods in HCMC to climate related environmental processes are primarily the result of inadequate and unsustainable urban planning practices. Currently seventy-two percent of the entire urban area of HCMC is below two meters mean sea level. This all attributes to a higher than average level of physical and social vulnerability in most parts of the city (Storch et al 2009).

3. Downscaling Climate Change Impacts and Sustainability Considerations to the Urban Level

The route of achieving sustainable urban development is relatively uncharted and even further uncharted when the considerations of climate change are taken into account. It is long known that plans and policies should address the environment, social and economic strength of developments. However, over the last three successive decades, HCMC has experienced rapid densification and expansion, with environmental considerations often ignored or neglected. This has led to what existing environmental information there was, and its maintenance often becoming obsolete. In this setting, the challenge is to, on the one hand, increase the urban response to adapt and increase the resilience of the current urban system of HCMC to the impacts of climate change, while on the other hand develop tools to increase the sustainability of urban-environmental planning for future developments.

With the forcing of high economic and demographic growth, the urban morphology of HCMC is characterised by recent rapid expansions of urban structures of both planned and informal nature. This has lead concurrently to both a rapid increase in the spatial extent of urbanisation and population density, while degrading valuable environmentally multifunctional natural areas in the hinterland and increasing the vulnerability of existing structures to climate-related impacts. The existing settlement structures of HCMC are integrated in a system that is affected by a number of internal and external pressures on overall urban sustainability, and therefore, the potential impacts of climate change on the city, its settlements, population and infrastructure should be assessed within the context of this complexity (Storch 2009, Moon et al 2009).

For an extensive urban area the size of HCMC, vulnerability to climate changes varies considerably from settlement to settlement and even within settlements. The location, present urban structure types, dominant building types, social-economic characteristics and

existing institutional capacity are all key factors that affect the ultimate vulnerability and adaptive capacity of a settlement in the mega urban context (Storch et al 2009). Furthermore, the exposure to and sensitivity for climate change related risks and impacts are a result of unsustainable physical processes, such as building construction, urban planning, infrastructure provision or the transportation, as well anthropogenic processes, such as lifestyle choices, that lead to vulnerabilities. Hence the fundamental motivation for downscaling climate change impact assessments to the urban scale lies in the understanding that every region exhibits its own unique urban development issues and paths as well as inherent resilience options and adaptation potentials. More often than not, a methodological void is seen between the regional climate change modelled, and the local urban development scenarios, which hinders the effectiveness of urban impact assessment methods. Furthermore, possessing knowledge of the future temperature fluctuations, or precipitation and flooding trends without knowing the urban development direction limits the assessment of vulnerabilities of existing and future urban structures in relation to the future climatic conditions in the regional context. For regional climate change projections, extreme events are more important than average events. It will be difficult to predict simultaneous increases in magnitude and 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.

4. The Urban Structure Type Approach for Ho Chi Minh City

The urban environmental planning information system represents the central instrument to integrate the requirements and measures for sustainable adaptation to climate change supported by the urban structure type approach. The latter acts as the central integrating component of an adaptation planning framework for Ho Chi Minh City. Its main function is to spatially link an indicator concept, which represents an 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 (see Figure 1). The main task in the assessment of climate change related impacts at the urban level is in the estimation of the possible damages that might arise to an anthropogenically-influenced system and its assets. 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 rainfall events, floods, etc., while "elements” at risk are not only assets, such as houses, urban infrastructure services or economic losses, but also human health and livelihoods.

The approach thus allows a multi-disciplinary identification of core indicators for spatially explicit vulnerability assessment procedures from various thematic and scientific disciplines as an essential element in dealing with the inherent complexity of the urban system in Asian mega-cities. 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 using the official land-use map as a basis. It further addresses the methodological challenge of integrating the multiple dimensions of risk and vulnerability, and the up- and downscaling of climate change impacts to the urban level, allowing for downscaled data to be integrated (Haggag & Ayad 2002). While an integrative vulnerability assessment identifies and characterises the urban system and it´s sensitivities to climatic risks, identifying opportunities for adaptation. The approach aids the understanding of the determinants of vulnerability, thus helping identify opportunities to reduce overall vulnerability in regards to climate change impacts, mitigation and adaptation policies.

