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DOES THE URBAN PLANNING OF SINGAPORE CONTRIBUTE TO ENVIRONMENTAL SUSTAINABILITY?

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Being a Report submitted to the faculty of The Built Environment as part of the requirements for the award of the *MSC. TOWN & COUNTRY PLANNING* at University College London:
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ABSTRACT

Singapore's government has always pride itself for adopting sustainable development principles since its independence. This study aimed to find out whether Singapore's urban planning is indeed contributing to environmental sustainability. First, the city-state's input-output streams were analysed to assess the possibility of it achieving environmental sustainability. Then the interactions between these streams and Singapore's urban planning were examined to determine whether the latter contributes to environmental sustainability in these streams. A set of criteria was also used to assess the contribution of Singapore's urban planning as a whole to the environmental sustainability agenda. Besides desktop research, interviews were conducted with planners and architects to seek their views.

It was found that Singapore's urban planning does contribute to environmental sustainability in certain input-output streams, and has done relatively well in protecting the environment for future generations, generating environmental benefits at the macro country level, minimising the use of resources, and capitalising on the multi-functionality of green and open spaces. However, Singapore's small landmass limits its ability to become fully environmentally sustainable, and also constrains the extent which its urban planning can contribute to environmental sustainability. In some areas, urban planning either plays a secondary role or has to be supplemented by technology, regulations and public education.

To better contribute to environmental sustainability, Singapore's urban planning should explore ways to reduce energy consumption, protect more nature areas, encourage adaptive re-use of old buildings and closed landfills, and develop Strategic Environment Assessment (SEA) for its land use plans and related policies. Nevertheless, it is recognised that it will take time to implement more environmentally sustainable urban planning and to increase the awareness of this concept amongst Singapore's planners. It is hoped that the government's upcoming strategies to achieve environmental sustainability would include a thoughtful review of its urban planning's objectives.

1.0 INTRODUCTION

1.1 Research Motivation & Background

In South East Asia, the States' leaders have recently adopted the "ASEAN (Association of South East Asian Nations) Declaration on Environmental Sustainability" in the 13th ASEAN Summit held in November 2007 (ASEAN secretariat 2007). Following that, Singapore, arguably the most developed country within ASEAN, has set up its own inter-ministerial committees to tackle climate change and environmental sustainability. As a start, the objectives of the Inter-Ministerial Committee on Sustainable Development (IMCSD) are two-fold:

i) To articulate a clear national framework and strategy to achieve a sustainable and high quality living environment that is consistent with economic growth; and

ii) To build new competencies and facilitate mind-sharing across the public, private and people sectors to develop Singapore as an "Eco-Hub" i.e. an innovative thought-centre and hub for urban and environmental sustainability (Ministry of National Development (MND) 2008a).

While the above seems to mark a stronger directive for Singapore to contribute to environmental sustainability, the country's official stand should be observed from its Prime Minister's statement on the ruling party's website. He stated that despite Singapore contributing less than 0.2 percent of the worldwide carbon emission, Singapore will participate in the global effort to reduce greenhouse gases (GHG) by redoubling its efforts to conserve energy and by being less wasteful (People's Action Party (PAP) 2007). However, he also reiterated that this will be done while safeguarding its national interests especially since the country is totally dependent on fossil fuels and is a major manufacturing base for multi-national corporations, and is a major sea and air hub (PAP 2007).

At various forums, the Singapore government has emphasised how it had to adopt sustainable development principles since its independence because of it being a small city-state with scarce resources and no hinterland

(MND 2008b & c). However, while the "Singapore Way" of sustainable development has focused on achieving both economic growth and a good quality of life (MND 2008c) with emphasis on a "clean and green, spruce and well maintained" environment (United Nations (UN) 2006), has the country also been planned in an environmentally sustainable way i.e. by considering its developmental impacts on climate change and wider environmental resources? As stated by Susan Owens (1994), we should be concerned not only with the environmental qualities of cities, but with a wider set of interactions between urban society and the regional and global ecosystem.

1.2 The Singapore Context

Singapore is a city-state with land size of approximately 700 sq km (versus Greater London which is about 1,600 sq km), and it has one of the highest population densities in the world of almost 6,500 persons per sq km (Singapore Department of Statistics (DOS) 2008). It consistently ranks high globally and regionally in terms of the competitiveness of its economy, its importance as an international air travel hub, its quality of life, etc (Economic Development Board (EDB 2008b). Although the services industries contribute to about 66 percent of Singapore's economy, the manufacturing sector still accounts for a quarter of its economy (Ministry of Trade & Industry (MTI) 2008). It is moving towards a more knowledge and research-based economy while still continually building on the growth potential of its existing manufacturing base (EDB 2008c).

The Concept Plan 2001 which maps out Singapore's vision for the next 40 to 50 years, had projected a long-term population of 5.5 million but this has been revised upwards to 6.5 million in the recent Mid-Term Concept Plan Review in 2006 (URA 2007). The land use allocation as of year 2000 is shown in Table 1, and it is observed that the uses which are generally deemed to be more pollutive i.e. industry, roads, infrastructure & utilities, together occupied almost 30 percent of the country's land area.

Table 1: Singapore's Land Use Allocation in Year 2000

Land use	**Housing**	**Industry**	**Roads, Infrastructure & Utilities**	**Commerce, Community & Institution**	**Parks, Sports & Recreation**	**Others (undeveloped, reservoirs, cemeteries etc)**
Area (%)	15.1	12.2	17.5	7.5	6.2	41.5

(Source: URA 2000)

Singapore has a generally flat terrain which is mostly lowland with a gently undulating central plateau that contains water catchment area and nature reserve (IndexMundi 2008). Despite limited land and high population density, Singapore enjoys a rich biodiversity where 10 percent of the land is set aside for nature reserves and parks, which are home to over 2,900 species of plants, 360 species of birds and 270 species of butterflies, and this is in addition to a network of park connectors, streetscape and waterfront greenery which brings the total area covered by greenery to about 47 percent of the country's land area (Arti Mulchand 2008). The need to "pack" a variety of uses within its small land size means the country constantly needs to assess how best to site the land uses so that they do not impinge on each other and the biodiversity, and still remain an attractive world city.

1.3 Research Aim & Objectives

Cities are said to be inherently dependent on its hinterland. Since Singapore is a city-state with no hinterland, it would have to be dependent on foreign countries. Nevertheless, it can still strive to become *more* self-sufficient and hence *more* environmentally sustainable. This study aims to examine whether its urban planning contributes to this goal. The objectives are:

a) To conduct a literature review on the concept of environmentally sustainable cities, the relationship between urban planning & environmental sustainability, and the theories & examples of environmentally sustainable urban planning;

b) To examine the interactions between Singapore's input-output streams and its urban planning, and whether the latter is contributing to environmental sustainability; and

c) To discuss whether Singapore's urban planning can be improved to contribute further to environmental sustainability.

1.4 Scope of Study

Urban planning is defined as "determining and drawing up plans for the future physical arrangement and condition of a community" (TheFreeDictionary 2008) or "the branch of architecture dealing with the design and organisation of urban space and activities" (Dictionary.com 2008). This study focuses on the siting of land uses (including road layout) and their related policies, but not the architectural/engineering technologies nor micro transport planning such as modes of transport.

1.5 Limitations of Study

Due to the infancy of the two inter-ministerial committees, their strategies and proposals are not yet public information. Hence this study was conducted without the benefit of knowing the ministries' plans. In the same token, there are sensitivities in conducting formal interviews with the relevant government agencies and officials involved, thus informal interviews were conducted with anonymous planners and architects to seek their personal views instead.

1.6 Flow of the Report

This chapter has described the research motivation, the Singapore context and the research objectives. Chapter *Two* will present the literature review, *Chapter Three* will describe the methodology that was adopted in this study, and *Chapter Four* will then examine Singapore's input-output streams. This is followed by *Chapter Five* which will provide an overview of Singapore's urban planning system and an analysis of its relationship with environmental sustainability, before suggesting improvements for a more environmentally sustainable urban planning and the challenges in achieving it. The concluding chapter will summarise the key findings and recommendations of this study.

2.0 LITERATURE REVIEW

2.1 Introduction

Sustainable Development in an Urbanising World

Sustainable development is often described as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs", as defined by the World Commission on Environment and Development (WCED 1987), also known as the Brundtland Commission (Haughton 2003). Urban systems with millions of inhabitants are unique to the current age and are both organisms and mechanisms in that they utilise biological re-production as well as mechanical production processes (Girardet 1999a). Within an increasingly urbanised world, roughly half of the world's population lives in urban centres – this means cities taking on the concept of urban sustainability (Rydin 2007), and the increased dependence of the earth's ecosystems on the patterns of urban growth (Alberti 2005).

Cities & Environmental Impacts

Haughton (2003) described that cities have long been depicted as almost inherently undesirable in environmental terms because they distort rural economies, foster energy-intensive lifestyles and transforms nature. With urban areas emitting four times more GHG than the rural areas and three-quarters of urban settlements located in coastal areas at risk from sea-level rise (UN 2008), both central and local governments are increasingly aware that efforts to improve the living environment must focus on cities (Girardet 1999a). Priemus (1999) proposed that the key to the reduction of environmental problems is to be found in the way we develop, manage and make use of our cities. As cities continue to grow in size and in their share of the growing global population and economic wealth, their environmental impacts will continue to be a central theme in the move towards global sustainability (Haughton 2003).

Cities & Environmental Sustainability

Environmental sustainability means seeking to sustain global life-support systems indefinitely (Goodland 1995), and sustainability means that a unit should use no more than it can replace (Blassingame 1998). Girardet (1999a) had reported that while cities occupy only two percent of the world's land surface, they use over 75 percent of the world's resources. Thus the sustainable city seems a contradiction because urban areas must exploit the resources of a wider environment for their survival (Owens 1994). Since urban resource demands and waste streams exert global impacts, attempts to improve the local environment without considering external impacts of urban behaviour are insufficient to address the true imperatives of sustainable development (Haughton 1997). The view that a city is inherently dependent on its hinterland is supported by many authors (Nijkamp & Pepping 1998, Girardet 1999a, Haughton 2003, Haughton & Hunter 1994 in Rydin 2007, Rydin 2007), and has been re-affirmed in concepts such as the 'ecological footprint'. A prerequisite for sustainable cities is therefore the sustainable use of the global hinterland (Rees & Wackernagel 1996).

Satterthwaite (2002 in Rydin 2007) has argued that there is no reason why well-governed cities should not achieve the highest standards in terms of quality of life, efficient resource use, low waste volumes and low GHG emissions per person. Finco & Nijkamp (2001) added that cities are in a unique position to develop proper sustainability strategies through the agglomeration advantages originating from their geographical synergy. White (2002) even proposed that environmentally sensitive cities will enjoy a competitive advantage that will increase over time as the global environmental struggle intensifies. Now that the environment is so heavily used, the limiting factor for much economic development has become natural capital (Goodland 1995).

2.2 Concept of Environmentally Sustainable Cities

Basiago (1996) reported that the idea that the contemporary pattern of world urbanisation is not 'sustainable' and that a 'sustainable' paradigm must be designed first appeared in Britain a quarter of century ago in *A Blueprint*

for Survival (The Ecologist 1972). In the 1960s, McHarg had argued that towns and cities were still part of a wider, functioning ecosystem – no matter how distorted – and that decision-makers should understand the altered but nevertheless functioning natural processes still operating within the city (Carmona 2001). White (2002) described that cities are part of the natural environment, and their inhabitants (including human species) ultimately depend on environmental quality such as the provision of clean air, clean water and healthy food for their maintenance, thus cities should function in harmony with the natural world. This is in line with Alberti (2005)'s statement that changes in ecological conditions that result from human actions in urban areas ultimately affect human health and well-being, and also Berg's view (1990c in Haughton 2003) that cities need to become life-enhancing and regenerative, 'securing reciprocity between the urban way of life and the natural web that surrounds it'.

Physical geographer Ian Douglas suggested that the city itself can be seen as an ecosystem with inputs of energy and water and outputs of noise, climate change, sewage, garbage and air pollutants, thus a way to consider the city-nature dialectic is to see the city as an ecological system with a measurable amount of environmental inputs and outputs (Benton-Short & Short 2008). White (2002) referred to Abel Wolman's concept of urban metabolism (Table 2) which focused on the major physical inflows to the city and outflows from it, and reasoned that the root cause of our imbalance with the natural ecosystems and biogeochemical cycles on which all life depends on is the decision to expand our use or throughput of resources with no thought of the consequences.

Table 2: Wolman's Concept of Urban Metabolism

Inputs	**Outputs**
Water	Sewage
Food	Refuse
Fuel	Air pollutants

(Source: after Wolman 1965 in White 2002)

Girardet (1999b) explained that in nature, every output is also an input which renews and thus sustains life. He showed that the linear processes by which cities transform environmental resources into waste products disrupt the planet's life support systems, and argued that a new approach is urgently needed to reorganise the metabolism of cities so that it becomes more 'circular' and recycles resources to maintain ecological balance (Girardet 1999b). White (2002) also agreed that 'waste' is not a natural concept in natural systems.

