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Assessing the Spatial Dimension of Sustainability in Asian Megacities: An Indicator-Based Approach

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1 INTRODUCTION

This paper presents significant initial experiences of the urban sustainability assessment research of housing policies at the urban planning level in Ho Chi Minh City (HCMC). 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 aim of this paper is to discuss the importance of socio-environmental efficiency indicators for sustainability assessment (SA) in spatial development planning. Although environmentally inefficient settlement development structures are resulting in an ongoing unsustainable use of land-resources, planning instruments have their limitations to promote the necessary structural changes in spatial development planning. A special focus will be laid on methodological issues of urban sustainability indicators and their spatial representation by multi-layered urban typologies for the evaluation of housing and settlement strategies. Based on current urban growth research, this paper offers a overview of available indicators that can describe the efficiency of regional and urban spatial structures in relation to land use and land consumption. The relevance of these indicators in relation to contrasting urban development models is verified. This section closes with recommendations for the integration of spatial-enabled sustainability indicators to assess the efficiency of zoning of new developments for residential areas and traffic infrastructures in urban planning.

2 MEGACITY RESEARCH WITHIN THE METROPOLITAN AREA OF HCMC

Asia offers an appropriate setting for the analysis of many of the institutional forces and the urban dynamics that impact the interconnections between humans and their management of environmental resources in the megacities of today (Lo and Marcotullio 2001). 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. Megacities of tomorrow like HCMC 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 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 megacity of HCMC has two interrelated perspectives: firstly urban growth, the evolving urban forms in the context of urbanisation, and secondly urban redevelopment within the inner urban area. HCMC covers 2,000 sq km, divided into 24 districts hosting an official population of more than 6 million. The inner city has an average population density of around 10,000 people per sq km. HCMC is undergoing a rapid urbanisation such that by 2020 the 17 inner city districts are expected to have a population of approximately 6 million, while the suburban area will have roughly 4 million residents (table 1).

HCMC	*Area (km^2)*	*Population 2004*	*Population 2020*	*Greenspace per capita*	*Floorspace per capita*
Inner Districts	494	5.2 million	6 million	2 m^2	7-8 m^2
Suburban Districts	1,601	1.0 million	4 million	475 m^2	
Whole City	**2,095**	**6.2 million**	**10 million**	**14 m^2**	(14 m^2 2010) 10 m^2

Population density of 10.000 inhabitants/km^2 in inner city districts (20.000-80.000 in inner-city informal settlements)

Table 1: Population distribution within the urban area of HCMC

This rapid population and economic growth since the policy reform of Doi Moi has put a large and increasing stress on the water resources and environment in HCMC. The demand from industry and

households surpassed the current distribution capacities. The water quality in underground sources and river courses is highly degraded due to many sources of pollution (Van Duc and Gupta 2000).

HCMC's infrastructure is overloaded and is unable to meet the needs of people living in highly dense urban areas (Van Khoa 2001). In HCMC, the public transport infrastructure can attract only around 10% of travel demand. The transportation infrastructure is poor and almost 90% of commuters use private forms of transport (table 2).

HCMC	*Number*	*Mode share*
Motorbikes	~3 million	60%-70%
Public Transport		10%

Transport infrastructure 8% (urban area) (standard 20-25%)

Table 2: Transport mode shares in HCMC

The dominance of motorcycles and the weakness of public transport have resulted in increasing emissions from private urban transport activities. The current urban transformation process requires that the urban planning system be based on a sound understanding of the housing and settlement development processes.

2.1 Conflicting Requirements of Sustainable Urban Development

To enable sustainable livelihoods for all within the bounds of the environmentally possible, the spatial planning aspects of sustainable urban development require the development of settlement and housing structures that facilitate equitable access to public resources and service opportunities and the efficient sharing of finite natural resources and agriculturally productive space in the metropolitan region.

- The social aspects of sustainable settlement and housing development primarily require providing people with opportunities for an acceptable quality of life. Planning strategies to ensure an acceptable quality of life are focused on the reduction of environmental threats to human health that arise from insufficient urban sanitary infrastructure, inadequate provision of safe water, hazardous water and air pollution, and poor environment-related public services like the management of public transportation and of solid waste.
- The environmental aspects of sustainable urban development of future megacities require a balance between protecting the natural environment and using its resources in a way that will allow the sustainable supporting of an acceptable quality of life for all urban residents. Environmental planning strategies are primarily concentrated on the reduction of impacts on natural resources and environmental systems of urban-based production, consumption and waste generation.