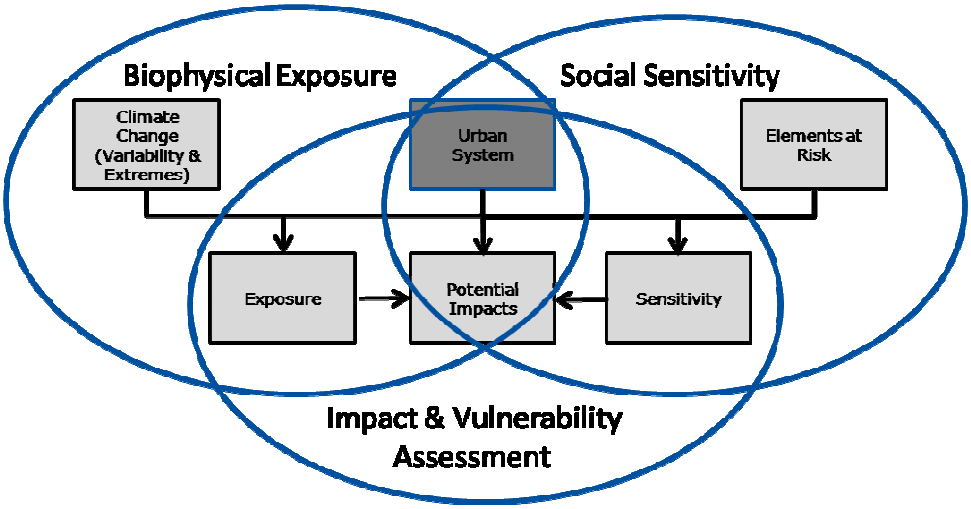

Figure 1: Climate Change Impact and Vulnerability Assessment at the Urban Level

The urban structure type approach acts to redefine the urban fabric of HCMC into a commonly accepted framework to structure the city into comparable categories of spatial areas using the official land use map as the main base (see Figure 2). The basic housing archetypes in HCMC were conceptually divided into subtypes to generate urban structure types that are reflective of different biophysical exposure or impact indicators. The physical boundaries of the housing typologies are defined by street blocks. Data collected from the study sites, representative of each housing typology, were used to formulate values for physical resilience and exposure of the building structure based on descriptive indicators. The spatial classification and subdivision of HCMC urban forms according to urban typological principles and derived from urban environmental indicators, offers a coherent structure to support cross-scale investigations across household, neighbourhood, district and urban scales. In this respect, the developed urban structure type defines urban areas with homogenous characteristics, which integrate similar urban environmental conditions.

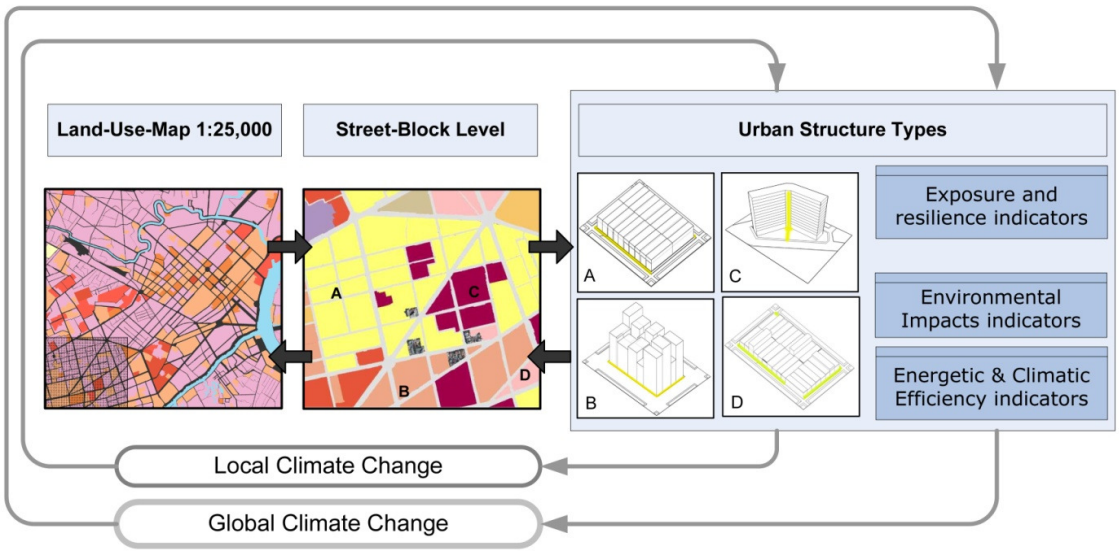

Figure 2: Downscaling Climate Change Impacts to the Urban Scale

Features of built-up areas, impervious surfaces, land use, housing types, 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. Adaptation planning in a development context requires tailored strategies for different settlement types as spatial planning concepts are very dependent on the particular local urban context as 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 providing planning recommendation maps as one fundamental determinant in the formation of urban vulnerability to climate change. The exposure and resilience pattern for each housing development helps to determine the ultimate vulnerability to climate change risks for the urban region. Different settlement types will have different implications for achieving the vulnerability. A mosaic of potentials will ultimately exist. Urban resilience and exposure are strongly influenced by the choices that are made regarding which housing types to build (Storch & Schmidt, 2008). The urban structure types offer discipline-specific approaches to 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.

5. A Sustainable Adaptation Planning Framework—Spatial Planning Information System

The objective of the adaptation planning framework is to advance and disseminate knowledge and inform decision-makers and the general public about the climate change risks, to increase their capacity to implement necessary adaptation measures and to strengthen the resilience of the HCMC urban system. The concepts of vulnerability and adaptive capacity derived from the urban structure type approach aim to provide the basis for an integrated assessment of climate-related impacts and possible adaptation options. The main tasks of the framework are fourfold: to compile existing vulnerability concepts from various thematic and scientific disciplines; to apply indicators for spatially explicit vulnerability assessment for climate change and natural hazards; to apply and improve GIS-based quantitative approaches for analyzing and modelling vulnerabilities and risks, and to undertake complex spatially explicit vulnerability and risk assessments for the mega-urban region of HCMC based on advanced GIS techniques and the integration of remote sensing data for data management, data analysis and up- and downscaling within the framework of mapping vulnerability and risks.