Furthermore, Newman (1999) quoted the laws of thermodynamics stating that anything which comes into a biological system must pass through it, therefore the amount of waste is dependent on the amount of resources required. Benton-Short & Short (2008) added that biogeochemical cycles are all subject to the basic Newtonian principle that matter can neither be created nor destroyed. Hence it is important to recognise that while we can manage the wastes produced, they require energy in order to turn them into anything useful and ultimately all materials will eventually end up as waste (Newman 1999). Many of the current environmental problems derive from the fact that the sinks on which we depend cannot absorb all our wastes, thus the challenge is to produce fewer of wastes and create markets for those that we do produce (White 2002). Priemus (1999) described an eco-device model involving three-step strategy for inputs and outputs (Table 3), while Rydin (2007) carried out an environmental input-output analysis of cities (Table 4) and described the idea of a recycling city with much diminished throughput.

Table 3: Eco-device Model for Inputs & Outputs

IN
(1) Prevent unnecessary use (2) Apply sustainable sources (3) Apply finite sources optimally
OUT
(1) Prevent waste (2) Recycle waste (3) Process waste in a clean way

(Source: Priemus 1999)

Table 4: Environmental Input-Output Analysis of Cities

Environmental System	**Inputs to cities**	**Outputs to cities**
Lithosphere	Food production sites Minerals and aggregates Hydrocarbons Habitat sites Land for development Landscape settings	Site contamination Landfill for waste disposal Land development
Atmosphere	Clean air Climate control functions	Air pollution at local, regional and global scales
Aquasphere	Water supply Water-based habitat sites Sites for water-based economic and social activities	Sewage disposal Polluted water Land drainage
Biosphere	Food Flora and fauna Habitats Living landscapes	Species change Species spread

(Source: Rydin 2007)

This view of urban environmental sustainability has led to calls to move towards greater self-sufficiency, towards reducing the resource inputs into the city, switching to renewable sources, using renewable sources within their capacity to renew themselves, and reducing the pollution and waste exported (Portney 2003 in Rydin 2007, Rydin 2007). This is similar to the 'self-reliant' city model as described by Haughton (1997) which emphasised sorting out a city's problems from within. By looking at the city as a whole and by analysing the pathways along which energy and materials move, it is possible to conceive of management systems and technologies which allow for the reintegration of natural processes, increasing the efficiency of resource use, the recycling of wastes as valuable materials and the conservation (and even production) of energy (Newman 1999).

Nevertheless, Rydin (2007) cautioned that a localist approach would ignore the social impact of such a shift in purchasing patterns where local communities elsewhere globally are dependent on exporting their produce. Galtung (1986 in Haughton 1997) also acknowledged that some inter-regional trading will be necessary and indeed desirable in raising some

regions to the life quality standards of others. Furthermore, Luck et al (2001 in Alberti 2005) showed that since natural resources are not typically distributed uniformly across landscapes, the location of urban areas and interurban competition may play a crucial role in determining the magnitude of the ecological footprint. Hence, Haughton (1997) rightly pointed out that just because people are concentrated in one area is not a reason for denying them access to resources outside their own bioregion, and inter-regional exchanges should be allowed as long as they do not damage the carrying capacity of external areas, are conducted on equal terms based on full costings, and meet the real needs of urban consumers, not the inefficiencies and profligacy of urban consumption habits. This has important implications for urban policy as it prompts the question whether the competence of urban policy is limited to its administrative borders or may extend to the rest of the world (Finco & Nijkamp 2001).

2.3 Land Use Planning & Environmental Sustainability

Not only does urban planning embrace sustainability within its wider spirit and purpose, even its traditional domain of amenity and physical land use contains topics of obvious relevance to modern environmentalism (Selman 1996). Owens (1994) stated that land use is linked to environmental change at all scales from the local to the global, and the significance of these interactions beyond the local scale is increasingly acknowledged and making an impact on land use planning policies. Alberti (2005) described the evolution of land uses and their ecological impacts as a function of the spatial patterns of human activities and natural habitats which affect both socioeconomic and ecological processes at various scales, while Kenworthy (2006) stated that the shape and form of a city set the basic framework within which everything else about the city has to operate and are especially important in how the city relates to its bio-region.

In many countries, land use planning has acquired the political burden of reconciling the development pressures with environmental concerns (Owens & Cowell 2002). Agenda 21 also emphasises the value of planning mechanisms as means of integrating environmental and developmental

interests, and of striking the right balance between users of a limited resource (Selman 1996). Stead (2005) stated that land use planning offers opportunities to reduce the environmental impacts of settlements and address the social inequalities of environmental pollution. Orishimo (1982 in Finco & Nijkamp 2001) found that the land use, the transport systems and the spatial layout of a city are critical factors for urban environmental quality. Arguing that cities are not necessarily bad, Haughton (2003) found that well-designed and well-managed cities have potential to be more environmentally friendly, and their design (i.e. size, shape, population densities and internal ordering) is central in shaping the way in which environmental resources are used, in particular energy. Owens (1994) also opined that the location of activities and the form of built environment influence energy and materials flows and therefore impinge on the regional and global environments as well as that at the local scale.

Therefore, to restructure a city to become more environmentally sustainable, we would have to start with the foundation first i.e. the land use pattern and infrastructure that support the anatomy of the whole city (Register 2002). However in the richer countries, the daily existence of urban dwellers is separated from the natural ecosystems, thus a paradigm shift in urban planning and management is required to re-learn how natural ecosystems function (White 2002). Owens (1994) argued that we need to re-conceive the planning system as embedded within a set of environmental constraints, and planners should consider how environmental objectives relate to the use and development of land and assess the contribution of land use planning measures. Rydin (2003) further described that the planning system, in adopting the goal of environmental sustainability, would have to encompass planning for anticipated environmental change, protecting the environment for future generations and actively generating environmental benefits from development.

2.4 Environmentally Sustainable Urban Planning of Cities

While the form of the contemporary city has been perceived as a source of environmental problems, there is a lack of agreement about the

desirable urban form in the context of sustainability (Jabareen 2006). White (2002) had proposed intensification of land use accompanied by mixed land uses to reduce travel distances and to encourage a return to public transport, walking and cycling, similar to the 'compact city' model advocated by Rogers (1998). Along the same reasoning, Selman (1996) described that town centres are worth maintaining because they are suitable for combining trips for different purposes such as shopping, leisure and employment. There is a degree of consensus that intensifying and mixing development in existing areas rather than dispersing growth and building on greenfield land would minimise environmental impacts of transport and maximise energy efficiency, although some have interpreted higher urban densities to mean less green spaces and lower standards of amenities (Owens 1994). The dilemma of the compact city is that some environmental effects (such as biodiversity) benefit from a certain spatial spread of the urbanisation, while other effects (such as restriction of mobility) benefit from a concentration of activities in the city, thus there is a need to find a good balance between spatial concentration and de-concentration (Priemus 1999).

White (2002) also suggested reversing the dependence on distant regions to support the city by making cities more self-sufficient, quoting examples such as the building on brownfield sites and the installation of photovoltaic arrays on residential and commercial buildings. Kenworthy (2006) reported that cities such as Zurich, Stockholm, Helsinki and Freiburg have provided for urban agriculture, forests and community gardens, as well as excellent public transport systems and high levels of walking and cycling, and also adopted environmental technologies. Girardet (1999a) added that some modern cities have made circularity and resource efficiency a top priority for example, by installing waste recycling and composting equipment.

Table 5 lists Haughton (2003)'s suggestions on how urban planning could improve the urban environment and Table 6 shows Stead (2005)'s proposed land use planning measures to reduce the environmental impacts of development in terms of resource consumption and environmental pollution.

Table 5: How Urban Planning could improve the Urban Environment

- Changing the shape, size, residential density, layout and location of activities in cities can bring energy-demand variations of up to 150%.
- Studies have shown that low-density cities use twice as much energy as high-density cities, taking account of climate and income variations.
- Increasing the percentage of people traveling by public transport is generally easier in higher-density, compact cities, and the increased use of public transport can bring about major energy savings, reducing the emissions of pollutants.

(Source: adapted from Haughton 2003)

Table 6: Land Use Planning Measures to Reverse Current Environmental Impacts

Environmental Indicator	**Development Density**	**Accessibility to Public Transport**	**Local Employment, Services & Facilities**	**Parking Restraint**
Energy consumption	All four measures reduce the need to travel and promote the use of alternative modes to the car, thus reducing transport energy consumption.			
	Higher density development has greater potential to use energy more efficiently (e.g. through CHP schemes)			
Land urbanised	Higher density developments require less land than lower density developments	Increasing the accessibility and use of public transport reduces the amount of land required for roads		Less parking space requires less land
Minerals extraction		Increasing the accessibility and use of public transport reduces the materials required for roads		Less parking space requires fewer construction materials
Carbon dioxide, Nitrogen oxides, Particulates	All four measures reduce the need to travel and promote the use of alternative modes to the car, thus reducing emissions from transport. Very high densities may however lead to high concentrations of local pollutants.			

(Source: Stead 2005)

However, Haughton (1997) also argued that such 'redesigning the city' debates have an internal focus that neglect where resources come from and where wastes go to. Instead, green urbanism for a city should mean (1) striving to live within its ecological limits, (2) designed to function in ways analogous to nature, (3), striving to achieve a circular metabolism, (4) striving toward local and regional self-sufficiency, (5) facilitating more sustainable lifestyles, and (6) emphasising a high quality of neighbourhood and community life (Beatley 2000 in Jabareen 2006). The rationale behind these criteria are similar to the elements found by Naess (2001) in the literature on sustainable urban development and spatial planning in wealthy industrial countries (Table 7) and Rees (1997)'s suggestions for planners and politicians in land use planning domain (Table 8).

Table 7: Sustainable Urban Development & Spatial Planning in Wealthy Industrial Countries

(1)	Reduction of energy use and emissions per capita in the area down to a level compatible with the ecological and distributional criteria for sustainable development at global level.
(2)	A minimising of the conversion of and encroachments on natural areas, ecosystems and soil resources for food production.
(3)	A minimising of the consumption of environmentally harmful construction materials.
(4)	A replacement of open-ended flows, where natural resources are transformed into waste, with closed loops relying on a higher extent on local resources.
(5)	A sound environment for the city's inhabitants, without pollution and noise damaging to the inhabitants' health, and with sufficient green areas for the population to experience and become emotionally related to nature.

(Source: Naess 2001)

Table 8: Suggestions for Planners & Politicians in the Land Use Planning Domain

(a)	Integrate planning for city size/ form, urban density and settlement patterns in ways that minimise the energy, material and land use requirements of cities and their inhabitants.
(b)	Capitalise on the multi-functionality of green areas (e.g. aesthetic, carbon sink, climate modification, food production functions) both within and outside the city.

(c)	Integrate open-space planning with other policies to increase local self-reliance in respect of food production, forest products, water supply, carbon sinks etc.
(d)	Protect the integrity and productivity of local ecosystems to reduce the ecological load imposed on distant systems and the global common pool.
(e)	Strive for zero-impact development such that the destruction of ecosystems and related biophysical services due to urban growth in one area is compensated for by equivalent ecosystem rehabilitation in another.

(Source: Rees 1997)

3.0 METHODOLOGY

3.1 Description of Methodology

The literature from books, journals and websites shows that the environmental sustainability of a city involves not just concerns over its own environmental quality, but also its impacts on the global environment. Hence we would need to first study the flow of resource inputs into and waste outputs from Singapore to determine whether it is environmentally sustainable in these input-output streams, before we assess the contribution of its urban planning to environmental sustainability.

In Step-1, Rydin (2007)'s environmental input-output analysis as shown earlier in Table 4 was adapted for use as the basic framework to analyse Singapore's input-output streams, while environmental sustainability is defined as achieving the three-step strategy described by Priemus (1999) in Table 3, with equitable inter-regional trading. The adaptations made to Rydin's analysis served mainly to reflect Singapore's unique situation as a city-state:

a) Since Singapore is only 700 sq km with a generally flat terrain, the concerns over landscape settings, living landscapes, species change and species spread have limited relevance, thus these were removed.

b) Given its small landmass, there is little value to separate water-based habitat sites from land habitat sites, thus these were combined and indicated as "habitat sites including flora and fauna".

c) Water bodies in the country are primarily reservoirs for use as water catchment and supply which may double up for recreational purposes, thus "sites for water-based economic and social activities" were removed.

d) Waste in Singapore is mainly disposed of via incineration, thus "landfill for waste disposal" were amended to "waste disposal (incineration or landfill)".

