EnviroInfo 2010 (Cologne/Bonn)
Integration of Environmental Information in Europe
 ISBN: 978-3-8322-9458-8

The Challenge of Spatial Information Management for Adaptation to Climate Change in Ho Chi Minh City.

Harry Storch, Nigel Downes and Hendrik Rujner
Brandenburg University of Technology Cottbus, Department of Environmental Planning
Erich-Weinert-Str. 1, D-03044 Cottbus
storch@tu-cottbus.de
downes@tu-cottbus.de
rujnehen@tu-cottbus.de

Abstract

The environmental dimension of spatial planning in emerging Asian megacities such as Ho Chi Minh City (HCMC) has become a strong rationale for coordinating spatially well defined adaptation actions and integrating mitigation policies. Climate change is changing the traditional context of urban development planning and is shaping the priorities of sustainability. While urban development trends in HCMC are addressing both mitigation needs and the rationale of adaptation to the effects of climate change, the main focus of combating climate change impacts in the mega-urban region of HCMC has to be the practical implementation of adaptation measures. Planned adaptation implies policy decisions and measures at the urban-scale that facilitates the reduction of the adverse impacts of climate change. For HCMC it creates the necessity to take climate change responses into account in spatial planning practices. This will also lead to changes in the traditional administrative structures that spatial planning is accustomed to. Since many of the main impacts of climate change have a land-use or water-management dimension, a downscaled and spatially explicit urban environmental planning information system can function as a switchboard for mitigation, adaptation and sustainable development objectives. Currently there are large differences in the way knowledge is produced, the analytical approaches that are used and the designed urban and environmental planning strategies. The proposed sharing of a commonly accepted spatial information base can engage the dialogue between stakeholders and scientists in order to support the development of spatially explicit planning strategies that anticipate the climate change risks at the mega-urban scale and contribute to sustainable and resilient settlement structures for HCMC.

1. Spatially explicit Research on Adaptation to Climate Change

In the emerging coastal mega-urban regions of Southeast Asia, climate change represents one of the greatest challenges. Recently climate change and its future impacts on Asian megacities in high-risk zones, such as the continent's main river delta regions, have emerged at the top of the international research agenda (Carew-Reid 2009). Since then, international policy agreements have been established to limit the emission of greenhouse gases. Nevertheless, even if a reduction in these emissions is achieved, the time lag in the climatic system will inevitably cause a substantial degree of climate change. The impacts of this change are, however, uneven with inter-tropical, densely populated delta regions exposed to rising sea levels (see Figure 1) among those expected to be hardest hit. Unlike mitigation, adaptation to climate change is more complex because adapting settlements to the negative impacts of climate change entirely depends not on its attributes to minimize energy consumption but, in contrast, on the geographical location of the existing settlement or planned urban development zone and area.

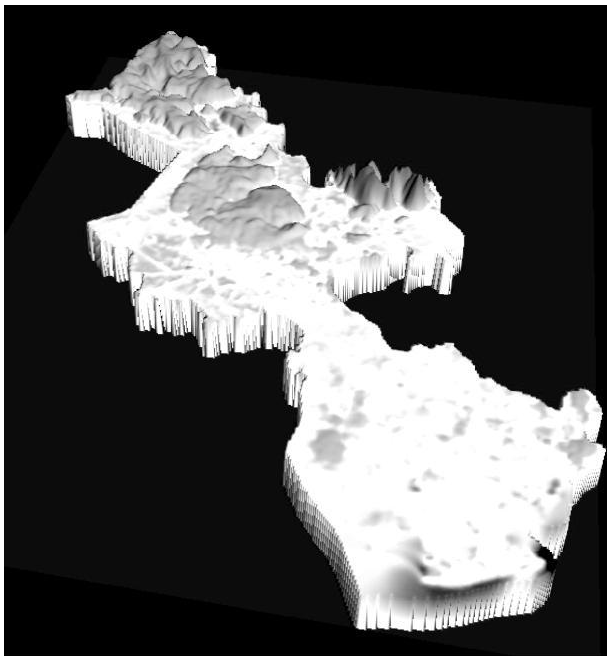

Figure 1: Digital Elevation Map of Ho Chi Minh City, Vietnam (Le Than Hoa 2010)
(Areas in gray-colors are located above 2m ASL)

