URBAN GROWTH - UNDERSTANDING THE DOMINANT DRIVERS AND SPATIAL DYNAMICS OF RISK

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Abstract

Asian cities located in deltaic settings such as Ho Chi Minh City (HCMC), exhibit higher exposure levels to flood risk primary as a result of their location, their low elevation and if located in tropical regions, the significant annual variations of climatic and weather extremes they incur. In these regions, adaptation to climate change and disaster risk reduction and management needs to focus on minimising exposure and reducing vulnerability via strengthening urban resilience. Scientifically predicted are the direct impacts of climate change on populations (i.e. by urban flooding) and the indirect effects through impacts on the climate-sensitive urban sectors (i.e. housing, energy system). Geographic context gives rise to the biophysical exposure, which includes factors such as topography, connectivity and urban structures which can be mediated by spatial planning or construction technology. Further the urban fabric of a society underlies the patterns of social vulnerability, including issues such as population density, levels of income, education and risk awareness and institutional capacity. Spatial planning measures to enhance the adaptive capacity should be directed towards decreasing biophysical exposures and the social vulnerability from the viewpoint of place-based risk assessments. Key urban impact and vulnerability indicators in megacities and metropolises vary considerably from settlement to settlement and even within settlements. The location, the urban structure types present, dominant building types, social-economic characteristics and existing institutional capacities are all key factors that affect the ultimate exposure, vulnerability and overall environmental performance of a settlement within a mega urban context. Exposure and vulnerability are highly dynamic factors with an important spatio-temporal dimension. Rapid urbanisation and settlement patterns driven by fast changes in socioeconomic development conditions are the key factors influencing the future levels and in exposure and vulnerability to climate extremes. Traditionally only snapshots of the current urban situations have been partially integrated into risk assessments, resulting often for highly dynamic urban regions in an overestimation of climate extremes as a stressor of risk. Our impact assessment study for HCMC highlights, that the influence of non-climatic stressors – like urbanisation as the spatial manifestation of socio-economic processes is still widely under acknowledged. An urgent need has arisen to readdress and improve the scientific methods and datasets to examine these

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non-climatic key drivers of future urban risk and to assess their relative importance for risk propagation compared to primary changes in climate. The most significant issue here is the integration of the future dynamics of urban development.

1. Introduction – The mega-urban region of Ho Chi Minh City, Vietnam

Coastal Asia is facing an urban century in which not only the population growth of cities will ultimately determine their resilience and sustainability, but also their patterns of development. The empirical interrelationship between rapid urbanisation processes in coastal Asia and the associated increases of risk to weather and climate-related disaster risks cannot fully be explained solely in terms of changes in population. Much more important however, is the consideration of the spatial distribution of people and economic assets in risk-prone areas, primarily as a result of rapid urbanisation. Here the sensitivity of the exposed population and assets can be used as an indicator for the ability to cope with and reduce risk. There can be little doubt, that a dominant factor contributing to increased vulnerability is urbanisation itself. How this dynamic pattern of urban development assists or hinders risk adapted planning and management is the critical issue that will be highlighted in our indicator-based assessment.

Figure 1. Skyline of Ho Chi Minh City's Central Business District and low-lying areas on the riverbank of Saigon River (Photo courtesy of Joep Janssen).

The southern Vietnamese city of HCMC represents one of the most dynamic examples of urban development and a megacity in the making (see Figure 1). The city is precariously located on the banks of the Saigon River, 60 kilometres from the South China Sea and northeast of the Mekong Delta, in an estuarine area of Dong Nai River system. In a short space of time, the city has grown into Vietnam's largest and most populous settlement, becoming an important port city for Southeast Asia and beyond and contributing a dominant share to the national economy. The official population of the city as of 2009 was 7.2 million, spread over a total administrative area of 2095 km^2 (Storch & Downes 2011a).