In addition, "clean air" and "climate control function" were removed to recognise that although they are provided by the atmosphere for proper functioning of the city and ecosystem, the concern is not about using them in a

sustainable way but rather how not to pollute the air or to cause ecological imbalance by over-emission of GHG. "GHG" and "Noise" were added as outputs to reflect their undesirability. "Land development" under outputs was changed to "dilapidated properties or wasteland" to better reflect the main concern against over-development where properties and land are left to waste. Lastly, water pollution and land drainage problems were combined as an output because land drainage problems could cause water pollution e.g. collection of silt, while water pollution could also cause land drainage problems e.g. clogging up of drains.

Step-1 is essentially a study of the city-state's inputs and outputs. As these are public information, a desktop research ranging from policy documents, reports, websites to press releases, was conducted. At the end of Step-1, an analysis was carried out to determine the possibility of Singapore achieving environmental sustainability in each of the input and output streams and to suggest whether urban planning could play a part.

Step-2 seeks to examine how Singapore's urban planning is currently involved in the identified input-output streams, and whether the interaction has contributed to environmental sustainability as defined earlier. A list of criteria based on the discussions from Rydin (2003) and Rees (1997) was also drawn up for determining whether Singapore's urban planning on a whole is contributing to environmental sustainability. Desktop research was supplemented by informal interviews with anonymous planners and architects. As explained in *Chapter One,* interviews were anonymous to protect the interviewees' credibility as their views and suggestions may not be in line with the strategies of the inter-ministerial committees which are still at the infancy stage. The informal interviews were useful for gaining ground perspectives on whether Singapore's urban planning is contributing to environmental sustainability and what role can or should it play. A total of seven interviews were conducted. Four of the interviewees are currently in private sector, of which two are planners who had vast prior experience in the government sector, and two are architects. The remaining three interviewees are planners in a government organisation. The questionnaire has been attached in the

Appendix. Table 9 presents the consolidated evaluation framework for this study.

3.2 Conclusion on Methodology used

The interviewees generally found it difficult to relate the input-output streams to their urban planning work. It seems to indicate that Singapore's planners may not be attuned to the environmental sustainability concept yet. Nevertheless, the interview responses have still given a snapshot on the knowledge and perception of Singapore's urban planners in terms of the relationship between urban planning and environmental sustainability. If not because of the infancy of the IMCSD during the period of this study, it could have been useful to interview those planners and government officials who are directly involved in the IMCSD to understand their strategies relating to urban planning. Hopefully the IMCSD will help to increase awareness of the environmental sustainability concept and lead to more innovative suggestions towards more environmentally sustainable urban planning.

Table 9: Two-step Framework to assess Urban Planning's Contribution to Environmental Sustainability

The concept of achieving environmental sustainability

Global Hinterland

Equitable inter-regional trading

INPUTS	**OUTPUTS**
(1) Prevent unnecessary use **(2) Apply sustainable sources** **(3) Apply finite sources optimally**	**(1) Prevent waste** **(2) Recycle waste** **(3) Process waste in a clean way**
Food production sites Minerals & aggregates Hydrocarbons *(fuel/ energy)* Habitat sites *including flora & fauna* Land for development ~~*Landscape settings*~~	Site contamination *Waste disposal (incineration or landfill)* ~~*Land development*~~ *Dilapidated properties & wasteland*
~~*Clean air*~~ ~~*Climate control functions*~~	Air pollution *(& greenhouse gases (GHG))* *Noise*
Water supply ~~*Water-based habitat sites*~~ ~~*Sites for water-based economic and social activities*~~	Sewage disposal *Water pollution & land drainage problems*
Food ~~*Flora and fauna*~~ ~~*Habitats*~~ ~~*Living landscapes*~~	~~*Species change*~~ ~~*Species spread*~~

(Source: adapted from Priemus 1999 & Rydin 2007, changes in *italics*)

Contribution of Urban Planning in these streams?

Urban planning's overall contribution to environmental sustainability

DOES URBAN PLANNING...
1) Plan for anticipated environmental changes? 2) Protect environment for future generations? 3) Actively generate environmental benefits from developments? 4) Integrate planning for city size/ form, urban density and settlement patterns in ways that minimise the energy, material and land use requirements of cities and their inhabitants? 5) Capitalise on multi-functionality of green/open-spaces (e.g. aesthetics and increase local self-reliance in respect of food production, forest products, water supply, carbon sinks) within and outside the city? 6) Protect the integrity and productivity of local ecosystems to reduce the ecological load imposed on distant systems and the global common pool? 7) Strive for zero-impact development such that the destruction of ecosystems and related biophysical services due to urban growth in one area is compensated for by equivalent ecosystem rehabilitation in another?

(Source: adapted from Rydin 2003, Rees 1997)

4.0 INPUT-OUTPUT ASSESSMENT OF SINGAPORE

4.1 Singapore's Inputs & Outputs

We will now examine how Singapore currently handles each of the input and output streams as listed in Table 9 followed by an assessment on whether it is moving towards environmental sustainability.

Inputs

Food

With its limited land size and lack of natural resources, it is no wonder that Singapore imports more than 90 percent of its food from overseas while setting aside 1,500 hectares of land (about two percent of Singapore's total land area) for intensive high-technology farms (Agri-Food & Veterinary Authority of Singapore (AVA) 2007). The diversified overseas sources helps to ensure the country's resilience in food supply, while the local farms provide a small measure of its vegetables, chicken, fish and egg supply (AVA 2006).

Minerals & Aggregates

Similarly, Singapore imports from overseas most of the minerals and aggregates required for its construction industry. To understand the scale of the issue, when Indonesia announced a ban on concreting sand exports in 2007, Singapore's government had to quickly procure them from other sources and release its own stockpiles to provide stability and certainty to the market, and it was also prepared to reactivate local quarries as part of the contingency plan (Building & Construction Authority (BCA) 2007b & c). Concurrently, the government is encouraging sustainable construction to reduce Singapore's heavy dependence on concrete by replacing it with more environmentally sustainable alternatives, and by increasing the reusability of such materials and products, thereby reducing waste as well (BCA 2007a & d).

Hydrocarbons (Fuel/ Energy)

Singapore is reliant on imported fossil fuels for energy needs and has limited scope of tapping into non-fossil fuel energy sources due to its geographical constraints (National Environment Agency (NEA) 2007). Its

energy sources are mainly piped Natural Gas from neighbouring countries and imports of oil, and the country is now looking to import Liquefied Natural Gas as well (Energy Market Authority (EMA) 2005?). Nevertheless, Singapore has acceded to the Kyoto Protocol of United Nations Framework Convention on Climate Change (UNFCCC), and will seek to increase energy efficiency (hence reducing GHG and air pollutant emissions) through initiatives such as:

a) The Energy Efficient Singapore Masterplan which addresses the major users of energy including industries, transportation, power generation, buildings and homes; and

b) Research and development (R&D) in energy efficiency and green buildings (Ministry of Information and the Arts (MICA) 2008?).

Land for Development

Singapore has adopted an integrated, long-term approach to land use planning, whereby government agencies come together to plan the land use and infrastructure needs over the horizon of a few decades (MICA 2008?). Land developments are staged in accordance to long-term demand and supply projections to sustain the limited land resource. The city-state's challenge of ensuring sufficient land for various uses is compounded by the fact that it is surrounded by international water boundaries that limit the additional land that can be reclaimed on its sea space, and its regional air-hub activities also constrain building skywards (Cheong 2008). In order to optimise its land, planners have to develop innovative solutions by co-locating compatible uses (Cheong 2008), and considering underground and high-rise developments wherever possible.

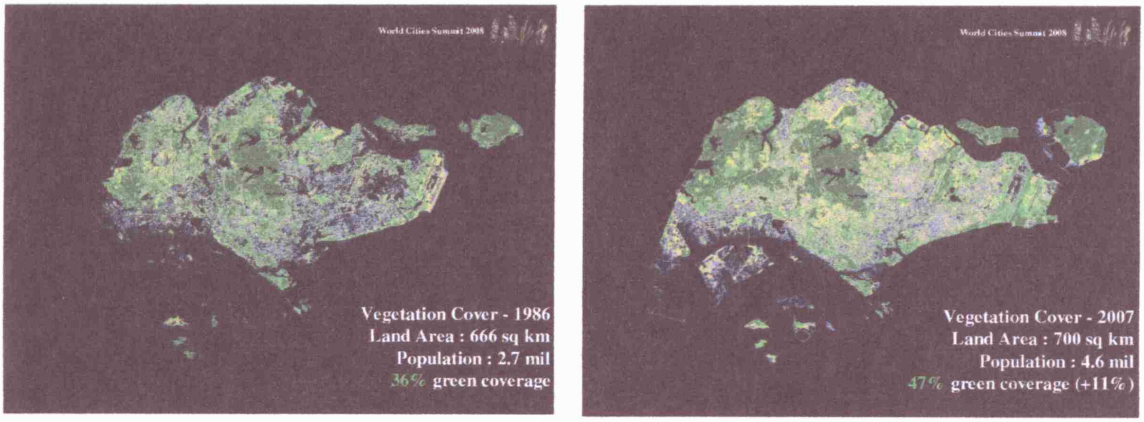
Food Production Sites

For food security reasons, Singapore has maintained some agricultural sites in areas that are not due for other developments yet. However, it remains to be seen whether these sites will be converted for non-food developments in future when faced with increasing population and competition from other land uses.

Habitat sites including Flora & Fauna

Singapore aims to create a unique conservation model that champions environmental sustainability in a small urban setting, which focuses on protecting its nature reserves and areas of rich biodiversity, and incorporating a biodiversity conservation component into the management of its parks, streetscape, park connectors and other areas (MICA 2008?). It has adopted a pragmatic approach in balancing development and biodiversity conservation and a policy of legally protecting representatives of key indigenous ecosystems, and has managed to increase its greenery areas from 35.7 percent in 1986 to 46.5 percent in 2007 despite its population increase from 2.7 million to 4.6 million during the same period (Ng 2008a).

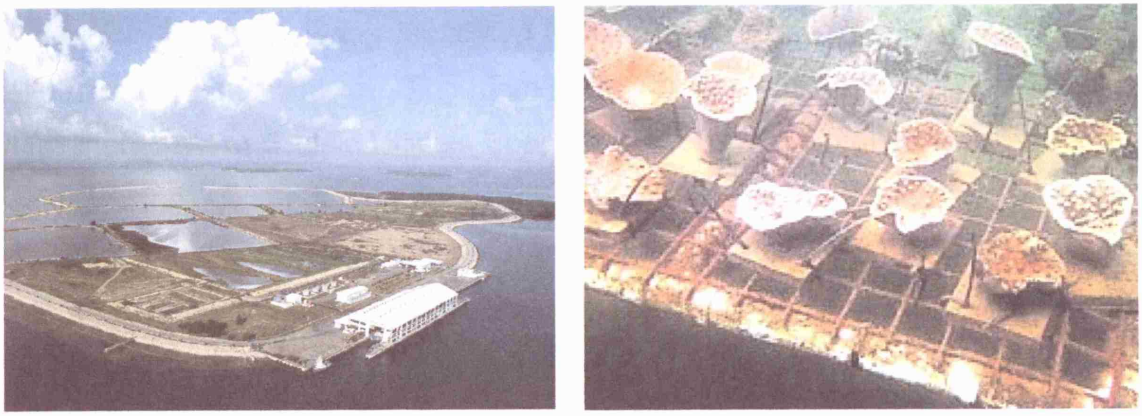
Image 1: Gradual Vegetation Increase from 1986 to 2007



(Source: Ng 2008b)

The country has also shown that development and biodiversity conservation can co-exist when well-planned and designed, for example, a rich marine ecosystem has been able to thrive on its offshore island Pulau Semakau alongside a man-made offshore landfill through the establishment of an in-site coral nursery (MICA 2008?). In addition, it has embarked on a long-term initiative to transform its pervasive network of drains, canals and reservoirs into beautiful streams, rivers and lakes (MICA 2008?) which will provide new opportunities to create water-based eco-habitats in the city (Ng 2008a).