2. Governance structures and spatial information management in HCMC

Governance frames how HCMC's institutions interpret and fulfill their responsibilities to ensure the safety and well-being of the urban population affected by climate change. The Adaptation Planning Framework focuses primarily on the spatial adaptation to climate change, climate variability and weather extremes. The governance component implies the development of spatial planning strategies that contribute to climate-proofing the urban development of HCMC within the existing planning system. Furthermore, adaptation strategies must be in line with the existing institutional structures of spatial planning policy in HCMC such as the relevant legislation, the prevailing normative principles and the associated tasks and responsibilities of the public and private parties involved. This does not ignore the fact that, given the observed effectiveness of current adaptation policies, adjustments to the institutional structures in the field of spatial information management could arise as result of our research findings (Campbell 2006).
The most important agencies which determine overall land use, spatial zoning and environmental quality in HCMC is the Department of Natural Resources and Environment (DoNRE). The planning department of the DoNRE is responsible for drafting and updating of the Land Use Plan, which is developed from the Master Plan (Nikken Sekkei & 2007). The next update is scheduled for the end of 2010 and will describe the medium-term development of the city until 2025. There is a significant interest of the DoNRE to bring the Land Use Plan in line with the future requirements of climate change. Our main objectives of the co-operation with the administrative planning institutions are proactive in laying the foundations for spatial adaptation planning on the urban level.

Table 1: Availability, Sources and Descriptions of GIS-Data in HCMCs Administration

Type	Scale/ Resolution	Format	Sources
Topographic map	1:50.000	.dgn	Department of Survey & Mapping
	1:25.000	Coverage	University of Social Sciences and Humanitie)
	1:10.000	Coverage	Department of Natural Resources & Environment
	1:25.000	Coverage	University of Social Sciences and Humanities
Cadastral maps	1:2.000 1:1.000 1:500 1:200	.dgn	Department of Natural Resources and Environment
Land use map (thematic map)	1:2.000 1:5.000 1:10.000	.dgn	Department of Natural Resources and Environment
Planning maps (thematic maps)	1:10.000 1:5.000 1:2.000	Paper maps	Institute of Planning (HIDS)
Aerophotograph	1:8.000 1:15.000	Aerophoto	
Landsat ETM+	30 & 15 (m)	Landsat ETM+	University of Technology
Spot 5	10 & 5 (m) 5 (m)	Spot 5	Sub-Institute of Science
QuickBird	0,6 (m)	QuickBird	Sub-Institute of Science

Source: Prof. Le Minh Vinh (Head of Division of Mapping, Geographic Information Systems (GIS) and Remote Sensing (RS), Department of Geography, University of Social Sciences & Humanities HCMC) Workshop HCMC 06.

For this purpose the DoNRE has significantly provided information and data to the research project and expressed its desire to receive partial primary recommendations for the upcoming revision of the Land Use Plan. Furthermore, only the DoNRE exhibits the expertise to verify the project proposals for the existing spatial requirements. Due to the fact, that in HCMC no central Spatial Data Infrastructure for planning-related governmental information exists, a large portion of the data acquired was inaccurate. Because the responsibility for spatial information management is distributed over many administrative departments (see Table 1), data sets received from different sources did not match, thus complicating the processing and analysis. Errors were detected, e.g. wrong or missing administrative boundaries. Furthermore, some necessary input data was either not available on the necessary spatial scale or not available at all. Another important aspect which must not be underestimated is that large portions of the data are available only in Vietnamese without any descriptive meta-data.

To overcome these problems and to make processing and analysing possible, the adjustment of certain data sets was required. Inconsistencies between boundaries of administrative units at different levels (Quận and Huyện compared with wards and communes) have to be eliminated in cooperation with Vietnamese partners. In some cases topology errors have to be corrected. Existing data will be aggregated or disaggregated to the necessary spatial scale and empirical investigations (such as road capacity investigations,

speed measurements etc.) have been and will be conducted further or have to rely on expert estimations. If necessary, data in Vietnamese has been translated into German.

3. Spatially-explicit Indicator System for Adaptation Planning

According to the redefined role of urban environmental planning in times of climate change, spatial planning concerns the vulnerability assessment of space and place as a basis for action or intervention. Accepting this new task, spatial planning goes beyond traditional urban land use planning to bring together, draw upon and integrate policies for urban development and land use. The challenge of a changing climate influences both the nature of urban spaces and profoundly how they can function. Therefore, the integration of climate change adaptation planning into the spatial planning framework at the urban level is necessary. Here the main task of an indicator system is to capture the degree of integrated adaptation measures of spatial planning in a quantifiable manner. The development of the proposed indicator system has been guided by the following principles: (1) Indicators for adaptation planning in a spatial planning context need to be based on adaptation and mitigation objectives that can be derived from spatially explicit land-use and urban development plans, (2) These indicators must reflect spatial planning's contribution to the achievement of integrating specified key sector-specific adaptation and mitigation policies in the urban areas of HCMC. The mean annual surface-water-runoff in HCMC is an example of a model-derived complex indicator, which is important to assist the generation of planning recommendation maps for land-use planning (see Figure 2).