'Quality of Life' - Liveable housing			**Quality of Natural Environment**	
Adequate and affordable housing	**Shelter**		**Resource use**	Freshwater use
Adequate sanitation	**Health**			Land use
Access to clean drinking water				Energy use
Air quality: indoor and ambient		<>		Waste produces
Absence of disease vectors			**Pollution and degradation**	Water quality
Access to health care				Air quality
Threat of natural or man-made disasters	**Safety**		**Protection of environment**	Conservation (land having formal protection status)
Indicator	*Issue*		*Issue*	*Indicator*

Table 3: Interrelationship between "liveable housing" and the natural environment described by core sustainability indicators

Because these different principles of sustainability obviously have conflicting requirements (Satterthwaite 1999) an integrated urban planning strategy will try to balance these different requirements (table 3). The resulting planning decisions need to be regularly monitored and assessed against agreed-upon urban

sustainability indicators. Because sustainable urban development holds these conflicting demands with different priorities in different regional contexts, it is not possible to define a general concept for sustainable human settlements. But urban-related sustainability indicator frameworks, like the Human Settlement Indicators of the Habitat Agenda, are creating an accepted normative framework based on human settlement-related indicators, defining urban sprawl and densification, and standards for basic needs, such as access to water and sanitation.

3 SPATIAL INDICATORS TO ASSESS THE EFFICIENCY OF URBAN LAND-USE

Settlement structure and its form of the built environment determine both the efficiency of resource uses and the quality of life of the inhabitants. Urban development planning of the last decades and the current discussion on sustainable spatial planning are characterised by contrasting and conflicting discussions about urban planning models that can combine high density in a sustainable urban form (Ewing et al. 2002). Spatial development in metropolitan areas worldwide is characterised by the continuing use of mainly agricultural land, a finite resource, for settlement and traffic purposes. These irreversible land use changes constitute an important issue for sustainability. In contrast to similar problems in Europe, urbanised areas in Asia are affected primarily by growth in employment and population. Other driving forces of land-use changes are mainly changing patterns of lifestyle, production and retail structures and transportation patterns.

Land consumption in metropolitan regions is characterised by a continuous and high rate mainly caused by the construction of new housing projects and transportation infrastructure. Therefore, land consumption is, because of its persistence, one of the main unsolved environmental problem areas. Consequently it is important to analyse the possible strategies, instruments and measures of an indicator-based policy instrument to optimise the policies and instruments in urban and regional planning and traffic management to reduce and manage the demand for land use in a more sustainable way.

The sustainable use of land resources is an important indicator for the evaluation of settlement structures and transport infrastructures from the point of view of an efficient spatial development. In contrast, the ongoing urbanization shows that the available instruments, spatial planning assessment methods, and many measures on regional and urban planning levels used to establish a more efficient land-use management are highly ineffective in the final evaluation. This is observed in the increasing rates of land consumption for residential areas and the resulting urban sprawl into surrounding areas.

3.1 Efficiency Indicators for Urban Land Use and their Impacts

In the spatial planning debate regarding sustainability impacts and spatial consequences of poorly managed expansion of residential areas in the outskirts of urban agglomerations, there is a need to have an agreed upon method to measure and evaluate the dominant structural changes in the urban landscape on a regional level. Beyond that, it is important for environmental and spatial planners to be able to demonstrate how the monitored sprawl of residential areas has real implications for an efficient land-use management and real impacts on the environment.

In the field of spatial and urban planning research, the main impacts of an inefficient use of land for settlement development are described as a spatial development in which the spread of residential development across the rural landscape far outpaces population growth (Nechyba and Walsh 2004). The efficiency of the resulting regional and urban spatial structure that this spatial development process creates can be measured and analysed (Apel et al. 2000, Ewing et al. 2002, Flacke 2003) by the use of the following spatial and structural indicators:

- Residential density and density of use,
- Variety of uses and mixed urban land use: Neighbourhood mix of homes, jobs, and services,
- Strength of agglomeration centres: Concentration and of polycentric structure settlements,
- Accessibility of public transportation infrastructures: Non car-based transport systems compatible with the city network.

In the following parts, these core indicators are explained with their relevance for and impacts on efficiency of use of land resources.

