Indicator-based Urban Typologies
Sustainability Assessment of Housing Development Strategies in Megacities

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Abstract

The paper is based on research experiences of the development of GIS-based sustainability indicators in the application area of urban planning in agglomeration areas. These indicators are related to the European DPSIR framework (Smeets and Weterings 1999): with a strong focus on indicators for assessing the impact of housing developments on the environment. They characterise driving forces and pressures related to demographic developments in agglomeration areas and their manifestation in the resulting land consumption and impacts on the environment. Housing-specific impacts on the urban environment are represented by per capita land consumption, land-use change patterns, and availability of environmental-related public services and infrastructure and the resulting sectoral impacts on environmental media. These indicators form the basis for spatial typologies that are based on intersections of housing-related environmental data and statistical demographic and socio-economic information. How the current lack of experience in the building and availability of these kinds of combined socio-environmental indicators limits the spatial assessment of environmental impacts of land-use changes resulting from urban planning policies in mega-cities will be discussed. Special attention will be paid to the importance of understanding the spatial structure of settlement area in agglomeration centres in order to develop standards and thresholds for indicators compatible with the observed spatial typologies. A main component used to describe the spatial pattern of agglomeration areas are urban typologies and their occurrence within the built-up area. Finally, it will be explained that the successful implementation of planning-related information and monitoring systems in urban agglomeration areas, requires a strategy that does not further ignore the spatial structure, dimension or demographic and socio-economic dependencies of indicators of housing-related environmental impacts on the environment.

1.   Introduction - Urban growth and sustainability in Asian megacities

The paper presents significant initial experiences of a sustainability assessment research project of housing and settlement policies at the urban planning level in Ho Chi Minh City (HCMC), Vietnam. The objective is to develop an integrated approach to the sustainable development of housing and settlement structures to balance urban growth and redevelopment in HCMC. The contribution outlines the methodology of an GIS-based and indicator-driven sustainability assessment and strategic environmental assessment (Schmidt et al. 2005).

Asian megacities are reaching sizes unprecedented in human history. Many countries have attempted to limit the growth of their largest cities and have responded to the dynamics of urban explosion with centrally planned institutional and administrative regulations and measures to reduce urban growth. These measures begin with the stimulation of regional and rural development and end with efforts restricting immigration and dispersing new migrants to government-planned resettlement areas as new growth poles.

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In contrast, solutions seeking to make megacities work for those who are there and the migrants who will inevitably arrive are very uncommon.

Having been heavily influenced by the failure of strategies focusing on national political institutions to limit or influence the growth of emerging megacities, as well as having hosted numerous debates regarding alternative approaches to influence the dynamics of urbanisation, Asia offers an appropriate setting for the analysis of many of the institutional forces and the urban dynamics that impact the interconnections between human and their management of environmental resources in the megacities of today (Lo and Marcotullio 2001).

An analysis of the wide range of costly and often ineffective institutional strategies to limit the growth in metropolitan areas in these countries shows that neither centralised administrative measures nor the invisible hand of the economic market are effective against the overwhelming forces of the on-going dynamics of urbanisation.

The fundamental reason for the failure of these mostly centralised urban planning policies is not only the lack of financial and personal resources, enforcement mechanisms, and administrative power and will, but increasingly the fact that fighting against the predominant urbanisation trend often means going against the development needs and benefits of individuals and communities in these metropolitan areas.

Because of the nation-wide and sometimes global dimension of environmental changes and resource problems, the resulting impacts that are actually occurring in these regions are expected to limit the political role of traditional institutions in the action field of effective environmental resource management (Gibbs and Jonas 2000). Megacities in Asia offer exceptional opportunities to analyse both the impacts of large-scale environmental resource problems and institutional responses to these impacts, as well as urban planning and management strategies to overcome the limits and failures in the management of environmental resources.

The research program puts a strong focus on environmental resource management to analyse the settlement dynamics of urban growth and change. The key hypotheses are that different types of environmental and resource problems require particular kinds of management strategies to organise the obvious limits to growth of a pure, informal urbanisation process in metropolitan regions (Mitlin et al. 1996). This sectoral distinction between different management strategies of environmental resource problems is offering the research option to show that urban planning management strategies are more successful in problem solving if they are based on a commonly accepted indicator framework for GIS-based sustainability assessment of housing strategies. Therefore one important research question is to overcome this traditional distinction between urban planning and information sciences and to analyse the often-ignored relationships among institutions and informed environmental management solutions.