Image 2: Man-made Landfill & Coral Nursery at Offshore Island Pulau Semakau



(Source: MICA 2005 and Hiroshi 2008)

Image 3: Artist's Impression of Transforming Water Courses into Water-based Eco-habitats

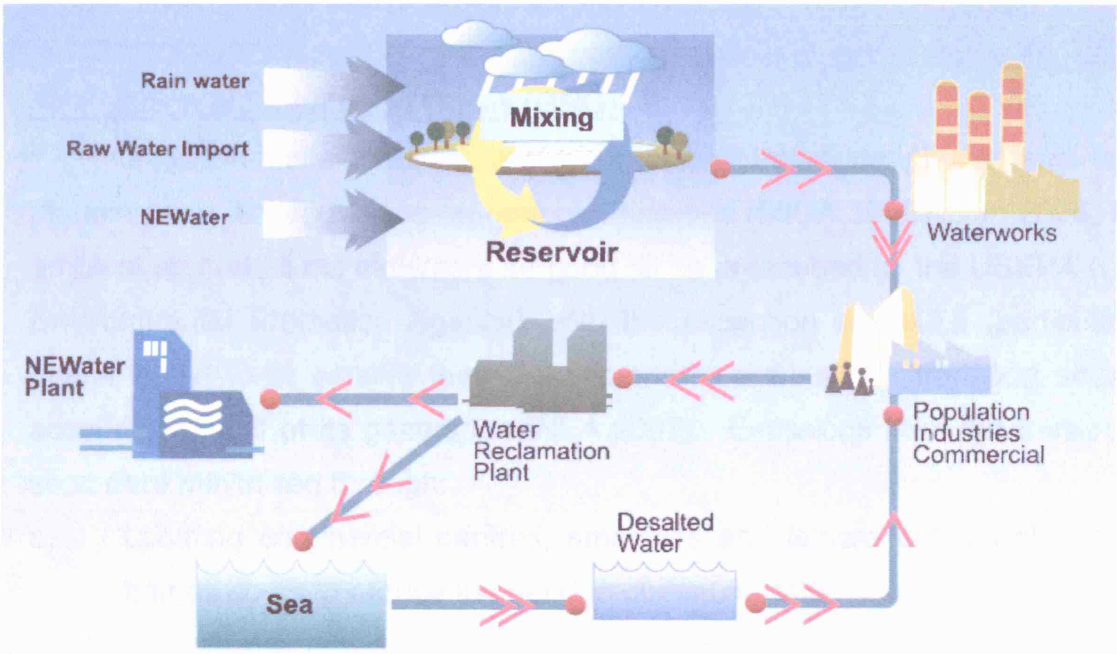
(Source: PUB 2007)

Water Supply

Water is a strategic resource in Singapore, not due to the lack of rainfall (2400mm per year, as it is in the equatorial rain belt), but because competing land uses limit areas available for storing rainfall (National Library Board (NLB) 2008). The city-state's water supply consists of water from local catchments

(which will occupy two-thirds of the country's land area by 2009), imported water from Malaysia, water reclaimed from sewers (termed as NEWater, which will meet 30 percent of Singapore's total water demand by 2010) and desalinated water (Public Utilities Board (PUB) 2008a). Through investment in water technology, Singapore has improved its security of water supply. Today everyone in the country has access to good clean drinking water (NLB 2008), and residents are encouraged to conserve water and keep all water catchments and waterways clean (MICA 2008?).

Image 4: Water Supply Cycle in Singapore incorporating NEWater



(Source: PUB 2008c)

Outputs

Sewage Disposal

Since its independence, Singapore went on a major infrastructural change in the used water system to address water pollution by becoming 100-percent sewered, and it is now able to collect 100 percent of used water and create a new source of water i.e. NEWater (Wong et al 2008). The current sewerage system is designed based on a 'separate system' which reduces the amount of pollution that gets into the waterways by:

a) Collecting used water in underground public sewers (used water from trade sources and industries are required to meet certain standards

before it can be discharged into public sewers) which lead to treatment plants to render it clean for re-use or discharge into watercourses; and

b) Collecting surface runoff in open drains which is then channelled to rivers and reservoirs (PUB 2008d).

The country is constructing a Deep Tunnel Sewerage System (DTSS) whereby used water will flow by gravity to two compact centralised water reclamation plants before the treated effluent is discharged into the deep sea, and this will free up land that are occupied by existing 130 pumping stations and six water reclamation plants (PUB 2008e).

Air Pollution & Greenhouse Gases (GHG)

Pollution considerations are incorporated into Singapore's land use planning and its regulations on factory emissions (MICA 2008?). In 2006, its ambient air met all the indicators for good air as prescribed by the USEPA (US Environmental Protection Agency), with the exception of PM2.5 (particulate matter equal to or smaller than 2.5 microns in size) where transport sector accounts for half of its generation (NEA 2007). Emissions from the transport sector are minimised through:

a) Locating commercial centres, amenities and leisure options closer to homes so as to reduce the need to commute (MICA 2008?)

b) Staging the provision of public transport infrastructure in tandem with developments (MICA 2008?), with Mass Rapid Transit (MRT) rail network as the backbone of the public transport system (Yam 2008);

c) Implementing vehicle population control and congestion charging, and stringent enforcement actions to reduce smoky vehicles on the roads (NEA 2007); and

d) Promoting clean vehicle technologies (MICA 2008?).

Since its scope for renewable energy is currently limited, encouraging energy efficiency is Singapore's approach of mitigating GHG emissions of which the most significant is carbon dioxide (CO_2) due to fuel combustion (NEA 2007). The country's efforts to provide greenery also help to absorb CO_2 emissions. Under the Singapore Green Plan 2012 which charts Singapore's

strategic directions to achieve environmental sustainability, it aims to improve its carbon intensity (i.e. CO_2 emission per GDP Dollar) by 25 percent from 1990 level by year 2012 (NEA 2007).

Water Pollution, Land Drainage Problems, Site Contamination & Noise

The impact of all developments on the environment is assessed to ensure that new developments are properly sited and are compatible with surrounding land uses, that the pollutant and noise emissions comply with standards, and that the wastes can be safely managed and properly disposed of (NEA 2002). Strict prevention, enforcement and monitoring reduce the occurrence of pollution incidents. In addition, being home to both the world's busiest port and more than 250 species of the world's coral, Singapore regularly conducts multi-agency exercises to maintain its responsiveness to marine accidents to protect the marine life (MICA 2008?).

Dilapidated Properties & Wasteland

Since the city-state has been applying its land resource optimally, the incidence of dilapidated properties and wasteland is low. Given the land scarcity and relatively high land price in Singapore, private sector land owners would not bear to leave their properties or land to waste. Furthermore, most land in Singapore is owned by the State or state-related agencies, which are required to put their vacated properties that are not yet due for long-term redevelopment to good use during the interim period. One recent example is where the government leased out vacated school buildings for interim office uses to ease the interim office space crunch.

Image 5: Converting Vacated School Buildings into Interim Office Buildings

(Source: Chan 2008)

Waste Disposal (incineration or landfill)

In 2006, Singapore produced nearly 2.6 million tonnes of refuse, with approximately 90 percent incinerated, and the remainder (non-incinerable refuse) sent to the only operating landfill near a Singapore's offshore island i.e. Pulau Semakau (NEA 2007). These Waste-To-Energy incineration plants (WTEPs) can reduce waste volume by 90 percent in a short time and in facilities requiring relatively small land areas as compared to landfills (Lee 2008). The incineration process helps reduce global warming by eliminating the production of methane which has a global warming potential over 20 times that of CO_2 and would have been generated if refuse were decomposed at landfills (NEA 2007). The WTEPs have advanced systems to ensure the flue gas complies with Singapore's clean air emission standards (Lee 2008). They also have energy recovery features which supplied two to three percent of Singapore's electricity needs in 2006 (NEA 2007) and can even recover scrap iron (Lee 2008).

Concurrently, Singapore has engaged in the 3Rs (Reduce, Reuse and Recycle) programme to encourage the public and the private sector to reduce waste at the sources (MICA 2008?). It also funds waste management and recycling test-bedding projects (Lee 2008). Singapore's recycling rate has increased from 40 percent in 2000 to 54 percent in 2007, and the target is a recycling rate of 60 percent come 2012 (MICA 2008?). The per capita municipal solid waste disposed of has also decreased from 0.94 kg/person/day in 2003 to 0.88 kg/person/day in 2007 (Lee 2008).

4.2 Possible Contribution of Urban Planning

Based on the earlier paragraphs, Table 10 gives a broad assessment on the possibility of Singapore achieving self-sufficiency and environmental sustainability in each of the input and output streams, and also provides a preliminary analysis on whether urban planning can play a part. The assessment shows that the possibility of Singapore achieving environmental sustainability is the lowest in handling food and food production sites, and the

highest in handling of land and properties, sewage disposal and pollution related to water, land and noise.

In addition, the preliminary assessment is urban planning has a huge part to play if the city-state were to achieve environmental sustainability in the management of land and properties. However, its contribution is secondary in the management of other input and output streams; and is almost nil in the management of food, food production sites and minerals and aggregates. The latter is in line with interviewees' responses that given Singapore's small landmass and lack of natural resources, the city-state inevitably relies on imports and technologies for food, minerals and aggregates; and urban planning could do little to increase Singapore's environmental sustainability in these streams. Nevertheless there were suggestions that urban planners might be able to reduce use of minerals and aggregates by encouraging adaptive re-use of buildings (instead of demolition), and increasing green coverage ratio (instead of using hardscapes). Others stated that policies would be needed to safeguard and increase the number of food production sites, for example by promoting roof-top farming.

In the next chapter, we will focus our discussion on those areas where urban planning is deemed to have a "high" or "medium" contribution, in order to ascertain whether Singapore's urban planning indeed contributes to environmental sustainability.

Table 10: Input-Output Assessment of Singapore & Possible Contribution of Urban Planning

Inputs	**Current ways of handling**	**Possibility of becoming more self-sufficient and environmentally sustainable** - ***prevent unnecessary use*** - ***apply sustainable sources*** - ***apply finite sources optimally*** - ***equitable inter-regional trading***	**Possible Contribution of Urban Planning?**
Food	Mainly dependent on imports; & Some small high-intensity local farms	***Low*** o Small land size with dense population and other competing uses limit land areas that can be set aside for local production; o Technological possibilities to increase intensity of local production are not sufficient	***Small*** o While urban planning can seek to set aside suitable land for agriculture, it is not sufficient to reverse the city-state's dependency on imports.
Minerals & aggregates	Mainly dependent on imports; Some stockpiles; & Encouraging sustainable construction methods	***Medium*** o Geographical constraints and lack of natural resources limit land areas that can be set aside for local mining operations; o Use of sustainable sources and sustainable construction technology can optimise the use of finite resources and reduce unnecessary use	***Small*** o While urban planning can seek to set aside more land for local mining operations, it may not be sufficient to reverse the city-state's dependency on imports. o While setting high-intensity developments may reduce the amount of minerals/aggregates per capita, technology remains the crucial factor to optimise the finite resources and reduce unnecessary use.

Inputs	**Current ways of handling**	**Possibility of becoming more self-sufficient and environmentally sustainable** - ***prevent unnecessary use*** - ***apply sustainable sources*** - ***apply finite sources optimally*** - ***equitable inter-regional trading***	**Possible Contribution of Urban Planning?**
Hydrocarbons (*fuel/ energy)*	Mainly dependent on piped natural gas from neighbouring countries and imports of oil; & Encouraging energy efficiency	***Medium*** o Lack of natural endowment and geographical constraints preclude possibilities such as nuclear, hydro and wind power (Energy Market Authority (EMA) 2005?) while size and cost limit the use of sustainable sources such as solar power; o Energy efficient masterplan and R&D in energy efficiency can optimise the use of finite resources and reduce unnecessary use	***Medium*** o While it may not be possible to reverse the city-state's dependency on fossil fuel imports, urban planning can play a part to increase energy efficiency through the siting of land uses e.g. compact city that reduces the need to commute.
Land for development	Long-term planning; High-density developments, & Land creation/ reclamation from filling up sea space if possible	***High*** o Judicious long-term planning and high-intensity development prevents unnecessary use of land and optimises the scarce land resource; o Limited sea space for additional land creation/reclamation; o Technological possibilities for high-rise or underground developments	***High*** o Judicious long-term urban planning coupled with technological innovations, is the key to optimising the scarce land resource.

Inputs	**Current ways of handling**	**Possibility of becoming more self-sufficient and environmentally sustainable** - ***prevent unnecessary use*** - ***apply sustainable sources*** - ***apply finite sources optimally*** - ***equitable inter-regional trading***	**Possible Contribution of Urban Planning?**
Food production sites	Some two percent of the country's total land area has been set aside for agricultural purposes	***Low*** o Faces increased competition from competing land uses given the long-term population projection of 6.5 million people; o Technological possibilities to increase intensity of food production on the limited land areas are not sufficient	***Small*** o While urban planning can currently set aside land area for agricultural purposes, whether these will be converted to non-food development in future will be a political and economic decision.
Habitat sites including flora & fauna	Protect its nature reserves and areas of rich biodiversity; Incorporate biodiversity conservation component into management of green spaces; & Increase green coverage	***Medium*** o Competing uses may override the will to protect biodiversity; o Technological possibilities and judicious planning may allow development and biodiversity conservation to co-exist	***Medium*** o Urban planning can ensure siting of compatible uses to better integrate green spaces and biodiversity with developments in a compact city.
Water supply	Imported from Malaysia; Reservoirs & water catchment; Desalination plant; & Reclamation of water from sewage i.e. NEWater (Ministry of Environment & Water Resources (MEWR) 2008b); & Encouraging water conservation	***Medium*** o Public education on water conservation to reduce unnecessary use; o Competing land uses limit areas available constructing reservoirs; o Technological possibilities to collect and reclaim/ recycle more water help to sustain the resource and optimise its use	***Medium*** o While technology and education remain key to improving self-sufficiency in water supply, urban planning can help to: - set aside land for related infrastructure; - ensure siting of non-pollutive uses in water catchment areas to protect integrity of water supply.