3.2 Linking indicators to Urban Development Models

Urban development planning of the last decades and the current discussion on regional planning are characterised by two contrasting and conflicting urban planning models (Apel et al. 2000):

- Network city - this widespread city is signified by the gradual dissolution of the traditional compact European urban structures. The network city represents a car-based urban planning model and is in line with the previously described trends in urban development: less residential density, fewer mixed land uses, decentralisation, dispersed structures, growth of private car-based transport.
- Compact city - this urban model is based on European urban culture and can be adapted to urban districts in polycentric, public transport-based regions. The compact city as an urban model represents an efficient use of resources such as land, energy, materials and time, and at the same time enables, through the concentration of human activities, the preservation of large greenfield areas in the countryside.

Indicator	Network City	Compact City
Residential density	The population is dispersed in low density development	High density of use, high residential density
Neighbourhood mix of uses	Rigidly separated uses (homes, shops, and workplaces)	Variety and mix of uses
Centeredness	Lack of well-defined activity centres (business, shopping)	Concentration of settlements, well-defined activity centres
Transportation choices	Poor access to public transportation choices: higher commuting rates and car ownership	Environmental-friendly public transportation choices, areas suitable for walking and cycling
Recycling of land	New developments mainly on greenfield sites	Redevelopment of brownfield sites and already built-up areas

(compiled from: Apel et al. 2000, Ewing et al. 2002)

Table 4. Efficiency of land-use for urban development strategies

Because efficiency indicators for residential land-use can be easily used to contrast and separate the two competing urban development models of the current spatial planning discussion (table 4), the efficiency of regional and urban development structures is a real, measurable phenomenon with real implications for indicator-based Sustainablity Assessment (SA) procedures in urban planning.

3.3 Recommendations for Spatial Planning Indicators

In general, spatial planning involves the setting of frameworks and principles to guide the location of residential development and physical infrastructure. Therefore spatial planning coordinates land-use related public and private investment decisions across space. As mentioned above, the trend of land-use changes and the resulting land consumption can be monitored in terms of spatial structural distribution, a system of activity centres and use densities and the patterns of interaction (commuting).

In HCMC, major deficits in the current regional planning framework to limit the environmental pressures associated with sprawl are a lack of spatially detailed data required to create indicators related to sprawl and land consumption and the resulting inappropriate zoning. Strengthening the regional planning competence requires an appropriate use of available data and a more precise and transparent zoning of future settlement areas (Runkel 1999). The current lack of usage and availability of socio-environmental efficiency indicators (Steinocher and Tötzer 2001) is limiting an appropriate zoning of land uses and the spatial assessment of environmental impacts of land-use changes resulting from spatial planning policies at the urban and regional levels in HCMC.

3.3.1 Indicators and Information Requirements for Urban Planning Systems

The control of the territorial setting of new residential areas must be acknowledged as the key task of spatial development plans. Therefore any assessment procedures against urban sprawl require detailed demographic information and land-use data to evaluate the spatial patterns of urbanisation and residential areas (Siedentop and Kausch 2004). The core data required are focused on the spatial concentration of land consumption as well as the distribution of newly created settlement areas. This information characterises driving forces and pressures related to demographic developments in agglomeration areas, their manifestation in the resulting land consumption and impacts on the compactness of urban structures. Special attention must be paid to the

importance of understanding the spatial structure of regions, agglomeration centres and cities in order to develop standards and thresholds for indicators which are compatible with the observed spatial structures of the assessed planning region.

The question of what type of residential development can be regarded as efficient in the use of land resources, and therefore limiting land consumption and protecting the countryside, must be more precisely defined by reference values on regional-level. A pragmatic approach to the assessment of settlement developments involving core indicators should be used (Apel et al. 2000, Wrbka et al. 2001, Flacke 2003), because they can largely be derived from the above-mentioned available land-use und socio-demographic base data. In order to provide improved control of the efficiency of land-use at the regional planning level, requires the primary definition of the basic parameters of urban development based on efficiency indicators (Flacke 2003, Wrbka et al. 2001). This means that definitions on the proposed type and scale of residential areas should be more specific and detailed than at present. This includes, for example, residential density and area size and basic information about the development potential in already build up areas or brownfields (Preuß and Ferber 2005). These indicators form the basis for spatial typologies that are based on intersections of land-use related environmental data and statistical socio-demographic information.

4 SPATIALISATION OF URBAN SUSTAINABILITY INDICATORS

Densification is the most important efficiency indicator for urban land-use patterns, because it reduces sprawl. Further, the dense structure of the compact city provides the necessary economies of scale for an efficient infrastructure, and provisions for certain types of public urban services and an efficient use of finite natural resources. Urban planning strategies based on the compact city model, with its efficient urban-related infrastructure and service provision and protection of the natural environment, promise to reduce the urban environmental footprint of megacities.

