The long-run cost of different forms of urban development is one of the major problems in the field of land use and transport and the sustainability of cities. This paper summarizes and evaluates the international literature that deals with social costs as a consequence of suburbanization: comprehensive ‘development impact studies’; studies on ‘public service costs’; and those simulating the local ‘fiscal impact’ of various development scenarios. Such a review is needed because all studies are based on different approaches, methods and scope, as well as differences in the cost items considered. They show significantly different results. Due to the resulting complexity of comparison and evaluation, and the lack of transferability of the results to other areas, a state-of-the-art evaluation is helpful. This paper focuses mainly on the involvement of demographical changes beyond the growth paradigm, the consideration of environmental effects, and the consideration of cost burden/repayment of public costs according to the cost-by-causer principle. Using tabular comparisons of different study types, it is shown that various studies obtained different qualitative and numerical results, depending on the methodology and detail or representing different land-use patterns. Notwithstanding the different international legal frameworks, an international agreement by researchers towards a common methodology is necessary in order to enable more efficient ‘fiscal impact’ analyses as an instrument towards more compact, cost-saving development, and thus avoid unnecessary social costs by increasing the efficiency.

Keywords: Urban Sprawl, Social Costs, Fiscal Impact, Literature Review
1. INTRODUCTION

Attempts to calculate the costs of the impacts of suburbanization and urban sprawl goes back to the 1970s when Anthony Downs and his team carried out a detailed cost analysis for the entire USA (“The Costs of Sprawl”) on behalf of the Real Estate Research Corporation (RERC, 1974). Basically, it found that high density planned development resulted in significant monetary savings. This study was updated and extended by a research group lead by Robert Burchell as a part of the Transit Cooperative Research Programme (TRB, 2002). Meanwhile, these seminal ‘development impact’ studies were amended by other studies carried out in USA, and also in other countries facing the same problems, especially in Europe. These studies often focused on the monetary aspect of population migration or different land-use patterns, and are often classified as ‘public service cost’ and ‘fiscal impact’ studies. They are a consequence of rising cost awareness and interest to provide infrastructure, not simply as ‘end of pipe’ items of the planning process (cf. OŘOK, 1999:86). They consider the issue of social costs prior to land-use development decisions, especially for new housing areas.

Generally, ‘public service cost’ and ‘fiscal impact’ studies have been carried out for a specific region with a particular planning issue. Although they already belong to mainstream planning practice in the USA, these studies are often undertaken from a premise that methodology, or findings of other studies, cannot be applied to other cities or regions, even when, in fact, the problems to be investigated are quite similar. This is one reason for the lack of a contemporary and systematic comparison of social costs studies. There had been some excellent synthesizes in the past (cf. Kelsey, 1993; Burchell and Listokin, 1995; Muro and Puentes, 2004; Schiller and Siedentop, 2005; Stabile, 2005), but they all focused on one specific category of studies (e.g. ‘public service cost’ studies) or one aspect of the whole. An exception is the literature synthesis, carried out by the Rutgers University, the Brookings Institution, Parson Brinckerhoff Quade and Douglas, and ECONorthwest in the run-up to the ‘Costs of Sprawl’ study (TRB, 1998). It systematically, and comprehensively, summarized the findings by dividing into major fields and subfields of impacts, including topical coverage, databases, methodologies, deficiencies, and alleged negative and positive effects of sprawl.

These economic and financial issues of land-use development have attracted growing interest for a number of reasons: public costs estimation and fiscal impact simulations are being carried out as a result of changes in socio-economic conditions in recent decades. The growing problem of an ‘ageing society’ has negative impacts on municipal budgets: the ratio between working and non-working generations is diminishing, even in the growing cities of Asia (measured in total population). The declining income tax revenues mean that the divide between expenses and revenues keeps on widening in many municipalities’ budgets, which impacts on the cost awareness of the public sector, especially in terms of public investment in infrastructure. This affects both point (sewage treatment plant, schools, hospitals etc.) and network-related (roads, sewage, water pipes etc.) infrastructure. The latter kind of infrastructure is particularly crucial in low density sprawling areas. However, even after considering new investment more carefully, the burden of the costs of operation and maintenance of existing infrastructure that inevitably follow remains for the public sector for the duration of the useful life of the infrastructure. (These costs can often be little influenced by a situation of declining demand.)
Beyond socio-economic changes, another economic land use issue is the environmental changes caused by urban growth. As reliable environmental cost estimations of CO₂ emissions from the housing and transport sectors are rare, a special challenge is attaching monetary values to these effects, which occur externally, i.e. outside of market schemes.

Apart from these mega trends, it is important to specify the costs on a per capita basis. To fully understand the growing burden of both infrastructure and environmental costs, cost calculation models are used. From the point of view of ‘beneficiary-pays-principle; the issue of proper allocation and repayment of the costs by the causer or user by user fees and taxes need to be included.

This paper carries out a comprehensive comparative review of the relevant social cost literature from Europe (primarily Germany), Japan and the USA with particular reference to the key question as to how far the aspects of demographic and environmental issues, as well as the equity issue of unfair cost burden, are considered in ‘development impact’, ‘public service cost’ and ‘fiscal impact’ studies. Relevant studies from the 1970s onwards have been identified from an Internet search using English and German keywords. It showed that studies have been mainly carried out in the USA, Europe and Japan. Section 2 starts with the description of the economic aspects of the interactions of urban sprawl and person transport. Section 3 describes the scope and findings from social cost studies divided into three study types, and is supported by comprehensive comparative tables. Section 4 comparatively evaluates 16 studies identified in relation to their findings concerning the costs of public infrastructure and environmental impacts, revenues and cost burden, and demographical aspects. Finally, section 5 summarizes the findings and suggests areas for further research.