2. Analysing urban development trends in HCMC

The official population forecast estimates that HCMC will become a megacity and reach a population of 10 million by 2020. According to official urban development strategy, HCMC will be developed in the future based on a multi-center pattern along the northeast, south/southeast, north/northwest, southwest direction. Therefore HCMC's planning administration has recently established so-called new urban areas as focal point for this new satellite development, which will integrate fringe areas in the currently more rural outer city districts. The city's current radial development structure is still impractical, resulting in insufficient land available for public services and for open space.

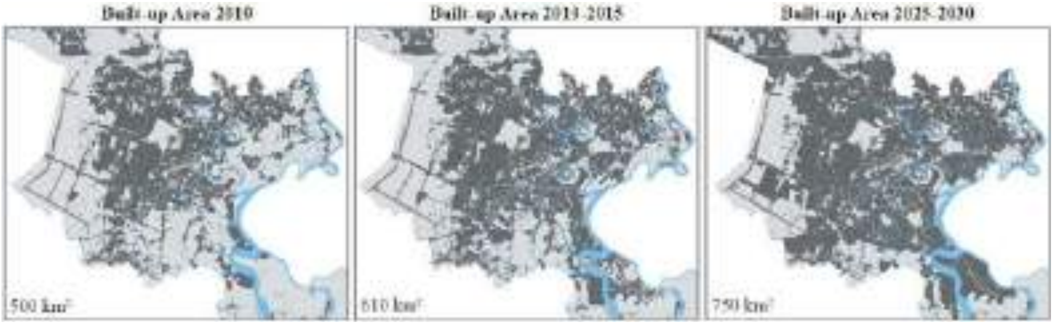


Figure 2. Ho Chi Minh City's official Urban Development Scenario up to 2025/30

Figure 2 illustrates the future urban growth process of HCMC based on the official land-use plans for the next planning period. The implementation of the land-use plans for the years 2010 up to 2025 will increase the total built-up area to 750 square kilometres (an increase of 50 percent) (Storch & Downes 2011a). In order to accurately define the precise spatial extent of the current built-up area, the digitalised version of the official land-use map 2010 at a scale 1:25,000 provided the common spatial geometry based on which a 'current land-use' map for the year 2010 was compiled. Current land-use was determined from visual interpretation of high resolution panchromatic satellite imagery; the classification was based on our urban structure type classification for the entire HCMC urban area (Storch & Downes 2011b; Downes et al 2011). A limitation of simple urban growth scenarios is that the simplified mapping of built-up areas over time does not show real land-use densities and often ignores the structural changes and alterations of the current and future urban settlement typologies.

2.1 Urban structural indicators to analyse development patterns

Urbanization is an extreme form of land use change. Rapid and dense urban expansion and inner-city redevelopment in HCMC in particular have had direct impacts at the local scale by changing the visible urban structure and form, thus triggering indirect effects like changing the urban climate and modifying the urban water-cycle and increasing energy demands for indoor cooling (Storch 2007; Storch et al 2007). The following questions will be explored for climate-related impacts in the urban environment of HCMC:

- 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 climate change related impacts on of the urban environment?

- Which urban structure typologies can be distinguished, and what is the relation between their characteristics and the assessed level of resilience against climate-related impacts?

- 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 urban-structural indicators into account?

- Which hotspot areas can be identified in the context of the predominant climate-related impacts in HCMC, like inner-urban flooding caused by high-degrees of imperviousness, and urban climate caused by high-dense building structures?

An important first step to estimate these hotspot areas is to describe the observable indicators related to urban form and structure. The most dominant feature of the urbanisation process in HCMC is the rapid growth of the city itself and the surrounding urban agglomerations. Urban population growth due to birth surplus and in-migration causes heightened land demands. In HCMC, urban growth and land consumption indicators are just about to be recognized in planning decisions, while a more regulating use of core urban indicators is still limited. Until recently the available information is often inadequate or spatially not explicit enough for assisting urban policies like indicator-based planning regulations.