Outputs	**Current ways of handling**	**Possibility of becoming more self-sufficient and environmentally sustainable** - ***prevent waste*** - ***recycle waste*** - ***process waste in a clean way*** - ***equitable inter-regional trading***	**Possible Contribution of Urban Planning?**
Sewage disposal	Treatment and reclamation of water at treatment plants, and treated effluent discharged into the sea through deep sea outfall (PUB 2008e); & Strict technical regulations and enforcement	***High*** o Technologies of water reclamation and treatment help to prevent waste, recycle waste and process waste in a clean way; o Technological possibilities of compacting the design of water reclamation plants make it possible for land scarce Singapore to construct the facilities	***Medium*** o While technology and regulations remain key to preventing, recycling and processing waste, urban planning can help to set aside suitable land for related infrastructure in tandem with proposed developments.
Air pollution & greenhouse gases (GHG)*	Judicious urban planning; Strict technical regulations and enforcement; & Promotion of green technologies	***Medium*** o Judicious urban planning, strict regulations and enforcement, and promotion of green technologies help to prevent air pollution and GHG emission; o Likely continued dependence on fossil fuel as the main energy source; o Providing greenery helps to increase carbon sinks and absorption of CO_2 emission	***Medium*** o While technology and regulations remain key to preventing air pollution and GHG emission, urban planning can help to: - ensure siting of uses do not pose adverse environmental impacts on surrounding land uses; - ensure accessibility to amenities so as to reduce the need to commute; - ensure accessibility to public transport especially mass rapid transit network to reduce emissions; - provide greenery to absorb carbon emission.

* Main contribution to GHG is CO_2 from power generation, industry, transport, building & household consumption (Ministry of Environment & Water Resources (MEWR) 2008a)

Outputs	**Current ways of handling**	**Possibility of becoming more self-sufficient and environmentally sustainable** - ***prevent waste*** - ***recycle waste*** - ***process waste in a clean way*** - ***equitable inter-regional trading***	**Possible Contribution of Urban Planning?**
Water pollution, Land drainage problems, Site contamination & Noise	Judicious urban planning; & Strict technical regulations and enforcement	***High*** o Judicious urban planning and strict regulations and enforcement help to prevent water pollution, site contamination and noise pollution	***Medium*** o While technology and regulations remain key to preventing pollution, urban planning can help to ensure siting of uses do not pose adverse environmental impacts on surrounding land uses.
Dilapidated properties & wasteland	Applying finite land resource optimally; Putting vacated properties to interim uses	***High*** o Judicious long-term urban planning and management prevent incidence of dilapidated properties or wasteland; o Market forces and government policies ensure re-use of vacated properties or land	***High*** o Urban planning to ensure both the development and redevelopment of land are staged in accordance to long-term demand and supply situation.
Waste disposal (incineration or landfill)	Mainly incinerated; The remaining disposed of at an offshore landfill; & Engagement with the public and private sector to reduce waste at the sources	***Medium*** o Limited land area to build more incineration plants and limited sea space for landfills; o Technological possibilities to recycle or re-use waste in a clean way; o Public education to reduce and recycle waste	***Medium*** o While technology and education remain key to preventing, recycling and processing waste, urban planning can help to set aside suitable land for related infrastructure in tandem with proposed developments.

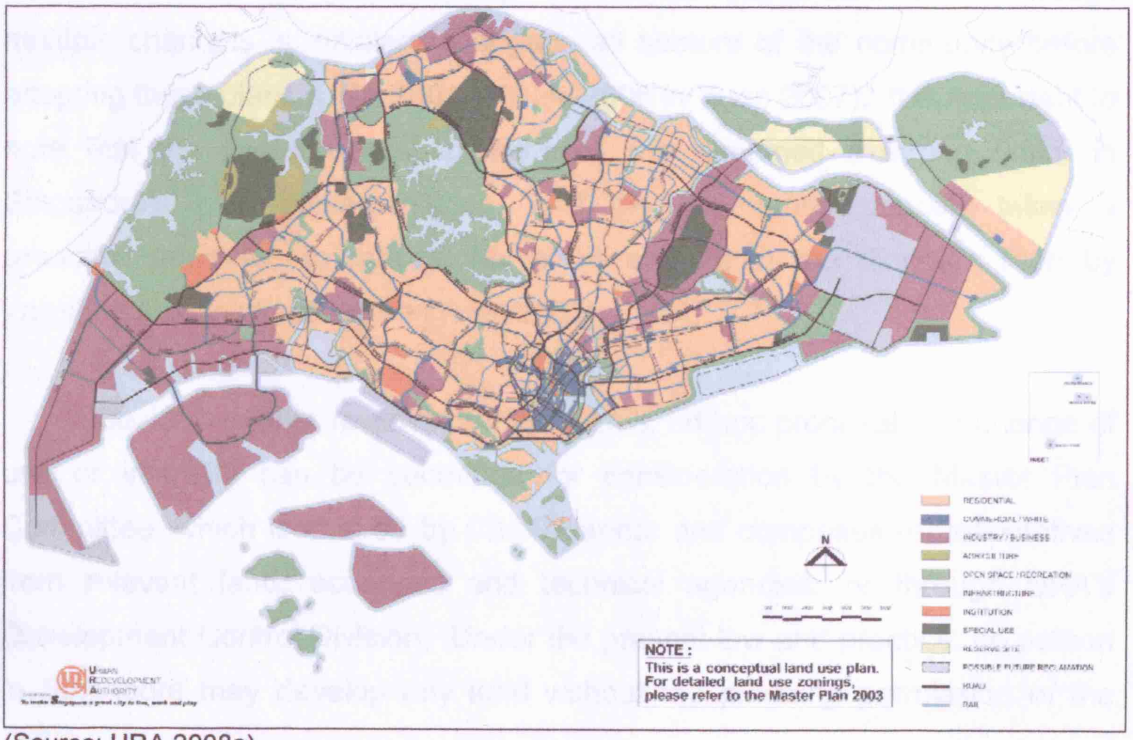
5.0 URBAN PLANNING & ENVIRONMENTAL SUSTAINABILITY

5.1 Singapore's Urban Planning System

Before examining whether Singapore's urban planning contributes to environmental sustainability, it is useful to first understand broadly Singapore's urban planning system. Singapore's urban planning is led and coordinated by its national planning authority, Urban Redevelopment Authority (URA), which is a statutory board under the Ministry of National Development (MND), and its physical development is guided by two key plans – the Concept Plan and the Master Plan.

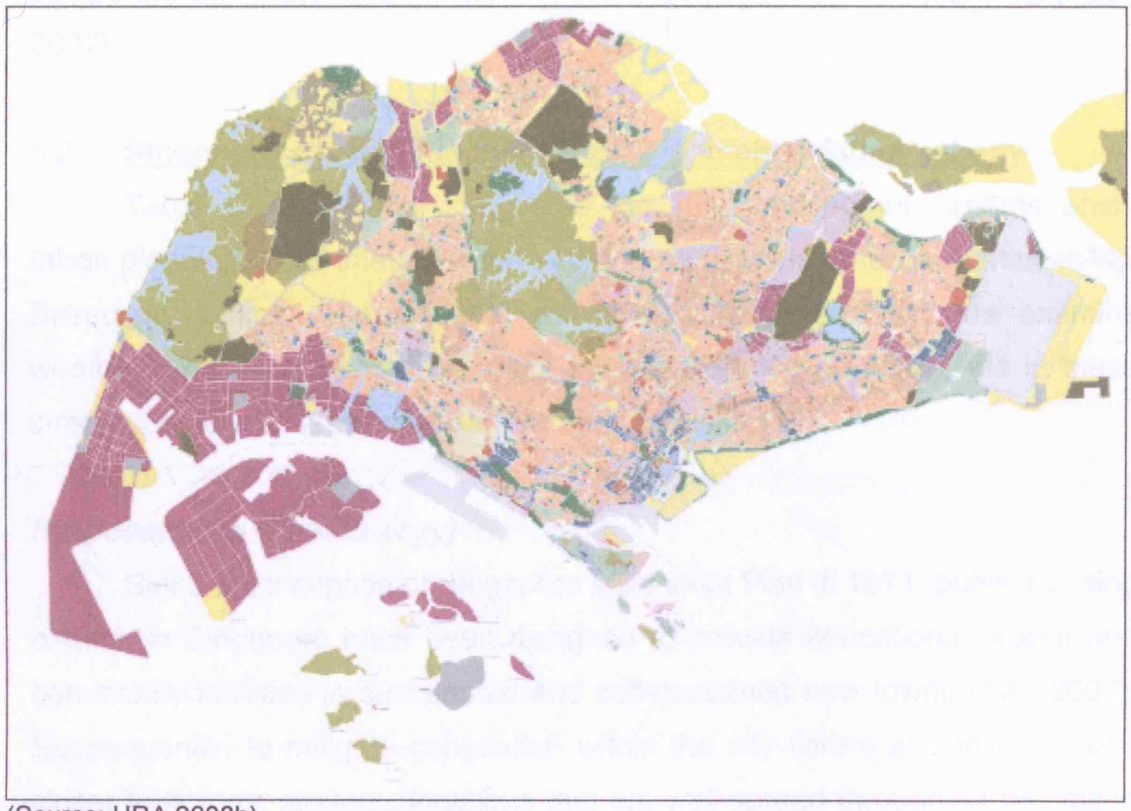
The Concept Plan is Singapore's strategic land use and transportation plan to guide its development in the next 40 to 50 years, and is reviewed every ten years taking into account changing economic and population trends and land use needs (URA 2008c). Conversely, the Master Plan is a statutory land use plan which translates the Concept Plan's broad long-term strategies into detailed plans showing the permissible land use and intensity for every land parcel, thus guiding Singapore's development in the medium term over the next 10 to 15 years, and is reviewed every five years (URA 2008c).

Image 6: Concept Plan 2001



(Source: URA 2008a)

Image 7: Master Plan 2003



(Source: URA 2008b)

Both these plans are prepared in collaboration with all relevant government agencies in an integrated approach to consider all major land use needs and trade-offs (URA 2008c). In addition, public consultation through multiple channels is initiated to engage all sectors of the community before adopting these plans (URA 2001 & Yuen 2006 in Yuen 2007). It is important to note that the government's commitment has remained a strong factor in Singapore's plan implementation, and the government usually takes a proactive approach to realise the vision set out in the Concept Plan by investing in key infrastructure (Yuen 2007).

Besides regular reviews of these plans, ad-hoc proposals for change of use or intensity can be submitted for consideration by the Master Plan Committee, which is chaired by Chief Planner and comprises representatives from relevant land, economic and technical agencies; or through URA's Development Control Division. Under the present law and practice, no person in Singapore may develop any land without the planning permission of the

competent authority, which is similar to the ideology of British planning (Yuen 2007).

5.2 Singapore's Urban Planning & Environmental Sustainability

Table 10 had earlier suggested the input and output streams which urban planning could interact with to contribute to environmental sustainability. Based on desktop research and interviewees' responses, we now examine whether Singapore's urban planning is indeed playing an active role in these streams, before assessing its performance as a whole.