2. ECONOMIC ASPECTS OF URBAN SPRAWL AND TRANSPORT

Many aspects of the development of population, land use and transportation are strongly related to economic issues. Rising travel demand that results from sprawling development triggers various costs on different levels, and for different actors. The growing need for road infrastructure burdens the municipal budget. Also, the regional and national budgets are involved, in the case where these investments are partly financed by transferred tax revenues. The operation and maintenance, including cleaning, repair and street lightning, are also expenses of the local budget. The private households migrating to those more remote suburban, or semi-rural, locations tend to possess more cars, especially if their income grows and they move from the core city. One reason is that the locus of their networks, such as working places, or personal relationships, does not shift simultaneously, so that travel demand increases. This is less an issue in mature economies because of new investment in transportation infrastructure. However, with the gradual saturation of infrastructure, especially in the urbanized areas, and growing budget constraints and environmental concerns, Hayashi (2006:135) has suggested a paradigm shift from massive construction of new infrastructure to an efficient use of the existing infrastructure.

But apart from investments, various economic effects need to be considered with the usage of transportation infrastructure. As a result of suburbanization, the number of car owners who have to bear costs for depreciation of the car purchase costs, operation costs for gasoline use,
maintenance and repair, and taxes for car ownership and usage increases. Taxes flow back to the governmental sector and are only partly used to finance transportation infrastructure. The availability and proximity of railway services also determine the ownership and usage of private cars.6)

Figure 1 shows the impact of the factors of land use - transport interactions (upper part) as well as the the result of the social costs impacts shown in the lower part. The financial threat of processes results firstly from the current and future trend of a shrinking and ageing population, due to the declining tax revenues. An additional financial disadvantage from a social point of view is the relatively low repayment of costs by utility charges and taxes. The consequences of ongoing suburbanization and growing automobile use are negative environmental effects (Figure 1) with higher energy consumption and higher emissions that induce external costs on both the local and global scales (climate change).

The influencing and influenced items described above are highlighted in grey, because they are the main focus of this paper. The aim is to find out in how far aspects of demographic changes, legislation

(Figure 1) Land Use-Transport Interaction and Social Costs
of cost sponsorship and the global environmental effects are considered in the relevant international literature.

3. SCOPE AND FINDINGS OF SOCIAL COSTS STUDIES

Social cost studies are undertaken for very different geographical scales, are calculated within different scopes, and use different approaches. However, they can be generally grouped into the following categories according to their aims and motivations: ‘public service cost studies’; ‘fiscal impact analyses’; and ‘development impact studies’.

‘Public service cost’ studies focus on the cost for constructing, maintaining and operating public facilities, incorporating direct related charges. When public cost studies include other additional public income of housing developments, such as property taxes, income taxes, or impact of the tax allocation systems (revenues and burdens according to the inter-governmental transfer system) they are referred to as ‘fiscal impact’ analyses. Within this paper, ‘development impact’ studies cover environmental, economic, fiscal, and, often, private, impacts. Because of their complexity, these genuine ‘social cost’ studies are carried out at a national level with a broad scope. A simple categorization of these types of study can be seen from Figure 2. In the following sections, the classification and scope of typical studies in each category will be analysed by using comparative tables. The tables aim to give a rough overview about the investigation area, their scope and approach, the considered residential development type, and the considered public infrastructure cost and revenue items. Furthermore, they show how far the cost burdenship is considered within the studies (except for the ‘fiscal impact’ studies that focus only on the municipal budget). Finally, the tables qualitatively summarize the main findings of these studies.

The largest body of research comprises studies on ‘public service costs’, sometimes misleadingly addressed as ‘fiscal impact’ studies, which are discussed in the next section. A series of studies from the 1980’s and 1990’s focusing on direct costs associated with different development patterns were carried out for different regions in the USA. For example, Duncan (et al., 1989) modeled the costs beyond the aspect of density by defining various forms of scattered development (Table 1) in the state of Florida The U.S. Environmental Protection Agency (USEPA) found for the Chesapeake Bay Area that the costs vary depending on whether its calculations are done on the intra-neighborhood, inter-neighborhood, or regional level. Table 1 illustrates how many public cost items this study considered compared to other studies, although all were limited to capital costs. The
<table>
<thead>
<tr>
<th>Development Type</th>
<th>Current Literature</th>
<th>Cost Burden</th>
<th>Public Infrastructure Costs</th>
<th>Main Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growing (Prototype)</td>
<td>USEPA (1993)</td>
<td>Specific charges</td>
<td>School, Day-care centers, Nursing homes, Sport facilities</td>
<td>Cost per dwelling unit of intra-neighborhood services declines as density increases and lot size diminishes.</td>
</tr>
<tr>
<td>Growing and Shrinking (Prototype)</td>
<td>Teichgraeber (1972)</td>
<td>Cross subsidies</td>
<td>Student Transport Services, Care for Elderly</td>
<td>O&amp;M costs per capita falls as population density increases.</td>
</tr>
<tr>
<td>Existing</td>
<td>NRDC 1998</td>
<td>Cross subsidies</td>
<td>Public facilities (Police, fire, waste, libraries, health care)</td>
<td>No savings social infrastructure, but tech. infrastructure 15% for compact vs. status quo development.</td>
</tr>
</tbody>
</table>

Intra-neighborhood services are highly sensitive to lot size (building density).
Natural Resource Defence Council (NRDC) concentrated its investigation on the costs for providing sewage and water services in Cleveland and Chicago. Speir and Stephenson (2002) aimed to calculate the costs for water and sewage services by isolating three specific spatial attributes of housing patterns, namely lot size (separation between houses), tract dispersion (separation between development tracts) and distance from existing water and sewer centers.

