Asia-Pacific Environmental Innovation Strategies (APEIS)
Research on Innovative and Strategic Policy Options (RISPO)
Strategic Policy Options

I. Title of sub-theme:
Development of environmentally sustainable transport systems in urban areas

II. Title of strategy:
Reducing transport demand

III. Title of strategic policy option:
Promoting compact cities and smart growth

IV. Brief description of the policy option
"Compact city" in this policy option refers to land planning focusing on higher density and better accessibility which reduces automobile dependency.[1] "Smart growth" is a general term for land use practices that create more accessible land use patterns which reduce the amount of travel needed to reach goods and services (Litman, 2003a). Experiences of compact city or smart growth include Curitiba (Brazil), Singapore, Hong Kong (PRC), Freiburg (Germany), and Portland (US). Critical instruments for this policy option include coordination with public transport infrastructure development, mixed land use, urban boundary, and coordination of different levels of government. Although there are still objections to the idea of high density land planning, accumulated data from international cities, such as that by Kenworthy and Laube (1999), indicate correlation of urban density with less transport energy use and car use per capita. At the same time, it should be noted that the difference in travel per capita becomes relatively small in cities which have high urban density - more than approximately 75 persons/ha - and most Asian large cities fall in this category. In cities with higher density than this, the more relevant approach is the formation of sub-centres within the city or development of a regional system of cities (refer to the SPO for "regional system of cities").

- **Objectives (what):**
  - To control urban sprawl and reduce kilometres driven by influencing the spatial structure of locations in the urban environment
  - To support a high transit share
  - To keep walking and cycling (the most environmentally friendly transport modes) attractive (Petersen, 2002)

- **Environmental Areas**:
  Climate change, Urban environment

- **Applicable geographic area and socio-economic conditions (where):**
  Geographical conditions:
  - Applicable in both existing cities or newly developed urban areas.
  - Likely to be more effective to reduce vehicle use in urban areas if density is raised beyond 20 to 30 persons/ha. Beyond 75 persons/ha, the effect begins to

[1] There is no single agreed definition of compact city. Denzwik and Saaty were the first to make an effort to define the term and their definition consisted of components such as high-density settlements, less dependence on automobiles, clear boundary from surrounding area, mixed land use, diversity of life, clear identity, social fairness, self-sufficiency of daily life, and independency of governance (Kaji, 2004).

saturate (Kenworthy and Laube 1999).

Socio-economic conditions

- Urgently needed in the areas experiencing strong economic and population growth (Litman, 2003a).
- Strong political will is needed.

- **Stakeholders:**

  by whom: Local (municipal level or district) government, regional (state, prefecture, or province) government, national government, land planners, transit authorities or companies, citizens

  for whom: Urban community

- **Time span:** Land planning needs a long-term perspective since it requires a considerable amount of investment for infrastructure, and has a long-term structural impact to the activities in the city.

- **Expected impacts:** It is expected that compact city and smart growth land planning will reduce total transport demand, contribute to reduction in vehicle kilometres travelled and transport energy consumption, and thereby reduce air pollution and CO_2 emissions per capita. Also, high density urban planning will improve the efficiency of public transport and reduce the consumption of land by road infrastructure.

V. Background

Increasing volume of road traffic is causing serious problems such as congestion, air pollution, noise, and accidents. One of the reasons for the increase in traffic volume is urban sprawl, the expansion of urban areas which increases trip lengths and leads to a higher dependency on automobile trips. “Compact city” or “smart growth, comprehensive land planning to increase accessibility by high density oriented land use, is regarded as one of the solutions to automobile dependency due to urban sprawl (Hayashi and Sugiyama, 2003, Litman, 2003a, Newman and Kenworthy, 1999, Petersen, 2002). Although there are still objections to the idea of high density land planning, accumulated data from international cities, such as that by Kenworthy and Laube (1999), indicate correlation of urban density with less transport energy use and car use per capita. Please refer to analytical background paper II-1 for various arguments for and against compact cities. Experiences from many cities also show that high density land use planning has impacts on maintaining low travel demand, higher transit share, and urban quality. Singapore is an example of high-density urban development closely integrated around the transit system (Singapore GPI). Curitiba, Brazil, is another example of effective integration of land use and public transport (Curitiba GPI). Other successful examples include Hong Kong (PRC), Freibourg (Germany), and Portland (US). In Asia, where urban areas have been undergoing rapid growth and transformation in recent years, successful management of the demand for travel will be difficult without comprehensive planning and management of land use and transport in the urbanised, urbanising, and potential growth areas in metropolitan areas (ADB, 2003). It should be noted that the effects of land planning are assessed from the viewpoint of urban transport and effects on other sectors are not discussed in this SPO.