1.1   Study area - Urban planning within the metropolitan area of HCMC

The transition of the economic system of Vietnamese cities (Boothroyd and Pham 2000) has brought about major transformations in the physical and functional urban structures over the last decades. The development of the future mega-city of HCMC has two interrelated perspectives: firstly urban growth, the evolving urban forms in the context of urbanisation, focusing on the processes in 'peri-urban' and surrounding rural regions, including expansion of suburbs and the formation of new residential quarters in former agricultural areas and secondly urban redevelopment, population redistribution within the inner urban area.

This transformation requires that the urban planning system be based on a sound understanding of the housing and settlement development processes. Housing and settlement development is in essence a complex system with differing patterns of behaviour at various spatial and temporal scales and centres on understanding the interactions between the built and socio-economic environments and the resulting natural environmental impacts.

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Urban and regional planning within the metropolitan area of HCMC has been identified as one of the critical policy areas that will need an assessment framework to evaluate effectiveness of planning policies based on quantitative and qualitative baselines for urban indicators. A special focus will be laid on methodological issues of sustainability goals and their spatial representation by urban indicators (Ravetz 2000) for the evaluation of housing and settlement strategies.

2. GIS-based sustainability indicator framework

The overall objective of the GIS-based sustainability indicator framework is to promote a better understanding of environmental and social impacts of planned developments in HCMC. In collaboration with university partners from Vietnam, the project will develop a framework for the environmental assessment of housing strategies, which will address a broad range of diverse issues. This needs to be compiled within a consistent framework that ensures completeness of the information presented, including:

- issues such as environmental problems, e.g. land consumption or various forms of pollution;
- environmental media such as air, water, soil and biodiversity;
- resource sectors such as housing, urban agriculture, inner urban recreation;
- environmental processes as a consequence of housing developments.

The selection and prioritisation of these issues, as well as their definition in terms of available or measurable data and their linkage to the overlying indicator framework and the relationships to environmental and socio-economic processes are of importance for a comprehensive sustainability and environmental assessment strategy for housing policies in HCMC. The indicator framework will be derived from the widely accepted and well documented framework in the area of sustainable development (UN-Habitat 2004). The central concepts of the sustainability indicator framework are housing-related issues and their related environmental and socio-economic indicators, which are defined by the urban typology approach. To be applicable, the indicators must have clearly defined reference points beyond the housing-related context. International and regional thresholds, standards or objectives and targets, where applicable, are currently defined in cooperation with the counterpart national research team in HCMC, such that the indicator values can be interpreted in the regional context of Vietnam.

2.1 Remote sensing and GIS techniques for urban growth research

Modern remote sensing and GIS techniques have had significant success in monitoring fast development processes in mega-cities. Remote sensing and GIS is used in megacites research to provide geo-referenced information on the shape, size and distribution of different land-use classes of the urban environment (Pauleit and Duhme 2000). The main application areas of these technologies in urban growth research (Herold et al. 2005) can be defined as follows:

- Monitoring urban growth (area change, structures, land consumption, soil sealing (Geospace 2000))
- Monitoring land cover/land-use changes (loss of agricultural area (Seto 2000), wetland infringement, loss of areas important for biodiversity (White et al. 1997), spatial distribution of inner-urban green and open spaces and natural areas)
- Mapping of environmental parameters (base data important for urban climate, access to and distribution of open space, calculation of sealed surfaces) (Elvidge et al. 1997).

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Even if the technological possibilities of new sensor-technologies are accepted, there actually remains a remarkable gap between the research-centred results offered by the remote sensing community in the field of urban growth management and the application of these spatial data products by the local planning agencies of urban agglomeration areas.

The urban landscape is dominated by built environments that are physically distinguishable from the surrounding natural environment and therefore are readily identified through the use of remotely sensed image sources (Foresman et al. 1997). However, these techniques are often poor when it comes to supporting decision-making on sustainable development, as they are providing detailed descriptions of urban form but are less helpful in understanding the functional characteristics of settlement development processes. The main reason is that remote-sensing has a strong focus on an ongoing monitoring of urban growth processes, but has its weakness in assessing the environmental impacts and sustainability effects of the underlying urban processes. The framework needed, however, has to go beyond this simple identification of an urban environment and to integrate the variability of the built environment, which is associated with variability in human use patterns in settlement areas (Harris and Longley 2001).