In Europe, calculations of public cost for new developments began in the early 1970s ("Städtebauliche Kalkulation", e.g. Teichgraeber, 1972) and have been further developed, especially in North Rhine Westphalia. Teichgraeber (1972) based his capital costs calculations on existing housing developments in Hamburg, Dusseldorf, Muenster, and Unna. A major Austrian study was carried out by the Austrian Conference for Spatial Planning (Österreichische Raumordnungskonferenz ÖROK) and divided into the network costs - sewerage, water, and road network (ÖROK, 1999) - and other social infrastructure, such as nurseries, health and service for the elderly. By taking several case study municipalities with different land-use structures and growth dynamics, the re-investment needs in infrastructure have been estimated for the near future. A recent study for the German Federal Office for Building and Regional Planning (Bundesamt für Bauwesen und Raumordnung) estimated cost parameters with a focus on 2020 for utilities, roads and many different public facilities for education, recreation, and health care (Siedentop et al., 2006). Savings potentials could be found, especially for utility and road infrastructure. Although these Austrian and German studies, carried out for governmental bodies, also considered charges and fees directly related to new urban development, their stated aim was not to balance all local expenses and revenues associated with new developments, e.g. additional tax revenues.

A different character is found in the only major Japanese cost estimation study, which was included in the ‘White Paper on Small and Medium Enterprises in Japan’ (2005). It refers to the full range of urban infrastructure comprehensively, but concentrates on the local differences only in respect to the aggregated operation and maintenance costs. A clear correlation between population density and ‘upkeep’ (= maintenance and operation) costs per capita can be determined (JSBRI, 2005). An earlier attempt to include the costs of infrastructure improvement and maintenance of a policy of de-suburbanisation can be found in Tomita (et al., 2003).

‘Fiscal impact’ analyses have recently become popular in Germany, especially since the German Council for Sustainable Development (Rat für Nachhaltige Entwicklung-RNE) suggested estimation of the current and future shadow costs of dispersed urban development that ensures more cost transparency concerning the structure of national and local budgets (RNE, 2004). The reason is the fiscal problem of providing infrastructure in regions with shrinking or unbalanced population development.

These studies can be categorized according to their cost calculation approach. One approach is to investigate changes in local government revenues and expenditures that occur as a result of new inhabitants. The calculation base is the average public unit cost per inhabitant, or per hectare (per capita cost approach). In the USA and Germany, this approach is applied by Buchanan and Weber (1982), Möckel and Osterhage (2003), DIFU (2005), Robinson (1990), and Verband Region Stuttgart (2006). Referring to Table 2, Möckel and Osterhage (2003) simulated the fiscal effects of
### (Table 2) Fiscal Impact Analyses

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<tr>
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<tbody>
<tr>
<td><strong>Area</strong></td>
<td>Dortmund (Germany)</td>
<td>Hamburg Metropolitan Area (Germany)</td>
<td>various communities and counties (USA)</td>
<td>Not area specific (Germany)</td>
</tr>
<tr>
<td><strong>Scope</strong></td>
<td>Municipalities/ City districts</td>
<td>Grids (1 hectare)</td>
<td>Municipalities</td>
<td>Municipalities</td>
</tr>
<tr>
<td><strong>Approach</strong></td>
<td>Simulation Model of migrative and demographic changes (per capita)</td>
<td>Impact of additional inhabitants based on various building and household types (marginal)</td>
<td>‘Cost of Community Service’ Evaluating revenues and expenses by land use category (per capita)</td>
<td>Impact of new housing and commercial developments (per capita)</td>
</tr>
<tr>
<td><strong>Development type</strong></td>
<td>Growing and shrinking</td>
<td>Growing</td>
<td>Growing</td>
<td>Growing</td>
</tr>
<tr>
<td><strong>Public Infrastructure Costs</strong></td>
<td>Capital (not annualized): Roads, Parks/ green, Utilities (sewage, land for public facilities), Nurseries, Schools</td>
<td>Capital (not annualized) + O&amp;M Roads (incl. lighting, cleaning, only O&amp;M) School transport, Nurseries, Nursing homes, Youth centers, Sport facilities, Other facilities for safety and social purpose (only O&amp;M), public transport (only O&amp;M)</td>
<td>Capital (not annualized) + O&amp;M Roads, Utilities (water, sewage, recycling), Schools, Public Security &amp; Safety (fire, sheriff) General administration</td>
<td>Capital (annualized) + O&amp;M Case 1: Roads, parks, drainage; Case 2: + connecting road; Case 3: + nurseries, El. Schools</td>
</tr>
<tr>
<td><strong>Fiscal Revenues</strong></td>
<td>Development charges , Property Tax, Income Tax (local share), Local allocation tax</td>
<td>Development charges, Property Tax, Income Tax (local share), Local allocation tax</td>
<td>Property Tax, Local allocation Tax, Other local charges, Revenues of Downtown Development Authority, School Fees</td>
<td>Property Tax, Commercial Tax, Local Allocation Tax</td>
</tr>
<tr>
<td><strong>Other Costs</strong></td>
<td>/</td>
<td>Induced person traffic</td>
<td>Downtown Development Authority</td>
<td>Municipal opportunity costs of loss of areas for farming or nature protection</td>
</tr>
<tr>
<td><strong>Main Results</strong></td>
<td>Strong dependence of municipal budgets on inhabitants, but additional revenues are balanced by additional expenses</td>
<td>New Housing developments are cost-effective in core cities rather than in smaller municipalities</td>
<td>Residential development generally does not pay of itself</td>
<td>New Housing developments are cost-effective if only inner development costs are considered, commercial developments are neutral or negative</td>
</tr>
</tbody>
</table>
migration and demographic changes in the population structure for the metropolitan area of Dortmund. On the other hand, the DIFU (2005) study, carried out for the German Federal Office for the Protection of Nature, has been undertaken without a specific local reference. It found different results according to the extent of considered infrastructure items. Three cases have been distinguished, whereas case 1 only focuses on roads, parks and drainage.