In general, the ratio between built-up and unbuilt land gives a first overall impression of the spatial character of the city (Gill et al 2008). Built-up areas typically include residential areas, industrial, and commercial areas. In emerging Asian megacities – like HCMC – the monitoring of the building footprint will not be sufficient. In order to analyse urban land use and urban density and spatial development trends over time typically a stepwise indicator approach is used. An initial indicator framework is composed of core sets of indicators measuring different aspects of urban land use and building density. The first step in assessing the existing urban structure and land-use efficiency is to evaluate changes of the urban form and housing structure and their relation to building density and land utilisation efficiency. The indicator framework leads from basic land use indicators to building density measurements and finally to a combined analysis of population densities and land use intensity. The most important efficiency indicator here is the ratio between built-up and unbuilt areas.

2.2 Dense Urban Development as Adaptation to Natural Flood Conditions

HCMC administrative area is divided into 24 districts, hosting in 2004 an official population of 6.2 million, 5.2 million of which lives in the 17 urban districts occupying an area of 494 km^2 have an average population density of around 11,000 inh/km^2. The inner-city urban areas are concentrating on an area of 140 km^2 more than half of the population resulting in an average density of 26.000 inh/ km^2, with peak values in inner-city informal settlements with up to 80.000 inh/ km^2 (GSO HCMC 2006).

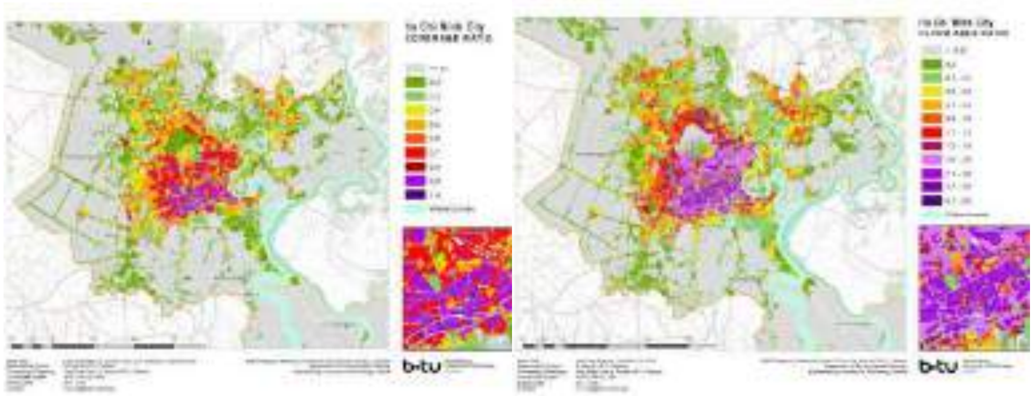


Figure 3. Coverage Ratio and Floor Area Ratio in HCMC's Urban Core in 2005

This extremely high-dense development of the inner city, with built-up (coverage) ratios of more than 0.6 (60% ground coverage) and floor area ratios of 1.5 and more (Figure 3), is mainly a manifestation of the necessary to adapt to the dominant flood risk situation of the city. Originally founded on relatively higher grounds, the city has densified through the infilling of open spaces or the redevelopment of existing buildings. However recently, great concern has bene raised at the city's rapid expansion into the lower-lying and former wetland surroundings, primarily at the expense of urban greenscape and valuable multifunctional natural areas. The city is currently incised by a dense network of rivers and canals of around 8,000 kilometres in length, which account for 16% of the total area. These waterways are affected by a semi-diurnal tide, subjected a high-tide level as high as 1.5 m AMSL. Often coincident with annual rainfall peaks a significant percentage of the city's neighbourhoods regularly experiences floods, due to a combination of tides, heavy monsoon rains and storm surge floods. The dimensions of this flooding are however constantly changing due to the ongoing rapid urbanisation.