The complex processes which are re-shaping settlement patterns in future megacities like HCMC, create urban-environmental systems which cannot be captured by the morphological framework of the urban/rural classifications derived remote sensing devices. Therefore the primary task is to identify key dimensions of regional settlement patterns (Seto and Kaufmann 2003), because these dimensions must be represented when moving on to the indicator-centred assessment framework of housing development structures. Based on the evaluation of existing indicators and their refinement with more regional appropriate measures, the necessary step is to consider how these separated indicators can be explicitly spatially combined in a more multi-dimensional approach to representing sustainability of settlement patterns and housing developments.

Quality of life, as access to basic housing needs and public services, and environmental quality are the determining factors in what a sustainable built-up environment is. However, there is a need for a framework that will be able to support claims about housing needs in relation to the context of society and the physical and natural environment. The purpose of the research is to investigate the way in which housing needs and sustainability will be able to reinforce each other (Satterthwaite 1997).

2.2   Inner urban structures

Different discipline-specific methodological approaches to the 'urban environment' require a commonly accepted spatial working basis, which can ensure that the resulting heterogeneous investigations can be trans-disciplinarily integrated by using an adequate spatially explicit classification. Therefore an "urban typology" concept was developed and will be used as a practicable method to organise the spatial order of housing developments in HCMC. The housing-related 'urban typology' provides a uniform methodological and spatial framework for the different tasks within the interdisciplinary network of the research project.

Housing-related urban development decisions require a rational characterisation of urban structural landscapes according to environmental relevant features. The typology approach ensures that data integration of different sources (remotely sensed, field-based, survey-based and map-based) with their original specific spatial/temporal resolutions and thematic contents can be operationally integrated in the GIS environment of the research-project. The concept of urban-typologies promises to deliver an integrated view of housing-specific problem areas to urban and environmental planners in a form that makes sense to them, because it provides a unit of analysis that is attractive to each of them, because the urban typology creates clusters of residential areas with similar housing structures, service/infrastructure availability, socio-demographic components and environmental pressures, and makes it possible to analyse commonalities and differences in urban development strategies.

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There is a need to create urban typologies of the settlement structure of cities such as building/population density, housing types, spread of public services, commute times and other environment-related infrastructure issues. Such an urban typology of housing and settlement structures can take into consideration socio-economic information to determine the livelihood and overall sustainability of these individual urban types. The proposed concept 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 (figure 1).

3. Urban typology

Urban typologies are selective windows on the urban landscape because the typology is based on urban indicators, which direct their focus on particular phenomena and exclude others from the analyses. For that reason, urban typologies and indicators have methodology implications that go well beyond technical discussions of definitions of measurement units. The selection of indicators will directly influence conclusions drawn from the typology-based analysis. The main purpose of urban typologies is to ensure that assessment of planning policies can be clarified and simplified by grouping residential areas and neighbourhoods with common characteristics and could therefore have similar sustainability problems and environmental impacts.

It is important to reflect on the role of urban typologies in bringing clarity to urban planning policy and implementation. This suggests that a limited number of core indicators, based on the key planning policy issues, will be more appropriate than a broader range of detailed descriptions which results in an overly fine-grained geographical classification. This could mean that the application of urban planning policies would become fragmented, thereby negating the principle aim of typologies of defining shared opportunities and providing more consistent and transparent planning approaches.

Because indicators used should reflect the housing-related sustainability issues that the urban typology is seeking to address, a layering of indicators is the most useful approach. It appears to be consensus that a useful urban typology must combine a range of different indicators. The selection of these indicators will directly influence the conclusions that can be drawn from the urban typology approach.

The urban typology emerged as a result of a need to provide opportunities for urban housing to low-income people in a situation where the danger of over-development or suburbanisation was considered as highly acute. The classification of settlement patterns and housing structures should be combined with analysis of socio-economic, environmental and public service/infrastructure characteristics in order to provide a more accurate picture of current housing problems.