Yet in heavily under-serviced urban areas in developing counties, densification can be detrimental. In HCMC informal settlements are examples of areas of extremely high density living, but inadequate levels of service and infrastructure provision creating serious health problems and increased environmental impacts in these urban districts. In these under-serviced urban areas poverty reduction is the primary issue and the necessary establishment of acceptable living conditions induces an increase in resource consumption and energy production. Higher density is therefore not the only indicator for sustainable urban structures.

4.1 Common Spatial Framework based on Urban Typologies

Sustainable urban development requires different strategies for different settlement types, because spatial planning concepts are very dependent on the particular local urban context. Different settlement types will have different implications for achieving sustainability of settlement and housing 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. 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 structural efficieny indicators leflecting the degree of compactness of housing areas in HCMC. 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.

Settlement and housing types in HCMC are not uniform. Understanding these different types in HCMC therefore becomes crucial to the urban planning debate in this metropolitan region. Building HCMC-specific urban typologies should be centred on the definition of settlement types according their compactness. To distinguish different settlement types it is important to define, based on urban form specific indicators, the core information layers that can help to differentiate one settlement from another.

Because of the difficulties of separating settlement and housing typologies in HCMC they are used in an integrated manner, to accept the complex nature and continued transformation of urban typologies in HCMC.

It is therefore not the primary goal to develop a general definition of settlement and housing typologies in HCMC. Rather, an analysis of the sustainability of urban typologies in a relatively representative model of different settlement and housing types is needed to assess the problems of different urban settlement and housing structures. Urban typologies can provide a tool for the structured and representative analysis of settlements in HCMC with its different components, of which housing is an important one.

Housing Typology	Description	Height (Storeys)	Block Size (Shape)	Street-Network	Built-up Ratio	Location	Housing Mix (Types)	Mixture of Usage (Res/So/Com)
Shophouse								
Type A	Shophouses on the border (street-orientated) of a slum area	1-3	large	irregular	medium	Inner-City	medium	medium (shops in the outside borders)
Type B	Medium-sized blocks with a small inner connection only for pedestrians	2-4	medium	regular	high	Inner-City	low	high
Type C	Small-sized blocks, every plot is connected to a street	2-3	small	regular	medium	Inner-City	low	medium (basically residential use)
Type D	High-density tourist area with hotels, restaurants, agencies in shophouses	2-8	small	regular	very high	Inner-City	medium	high (basically commercial use, only some residential use)
Type E	Redevelopment site with shophouse typology for middle- to high income groups	5	small	regular	high	Inner-City, Redevelopment Area	low	medium (sometimes residential use only)
Type F	Orthogonal shophouse pattern in the periphery	1-2	medium	regular	medium	Outer Districts	low	medium
Type G	Linear street-orientated sprawl	1-2	no blocks	irregular	low	Outer Districts	medium	medium
Villas Structure								
Type A	Mainly original villa structure from the French influence	1-3	medium	regular	medium	Inner-City	medium	medium-high
Type B	Villa structure with an intense mix of other typologies	1-3	medium	regular	medium-high	Inner-City	rich	medium-high
Condominium								
Type A	High-density linear apartment blocks	5-6	small	regular	high	Inner-City	Low (plug-in in shophouse area)	medium (shops, services on ground floor)
Type B	Medium-density apartment blocks with designed public space and partly occupied by slum buildings	5-6	large, (linear row-structure)	irregular	medium	Outer Districts	medium	medium (shops, services on ground floor)
High-rise								
Type A	High-rise apartment buildings as plug-in in existing settlement structure	ca. 20	small	irregular	high	Inner-City	low	low
Type B	High-rise apartment buildings in the new development area Saigon-South	20-24	medium	regular	medium-high	New Development Area	low	medium (shops, supermarkets on ground floor)

(Source: Storch and Eckert 2007 Tab.1)

Table 5. Study Sites, Housing Typologies

4.2 Methodology - Data collection based on Housing Typologies

In general, data on the housing typologies will be gathered by examining actual study sites within the metropolitan area of HCMC. Prior to the selection of these study sites, the kinds of housing development inherent to each typology were identified.

Four representative types, so called archetypes, of residential development were generally identified (table 5):

- Shophouse (tubehouse with small lot wide) patterns,
- villas structures,
- condominium (mid-rise multiple family apartment buildings) and
- high-rise apartment blocks (up to 20 storeys high).