Hydrocarbons (Fuel/Energy)

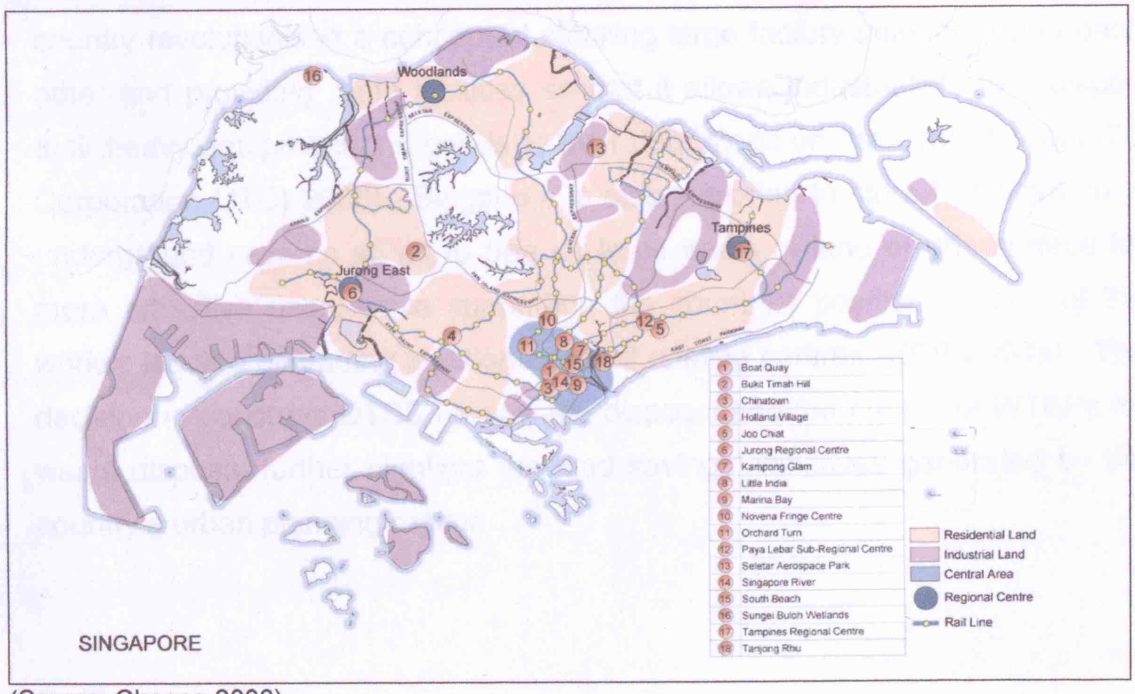
Since the inception of Singapore's Concept Plan in 1971, public housing estates in Singapore have been designed to provide educational, social and community facilities in sustainable and self-contained new towns (Yap 2007). Subsequently, to mitigate congestion within the city centre and to bring jobs closer to homes, strategic locations that are well-spread throughout the island and well-served by MRT stations were identified to develop more commercial centres outside of the central area Cheong 2008). Tampines Regional Centre was the first example. Sim & Goh (1998) reported that residents who used to travel downtown for shopping goods could now fulfill their shopping needs partially at the shops in Tampines Regional Centre. Hence both the new towns and the regional centre concepts not only create a conducive social environment, but also reduce the need for long-distance commute and thus the fuel consumption by transport. The high-density living in the city-state also helps to lower energy consumption since Haughton (2003) has found that high-density cities use half the energy as compared to low-density cities, after taking into account climate and income variations.

In addition, Singapore's luxuriant greenery including a hierarchy of parks provided based on a guideline of 0.8 hectare of parkland per 1,000 population (Ng 2008a), the planting verges along roads, and the latest greening approach of sky-rise greenery, all require creative urban planning amidst competing uses (NParks 2008). More importantly, these efforts help to reduce the island's ambient temperature and hence its energy requirements for

cooling. For example, sky gardens can reduce roof ambient temperature by 4°C and reduce the heat transfer into the rooms below (Wong 2008).

Most interviewees agreed that although Singapore will still depend on fossil fuel energy sources in the foreseeable future, urban planning can help to reduce the use of hydrocarbons by reducing the need for commuting and air-conditioning. They added that the former could be achieved by creating mixed use developments and making them conducive for walking, cycling or using public transport. The latter could be done via planning for more greenery and stipulating urban design requirements that enable more natural ventilation by considering sun-shading and wind-tunnelling effects. However, it is interesting to note that one senior planner raised concern that the continuous pressure of road traffic congestion and the lower financial feasibility of new MRT lines may indicate that the multi-nodal regional centre strategy does not work in Singapore. He opined that the length of Singapore (which is about 42 km (Encyclopedia of the Nations 2007)) does not deter people from travelling to central area, unlike in larger countries. Instead, he suggested that a bi-nodal centralised growth strategy might be more suitable for the small country - one node for clean uses, and the other for industrial uses which Singapore still depends on.

Image 8: Conceptual Plan showing some key areas of Singapore & its Regional Centres



(Source: Cheong 2008)

Land for Development

The regular reviews of Singapore's Concept Plan ensure that its limited land resource is stretched and sustained for a longer period of time. For example, Concept Plan 2001 aimed to gradually increase housing densities and to focus on building of new housing within existing towns, instead of creating more new towns (URA 2001). The urban planning regime is also undoubtedly the "custodian" to trigger innovations and initiatives on land optimisation. In each Concept Plan review, a stock-take is carried out on the land quantum occupied by various activities, and these are compared against the long-term land demand and supply projections. Amongst other objectives, this exercise reminds the various ministries how well (or poorly) they have used their land, and the land quantum remaining for their respective uses. Thus when necessary, this triggers the search to increase the intensity of land use (via higher-rise or underground developments) or to increase landmass (by reclamation of sea space).

Obvious examples are found in the industrial sector. In many countries, it is commonplace for residential and office buildings to go skywards. However in Singapore, high-rise initiatives must necessarily be extended to industries, and the challenge is on getting heavy industries to intensify their land. The country revolutionised a concept of stacking large factory units on top of each other and providing ramp facilities so that it allows industrialists to transport their heavy equipment and goods to their door-steps on the upper floors (JTC Corporation (JTC) 2008). Singapore is also exploring to store hydrocarbon in underground caverns so as to free up large tracts of land on the surface for more attractive uses, while supporting the country's position as one of the world's leading oil trading locations and oil refining centres (EDB 2008a). The decision to construct DTSS for sewage disposal and the choice of WTEPs for waste disposal further highlight the land savings' initiatives generated by the country's urban planning regime.

Image 9: High-Rise Industrial Facilities for Heavy Industries

(Source: Lee Construction 2008 & JTC Corporation 2003)

All interviewees strongly agreed that urban planning can contribute to environmental sustainability in this area since it dictates the intensity and mix of land uses and also determines whether greenfield developments should be allowed. However, one planner highlighted that Singapore should review its need for five airports on its main island (which include military airbases) as these impose height constraints on most parts of the island. Some raised concern that the city-state might become over built-up and suggested the need for more prudent evaluation of inward investments and developments. These are examples of how economical and political decisions implicate urban planning and the larger environmental sustainability agenda.

Habitat sites (including Flora & Fauna)

Given its small landmass, an active economy and an increasing population, it is definitely not by accident that Singapore has managed to set aside 10 percent of its total land area for parks and nature reserves, and achieved green coverage of 46.5 percent. Its efforts to cluster groups of parks with complementary ecosystems, to establish an in-site coral nursery beside an offshore landfill, and to create water-based eco-habitats by transforming its watercourses (Ng 2008a) are guided by its belief in balancing economic development with the conservation and enhancement of biodiversity through careful planning and judicious land use (MND 2008d).

Nevertheless, there is evidence that the government recognises their limits may one day catch up with them. Although Concept Plan 2001 has designated Pulau Ubin, a rustic island northeast of Singapore mainly as open space and reserve land with the intention to leave it in its natural state for as long as possible, it also qualified that due to Singapore's limited land resource, there is a need to retain the flexibility to review the situation in future should circumstances change (URA 2001).

General consensus from the interviews is urban planning can help sustain the habitat sites by avoiding greenfield developments, safeguarding sites with biodiversity and integrating them with urban fabric, which Singapore is doing relatively well. However, most also acknowledged that due to Singapore's limited landmass, the question would be what are the sites and the optimum quantum for preservation of biodiversity? This is again a decision that should be taken at the macro political level rather than at urban planning level.

Water Supply

Paul Reiter, the Executive Director of International Water Association (IWA), stated that water is often an after-thought of urban planning, but Singapore has by building the capacity upfront, managed to increase its population without adding massive amounts of resources (Wong et al 2008). His statement highlights the role played by Singapore's urban planning in ensuring clean and reliable water supply in advance of demand.

Indeed, within 700 sq km of land, it is no small feat to decide how best to set aside land for the existing 14 reservoirs, and the water reclamation, NEWater and desalination plants alongside other uses. In addition, to increase its water catchment area from the current 50 percent to two-thirds of Singapore's total land area requires not only water technology breakthrough, but also agreement between the urban planning and the economic agencies on the appropriate siting of industries so as to protect integrity of the water supply and yet maintain Singapore's economic competitiveness. Besides planning land uses on the surface, judicious urban planning and coordination

amongst the agencies allow underground spaces to be set aside for the separate piping system which facilitate the collection of used water and the provision of water supply.

The interviewees suggested that water technology and likely public education would help to improve the environmental sustainability of water supply, but urban planning policies on judicious siting of reservoirs and land uses do affect the size and areas that can be set aside for water catchment.

Sewage Disposal

Similarly, long-term and judicious urban planning has helped set aside land for the infrastructure related to sewage disposal. For example, the DTSS project would require planning of the tunnel routes so that they will not compromise existing and future underground developments.

Most interviewees were unable to describe how urban planning could contribute to environmental sustainability of sewage disposal. A few suggested that integrating the planning of sewerage systems, treatment plants and pollutive uses with land use planning would enable better recycling and treatment of sewage. One planner added that regulations are also required to set the standards and monitor the disposal.

Air pollution & GHG

Singapore's urban planning which focuses on town and regional centre concepts and mass public transport helps to reduce commuting needs, and hence both the PM2.5 and CO_2 emissions. This is aligned with Owen (1994)'s view about the influence of land use on the wider environment through travel patterns and pollution. Land use policies such as reducing carparks provision in the city centre and providing sheltered walkways also seek to encourage use of public transport and walking respectively. However, it is observed that Singapore has yet to introduce cycling infrastructure in the city centre as exemplified by Paris and London, although efforts are underway to promote cycling in Singapore's neighbourhood towns.

The power generation sector is the single largest primary source of CO_2 emissions (i.e. combust fuel directly) in Singapore, and amongst the users of generated electricity, the industrial sector accounts for about 54 percent of Singapore's CO_2 emissions (MEWR 2008a). Thus, government agencies are encouraged to maximise energy efficiency by planning industrial land and facilities with cogeneration and trigeneration in mind (MEWR 2008a).

In addition, land use policies (and technical conditions) ensure that siting of activities do not pose adverse environmental impacts such as air pollution on surrounding users. One example is the requirement to site light industries and heavier industries at minimum distances of 50 metres and 100 metres respectively from residential buildings, while special industries should be sited at least 500 metres or 1 km away, depending on the nature of activities (NEA 2004).

The interviewees' responses on how urban planning contributes to environmental sustainability in this stream fall into the broad themes of reducing the need to commute, clustering pollutive industries away from other activities, and planning more greenery to act as nuisance buffer and also as carbon sinks to absorb CO_2 emissions.

Water Pollution, Land Drainage Problems, Site Contamination & Noise

Land use policies and technical conditions also dictate and regulate the location of activities to prevent other forms of pollution. Noise pollution is one of the considerations in setting the above-mentioned guideline distances on siting of industries from residential buildings. In addition, pollutive industries are not allowed within water catchment areas, and sites which have been contaminated by pollutive uses must be cleaned up before being allocated for non-pollutive activities (NEA 2004). Extensive planning and technical regulations help to safeguard land for existing and future drainage systems (PUB 2008f), and together with the network of sewers and other watercourses, these help to prevent water pollution and drainage problems.

Interviewees generally agreed that urban planning reduces pollution in these aspects through the prudent siting of land uses in relation to water catchment areas and surrounding uses. As in most other streams, again technology and regulations are seen as important in controlling such pollution. One planner however opined that Singapore should focus on attracting less pollutive industrial uses given our small landmass and the larger buffers that pollutive industries would require from neighbouring uses. Although this may sound ideal from urban planning view point, sources from government agencies say that Singapore's economic advantage still lies in attracting process industries, such as chemical plants which are more pollutive.

Dilapidated Properties & Wasteland

The planning system comprising of the Concept Plan and the Master Plan facilitates advanced land use planning and the "rationing" of land supply to meet demand projections. At the same time, active monitoring of the occupancy of state's properties coupled with the relatively high land prices, encourage both public and private sectors to optimise their land and properties even for interim periods, instead of leaving them to waste. Such interim uses are facilitated through the mechanism of temporary planning permission.

The interviewees concurred that urban planning can prevent the incidence of dilapidated properties and wasteland by putting them to adaptive re-use or temporary uses, or by early identification of areas for redevelopment/ refurbishment. One planner lamented that Singapore has a "culture" of demolishing run-down properties. He added that urban planning and urban design could add value and incentivise the mixing of new and old properties in developments.

Waste Disposal (Incineration or Landfill)

The decision to incinerate Singapore's waste recognised that its 700 sq km would, firstly be unable to cater to landfills for the long-term, and secondly be unable to allow the creation of adequate buffers to prevent the spread of smell nuisance and other public health hazards if waste disposal were slow in Singapore's warm and humid climate (Lee 2008). Hence, since the early days,

urban planning had safeguarded suitable sites that are further away from residential and commercial estates for waste disposal facilities, so that they can be developed in tandem with Singapore's projected growth. With the current emphasis on waste recycling, a closed landfill site (at Sarimbun) has been identified and allocated for recycling activities (Lee 2008).

Interviewees generally were unable to relate urban planning's contribution to the environmental sustainability of this stream. One planner indicated that closed landfills could be used to site appropriate industries in future, and another suggested clustering symbiotic industries together to create a zero-waste development.