3.1 Indicator-based typology building

The indicators used to formulate the urban typology are predominantly focused on housing structures and settlement pattern (Flood 1997), with environmental capacity/sensitivity and socio-demographic and economic characteristics also being included. Therefore housing related typologies must be developed on the basis of criteria which reflect these additional socio-economic and environmental issues. The following criteria and indicators have been identified to build the urban typology approach:

- Housing: In urban areas, typologies are intrinsically linked to housing developments. These criteria led to areas being defined in relation to the characteristics of a city's housing market. This allows for urban planning policies to respond to deficits in housing quality which do not meet the population's needs or to limit development in areas where there is extreme pressure on the environment due to a lack of capacity for environmental-related services and infrastructures.

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- Transport and accessibility: Transportation-based indicators are sectoral tools, but a robust urban typology should combine analysis of housing conditions and transport provisions to encourage sustainable modes of transport.
- Environment: Landscape and environmental assessments provide guidance on the ways in which development plans and controls can respond to these issues. Environmental sensitivity and assessment indicators offer the capacity to assist the identification of areas where housing-related development impacts require careful consideration (Bouland and Hunhammar 1999).
- Service availability: Public service and infrastructure related issues such as access to piped water and sewage capacity, the availability of domestic waste collection services and the lack of these services available to the residents, have an important influence on the ecological footprints and environmental impacts of residential areas (Button 2002). Assessing levels of infrastructure and service is important for the definition of settlement zones, which require different solutions in order to remedy existing environment-related public service/infrastructure problems.
- Population characteristics: Socio-demographic characteristics covering a range of indicators such as social and economic status, household composition and migration patterns. Economic characteristics can describe levels of dependence on particular sources of employment, income and the relationship between the residential area and the urban economy.
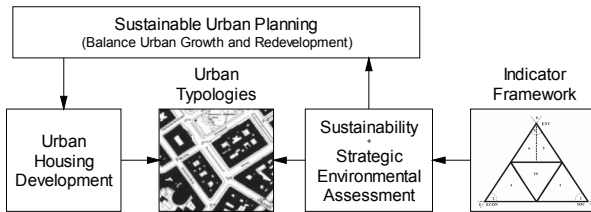

Fig. 1:
Urban typologies and sustainability assessment of housing development strategies

It is suggested that this urban typology is a more accurate approach that allows for consideration of settlement, socio-economic and environmental characteristics. The ability to develop such an approach is, however, highly dependent on data availability and consistency. The drawing of conclusions based on a combination of indicators has made clear that some aspects of the urban typology are sometimes difficult to define when data sources available for analyses are lacking in detail - mainly in relation to socio-demographic and public service/infrastructure related issues. These findings reflect the strong influence of settlement and housing strategies on the development of urban typologies. Therefore testing the typology in consultation with planning institutions to ensure that it reflects their perception of differences across the urban area will be an important next step. In the case of layered typologies, which combine different indicators, it is important to undertake some ground-truthing.

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4. Discussion and conclusions

The strong spatial focus on urban typology facilitates the analyses of different housing-related environmental resource management strategies. Different housing and settlement structures and types have a unique development history, its own built environment representing its specific planning and development history. However, despite these differences, these settlement types have some limiting sustainability factors in common. Regardless of housing structure and the socio-economic development level, all face the challenge of meeting the environmental resource needs of their population on severely limited environmental capacities. All are faced with water resource problems, air pollution and traffic congestion. On a more detailed level, however, it is clear that their planning and management strategies will be clearly distinguishable in their success in solving a number of environmental and resource specific limitations.

The urban typology should be viewed as the missing link between land cover/use centred spatial planning research and urban planning policies (Weiland 2001). The urban planning framework is a key mechanism for achieving this in the future, and it must be informed by urban typologies based on core sustainability indicators. This could help the urban planning system to act as an interface, connecting development strategies to produce a more sustainable approach to future developments in the housing sector. This in turn implies that the development of an urban typology requires time and the inputs of different stakeholders if it is to be developed as an administrative urban planning tool that can work over the long term and at different levels. It appears that urban typologies should be sufficiently flexible to allow for the review of change over time.

The outcome of this research project will show whether a GIS-based sustainability assessment of urban developments fulfils only a technical role as a pure planning information system, or whether it might occupy a more central role in terms of sustainability assessment based on indicator-based modelling of form and function of defined urban typologies. This opens up new prospects for comparing cities in terms of typological-based functional indicators of sustainability, and the integration of the spatial dimension with an understanding of the social, economic, and environmental dimension.

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