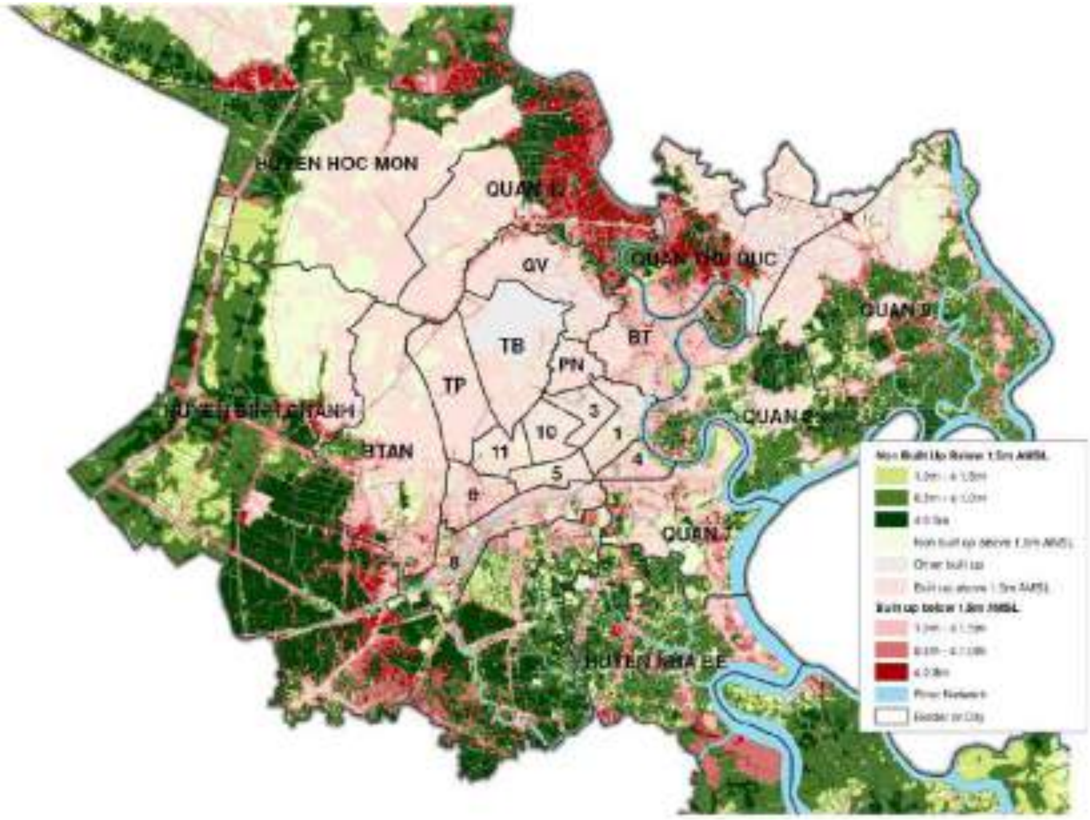
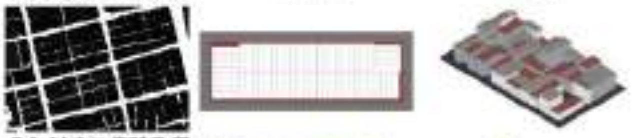


Figure 4. Ho Chi Minh City's Built-up Areas in Flood-risk Areas (areas below high-tide-level 1.5 m AMSL)

Figure 4 highlights well that the current urban form and structure of HCMC is strongly influenced and to some extent constrained by its surrounding natural conditions. The few remaining open spaces surrounding the extremely dense core – mainly agricultural land –have an elevation of below the current high-tide level of 1.5 m AMSL. These spaces act as a natural blue and green belt – akin to flood risk zoning by nature – and strongly influences the ongoing inner-city re-densification. Hence an understanding the interrelationship between urban densification and adaptation processes to current flood risk can guide the spatial adaptation processes of HCMC in the uncertain times of rapid urban growth and climate change.