One subcategory of the per capita approach is the ‘cost of community services studies’, introduced by the American Farmland Trust (AFT). In different local studies, the farming lobby has carried out community-wide calculations of the revenue-expenditure situation, divided by the land-use categories of housing, commercial, and farming. If the ratio between expenditure and revenues is less than 1, then this land-use category as a whole is said to “pay for itself”.

The second calculation method, the marginal cost approach is applied to forecast the impact of new housing developments, based on different scenarios with prototype development patterns, at the geographical scale of neighborhoods or municipalities. It has been applied by Burchell (1992), and also recently in Germany by a study carried out for the Federal Ministry of Education and Research (BMBF, 2006). In his Doctoral Dissertation, Gutsche (2004, see Table 2) modeled the effects of new housing development on a microscopic scale, including a wide range of infrastructure items, and including the effects on person transport demand in the Hamburg Metropolitan Area.

‘Development impact’ studies cover environmental, social, economic and fiscal impacts. Because of their complexity, these genuine ‘social cost’ studies are carried out at a national level with a broad scope. The pioneer study by the Real Estate Research Corporation (RERC, 1974) modeled the impacts of sprawl by using six hypothetical new communities and standard unit cost data for many different kinds of network and social point infrastructure. It isolated the variable of density from those of structural age, obsolescent layout, and low-income population and concluded that low density is extremely costly on energy, environment, and fiscal grounds. Based on the RERC study, the Transportation Research Board study used an advanced model that calculated the cost differences in all US American counties, which had been categorized as urban center, urban, suburban, rural center, rural and undeveloped (TRB, 2002:54). The calculations for the development scenarios were mainly based on Burchell’s “Development Impact Assessment Handbook” of the Urban Land Institute (Burchell, 1994). Impacts are based on mathematical models, often consisting of several layers, using different prototype development scenarios, varying by housing type and density. They consider environmental, and other external and private, costs in addition to the classical monetary cost items (often divided into capital, operational, and maintenance costs). On the revenue side, they not only take directly-related charges and fees into consideration, but additionally direct- and indirect-tax revenues associated with the urban development. (More details are described in the right-hand column of Table 3.

In contrast, a Swiss study (ARE, 2000), carried out for the Federal Office of Spatial Development (Bundesamt für Raumentwicklung), used a static norm cost model for different types and locations of development. After considering all infrastructure items in the first step of the study it later concentrated on utilities, road and rail infrastructure. Finally, the study by Parsons Brinkerhoff Quade &
### Table 3: Development Impact Studies

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<tr>
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</thead>
<tbody>
<tr>
<td>Scope</td>
<td>neighborhood/ community</td>
<td>regional level</td>
<td>existing + new neighborhoods</td>
<td>counties</td>
</tr>
<tr>
<td>Approach</td>
<td>Modeling six Development Pattern with Standard unit cost data (10000 dwelling units)</td>
<td>Full Social Cost of Alternative Land Development Scenarios (SCALDS) Model Empirical average cost data</td>
<td>Norm cost model (amount x value) for different types and locations of development</td>
<td>Development scenarios (suburbanization/ planned development) (2025), Calculating savings of land consumption and infrastructure costs</td>
</tr>
<tr>
<td>Development type</td>
<td>growing (prototype)</td>
<td>existing</td>
<td>growing (prototype)</td>
<td>growing (prototype)</td>
</tr>
<tr>
<td>Public Infrastructure Costs</td>
<td>Capital + O&amp;M: Open Space/ Recreation Schools Roads Utilities (sewage, water, rain drainage, gas, electric, telephone) Public facilities &amp; Services (police, fire, waste, library, health care, churches, general gov.) Land</td>
<td>Capital + O&amp;M (marginal) Utilities (sewage, water, rain drainage) Roads (incl. Highways) (Net) Transit School</td>
<td>Capital + O&amp;M (per capita + marginal) Utilities (sewage, water supply, electricity) Roads, Rail only qualitative: Health care, police safety + security, social welfare, general administration, leisure and recreation, culture, sports</td>
<td>Capital: (per capita, for transit: marginal) Roads Utilities (water, sewage) Fiscal Impact: Roads Schools Local Public Services (police, fire, public works, general gov., recreation/ culture, health, welfare, incarceration, courts, parks)</td>
</tr>
<tr>
<td>Fiscal Revenues</td>
<td>Service Charges, Taxes no</td>
<td>Charges, Taxes</td>
<td>All Taxes, Charges, Transfers</td>
<td></td>
</tr>
<tr>
<td>Private Costs</td>
<td>Personal Effects (Use of discretionary time, psychic costs, travel time, traffic accidents, crime) Private Residential (only Capital)</td>
<td>Private travel costs (vehicle costs, gasoline, taxes, maintenance, transit fares, parking, accidents, travel time)</td>
<td></td>
<td>Private Real Estate Development Costs Personal costs (Travel miles and costs, Quality of Life, Urban Decline)</td>
</tr>
<tr>
<td>Cost Burden</td>
<td>Divided into governmental and private sponsorship</td>
<td>Divided into public and private cost sponsorship</td>
<td>Includes uncovered costs of Road and Rail infrastructure</td>
<td>Pairing of public costs with revenues</td>
</tr>
<tr>
<td>Main Findings</td>
<td>Urban density as fundamental variable of the overall costs sustained by the community (No model application included)</td>
<td>Cost of technical infrastructure depends on density and location</td>
<td>Sprawl consumes more land and infrastructure, and has fewer positive fiscal impacts</td>
<td></td>
</tr>
</tbody>
</table>
Douglas, Inc and ECONorthwest (Douglas and Seskin, 1998) developed its own model, aiming to calculate the marginal capital, operation and maintenance costs of the most important kinds of infrastructure, but did not aim to apply this model to any case study.