Table 11 has summarised the assessment of Singapore's urban planning involvement in the input and output streams. Based on prior discussions, desktop research and the interviewees' responses, Table 12 has evaluated whether Singapore's urban planning as a whole is contributing to environmental sustainability. It is seen that Singapore's urban planning is clearly contributing to environmental sustainability in input-output streams such as land for development, habitat sites, water supply, and pollution related to water, site contamination and noise. Furthermore, it has done relatively well in protecting the environment for future generations, generating environmental benefits at the macro country level, minimising resources, and capitalising on multi-functionality of green and open spaces.

Table 11: Involvement of Singapore's Urban Planning with the Input-Output Streams

Inputs/ Outputs	**Prior Prelim Assessment**	**Assessment after research and interviews**		**How should Singapore's Urban Planning be improved to enhance its contribution in handling these inputs/ outputs?**
	Possible Contribution of Urban Planning?	**Can Urban Planning indeed contribute?**	**Is Urban Planning contributing?**	
Food & Food Production Sites	**Small**	**Small** *Depends more on political decision and technology to safeguard and increase the number of food production sites, for example by promoting roof-top farming.*	**Little can be done**	
Minerals & Aggregates	**Small**	**Small**	**More can be done**	- Reduce use of minerals & aggregates by encouraging adaptive re-use of buildings (instead of demolition), and increasing green coverage ratio (instead of using hardscapes)
Hydrocarbons (Fuel/ Energy)	**Medium**	**Medium**	**More can be done**	- Create mixed use developments conducive for walking, cycling or using public transport - Plan more greenery and stipulate urban design requirements that enable more natural ventilation - Dissenting view on application of multi-nodal strategy in Singapore??

Inputs/ Outputs	**Prior Prelim Assessment**	**Assessment after research and interviews**		**How should Singapore's Urban Planning be improved to enhance its contribution in handling these inputs/ outputs?**
	Possible Contribution of Urban Planning?	**Can Urban Planning indeed contribute?**	**Is Urban Planning contributing?**	
Land for Development	**High**	**High** *But its contribution is implicated by economical and political choices such as the need for five airports and its "fervent chase" after investments/ developments.*	**Yes**	
Habitat sites (including Flora & Fauna)	**Medium**	**Medium** *But it is a political decision on what is the optimal quantum for preservation.*	**Yes**	
Water Supply	**Medium**	**Medium** *But technology and public education play an important role.*	**Yes**	
Sewage Disposal	**Medium**	**Somewhat Unclear** *Most interviewees pointed to the importance of technology and regulations but were unable to describe clearly urban planning's role in this stream.*	**Somewhat Yes** *By integrating the planning of sewerage systems, treatment plants and pollutive uses with land use planning to allow for better recycling and treatment of sewage.*	

Inputs/ Outputs	**Prior Prelim Assessment**	**Assessment after research and interviews**		**How should Singapore's Urban Planning be improved to enhance its contribution in handling these inputs/ outputs?**
	Possible Contribution of Urban Planning?	**Can Urban Planning indeed contribute?**	**Is Urban Planning contributing?**	
Air pollution & GHG	**Medium**	**Medium** *Technology and regulations also play an important role.*	**More can be done**	- Continue to explore ways to reduce the need to commute and making it more conducive to walk, cycle or use public transport, e.g. by providing sheltered walkways or cycling infrastructure
Water pollution, Site contamination & Noise	**Medium**	**Medium** *Technology and regulations also play an important role. And urban planning's contribution is implicated by economical and political choices on whether to continue attracting pollutive uses.*	**Yes**	
Dilapidated properties & Wasteland	**High**	**High**	**More can be done**	- Urban planning and urban design could add value and incentivise the mixing of new and old properties in developments
Waste Disposal	**Medium**	**Somewhat Unclear** *Interviewees generally could see the role of technology but were unclear about possible role of urban planning.*	**More can be done**	- Stage and prepare closed landfills to site appropriate developments in future - Cluster symbiotic industries together to create zero-waste developments

Table 12: Contribution of Singapore's Urban Planning as a whole to Environmental Sustainability

Does Singapore's Urban Planning as a whole...	**Assessment of Urban Planning's contribution from earlier discussions and desktop research**	**Interviewees' comments**	**Interviewees' Suggestions for Improvements to Singapore's Urban Planning as a whole**
a) Plan for anticipated environmental changes? (As an island state, Singapore is not spared from effects of climate change such as warming temperatures and rising sea levels (MEWR 2006).)	***Not apparent in tackling rising temperatures*** - Not apparent in tackling rising temperatures, but indirectly helps to reduce CO_2 emission. - Has helped to reduce flood prone areas in Singapore from 3,178 hectares in 1970s to 98 hectares in 2008 through safeguarding land for drainage systems, coupled with effective drainage management and flood control (PUB 2008f).	***Little, or Not Apparent*** - Generally felt that there is little planning for environmental changes or it is not apparent. - One observed that the recent Marina Barrage project will reduce flood risks. It is a dam built to keep out seawater and is also part of a flood control scheme to alleviate flooding in low-lying areas in the city (PUB 2008b). - Another suggested that IMSCD could help promote planning for anticipated environmental changes.	- Create mixed use developments conducive for walking, cycling or using public transport in order to reduce energy use - Promote environmentally-friendly city or estate development, instead of just environmentally-friendly buildings - Plan more greenery and stipulate urban design requirements that enable more natural ventilation
b) Protect environment for future generations?	***Yes*** - Preserves natural habitats and green spaces. - Protects the general environment by limiting pollution. - But the will to protect the natural habitats may be overridden by economic considerations in future.	***Yes, to a certain extent*** ***But more can be done*** - Were unanimous that it contributes to this aspect. - Current efforts include conservation of trees, green spaces, nature areas & water bodies, and prudent long-term planning. - Some felt it should go beyond conserving natural environment and limiting pollution e.g. reducing energy usage also indirectly protects the environment through tackling climate change. One felt it should include conserving land for future generations.	- Identify more nature areas island-wide which are worth conserving and demarcate them as protected areas - Place greater emphasis on low energy and sustainable planning & design - Adopt centralised smart growth strategy might allow for more land to be set aside for future generations??

Does Singapore's Urban Planning as a whole...	Assessment of Urban Planning's contribution from earlier discussions and desktop research	Interviewees' comments	Interviewees' Suggestions for Improvements to Singapore's Urban Planning as a whole
c) Actively generate environmental benefits from developments? (i.e. Do the siting and layout of land uses and its related policies generate environmental benefits from the developments?)	***Yes, to a certain extent*** - At macro level, it generates environmental benefits such as: i) minmising resources/ energy due to compact city layout; ii) providing greenery which acts as carbon sinks; iii) preserving biodiversity; & iv) preventing water pollution. - But difficult to pinpoint specific environmental benefits generated at a smaller scale. One example could be the setting up of coral nursery at Semakau island beside the landfill.	***Yes, to a certain extent*** ***But more can be done*** - Most cited the recent promotion of environmentally-friendly buildings as an example. - But a senior planner correctly highlighted that this is a contribution from building technology/design rather than urban planning. He said more could be done at urban planning & urban design level. - One planner felt that the current focus is on *passive* reduction of energy usage instead of *active* generation of renewable energy.	- Actively consider at the estate level how the siting of developments in an integrated way can help to generate environmental benefits such as: ▪ harnessing renewable energy; ▪ creating more carbon sinks; ▪ preserving biodiversity; & ▪ reducing and recycling waste *(Singapore already reclaims 100% of its used water and has strict regulations against private collection of rainwater from water catchment areas)*
d) Integrate planning to minimise resources such as energy, material and land use?	***Yes, to a certain extent*** - Judicious long-term planning with regular reviews of its Concept Plan and Master Plan ensure that land resource usage is optimised and kept in check. - Its mixed-use high intensity strategy helps to reduce energy consumption by transport & cooling. More could be done in this area. - Should do more to minimise the use of minerals and aggregates.	***Yes*** ***But more can be done*** - All agreed that it contributes to this, but a few felt it could be improved further. - One raised the need to cap Singapore's population density at an optimum level in order for Singapore to be sustainable in the long run especially with its limited land resource (requires political decision).	- Continue to reduce the need to commute and make it more conducive to walk, cycle or use public transport, e.g. by providing sheltered walkways or cycling infrastructure - Plan more greenery and stipulate urban design requirements that enable more natural ventilation - Reduce use of minerals & aggregates by encouraging adaptive re-use of buildings (instead of demolition), and increasing green coverage ratio (instead of using hardscapes)

Does Singapore's Urban Planning as a whole...	**Assessment of Urban Planning's contribution from earlier discussions and desktop research**	**Interviewees' comments**	**Interviewees' Suggestions for Improvements to Singapore's Urban Planning as a whole**
e) Capitalise on multi-functionality of green/ open spaces?	***Yes, to a certain extent*** - Examples include: i) transforming its watercourses to create eco-habitats; ii) using open spaces for recreational purposes e.g. community gardens on open spaces in public & private estates, schools (MND ?); & iii) easing planning rules to allow use of local farms for recreational/ educational use by allowing shops, restaurants & farm-stays (Miriah 2008).	***Yes, to a certain extent*** ***But more can be done*** - Most felt it does capitalise on multi-functionality of green/ open spaces for recreation and water catchment. - But most also opined that not enough is done to explore multi-functionality of green/ open spaces for food production purposes.	- Explore more uses of green/ open spaces for food production e.g.: ▪ farm on open spaces not needed or due for development yet, ▪ roof-top farming, ▪ integrate farms into parks/ open spaces - Relocate military training areas offshore to open up vast areas of green for other uses (however this entails non-urban planning considerations)
f) Protect integrity and productivity of local ecosystems to reduce ecological load on distant systems and global common pool?	***Not apparent*** - Its efforts to reduce resource/ energy usage, provide carbon sinks & preserve biodiversity are unlikely motivated by desire to reduce ecological load on others. - Smallness of Singapore means its contribution to the global pool may be indiscernible or even debatable e.g. although its carbon emission contributes less than 0.2 percent to world's total (PAP 2007), its 2004 fossil fuel CO_2 emission rate per capita was higher than Japan & UK (Carbon Dioxide Information Analysis Centre (CDIAC) 2004).	***Not apparent*** ***Difficult in Singapore's context*** - Half of the interviewees were unable to relate urban planning to this aspect. - Two opined that it is difficult in Singapore's context given its small landmass & lack of natural resources. - One cited urban planning's efforts at maintaining biodiversity zones as contributing to this aspect.	- Tap on Singapore's compactness to reduce wastes on all fronts e.g. plan zero-waste estates or towns

Does Singapore's Urban Planning as a whole...	**Assessment of Urban Planning's contribution from earlier discussions and desktop research**	**Interviewees' comments**	**Interviewees' Suggestions for Improvements to Singapore's Urban Planning as a whole**
g) Strive for zero-impact development such that the destruction in one area is compensated for by rehabilitating another area?	***Very limited*** - Unlikely possible, as the need to convert a natural habitat for other uses (for example in the case of Pulau Ubin as cited earlier) would likely be due to lack of alternatives given its limited land supply. - Authorities' efforts to transplant mature trees or coral reefs affected by developments may be considered rehabilitation efforts on a small-scale.	***Very limited*** - All felt that due to Singapore's small landmass & lack of natural resources, there is little or no scope for this. - One suggested that the planning authorities' requirement to transplant trees or sequence removal of trees that are affected by developments could be considered small-scale "rehabilitation". - Another suggested that Singapore might have to compensate for the destruction on its own land by rehabilitating areas in other countries (this would be beyond urban planning's mandate).	- Consider more innovative rehabilitation strategies e.g. replacement of trees lost via high-rise greenery and ecosystems

5.3 Suggested Improvements to Urban Planning

However, the above assessment also shows that there are still areas where more could be done to achieve more environmentally sustainable planning. The suggested improvements are categorised broadly into four groups. The first group of suggestions focuses on reducing energy consumption. These include creating more mixed-use developments and making them conducive for walking, cycling or using public transport, planning more greenery, and stipulating urban design requirements to enable more natural ventilation. There was a daring proposal to review the suitability of multi-nodal strategy in Singapore, but the feasibility of changing the strategy at this juncture (after having implemented parts of it) would have to be considered.

Secondly, many felt strongly for the need to quickly identify and protect more nature areas before these are destroyed, and to explore using more green spaces for various uses, especially food production. In cases where the nature areas or green spaces have to make way for alternative developments, more innovative rehabilitation strategies such as replacement via high-rise greenery or ecosystems should be explored. The third group of suggestions called for more adaptive re-use of old buildings, and the preparation and staging of closed landfills to site appropriate future developments.