The dominant building typology in HCMC is currently the so-called shophouse typology, seen often as a flat-roofed row house on a parcel with a plot size of approximately 4 x 20 m. The shophouse typologies are dominant in HCMC, accounting for 95% of the residential Urban Structure Types (Table 1). With building heights between two and five floors, very high levels of density are achieved. It is important to understand the future urbanisation challenges and the requirements for the provision of basic urban services and technical urban infrastructure preparation. Besides sprawling new urban developments, the ongoing continuous compacting and densification, horizontally as well as vertically, of existing settlement structures are a visible trend for HCMC's development pattern.

Table 1. Density-Indicators of HCMC's Shophouse-based Urban Structure Types

Code /Urban Structure Type Name	Building Footprint	Plan View	3D View	Built-up Ratio (%)	Floor-Area Ratio (%)	Avg. no. of floors
111 / Shophouse Reg. New				45	123	2,7
112 / Shophouse Reg. New Community				26	88	3,4
113 / Shophouse Reg. Alleyways				37	133	2,7
114 / Shophouse Reg. w/ Yards				28	64	2,2
121 / Shophouse Irreg. High-dense				38	134	2,7
122 / Shophouse Irreg. w/ Yards				38	88	2,3
123 / Shophouse Irreg. Scat. (Peri-urban)				14	30	2,2
124 / Shophouse Irreg. Clust./Line (Peri-urban)				15	29	2,0
125 / Shophouse Irreg. w/ Itr. Fields (Peri-urban)				5	9	1,9
131 / Shophouse w/ Indust.				38	81	2,1

2.3 Urban Indicators describing the change of Built-up Structures

The core indicator set measures the issues linked to the extent and growth of built-up areas and the efficiency of the land utilisation (floorspace) in relation to the common spatial unit of the official land-use blocks. The following urban growth and (re-)development oriented aspects are measured by a comparison of core-indicators over time, describing more specifically the growth rate at which built-up areas and floorspace have expanded and evolved over time, between 2005 to 2010.

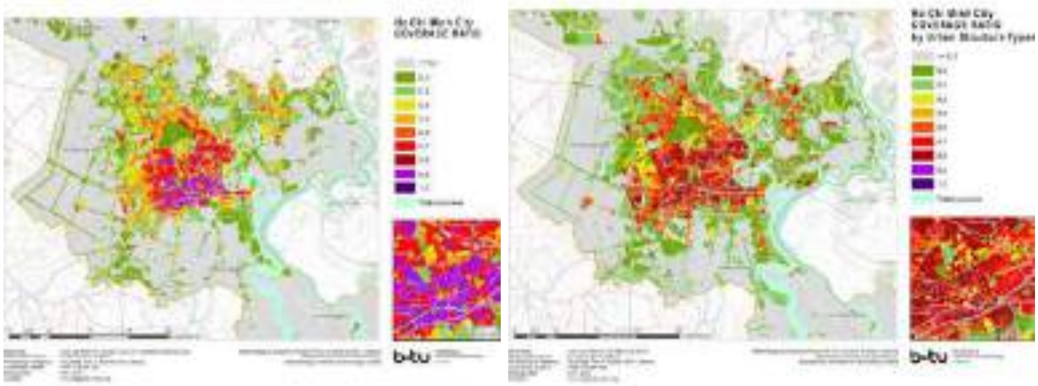


Figure 5. Comparison of the Indicator "Coverage Ratio" between 2005 and 2010 (Map for 2005 (left) is based on building footprint data. Map for 2010 (right) is based on urban structure type mapping).

Figure 5 illustrates the urban development for the period 2005 to 2010 for built-up areas based on the indicator ground coverage ratio. Ongoing sprawl development has taken place along main transportation routes on agricultural land, counteracting the official development according to the satellite urban model. Additionally recent and current residential areas are dispersing towards eastern (District 2, 9 & Thu Duc), southern (District 7, Nha Be) and western directions (District Tan Phu, Binh Tan, Binh Chanh).

Even in the existing urban core (District 6, Binh Thanh) (re-)development activities are high. Overdevelopment in the existing urban core will result in an overload of the limited urban basic services and infrastructure.