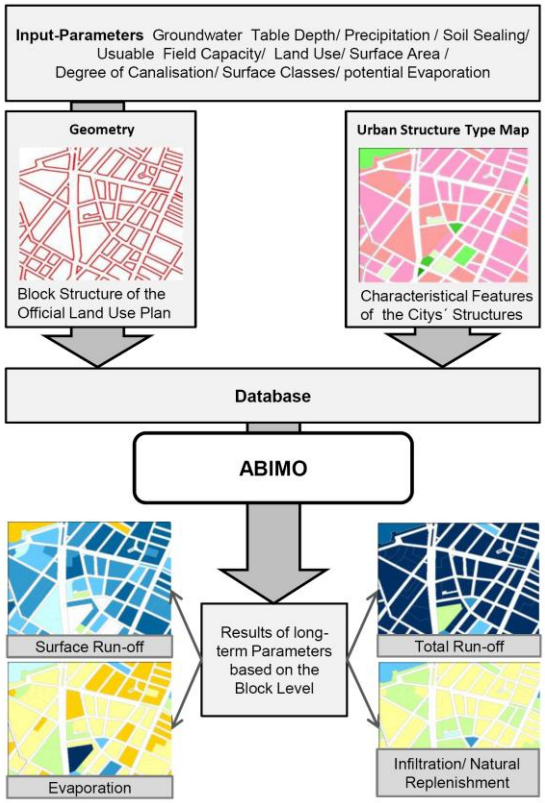

Figure 2: Utilization of the Water-Balance Model ABIMO for HCMC (Rujner et al. 2010)

Indicator sets can then be incorporated into a monitoring system that can assess spatial planning outcomes in terms of cross-sectoral adaptation and mitigation policy integration. Naturally, this type of analysis has to include the spatial dimension of the indicator system, by emphasizing the importance of functional areas, spatial linkages and connections. Urban planners and key stakeholders can then utilise these planled indicators to revise their assumptions and core strategies that initially led to the policy actions. They will then be able to modify climate-related adaptation and energy-related mitigation policy in light of new issues identified. As a result the adaptation planning framework will help provide a communicative and iterative learning approach to monitoring, which will embed monitoring right in the centre of the policy-making process. Given the complexity of spatial policy implementation for adaptation and mitigation measures, the analytical and model-driven integration of base indicators is an essential tool for providing a more rounded view of different aspects of climate change policy. The emphasis is on developing a group of indicators within each thematic sector (Flooding, Climate, Energy and Transport) and collectively analysing them to understand the broader thematic spatial planning outcomes. This approach facilitates cross-cutting analysis by combining indicators across different thematic sectors, as well as including other more contextual sets of indicators.

4. Spatial Information Management for Adaptation Planning

New policy approaches are required in Vietnam to deal with climate change, especially in regards to spatial planning. It is important to consider innovations in the spatial planning system, to support the efforts to mainstream climate change adaptation. Spatial Planning, as place-based and problem-solving strategy, will be a key-tool for sustainable adaptation (Galderisi et al. 2005). Incorporating the spatial context, adaptation measures can be define as, actions and interventions that are based on critical thinking of space and place. Integrating adaptation policies into the existing system of spatial planning will need an information-based decision-making process through which the options for the development of places are assessed and finally implemented expressed in policy, regulatory and investment terms.

Spatial planning has a key role to play in developing strategies in climate-proofing the urban area of Ho Chi Minh City. This is reflected into our spatial-explicit research strategy, integrating spatial planning and adaptation strategies and promoting cooperation between the key players in administrative departments and relevant research institutions. The main intention of focusing on spatial planning is to use climate change and urban development scenarios for developing long-term adaptation strategies. Within the framework of spatial planning, a wide array of instruments and tools are available, but more spatially integrated adaptation than currently occurs, is required to reduce vulnerability to climate change. Especially related to spatial strategies for adaptation planning in mega-urban regions, such as HCMC, where there are barriers, limits and costs which are not fully understood.