The fourth group requires a more drastic re-look at the overall objectives of Singapore's urban planning to proactively consider environmental sustainability. One proposal is to tap on Singapore's compactness by clustering symbiotic land uses together to create zero-waste estates or towns. Another idea is to consider how the siting and layout of land uses at the estate level can be integrated to help generate environmental benefits such as reducing energy consumption, harnessing renewable energy, creating more carbon sinks and biodiversity, etc. Such a macro change would be similar to conducting a Strategic Environment Assessment (SEA) for the land use plans and related policies, which currently is not in place in Singapore. SEA is a process to ensure that significant environmental effects arising from policies, plans and programmes are identified, assessed, mitigated, communicated to

decision-makers and monitored, and that opportunities for public involvement are provided (Centre for Sustainability (C4S) 2008). Together with the concept of environmental capacity, these should identify areas where development can be accommodated and conversely where the environment cannot support additional development (Stead 2005).

5.4 Challenges to Environmentally Sustainable Urban Planning

This assessment has also raised a realistic issue. There is a limit to how environmentally sustainable Singapore can become, as well as how environmentally sustainable urban planning can pan out in the city-state. As Finco & Nijkamp (2001) stated, although it may be easier for a smaller geographical scale to achieve strong sustainability, its claim on external sources may also be higher such that local sustainability may be achieved at the detriment of other areas. Singapore's small landmass "magnifies" the problem that world cities face - how to reconcile its status as a global trading centre with the new requirement for sustainable development, and the aspirations of its people? (Girardet 1999a).

The focus on economic growth means that safeguarding land for uses such as habitats and food production is a "bonus" and not a "given". Being an air-hub means the intensity of developments is constrained by height limits imposed by airports. Dependence on industrial investments means that constraints are imposed on activities surrounding the pollutive industries. Hence, the ideals of environmentally sustainable urban planning are intricately affected by the upstream political and economic decisions.

Even in areas where there is room to improve urban planning, notwithstanding the necessary political will, it is unrealistic to expect rapid results because of spatial inertia arising from the physical layout of the cities, the character of the existing housing stock, the energy supply systems and other aspects of the physical infrastructure (Stilwell 2000). Furthermore the assessment shows that in many areas, urban planning has to be implemented together with technology, regulations and public education for Singapore to achieve environmental sustainability. This is similar to Owen (1994)'s view

that land use planning can be an important (longer-term) means of maintaining choice within constraints, but it is unlikely to be very successful in changing behaviour when it acts in isolation.

The experience from the informal interviews also implies that Singapore's planners may not be clear what environmentally sustainable urban planning encompasses. In bigger countries such as United Kingdom where there are city and rural regions, urban planners in the city might consider the impact of their city's development on the rural regions which the city depends on for its resources. However, given Singapore's unique small-city-island-state situation, this would effectively mean Singapore's planners should consider how the functioning of their country impacts environmentally on other countries. Since traditionally this is not what urban planners are taught to do, it could explain why environmentally sustainable planning remains a remote concept to Singapore's planners. To progress from here, planners will have to work closely with other sectors to understand the 'big picture' i.e. how to integrate urban planning with other sectors to know the origin of the resources and the destination for the wastes, so as to better contribute to environmental sustainability.

6.0 CONCLUSION & FURTHER RESEARCH

6.1 Key Findings & Recommendations

This study has conducted a pilot assessment of the interactions between Singapore's input-output streams and its urban planning, and evaluated whether urban planning does contribute to environmental sustainability in these streams and as a whole. It has also provided suggestions to achieve more environmentally sustainable planning, while highlighting the constraints that Singapore faces in attaining this goal.

In summary, Singapore's urban planning does contribute to environmental sustainability in streams such as land for development, habitat sites, water supply, and pollution related to water, site contamination and noise. It has also done relatively well in protecting the environment for future generations, generating environmental benefits at the macro country level, minimising use of resources, and capitalising on multi-functionality of green and open spaces.

However, Singapore's small landmass limits its ability to become fully environmentally sustainable, and also constrains the extent to which its urban planning can contribute to environmental sustainability. In some areas, urban planning plays a secondary role or has to be supplemented by technology, regulations and public education. Furthermore, even in those areas where improvements could be made, it will take time to implement more environmentally sustainable urban planning and increase the awareness of the concept amongst Singapore's planners.

Despite the challenges, Singapore's urban planning could still be improved by focusing on:

a) reducing energy consumption;
b) protecting more nature areas, and exploring more green spaces for various uses especially food production;
c) encouraging adaptive re-use of old buildings, and staging closed landfills to site appropriate future developments; and

d) developing the concept of SEA on its land use plans and related policies.

6.2 Environmentally Sustainable Urban Planning in S'pore & ASEAN?

Singapore hopes to become a sustainable city by enhancing its resource efficiency to support growth and achieve higher environmental standards despite a growing population (Eveland 2008). With ASEAN's Declaration on Environmental Sustainability and the country's new inter-ministerial committees, there will be a stronger push for Singapore to explore ways to become more environmentally sustainable, which hopefully will include a review of its urban planning's objectives.

Singapore is often cited as one of the world cities and the most developed nation within ASEAN, whose success in certain areas inspires other countries. However its unique small-city-island-state situation implies its path towards environmentally sustainable urban planning would differ from that of the other larger ASEAN countries. Although all countries should follow the input-output rules, they differ in the balance of attention between inputs and outputs that will be needed to achieve environmental sustainability (Goodland 1995). Furthermore, the natural environmental, spatial-economic and ecological features vary markedly between cities and within cities, thus local tailor-made solutions are required, and the spatial development of an area and the activities within it will have to be geared to these features (Priemus 1999).

6.3 Areas for Further Research & Work

In this pilot assessment, each stream was considered on its own when analysing the role of urban planning. However, there could be inter-relationships between the streams which may affect the eventual outcome on environmental sustainability. For example, while having desalination plants may be perceived as applying sustainable sources for water supply, if the plants were fuelled by fossil fuels, the original water problem would have turned into an energy-GHG-climate change problem (Harding 2006). The safeguarding of land for desalination plants by urban planning would then have inadvertently lowered the country's environmental sustainability. Hence, for

more comprehensive research in future, the inter-relationships between the streams and their implications for urban planning could be analysed.

Word count – 10,810

7.0 APPENDIX

7.1 Specimen Questionnaire

Does the Urban Planning of Singapore contribute to Environmental Sustainability?

Aim of this study
It has already been acknowledged that cities are inherently dependent on its hinterland. Since Singapore is a city-state with no hinterland, going by the above reasoning, it would have to be dependent on foreign countries. However, there lies a possibility that it can strive to become more self-sufficient and hence more environmentally sustainable. Thus the aim of this study is to examine whether Singapore's urban planning contributes to this goal.

Definitions adopted in this study
Urban planning in this context is defined as "the siting of land uses (including road layout) and their related policies". It excludes building/engineering technologies as well as micro transport planning such as modes of transport.

To achieve environmental sustainability of a city encompasses actions targetted at the city's input & output streams:

- For inputs, there is a need to (1) Prevent unnecessary use, (2) Apply sustainable sources, & (3) Apply finite sources optimally; and
- For outputs, there is a need to (1) Prevent waste, (2) Recycle waste, & (3) Process waste in a clean way (Priemus 1999).
- In addition, if inter-regional trading is necessary, there is a need to work towards equitable trading where: they do not damage the carrying capacity of external areas; they are conducted on equal terms based on full costings; and they meet the real needs of urban consumers, not the inefficiencies and profligacy of urban consumption habits (Haughton 1997)

Questionnaire
(The names and organisations of the interviewees will not be quoted in the study.)

Purpose of questionnaire
There are 2 steps to evaluating whether Singapore's urban planning contributes to environmental sustainability.

Step-1 is essentially a research on how the city currently handles the amount and flow of resource inputs into and waste outputs from the city.

Step-2 seeks to examine whether and how Singapore's urban planning is currently involved in these input and output streams, and whether it has contributed to environmental sustainability.

While desktop research is the main methodology adopted for both Steps of the evaluation, informal interviews would assist to gain some ground perspectives for purposes of Step-2.

Q1. For each of the inputs listed below, in your view, <u>can</u> urban planning in Singapore help:
(1) Prevent unnecessary use,
(2) Apply sustainable sources, &/ or
(3) Apply finite sources optimally?

<u>Ans:</u>

(i) Food, minerals and aggregates

_____

_____

If so, how do you think it can be done?

_____

_____

(ii) Hydrocarbons *(fuel/ energy)*

_____

_____

If so, how do you think it can be done?

_____

_____

(iii) Land for development

_____

_____

If so, how do you think it can be done?

_____

_____

(iv) Food production sites (i.e. to prevent conversion for non-food developments)

_____

_____

If so, how do you think it can be done?

_____

_____

(v) Habitat sites including flora and fauna (i.e. to prevent conversion for developments)

_____

_____

If so, how do you think it can be done?

_____

_____

(vi) Water supply

_____

_____

If so, how do you think it can be done?

_____

_____

Q2. For each of the outputs listed below, in your view, <u>can</u> urban planning help:
(1) Prevent waste,
(2) Recycle waste, &/ or
(3) Process waste in a clean way?

<u>Ans:</u>

(i) Sewage disposal

_____

_____

If so, how do you think it can be done?

_____

_____

(ii) Air pollution & Greenhouse gases

_____

_____

If so, how do you think it can be done?

(iii) Dilapidated properties and wasteland

If so, how do you think it can be done?

(iv) Site contamination

If so, how do you think it can be done?

(v) Waste disposal (incineration or landfill)

If so, how do you think it can be done?

(vi) Polluted water & land drainage problems

If so, how do you think it can be done?

(vii) Noise

If so, how do you think it can be done?

_____

_____

Q3. In your view, on the whole, describe whether Singapore's urban planning currently contributes to environmental sustainability in terms of the following (a)-(g):

a) Planning for anticipated environmental changes?

_____

_____

And in what ways do you think urban planning can better contribute in this aspect?

_____

_____

b) Protecting environment for future generations?

_____

_____

And in what ways do you think urban planning can better contribute in this aspect?

_____

_____

c) Actively generating environmental benefits from developments?

_____

_____

And in what ways do you think urban planning can better contribute in this aspect?

_____

_____

d) Integrating planning for city size/ form, urban density and settlement patterns in ways that minimise the energy, material and land use requirements of cities and their inhabitants?

_____

_____

And in what ways do you think urban planning can better contribute in this aspect?

_____

_____

e) Capitalising on multi-functionality of green/open-spaces (e.g. aesthetics and increase local self-reliance in respect of food production, forest products, water supply, carbon sinks) within and outside the city?

_____

_____

And in what ways do you think urban planning can better contribute in this aspect?

_____

_____

f) Protecting the integrity and productivity of local ecosystems to reduce the ecological load imposed on distant systems and the global common pool?

_____

_____

And in what ways do you think urban planning can better contribute in this aspect?

_____

_____

g) Striving for zero-impact development such that the destruction of ecosystems and related biophysical services due to urban growth in one area is compensated for by equivalent ecosystem rehabilitation in another?

_____

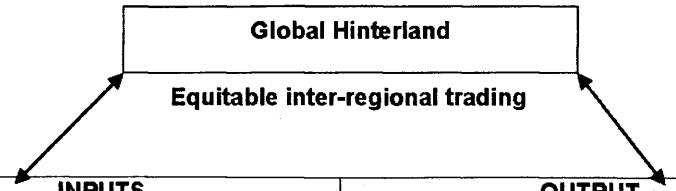
_____

And in what ways do you think urban planning can better contribute in this aspect?

_____

_____

The concept of achieving environmental sustainability



INPUTS	OUTPUT
(1) Prevent unnecessary use **(2) Apply sustainable sources** **(3) Apply finite sources optimally**	**(1) Prevent waste** **(2) Recycle waste** **(3) Process waste in a clean way**
Food, minerals & aggregates	Sewage disposal
Hydrocarbons *(fuel/ energy)*	Air pollution & greenhouse gases (GHG)
Land for development	Dilapidated properties & wasteland
Food production sites	Site contamination
Habitat sites including flora & fauna	Waste disposal (incineration or landfill)
Water supply	Water pollution & land drainage problems
	Noise

(Source: adapted from Priemus 1999, Rydin 2007)

Contribution of Urban Planning in these streams?

Urban planning's overall contribution to environmental sustainability

DOES URBAN PLANNING...
1) Plan for anticipated environmental changes?
2) Protect environment for future generations?
3) Actively generate environmental benefits from developments?
4) Integrate planning for city size/ form, urban density and settlement patterns in ways that minimise the energy, material and land use requirements of cities and their inhabitants?
5) Capitalise on multi-functionality of green/open-spaces (e.g. aesthetics and increase local self-reliance in respect of food production, forest products, water supply, carbon sinks) within and outside the city?
6) Protect the integrity and productivity of local ecosystems to reduce the ecological load imposed on distant systems and the global common pool?
7) Strive for zero-impact development such that the destruction of ecosystems and related biophysical services due to urban growth in one area is compensated for by equivalent ecosystem rehabilitation in another?

(Source: adapted from Rydin 2003, Rees 1997)

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