Figure 6 (overleaf) illustrates the individual new developments and redevelopment activities – mapped on the level of building types (Table 2) – between 2005 and 2010 lie within the current urban core area. Even if the concentrated developments are focused in new urban areas in the outer districts are more 'visible', the huge number of individual construction activities on multiple single construction sites on building level is surprisingly – while counteracting the official development strategy – dominate in the inner city core areas.

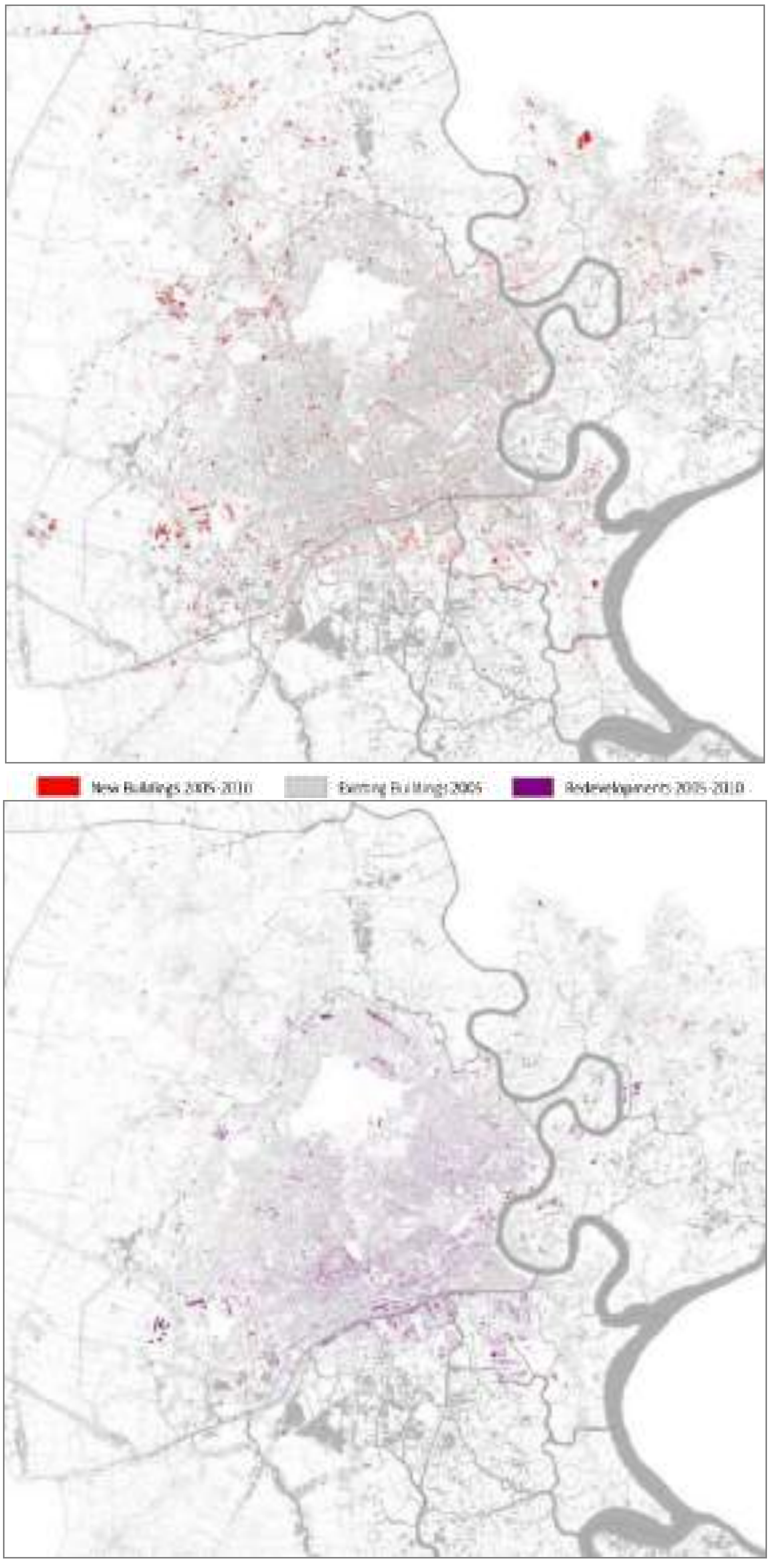
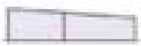
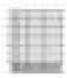