The concept of vulnerability has become a guiding principle of adaptation policy (Füssel 2007). Social acceptability of vulnerability to the impacts of future climate change can only be established in the context of the decision making process of land-use planning, because only here are the trade-offs with other costs and benefits related to existing spatial planning alternatives visible. Uncertainty is a fundamental aspect of vulnerability assessment, and decision support for adaptation planning has to accept substantial uncertainty. By doing research based on spatial information relevant for land-use planning, some important degrees of uncertainty may be taken away.

Spatial information management is a critical tool for the modeling of land use change under different scenarios for climate change. Furthermore it is needed to assess the quality of existing knowledge about emerging spatial planning problems, and to identify gaps in existing spatial information. The most detailed applied studies are necessary for the main future “hotspots” including areas planned for urban growth, but at risk of flooding and other impacts of climate change.

5. The Need for Spatial Data Infrastructure for Adaptation Planning

GIS-based scenarios linking urban development and climate change are exploring previously hidden areas of future risk. These scenarios can be used to provide a systematic assessment of spatial plans and to formulate alternative policy paths for land-use planning. Integrating climate change into land-use planning in HCMC is a complex decision making problem, which requires a careful assessment of the decision situation, related to the concrete places and spaces. A wide array of adaptation options is available, but more extensive adaptation than is currently occurring is required to reduce vulnerability to climate change. There are barriers, limits and costs which are not fully understood.

Currently in Vietnam an important aspect of difficulty in implementing the adaptation measures into spatial planning is the lack of tools and methodologies to instruct and consult the administrative decision makers and more sectoral experts on local-level. To improve the capacity for effective spatial information management, training and knowledge upgrading for collecting and utilizing the data on climate change. Improving and developing the required tools and methodologies for spatial analysis required for spatial adaptation strategies to climate change, are important activities that should be done immediately.

Table 2: Geodata required to utilise the Water-Balance-Model ABIMO (Rujner et al. 2010)

Thematic area	Geodata	Responsible Institution in HCMC
Land Use	Land Use Plan	Department of Natural Resources and Environment, General Planning Division
Hydological Data	Long-term annual Precipitation. Regional Potential Evaporation. Water levels of Watercourses. Depth of Groundwater table.	Sub Institute of Hydrology, Meteorology and Environment
Soil Sealing (Building Data)	Building Footprints. Street-Network.	University of Social Sciences and Humanities
Soil Data	Soil Map of Ho Chi Minh City Field Capacities of different Depths	Sub-National Institute Agricultural Planning and Projection, HCMC, Vietnam
Drainage System	Sewer System of the city-centre	The Steering Centre of the Urban Flooding Control Program University of Technology Minh City
Urban Structure	Built-up area Surface Classes Actual Land Use	BTU Cottbus: Department of Environmental Planning, BTU Cottbus, Germany

The main challenges for capacity-building are to improve the quality of spatial information management and the development of a spatial data infrastructure. Ho Chi Minh City, like Vietnam, has so far not implemented a spatial data infrastructure that at least would be accessible though government channels to authorized departments on regional and urban-level. There are numerous trans-national and private consultant companies, governmental agencies, universities and research institutions that are managing their individual geo-databases, resulting in standards and compatibility problems that have to be resolved. Within Vietnam, currently GIS Data are typically in non-standardized formats. Each institution creats their own datasets for their specific purposes, making it extremely difficult to integrate thevaluable geodata to generate more complex spatial indicators, such as surface-water-runoff models of high-density cities such as HCMC (see table 2). Additionally, in general the more accurate and detailed the geodata managed by an

institution in Vietnam is, the lower the interest to share these data with other governmental institutions and the higher are the pricing of these data for private or research institutions outside of the administrative system. Setting up a spatial data infrastructure for the mega-urban region of HCMC would be a critical task to improve the quality and accessibility for spatial assessments that require a highly interoperable GIS-data environment.

6. Conclusion and Outlook

Spatial planning strategies which focus on the adaptation strategies to climate change require information regarding future changes at a scale relevant to the area under investigation. This necessitates spatially more explicit climate effect models that provide useful information at both the regional and urban level, taking into account the many uncertainties at these spatial levels. Here unprecedented cooperation and research is needed to identify the planning options available for adapting these regions to changing climate, advancing and disseminating knowledge and understanding.