Based on these four housing archetypes, each of these types was conceptually divided into two subtypes to generate the housing typologies, with the exception of the shophouse structure, which was divided into seven subtypes to reflect the broad variety of these predominant settlement structures occurring in the inner-districts of HCMC. The shophouse is a building typology found throughout much of Southeast Asia. They are mostly two to three storeys high and serve both shops on the ground floor and living quarters above. In HCMC, shophouses are located predominantly in the inner-city districts. Following building-specific indicators were used to define the final housing typologies (table 5):

- Height (storeys),
- block size and shape,
- structure of the street-network,
- built-up ratio,
- location in the metropolitan area,
- housing mix and mixture of usage (multi-functionality).

These housing typologies are used to define the study sites for the data collection procedures.

4.2.1 Housing Typologies – Selection of Study Sites

Each study site represents one housing typology found within the settlement pattern of HCMC. First, these study sites were spatially defined through examination of satellite images and later verified by ground recognizance. Study Sites were selected following three primary criteria:

- archetypical representation of the housing typology;
- conformance of the shape and size of the street block arrangement to the overarching archetype; and
- correlation to pre-existing statistical and spatial data sources.

The final criterion was included to simplify the data collection process during the initial phase of the research programme, where all available data required for the multi-layered approach should only be aggregated to reflect the typology-driven accepted common spatial framework. Out of this process, a first requirement for thirteen study sites was realized (table 5).

Up to four study sites are selected for each of the housing typologies. Each study site is selected to represent one housing typology found within the neighbourhood pattern on district level. The physical boundaries of the housing typologies are defined by street blocks. The study site is embedded within the surrounding urban fabric of the neighbourhood pattern. Data collected from the Study Sites for the representing housing typology will be used to formulate scores for sustainability based on the multi-layered approach. The neighbourhood pattern is represented as a puzzle, in which the separate housing typology pieces fit together to form the complete picture of settlement developments in HCMC.

5 TYPOLOGY BUILDING BASED ON SUSTAINABILITY INDICATORS

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 (table 6), based on the concept of urban typologies. The typology-based approach allows a (scientific) trans-disciplinary identification of core indicators for the spatial information system. 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 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. This has led to a multi-layered typological approach (table 6) in which urban typologies to highlighting the major aspects of sustainable urban development can be identified. The framing of these factors was based on a set of requirements drawn from international descriptions of the characteristics of a sustainable settlement as measured by the described indicator conceptions.

This multi-layered approach reflects that the livelihood of the neighbourhoods in general is dependent on the combined effect of a range of sustainability-related factors, rather than the presence or absence of single aspects of urban sustainability. To assess the sustainability of urban settlement developments, four different layers must be analysed (table 6):

- The physical structure – how the settlement with its form of the built environment is related with the different parts of the city, responds to the topographic situation and is integrated within the natural environment.
- The urban environmental land-use patterns – spatial environmental sensitivity indicators offer the capacity to assist the identification of areas where housing-related development impacts require careful consideration (Bouland and Hunhammar 1999).
- The use patterns – are described by the public provision of urban infrastructure and services, which defines the way the settlement uses its resources and the impacts on the urban and regional natural environment.
- The social system – how the settlement provides opportunities for an acceptable quality of life to their residents.

The data collection is based on two sources: a GIS survey of pre-existing statistical data aggregated on street block level and ground reconnaissance. The indicator-related data collection was chosen on the basis of the four layers establishing the multi-dimensional housing typologies: housing structure, urban land-use pattern, housing-related infrastructure services and socio-demographic characteristics.

The main task of the multi-layered typology approach is to illuminate the connection between patterns of housing development and the sustainability of the metropolitan region of HCMC. The data collection for the housing typologies has to be distilled into four factors. These four layers were selected to reflect sustainable spatial planning research that has evolved in response to an increased concern about the environmental, social and economic costs of continued unsustainable urban development. Urban sustainability goals generally state that all residents have the right to clean air, safe water and affordable housing. This means communities should be designed to reduce dependence on private modes of transport; to protect the functioning of streams, sensitive natural areas and resources; and to foster an acceptable quality of life for residents.

These features are jointly influencing sustainability factors such as: commuting behaviour, housing affordability, the formation of social ties and job opportunities, and the efficiency of the use of land and natural environmental resources in general. The layered approach of housing typologies helps to indicate how successful each typology is in achieving these goals.