Figure 6. New Developments (Top) and Redevelopment Activities (bottom) between the years 2005 and 2010. (The Analyse is based on a detailed Mapping of Building Typologies, shown in Table 2, on a scale 1:5000 in 2005 and 2010)

Table 2 additionally underlines with the comparison of urban structural indicators (ground coverage and floorspace) and the ongoing densification pattern trend between 2005 and 2010. Except the more informal building types, all building types are significantly increasing in built-up (coverage) and additionally in floorspace density. Especially the dominant shophouse-related building type show a doubling of the total ground coverage and – due to an increase in average height – the floorspace for this type has increased more than 150% in only 5 years.

Table 2. Urban Structural Changes in HCMC from 2005-2010 - Core Indicators for dominant Building Types.

Building Type		2005 Coverage (ha)	2005 Floorspace (ha)	2005 Height (flr)	2010 Coverage (ha)	2010 Floorspace (ha)	2010 Height (flr)	Change 2005- 2010 Coverage (%)	Change 2005- 2010 Floorspace (%)	Change 2005- 2010 Height (%)
Apartment		113	569	5.0	166	890	5.3	48	57	6
High-rise		19	120	6.4	28	223	7.9	51	86	23
Detached		2149	2824	1.3	2872	5893	2.1	34	109	56
Semi detached		317	334	1.1	458	724	1.6	45	117	50
Temporarily-built and others		37	41	1.1	17	21	1.2	-54	-50	8
Terraced		3496	7001	2.0	7154	18001	2.5	105	157	26
Villas		893	1504	1.7	897	1777	2.0	0	18	18
Wood-framed, thatch- roofed		54	56	1.0	52	53	1.0	-5	-6	-1
Markets		8	29	3.5	17	66	3.8	108	126	9
Hotels		39	160	4.1	45	226	5.0	16	41	22
Office building		113	595	5.3	131	777	5.9	16	31	13

3. Administrative Integration and Implementation

Figure 7. Discussion of Planning Recommendations for Adapting HCMC's Land-use Plan to Climate Change, Department of Natural Resources and Environment 2011).

This study highlights the importance of effective land-use planning as a strategy and a key tool for sustainable adaptation, as well as the importance of a better understanding of the relationship between future urbanisation and climate change impacts. Land use planning is seen as having a key role to play in developing strategies to climate-proof HCMC. As such, our research has not been carried out in isolation but from the outset was foremost intended to assist the Department of Natural Resources and Environment (DONRE) with administrative policy making—in making informed decisions underpinned by the latest assessment techniques. Our approach assessing climate change and urban development scenarios aid the development of long-term adaptation strategies. The results presented in this paper show the gravity of the grave challenges faced by DONRE with respect to climate proofing future urban development. Ultimately, DONRE has the task to determine the overall land use, spatial zoning and environmental quality of HCMC. As such, DONRE possesses executive powers over one of the most important instruments for the adaptation of HCMC to climate change, the steering and management of land-use. To their credit, DONRE has become very conscious of its responsibility in relation to climate change responses and the management of associated impacts. Externally, these matters have gained increasing acceptance and importance within the wider administrative structure of

HCMC, while, internally they have reinforced the essential need to adapt their own planning (Storch & Downes, 2011b; Storch et al., 2011). However integrating climate change considerations into land use planning in HCMC is inherently a complex decision-making problem, which requires the careful assessment of the current decision situation, related to space.