For our research project a mega-urban approach is the main guiding element. Only at the urban level is it possible to integrate the many layers of site specific information and to work closely with the many administrative actors. The presence of a megacity like HCMC enables the site specific weighting of options, the integration of stakeholders and administrative institutions and the results and success of measures to be evaluated. In HCMC, demand is a significant driver for knowledge development and transfer. Cooperative research regarding climate, water, the natural environment and urban development paths serves as the basis for developing plans for successful and feasible adaptation strategies. Adaptation options themselves and their feasibility can best be examined in a regional and urban context, since that is where it is possible to utilise spatially explicit research results, local knowledge and institutional experience most effectively for intervention strategies (Storch et al. 2007).

To gain insight into the effects of climate change on the urban level, such as the risk of flooding, heat stress in built up areas, a higher level of land subsidence and inadequate sewer capacity and to appropriately deal with them, the planning authorities of HCMC need to use spatially explicit information of climate effects highlighting which problems are to be found where, as well as diagrams of promising adaptation measures and projects. The indicator-based assessment approach we are taking calls for knowledge – and the dissemination of knowledge – to comprehend the consequences of climate related impacts on the urban area of HCMC.

If spatial planning activities involving indicator-driven spatial databases are not coordinated with the local administrative planning bodies, the indicator-specific data generated at various levels for urban planning and management purposes remains uncoordinated and limits their use to support decision making. In order to address these issues in a holistic manner, the central Spatial Urban Information System, developed from our specific GIS databases, will assist spatial planning decisions at the most relevant scales for the HCMC mega-urban region. The Urban Information System will also be useful for assisting the modification and preparation of the upcoming versions of the Land Use Plan and the Urban Development Plan. Furthermore it can lend its support more detailed urban planning schemes and serve as a decision-making support and strategic environmental assessment platform. The Urban Spatial Information System has the key objective to meet the requirements of land-use, urban and environmental planning in the existing organisational and institutional environments of the administrative spatial planning departments of HCMC.

7. Acknowledgement

The research project ‘Integrative Urban and Environmental Planning for Adaptation of Ho Chi Minh City to Climate Change’ (www.megacity-hcmc.org) is financed as part of the research programme 'Sustainable

Development of the Megacities of Tomorrow' by the German Federal Ministry of Education and Research (BMBF). The main phase of the BMBF-research programme focuses on "energy- and climate-efficient structures in urban growth centres" and will run up to 2013 (www.emerging-megacities.org).

8. Literature

Campbell, H. (2006) "Is the Issue of Climate Change too Big for Spatial Planning?" Planning Theory and Practice, Vol. 7, Nr. 2, pp. 201-230.

Carew-Reid, J. (2009) "Climate Change Adaptation in HCMC Vietnam". In: Vietnamese Institute for Urban and Rural Planning and Ministry of Construction (ed.): International Symposium for the Hanoi Capital Construction Master Plan to 2030 and Vision to 2050 (brochure). pp. 109-135.

Füssel, H.-M. (2007) "Vulnerability: a generally applicable conceptual framework for climate change research". Global Environmental Change 17, pp. 155–167

Galderisi, A., Ceudech, A., & Pistucci, M. (2005). "Integrated vulnerability assessment: the relevance "to" and "of" regional and urban planning". Naples, Italy: Department of Urban and Regional Planning, University of Naples Federico II.

Nikken Sekkei & UPI (Urban Planning Institute of HCMC) (2007): "The Study on the Adjustment of HCMC Master Plan up to 2025". Final Report. Ho Chi Minh City, Vietnam.

Rujner, H.; Goedecke, M., Storch, H. Moon, K. and Downes, N. (2010): GIS-basierte Kopplung des Abflussbildungsmodells ABIMO mit dem stadtstrukturellen Planungsinformationssystem von Ho Chi Minh City (Vietnam). In: Strobl, J., Blaschke, T. und Griesebner, G. (Hrsg.) (2010) Angewandte Geoinformatik 2010,Beiträge zum 22. AGIT-Symposium Salzburg, XVII, Wichmann : Heidelberg.

Storch, H.; Bang Anh Tuan and Schmidt, M. (2007) Spatial Information Management for Megacity Research in Asia. In: Hryniewicz, Olgierd; Studzinski, Jan; Romaniuk, Maciej (Eds.) Environmental Informatics and Systems Research, Proceedings of the 21th International Conference on Informatics for Environmental Protection, EnviroInfo 2007 Warzaw, Poland, Aachen: Shaker, pp. 491-500.