VI. Critical instruments

Design, planning and management: Coordination with public transport infrastructure development

Density increase will be best achieved if development areas are located in areas that are

well-served by public transport, or public transport provision is required as part of the development (Petersen, 2002, Newman and Kenworthy, 1999). Many cities known for successful compact city or smart growth planning actually have developed plans integrating public transport. Examples include: Singapore's integration with radial and circumferential mass rapid transit, Curitiba's integration with bus rapid transit on the linear main roads, Freibourg's integration with light rail transit and environmental commuter pass, and Holland's land use policy based on the categorisation of locations according to accessibility to public (and road) transport called A, B, C Policy. For details of those cases, please refer to analytical background paper II-2.

Design, planning and management: Mixed land use

Studies suggested that compact city and smart growth would be effective if used with mixed land use planning. Mixed land use will reduce the distances to various destinations from households, thereby encouraging people to walk or ride bicycles, or take public transport. These transportation benefits can be significant but are not always obvious (Bernich and Cervero, 1997, as cited in Newman and Kenworthy, 1999). One approach to incorporating mixed land use with density is the "urban village" concept. Key characteristics of urban villages include: high-density land use, especially at the centre, so that everything within the "village" is within walking and cycling distance, mixed land use, with offices, shops, businesses, and community facilities integrated into residential development so that there is more local activity, and so on. Examples of urban villages include Arabella Park, Munich, Zamila Park, Munich, Stockholm's Satellite Centres, and Vancouver, British Columbia (Newman and Kenworthy, 1999).

Self-regulation: Urban Boundary

The "urban boundary" is a regulatory measure taken to avoid urban sprawl. Urban development is controlled by banning development beyond a certain line around the city, and preserving it for agriculture or natural habitats. With increasing population in an urban region, both the density within the city and in the surrounding areas will increase and form satellite cities (Petersen, 2002). In Europe, this has been commonly practiced. For example, "green belt" policy was first introduced in the United Kingdom and many European cities had introduced land use regulations involving limits on the urban areas and zoning on land use. In the United States, Portland, Oregon has been setting "urban growth boundaries". In Asia, Korea has introduced a green belt policy. For more information of those examples, please see analytical background paper II-3.

VII. Impacts of instruments selected

a. Impacts on the driving forces for environmental degradations

International statistical data collected by Kenworthy et al, have shown that urban density has an evident relationship with the driving forces of environmental degradation such as the length of travel to work, distance driven by vehicles, and energy consumption. Urban density was also estimated to contribute to the reduction of cost of public transport.

Figure 1 shows the correlation between density and car use per capita. This figure means that as density increases, the vehicle kilometres travelled (VKT) per person decreases. There appears to be a critical point (about 20 to 30 persons per ha) below which automobile-dependent land use patterns appear to be inherent characteristic of a city. It has to be noted, however, that Asian cities, which have high urban density - more than approximately 75 persons/ha - show relatively small differences in vehicle kilometres travelled per capita. Correlations similar to Figure 1 was observed for density and energy use (please see analytical background paper II-4). It was also estimated that higher urban density reduces the cost of public transport (see analytical background paper II-5).

Experiences show that land use planning can only resist the spread of car use to a limited extent. This has been exemplified by the European experiences, where a degree of car-based sprawl has taken place despite land use planning efforts (Petersen, 2002).