Clearly, the structure and arrangement of housing areas are factors influencing urban sustainability. Recognition of this connection makes it possible to re-evaluate the housing development pattern as a fundamental determinant in the formation of urban sustainability, because, if replicated on multiple sites, the housing development pattern becomes an integral part of the urban fabric of HCMC. The sustainability of each housing development helps to determine the ultimate sustainability of the urban region. Urban sustainability is strongly influenced by the choices that are made about the housing types to build.

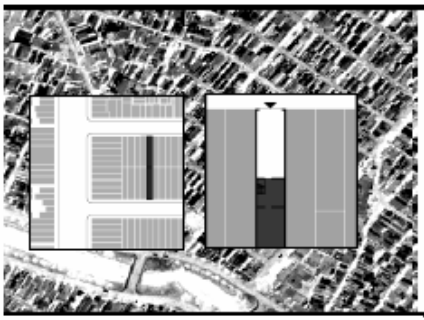
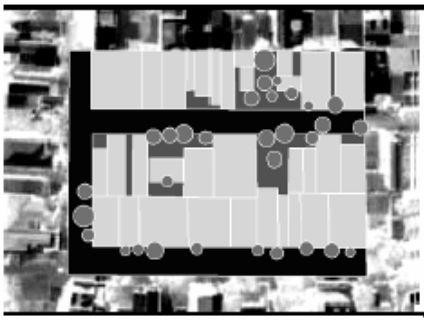
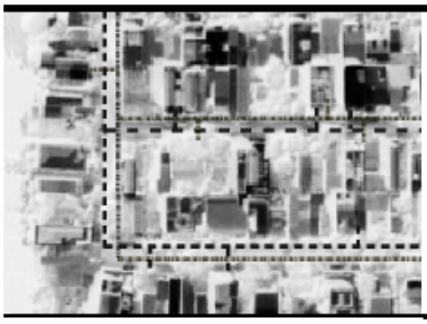
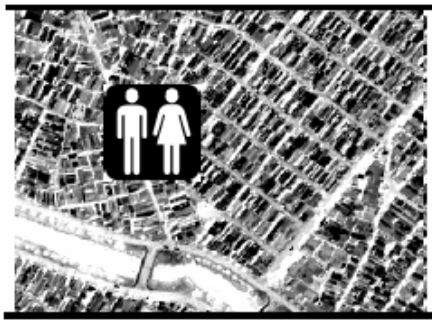
Layer 1 – Physical Structure	*Housing Structure*	
	Compactness (Density + Structure)	**Floor area, Height (storeys)**
		Built-up ratio,
		Block size and shape
		Structure of the street-network
		Location in the metropolitan area
		Multi-functionality / mixture of usage
	Informality	**Informal Settlement rate**
	Accessibility	**Low income people accessibility to housing**
Layer 2 Urban Land Use	*Urban/Environmental Land-use Pattern*	
	Land resource	**Land use structure**
	Green area	**Green area (trees, grass, waters)**
	Community space	**Community space**
	Green areas	**Distribution of green areas**
	Underground water	**Quality of underground water**
		Intensity of exploitation
	Surface water	**Quality of surface water**
Layer 3 – Use Pattern	*Public Infrastructure Services*	
	Sanitation (Accessibility)	**Clean water supply**
		Sewage system
		Waste collection system
	Water pollution	**Volume/ Treatment of wastewater**
	Disposal/Collection	**Domestic waste generation/collection**
	Treatment	**Volume of treated waste**
	Transportation modes	**Density/ Ratio/ Efficiency of public transportation**
	Energy	**Consumption of energy**
Layer 4 – Social System	*Social Sciences and Human Geograph*	
	Density	**Population density**
	Population change	**Migration/ Natural growth rate**
	Economic structure	**Income**
	Poverty	**Population living below poverty line**
	Unemployment	**Unemployment rate**

Table 6. Multi-layered Urban Typologies based on Sustainability Indicators.

6 DISCUSSION AND CONCLUSIONS

The concept of multi-layered urban typology looks at the housing development as a regional building block. Rather than examining the effects of housing developments on single aspects of sustainability independently, possible combinations of these aspects are explored. The goal of the data collection is to determine the relative sustainability of each housing typology. Although all of the defined housing typologies are preexisting in HCMC, the purpose of the multi-layered approach is to describe how each would function as new developments in the metropolitan area of HCMC. The results of the investigation of multi-layered housing typologies will be applied in the Sustainability Assessment of new housing developments, where urban planning administrations may combine different housing typologies to explore the implications of the resulting settlement pattern on the creation of a sustainable urban development region.

The strong spatial focus on urban typology facilitates the analyses of different housing-related environmental resource management strategies. 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.

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