Table 3 contains additional monetarized environmental effects for both residential and travel activity. It also contains additional rows for private cost items and “other costs” - the latter one because not all considered costs in these studies could be subsumed under “public infrastructure costs”.

4. EVALUATIVE COMPARISON

This section evaluates the studies with respect to results and approaches in relation to the estimated costs for the public sector, as well as for the environment (sub-section 4.1), and to their consideration of revenues and cost burden (sub-section 4.2) - included in Tables 1 to 3. The last sub-section refers to the aspect of demographical changes.

4.1 Costs of Public Infrastructure and Environmental Impacts

First, an overview of the cost characteristics and items that have been considered is given here. This is followed by a survey of the potential of public cost reduction by changing urban form and location of housing development. In the final section, the treatment of environmental costs will be evaluated.

Cost Types and Items

When allocating the studies in Tables 1 to 3 by their cost types, investment (‘capital’) and running (‘operation + maintenance’) costs of infrastructure are often jointly considered (see Figure 3). However, depending on the assumptions of the authors, some ‘public service cost’ studies (Table 1) focus their model on only one of the mentioned types. In contrast, the development impact studies (Table 3) consider both types and additionally include environmental aspects.

When looking at the cost items in Table 1, it can be seen that the range of considered infrastructure items in the ‘public service costs’ studies is often narrowed down. Siedentop (et al., 2006), for example, concentrated their model on water, sewerage, roads, and long-distance heating - the latter one because of its ubiquity within Eastern German satellite towns. The other infrastructure items had been chosen because of the public duty to provide this service, their sensitivity to land-use patterns, and the huge public monetary burden (Siedentop, et al., 2006:39-40). With similar arguments, a few US studies have focused on costs of water supply and sewerage only. NRDC and Speir and Stephenson (2002) are referring to
previous findings by Burchell and Listokin (1995) and Duncan et al. (1989), when they made their selection of items to include.

‘Fiscal impact’ studies, however, cover both cost categories in order to include all fiscal relevant aspects. Therefore, the costs are often not annualized with consideration of depreciation of their resource consumption in the long term (with the exception of DIFU, 2005) (see Table 2). However, the approaches differ substantially and do not lead to a common result concerning “fiscal rentability” of new developments for the public sector (= balance of additional revenues and expenses). If different development types have been considered, these studies normally suggest that a compact growth pattern is more efficient than a dispersed one.

As shown in Table 3, ‘development impact studies’ try to cover all relevant cost items from utilities, roads, and schools, towards various other kinds of public facilities - but their scope is generally relatively broad. The costs occurred by different land use patterns, as applied in Conrad and Seskin (1998) and TRB (2002), are being articulated at the regional or county level. Thus, cost estimations often are too aggregated.

Costs of public transport are often explicitly factored out due to their special characteristics. The reason is that the standard is often locally different as a result of political decisions and cannot be fully regarded as mandatory official duty (Siedentop et al., 2006:39-40; Gutsche, 2004:193). In the USA, only the TRB study included long-run average transit costs based on the National Transit Database (TRB, 2002:332).

**Infrastructure Cost Reduction Potential**

In contrast to fiscal impacts, public costs (Table 1) are often calculated on the base of different development scenarios. But there is no common understanding on which methodology (e.g. per capita average vs. marginal cost approach) should be used to calculate them. As a result, the cost saving potential (in percent) by changes in urban form and location depends on the individual definition of the compared scenarios. Although there is a general agreement that density is linked to the infrastructure costs, there is less agreement about the interrelationship between development form and infrastructure cost (TRB, 1998:50). However, some studies found a substantial cost reduction potential, as illustrated in Figure 4 (numbers refer to the literature). This shows the variety of cost sensitivities influenced by change of land use structure, depending on its methodological design (considered land-use pattern types, infrastructure and cost items, and time perspective). Especially for the network infrastructure (lifelines) a large variance in result can be found ranging from 15 % to nearly 80%. For schools, taken as an example of a point infrastructure, the range is much lower, but still large: between 4 % and 30% of school costs could be saved depending on the land-use pattern.