4. Summary and Conclusion

In the face the complexity and uncertainty of urban environmental planning for adaptation and mitigation in rapidly growing urban risk areas, spatial urban form matters. It is however often overlooked. Denser and compacter urban environments generally have lower per capita greenhouse gas emissions because they enable public transit. At the same time, a larger blue and green infrastructure is in general beneficial to adaptation, as it provides room for urban open spaces and urban agriculture, the natural spaces for retention of storm and flood water management, and areas to generate and transit cool and fresh air lowering and offsetting the energy demands for cooling in tropical climates. Urban development strategies need to reconcile both goals – mitigation and adaptation - to be really climate resilient.

Planning for risk and uncertainty for future urban growth will not just be a challenge for high flood prone areas; it will be a broader challenge impacting on the nature and location of future urban development, particularly in planning for climate change. There is a strong correlation between the urban vulnerability and physical exposure. Here land use planning that takes into account disaster risks is the single most important adaptation measure for minimising future disaster losses. The spatial planning framework and subsequent urban planning decisions, as currently applied, do not attach sufficient importance to physical exposure and the rate of urban growth being associated with the risk of disaster losses. Urban growth does not increase exposure of population to risks per se. In general, urban governments are responsible for regulating either building or development in a way that reduces risks. For high-dense Asian megacities, the complexity of risk and vulnerability requires high resolution spatial information systems in order to identify hazard patterns, vulnerability and risk at a scale that can provide information for urban land-use and development planning. Urbanisation does not necessarily have to lead to an increasing hazard portfolio and can, if managed properly, contribute to reduce risk. However, there are a number of key characteristics of the urbanisation process that do directly contribute to the configuration of risk. Spatial and physical exposure alone does not explain nor directly lead to increased urban risk. If urban growth in risk-prone locations is directed by adapted land-use zoning and guided by adequate building standards, resulting risk patterns can be effectively managed and reduced. It is the ‘spatial dimension’ the form and structure of urban settlement that concerns urban and regional planning.

5. Acknowledgments

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6. References

Downes, N., Storch H., Rujner, H., Schmidt M. (2011) Spatial Indicators for Assessing Climate Risks and Opportunities within the Urban Environment of Ho Chi Minh City, Vietnam. In: Isocarp (Eds.) E-Proceedings of 47th ISOCARP Congress 2011 “Liveable Cities Urbanising World, Meeting the challenge” Wuhan China, Case Study Platform www.isocarp.net and Congress CD, 13pp. The Hague: ISOCARP.

GSO HCMC (General Statistical Office of Ho Chi Minh City) (2006) Statistical Yearbook of Ho Chi Minh City 2006.

Gill, S., Handly, J.F., Ennos, A.R., Lindley, S., Theuray, N., Pauleit, S. (2008): Characterising the urban environment of UK cities and towns: a template for landscape planning, in: Landscape and Urban Planning, 2008, 87, pp. 210-222

Storch, H. (2007) GIS-based sustainability assessment of housing and settlement structures within the metropolitan area of Ho Chi Minh City. In: Zeil, P. and Kienberger, S. (Eds.): Geoinformation for Development. Bridging the divide through partnerships. 65-75. Heidelberg: Wichmann.

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

Storch, H., Downes, N. K. (2011a) Ho Chi Minh City Confronts Risk of Flooding. In: Rollnick, R. (UN-Habitat) (Ed.) Urban World, 4(3), 46-47. London: UN-Habitat and Publishing for Development.

Storch, H., Downes, N.K. (2011b): A scenario-based approach to assess Ho Chi Minh City’s urban development strategies against the impact of climate change. J. Cities, 28 (6) Special Issue: Low Carbon Cities), 517–526. DOI:10.1016/j.cities.2011.07.002

Storch, H., Downes, N., Katzchner, L. and Thinh, N. X. (2011) Building Resilience to Climate Change Through Adaptive Land Use Planning in Ho Chi Minh City, Vietnam. In: Otto-Zimmermann, K. (Ed.) Resilient Cities: Cities and Adaptation to Climate Change, Proceedings of the Global Forum 2010, Local Sustainability 1, 349-363. Berlin: Springer. DOI:10.1007/978-94-007-0785-6_35