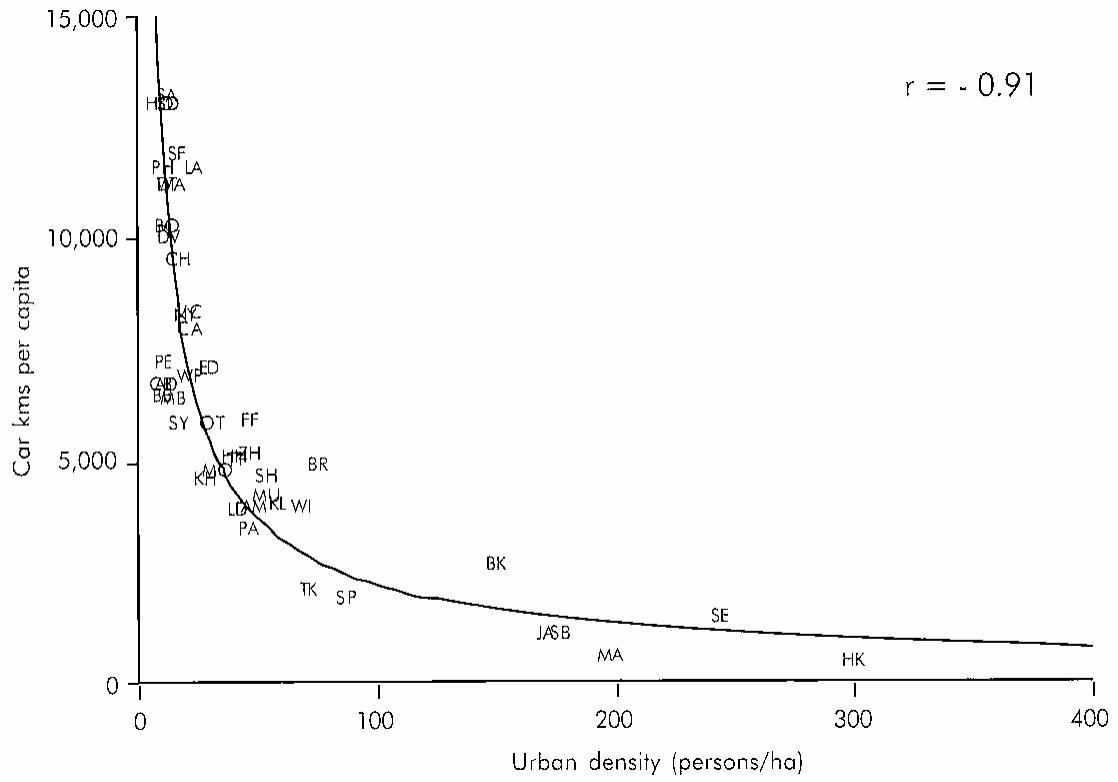

Figure 1, Car use per capita and urban density in global cities, 1990.
(Source: Kenworthy and Laube, 1999).

b. Impacts on the environment and socio-economic conditions

According to Kenworthy and Laube (1999), there is a strong negative correlation of per capita air pollution emissions with density, suggesting that cities with lower automobile dependence, not surprisingly, emit less emission from their transportation sector (Table 1). This, however, is offset by an almost equally positive correlation between urban density and the quantity of emissions generated per hectare due to activities of residents.

Table 1: Correlations between urban form and air pollution, 1990

	Densities				Centralisation			
	Urban density (persons/ ha)	Inner area* density (persons/ ha)	Outer area** density (persons/ ha)	CBD*** density (persons/ ha)	Prop. of pop. in CBD (%)	Prop. of pop. in inner area (%)	Prop.of jobs in CBD(%)	Prop. of jobs in inner area (%)
Total pollutant emissions per capita	-0.808 log s < 0.0005	-0.743 log s < 0.0005	-0.797 log s < 0.0005	-0.527 log s < 0.0005	-0.527 log s < 0.0005	-0.450 lin s < 0.005	-0.467 lin s < 0.005	-0.561 lin s > 0.0005
Total pollutant emissions per ha	+ 0.757 lin s < 0.0005	+ 0.725 log s < 0.0005	+ 0.738 log s < 0.0005	+ 0.770 lin s < 0.0005	+ 0.700 lin s < 0.0005	+ 0.443 exp s < 0.005	+ 0.341 lin s < 0.025	+ 0.251 pow s < 0.05

(Source: Kenworthy and Laube, 1999)

*inner area: the part of the metropolitan area that was contiguously developed by about 1939.

**outer area: the difference between the inner area and the metropolitan area.

***CBD (Central Business District): the area with the most significant single employment concentration in the metropolitan area.

Shaded correlation is not significant at the 95 per cent confidence level.

VIII. Evaluation of the policy option - Analysis A –

a. Sustainability:

Well planned compact cities and smart growth have shown sustained effects for more than ten years or decades. For example, Curitiba's master plan was developed in 1965 and public transport was started in 1974. The city is still developing along the corridor, and public transport has a high share and is attracting more passengers. Singapore started aggressive land use planning and integration policy in 1970s and has shown low VKT and energy use per capita as shown in Figure 1. Experiences of Freibourg and Portland also show long term sustainable impacts.

b. Equity:

Compact cities and smart growth have mixed implications to equity. On the positive side, it increases accessibility and transportation options to more people at a cost cheaper than owning and using automobiles, which benefits those who cannot afford or drive vehicles. On the other hand, compact cities and smart growth may raise housing costs (Litman, 2003a).

c. Efficiency:

Efficiency in terms of outputs of compact cities and resources used to develop them is difficult to assess in one value since land planning has diverse effects and is quite location specific. Positive outputs of compact cities related to vehicle reduction include saving of transport cost, time required for transport, less pollution, and resulting reduction of negative health effects. For the data on saving of transport cost, please refer to analytical background paper II-6. Other positive outputs include energy saving per capita due to increase in energy efficiency and less land required for road and parking spaces. Resources used for compact city and smart growth include additional planning, land and property acquisition (e.g., for green belt, zoned areas, public transit, artery roads, walking and biking streets, etc.), and construction and maintenance of infrastructure (Litman, 2003a, 2003b). An estimate in Toronto showed that more clustered land planning has potential savings of public costs (utilities, government services, and transportation infrastructure). For details, please see analytical background paper II-7.

d. Effectiveness:

Data shown in Section VII and experiences of cities indicate that high density urban planning has observable effects for the objectives to control urban sprawl, reduce kilometres driven, and support a high transit share. The effect for the objective to keep walking and cycling attractive is not statistically proven but appears to be dependent on the instrument of mixed land use. It was also shown that energy consumption per capita and total pollutant emissions per capita would be reduced, although it was also indicated that those per capita effects could be offset by the number of urban residents.

e. **Relevance:**

The objective to "control urban sprawl and reduce vehicle kilometres traveled by influencing the spatial structure of locations in the urban environment" is relevant to the strategy of reducing transport demand since spatial structure has a large influence on travel demand. Without addressing urban sprawl in a structural way, it is very difficult to reduce travel demand over the long run. The objective to support a high transit share and have non-motorised transport attractive is rather relevant to another strategy of this project - to increase public transport share.

IX. Implementation Issues:

Required resources for high density urban planning very much depends on the case, since it is quite complex and location specific. Implementation of high density urban planning would require: additional planning, land and property acquisition (e.g., for green belt, zoned areas, public transit, artery roads, walking and biking streets, etc.), and construction and maintenance of infrastructure (Litman, 2003a). The total cost is quite substantial since the scale and amount of required resources is very large. In the case of Toronto, it was estimated that 25-year public cost of central land planning will be $49.2 billion Canadian ($39.1 billion for capital costs and $10.1 billion for operation and maintenance)[2]. This estimate is less than the case of spreading land use over the long run (see the discussion in Section VIII-c).

X. Applicability and limitation:

Geographically, a high density urban area is applicable in both existing cities and newly developed urban areas. In the Asian context where large cities are already populated with high density, especially newly developed urban cities, it has a high potential for application. The correlation between urban density and automobile use indicates that it may greatly enhance the chance of introduction of public transit, if the density is raised to above 20-30 persons/ha. However, as shown in Figure 1, the difference in vehicle kilometres travelled per capita becomes relatively small in the cities which have high urban density - more than approximately 75 persons/ha - and most Asian large cities fall in this category. In fact, within the urban area many traffic problems result from over-concentrated development in the central district (Petersen 2002). Therefore, high density planning would be applicable until the density reaches some level (75 persons/ha) and if it goes beyond, the more relevant approach is the formation of sub-centres within the city or the development of a regional system of cities. Some scholars suggest that this kind of a decentralised concentrated urban form would be more suitable for larger cities with populations above 500,000 (Owens and Rickaby, 1992, and Breheny, 1996, as cited in Tomita et al., 2003). For the details of regional system of cities, please refer to the SPO for that option. It should also be noted that applicability of compact city and smart growth is limited to cities in the process of expansion.

To be sure of the effect of compact city and smart growth on vehicle use, provision of alternative modes such as public transport is important, as discussed in Section VI. In addition, compact city and smart growth planning should be introduced with travel demand management policies since the effect of land use planning to resist the spread of car use is limited as discussed in Section VII. The example of Singapore shows the effect of this kind of policy mix (please refer to analytical background paper II-2). It is also very important to introduce policies for cleaner vehicles, because per capita effects of pollution reduction can be offset by the number of urban residents.

[2] Currency year is 1995. One Canadian dollar was equivalent to 0.73233 US on 15 September 1995.

In terms of socio-economic conditions, strong political will and support from the citizens is needed (Litman, 2003a). Since each city has its own background and conditions, the impacts of major transport and other urban infrastructure decisions on urban development, and the resulting travel patterns, should be carefully considered when preparing transport plans. Finally, the planning framework should be realistic in terms of what government can achieve although it is also important to have a vision: it should aim to create an appropriate investment and regulatory environment within which the travel, housing, and industry markets can respond (ADB, 2003).

XI. Related Good Practices

- Integration of land use and bus system in Curitiba, Brazil
- Environmentally sound transportation planning in Singapore

XII. Related Analytical Background Paper(s) (- Analysis B -):

Analytical Background Paper on Compact city and smart growth.

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