This variety is a result of the complexity of grasping all cost influencing land-use parameters. As for capital costs, Frank (1989:37) concluded:

“The crucial terms are density, and lot size or lot width, municipal improvement standards; characteristics of the occupants, contiguity of development, distance to central facilities, and size of the urban area. Each one, when allowed to vary, has a discernible effect on development cost, but when they are allowed to vary at the same time, the independent effect of each is difficult to measure because of simultaneous effect”.

These findings suggest that both the applied methodology, and the local situations, result in
different cost sensitivities.

Environmental Impacts

The first ‘development impact study’ to monetarize environmental impacts of residential development was done by the Real Estate Research Institute, divided into impacts by construction (water pollution, wildlife and vegetation, and visuality), by living (air pollution from residential heating), and by resulting usage of cars (air pollution, noise) (RERC, 1974:4). Similar urban environmental cost factors can be found in the study by Conrad and Seskin (1998), but additionally, energy costs and consumption were considered. The first study to include global environmental costs was ARE (2000). Along with pollution and accident costs, the costs of climate change have been estimated as the result of additional public and private traffic. This has been roughly calculated by multiplying emission factors with additionally estimated transport demand, based on a specific analysis of the Swiss micro census. After that, estimated cost values from the literature have been applied to the resulting vehicle-km for each mode. However, due to the complexity, these estimations had only been verified on the base of different community types (central vs. suburban) but not for different housing development patterns (ARE, 2000:17-27). The TRB Study included several types of travel costs for society, such as air, water and noise pollution, and climate change. For this purpose, the study applied unit cost values per vehicle miles traveled (VMT), as suggested by Delucchi (2000).

In Germany, Gutsche (2004) treated not only the

| Water / sewage | 4 | 10 | 2 | 8 | 6 | 11 |
| Roads (local)  | 4 | 2  | 5 | 11 |
| All Lifelines  | 10| 2  | 5 | 13 | 7 | 9 |
| Schools        | 5 | 1  | 11|

Sources; literature cited and Schiller and Siedentop (2005)

(Figure 4) Cost Savings in % by the Change in Land Use Structure
fiscal impacts of additional inhabitants in the Hamburg Metropolitan Area, but also modeled the impact of the fiscal system on transport demand. Although he did not investigate specific environmental impacts of the additional traffic, he evaluated alternative housing locations according to their transport demand intensity. The German Institute of Urban Affairs included the revenue effect from natural protection, and other open space areas, in their fiscal impact study (DIFU, 2000: 20). By doing so it calculated the positive effect (i.e. opportunity benefits) of not undertaken land-use development, or the monetary value of land preservation, which was an innovation for Germany.10

Only a few studies have attempted to monetarize environmental impacts attributable to the suburbanization process. Although new methodologies and modeling techniques for land-use/ transport interactions have been developed, they have rarely been linked with social cost studies. Moreover, ‘public costs’ or ‘fiscal impact’ studies should not be the only base for local and regional development decisions, but rather be embedded into ‘development impact’ studies, as suggested by Edwards (2000) in her Community Guide to Development Impact Analysis.

4.2 Revenues and Cost Burden

After treating the cost side of the studies, this subsection focuses on municipal revenues. To enhance the understanding, the differences in fiscal systems in USA, Germany and Japan will be briefly discussed, involving the issue of ‘sponsorship’ (repayment of public costs by the receiver of the service).

Different Fiscal Systems

‘Fiscal impact studies’ can only be understood by having a closer look at the different local funding and tax systems across countries. In the USA, this type of study became prevalent for two reasons: ongoing pressures to convert farming land into other usages; and the increasing dependence of community budgets on local tax revenues while the demand for public services increases. Although every state can decide on the kind of local taxes in own jurisdiction, the property tax, levied on real estate property, becomes an increasingly important part of local revenues, especially after reductions in federal and state funding to local governments in the 1990s (Kelsey, 1993:1169).

The largest sectors of expenditure are schools and police, of which full costs have often to be financed by property tax.11 In contrast, in Japan and Germany, the financial responsibilities for these public facilities are shared with higher governmental tiers.12 Moreover, inter-governmental transfer taxes (= local allocation tax, kommunaler Finanzausgleich) are of high importance for German municipal revenues. These taxes are granted from the Federal budget, or by means of redistribution among municipalities. Their amount depends on ‘municipal demand parameters’, as well as the ‘tax resource power’ of the municipality. However, the financial resources are often insufficient to finance the full amount of rising costs, especially for operation and maintenance. The situation is similar in Japan: the growing gap between autonomous revenue and total expenditure is being financed by transfers from the central government to an increasing extent (Shirai, 2005:27).

Aspect of Cost Burden

From an economic point of view, problems only occur if costs are not paid by those who are causing them. Therefore, it is important that the aspect of sponsorship, or repayment of public costs by the receiver of the service, is considered within the
studies. Thus, some public costs, become private costs due to charges or taxes.

‘Development impact studies’ include private costs as a result of the suburbanization process in their cost estimations - for example, for additional need to travel (c.f. Figure1) - but they have failed to systematically incorporate the issue of cost burden. ‘Public service cost studies’, narrowly focus on the cost of certain infrastructure items, merely assuming that “governments bear the vast majority of these costs”. (Speir and Stephenson, 2002:56) concentrated their study on water and sewage infrastructure following this argument). But ‘public service cost studies’ studies often neglect other revenue effects of additional development, such as changes in direct or indirect taxes. However, they partly point out the problem of cross-subsidizing, but rather as an additional argument for quantification without the attempt to quantify them (e.g. Speir and Stephenson, 2002:65).