The structure of the indicator system represents an integrative concept, from the substantial data basis to the application–orientated modelling of initial project results. The intra- and inter-disciplinary linkages of the strategic thematic fields *"urban flooding, urban climate, urban energy and urban transport"* are displayed within the coordinating element *adaptation planning framework*. From the mutual usage of specific, as well as remotely sensed data, spatial-orientated, indicator-based maps are generated for individual indicator sets and are further refined to form analysis maps through model utilisation. At the heart of the indicator system lie the official land use and the urban structure type maps, allowing a uniform scale and the ability to provide adaptation recommendation for particular urban structures. All thematic maps and analysis maps will be based upon the urban structure typology approach. Finally, planning recommendation maps and databanks containing planning relevant information will be produced. The indicator system was developed as such, so that single indicators are not intended for use in an isolated manner, but rather within an integrative

framework which views them as parts of the resulting zoning guidelines in spatially explicit planning recommendation maps.

The thematic fields of application were selected based on the following considerations: the thematic fields should reflect future urban problems caused by climate change; the themes should reflect current urban environmental problems and be related to current climate extremes or variability in the metropolitan region of HCMC; and the thematic fields should allow the comparison of adaptation strategies and mitigation measures. The chosen themes promote vertical and horizontal feedback and loops between the integrative thematic fields. 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 CO_2 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.

The official HCMC Land Use Plan itself displays only the pure designation of land use utilisations. The inherent qualities, *i.e.* environmental significance or the exposure or resilience of areas or structures, the urban structural densities or the real utilisation are not illustrated. For measures and planning recommendation maps, an initial differentiation between the restoration of the existing asset and the planning recommendations / guidelines for new designated areas has to be undertaken. Using the example from the urban climate and flooding viewpoint, the focus here lies on recommendations and measures for the protection of green and open spaces and the establishment of more urban green in existing structures. Additionally, the fundamental guidelines for new development sites, i.e. regulations regarding building height, building density, and soil sealing degree, will be suggested.

6. Outlook

For the process of sustainable adaptation to climate change, spatial land use planning is a key criterion for effective strategies to deal with challenges. Adaptation is unrealisable without improvements in the usability of scientific results for decision-making and their integration into the planning process. To identify and estimate the local risks arising from climate change, the results will support the HCMC administration to establish a well-founded database with reliable information. On the basis of such data, maps incorporating planning advice in reference to measures (restrictions, bans, conditions, and development objectives) will be transferable end products. Utilising the adaptation planning framework approach outlined above, the overall aim is the interlocking of the planning recommendation maps: multi-functionality of the landscape functions. In this respect, the same area may contain significant unsealed surfaces, or exhibit an infiltration, retention and / or evaporation potential. In addition, the same or adjacent area may also render itself suitable for preferential roof greening or for the development of retention water bodies or even for the protection of riparian buffers. In such a way the adaptation planning framework with the urban structure type approach at its heart aims to advance and disseminate knowledge and inform decision-makers and the general public about the climate change risks, to increase

their capacity to implement necessary adaptation measures, and to strengthen the resilience of the HCMC urban system.

7. Acknowledgement

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References

Banzhaf, E., Hannemann, K., Martini, M., Grescho, V. and Netzband, M. (2007) "Monitoring the urban development with integrated system from RS observation and GIS information." *Urban Remote Sensing Joint Event*, Paris, 1-7.

Haggag, M., & Ayad, H. (2002). The Urban Structural Units Method: A Basis for Evaluating Environmental Prospects for Sustainable Development. In: Macmillan, P. (Ed.) *Urban Design International*, Vol. 7 (Number 2), pp. 97-108(12).

Ho Long Phi (2007) "Climate change and urban flooding in Ho Chi Minh City". *Proceedings of the Third International Conference on Climate and Water* 3-6 September 2007, Helsinki, Finland, pp. 194-199.

Moon, K, N. Downes, H. Rujner and Harry Storch (2009) "Adaptation of the Urban Structure Type Approach for Vulnerability Assessment of Climate Change Risks in Ho Chi Mih City. *56th ISOCARP Congress* ,Porto, Portugal.

Storch, H. and Schmidt, M. (2008) "Spatial Planning: Indicators to Assess the Efficiency of Land Consumption and Land-use," in Schmidt, M. Glasson, J. Emmelin, L. and Helbron, H., editors. Standards and Thresholds for Impact Assessment. Environmental Protection in the European Union, Volume 3. Springer, Heidelberg, p 215-226.

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. and 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.

Storch, H. (2008) "Adapting Ho Chi Minh City for Climate Change. Urban Compactness: a Problem or a Solution." *44th ISOCARP Congress*, Dalian, China.

Storch H (2009) "The Spatial Dimensions of Climate Change at the Mega-urban Scale in South East Asia: Urban Environmental Planning Strategies for Ho Chi Minh City´s Response to Climate Change *45th ISOCARP Congress*, Porto, Portugal.

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