The proper consideration of development impact fees and charges is important, bearing in mind the “polluter-pays”-principle, which is an objective of different urban policies, including the application of charges and fees. In general, development fees and charges should cover the marginal infrastructure costs, triggered by the additional development (DIFU, 2005:57). In Germany, those charges (Erschlieβungsbeitrag) are obligatory for every new housing development, but they can legally cover only investment costs. Moreover, they are limited to certain items, such as parks and linear infrastructure (local roads and drainage). Because of the growing operation and maintenance costs, DIFU concluded that reviewing this regulation is necessary in order to fund additional facilities beyond their investment costs (DIFU, 2005:5).

The other utilities (energy, water, waste, sewerage, and telecommunication) are often funded by user charges entirely and thus excluded from social cost calculations (DIFU, 2005:12; Gutsche, 2004:190 -191). However, following this argument, the problem of cross-subsidizing is not considered, since this issue is not relevant for the municipal budget. Experts argue that necessary renewal measures in network infrastructure cannot be financed by the legal charges (Herz, 2004:17). In the USA, a study by the Natural Resource Defense Council (NRDC, 1993:3) analyzed the cost effectiveness of the zone-differentiated rate structure in the Cleveland Division of Water, which applies higher rates for locations farther from the urban core. Although this structure turned out to be a step in the right direction, “the cost of sprawl” is being subsidized by ratepayers in non-sprawling locations.

4.3 Demographical aspects

Reliable cost estimation cannot be achieved without considering the people served by public services. In fact, demographic characteristics are a major factor in determining the demand for local services and their resulting costs in the case of new residential developments. In the USA, education costs only relevant for specific age groups are the highest cost per dwelling (USEPA, 1993:12). However, the local differences of household and family types are often not incorporated into the calculations. As described in section 2, the ageing of society has a negative influence on tax revenues: elderly people usually have a fixed, and relatively low, income, which makes it difficult for local governments to raise property taxes, “especially when it raises the specter of forcing the destitute elderly from their homes” (Kelsey, 1993:1171).

Moreover, US studies either consider an existing development state, or investigate the costs for future growth of population and land-use. Generally, they do not consider different demographic scenarios,
especially the phenomenon of shrinking. A shrinking population and ageing society simply has not yet become a major issue in the USA, because the majority of the regions are still growing (DIFU, 2005:29). In contrast, this has become a big issue in other matured countries: a German study group lead by Siedentop chose a methodological approach to cover both growing and shrinking regions. By normatively defining typical infrastructure configurations, the calculation model is based on an resource consuming approach, showing the actual costs of infrastructure provision, including their deconstruction ahead of schedule (Siedentop et al., 2006:X).

Declining public investment is one result of a demographical development. In the past, it has been argued that, influenced by the growth paradigm, social costs per capita would decrease after the ‘urban infill’ of the ‘leapfrog development’ had occurred. However, it has now become a feeble argument because only a few regions in matured countries are still characterized by significant growth (cf. Schiller and Siedentop, 2005:86): in many regions of developed countries, the population is stagnating or shrinking. The most important cost factor is the existing, often underutilized, infrastructure. Japan, for instance, currently experiences the phenomenon of growing and shrinking regions at the same time in terms of population development, mainly triggered by regional economic factors. As a result, many regions are facing unnecessary costs: the central city is providing over-capacity in terms of public facilities; at the same time, suburban neighbor communities may have to invest in, or extend, public facilities because of growing in-migration.

Another demographical issue is the incorporation of induced traffic. Only Gutsche estimated this effect stratified by gender and main activity of each person from a household survey (2004:51), but he did not incorporate forecasts of demographical changes. In contrast, the study for the Swiss Federal Office of Spatial Development points out different demographic configurations of different settlement types, but could not incorporate these insights into transport demand estimations (ARE, 2000:21).

5. CONCLUSION AND FURTHER RESEARCH

By undertaking a review of various kinds of studies from Europe, Japan and the USA, the economic aspects of different land-use patterns and transport has been described. Sixteen relevant studies have been analyzed and evaluated in terms of their scope and main findings. It has been found that building density is the key parameter for social costs. This has been found to be most influential in studies since the 1970s. However, in terms of methodology, a recent shift can be detected from comprehensive ‘development impact studies’, with a spatially and thematically wide focus, towards leaner studies focusing on public community service costs. Due to the rising constraints of the municipal budget, the local fiscal impacts of certain developments are increasingly attracting attention.

The survey also shows that the transfer of one model to other regions turns out to be troublesome because of the wide range of applied methods, and the local legal and structural differences. Consequently, most ‘fiscal impact’ studies (including the ‘cost of community service studies’), and a few ‘public service cost’ studies, are still carried out case by case, which make them costly. Facing the wide variety of results from different studies for different regions that are shown in Figure 3, two steps are suggested. First, in order to isolate methodological biases, several recognized approaches should be applied to the same case
study region. Secondly, the same approach needs to be applied to different municipalities/regions. Only by undertaking “cross-application” studies can the sensitivity be understood and the “this place is unique” syndrome, which impedes the accessibility of this literature to ordinary citizens (Kelsey, 1993:1170), can be countered. To establish a general and more efficient application, ‘fiscal impact’ studies should be nationally standardized and legally institutionalized not only in the USA. Moreover, it is necessary to properly consider the middle- to long-term effects, such as taxes, charges, or fees, which are often affected after a certain time period by new developments, or the decommissioning of existing housing areas.

It is important to note that development decisions should not only be based on the estimated fiscal impact: ‘fiscal impact’ studies are undertaken to focus attention on the impacts relevant for the local municipal budget. Certain infrastructure items are completely neglected depending on the legal situation, e.g. many parts of the rail-based public transport. Obviously, the construction and extension of railway and subway lines will boost the public costs of infrastructure, but those investments are often beneficial to society, as applied in the ‘development impact’ studies. This has been demonstrated in several comprehensive cost-benefit investigations, considering the external benefits in terms of savings in car traffic due to the improved public transport service, accessibility improvements and effects on urban development.

This paper was predicated on the question as to how far the different kinds of studies incorporate demographic aspects, environmental parameters, especially with those to the global issue of climate change, and the issue of repayment and unfair cost burden.

It can be stated that only a small number of studies incorporate the effects of a shrinking population and the necessary deconstruction of urban structures. Most US studies are still assuming general population growth. Recent and ongoing German studies deal specifically with shrinking problems of many regions.

In respect to environmental issues, it can be concluded that all ‘development impact’ studies treated these aspects, at least in terms of the follow-up costs of additional person transport demand. Energy consumption and costs have been modeled as well, which does require an additional step to estimate the effects of climate change. Moreover, the results are often very approximate, which are a result of the difficulties to forecast additional transport demand from new developments. Too many unknown parameters are influencing the travel behavior of newly-settled households. Another important cause of CO₂ emissions is the land-use change itself - surface sealing, life cycle emissions of additional infrastructure, and so on. Land-use change has not been considered in any of the studies reviewed.

Only a few studies have aimed to uncover those costs left for the society, i.e. not burdened according to the beneficiary-pays principle. Also, the problem of cross-subsidizing of public services within one region according to land-use structures has been only seldom addressed, and then only qualitatively. However, for a comprehensive incorporation of these issues, the differences in fiscally-relevant urban policy need to be evaluated. This includes fiscal instruments, as well as the financial involvement of the private sector through urban development contracts. In spite of the wide range of existing studies, international comparative studies on these issues are rare.
For the sake of promoting a socially cost-efficient urban development, more case studies are necessary. However, even more important, is that future research should focus on finding a commonly acknowledged methodology, with special consideration of the current local and global challenges addressed in this paper. The World Conference on Transport Research has spontaneously spawned international collaborative research projects (for example, WCTRS and ITPS, 2004) and this research challenge is worthy of an international team approach.

FOOTNOTES

1) Social Costs are defined as the full range of costs including private and external costs in this paper - following the most common definition.

2) Conrad and Seskin (1998, p. 15), for example, wrote their report as part of a series of training programs being undertaken by the Federal Highway Administration (FDHA) to improve the practice of transportation planning, through integrating it with other planning processes (particularly land-use planning) and enhancing the process of project evaluation and selection.

3) Thus, they should take into consideration that they do not generally reflect additional costs of maintaining and operating more dispersed infrastructure because residents in denser, more contiguous, developments could end up subsidizing public services for those in more sprawling patterns ("cross-subsidizing", c.f. Litman, 2004, p. 11).

4) However, also some cost studies have been carried out also in other countries. For an overview of Infrastructure Costs Studies for Australia in the 1980s and 1990s see Troy (1996).

5) This relationship is covered by an own field within Economics = Urban Economics. For a comprehensive summary of the theoretical aspects of urban economics see Hirsch (1973).

6) The negative correlation of the quantity and quality of railway networks on the car ownership rate has been empirically verified by comparing the metropolises of London Tokyo, Nagoya, and Bangkok (Hayashi et al., 1994, pp. 81ff).

7) The Ministry of Urban Development, Culture and Sports developed a computer Model called ERNA 1.0 in 1997, further developed to ERNA 2.0 in 2001.

8) This relationship has been generally accepted and confirmed by many other subsequent studies. However, some studies suggested the opposite relationship (e.g. Windsor, 1979), and others found that the service costs have a non-linear relationship (J-curve) with growing density. Ladd (1992) found that only at a very low density level, increased population density lowers cost of providing services. Beyond this point, the relationship turns around.

9) An exception was made for the calculation of Person Transport Costs, grasping different densities by using the 4 square mile grid structure of the National Personal Transportation Survey (TRB, 2002, pp. 313ff).

10) The US studies range from national reviews of the loss of farmlands and farms over time to regional/state investigations of a similar type (cf. TRB, 1998, p. 74).

11) The farming lobby, which states that their sector is contributing too much money to cover these costs, introduced the slogan "Cows don't go to school".

12) In Japan, the police, and the salary of teachers, are prefecture expenditures, whilst in Germany they are paid solely by the federal states.

13) "The cost of sprawl is cost of supplying some infrastructure in advance of its eventual need and
will ultimately be lower the more rapidly the infill takes place” (Altshuler and Gomez-Ibanez, 1993, pp. 72-73).

14) This methodology has been applied when comparing different Land Use/Transport models by the International Study Group on Land Use Transport Interaction ISGLUTI (Wegener, et al. 1991).

15) These items are part of e.g. the compulsory ‘Standardized Evaluation’ (Standardisierte Bewertung), for many major public transport projects in Germany, as well as the projects listed in the Federal Transport Infrastructure Plan (Bundesverkehrswegeplan).

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