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**The consequences of urban sprawl
in a context of decline:
The case of Leipzig**

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URBS PANDENS

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Introduction

This is a contribution to the EU-funded project URBS PANDENS. One aim of URBS PANDENS is to carry out an integrated impact assessment of social, economic and environmental consequences of urban sprawl in Europe. This paper intends to answer the following questions:

- What are the consequences of urban sprawl in the Leipzig region?
- What are recent trends and issues of urban sprawl?

In order to provide a guide for analysing the impacts and consequences of sprawl, a list of topics and issues that identify potential consequences of sprawl was drawn up along the three dimensions of sustainability (ecology, economy and social welfare). Using this checklist, the project partners in URBS PANDENS analysed the extent and specificity of sprawl in their particular case study regions and tried to investigate the interrelationships between the phenomena examined. Originally, the checklist comprised 22 potential consequences of urban sprawl. However, only 12 of these aspects were found to be relevant in the Leipzig case, and they are discussed below. We added another ‘consequence of sprawl’, the reaction of local policy-makers. The present paper contains our findings for the Leipzig region.

The main sources of information to which we referred were firstly standard statistical data provided by the Federal State of Saxony and Leipzig City Council (e.g. data on car ownership, building and housing, population, and local development plans) and secondly specific data on environmental and social issues collected by Leipzig City Council as well as during previous UFZ projects (comprising GIS data). Thirdly, we surveyed the literature on urban development in the Leipzig region. Fourthly, we drew on ‘soft data’ yielded by our interviews with experts and our own knowledge of the region.

The following paragraphs address four problems in particular along which the discussion of the potential consequences of urban sprawl dealt with in the respective paragraph is organised: (a) the connection between urban sprawl and the potential effect (under scrutiny); (b) the available data sources; (c) the empirical data for the Leipzig region; and finally (d) the validity of the data referred to (as a more or less unambiguous indicator of an effect of sprawl, i.e. alternative interpretations of the data).

ENVIRONMENTAL

Urban sprawl is often blamed for its negative environmental effects. The environmentally harmful effects of sprawl most frequently mentioned are ‘uncontrolled’, unsustainable land consumption and an increase in car traffic. The problem of environmental degradation is also at the focus of the URBS PANDENS project. One major problem however is unambiguously attributing particular environmental phenomena to urban sprawl, i.e. distinguishing the environmental effects of urban sprawl from the environmental impact of other (non-spatial) societal developments. In the following sections we discuss several types of data that can provide indications about the environmental consequences of urban sprawl in the Leipzig region, i.e. data on land consumption, surface sealing, mobility and traffic, energy consumption and pollution.

01. Land ‘consumption’

The development of land for ‘urban’ purposes (housing, production, retail, leisure) and the subsequent loss of open and agricultural land and green space is a universal consequence of urban sprawl – and in most cases also part of its definition (cf. Chin 2002). In Leipzig as well as in its surroundings, the consumption of formerly undeveloped land has been enormous throughout the last decade. Unfortunately, there has been no continuous land use monitoring that would allow a precise quantification of the recent loss of open land. Instead we can use three kinds of data in order to estimate the level of land ‘consumption’ and the changes in land use patterns: (a) firstly, the official land use statistics; (b) secondly, satellite images that can be fed into a GIS system; (c) and thirdly, data on areas subject to development planning. Types (a) and (c) are usually less precise than GIS data and do not allow spatial patterns to be identified; on the other hand they are available for the entire region under scrutiny, whereas data based on the analysis of satellite images is only available for the territory of the city of Leipzig.

(a) Land use statistics

The official German land use statistics (collected under the federal agricultural legislation and provided by the national, regional and local departments of statistics) clearly reflect recent urban land use change. As can be seen from Table 1, within the urban region of Leipzig (defined as the city of Leipzig and 16 adjacent municipalities) the amount of urban land in-

creased by more than 14% in just eight years between 1993 and 2001. Unfortunately, land use statistics dating from before 1993 cannot be compared to the figures quoted here because the statistical systematology was extensively changed in the course of German unification. For this reason a long-term comparison of land use data is impossible.

Table 1: Urban land ('Siedlungs- und Verkehrsfläche') in the Leipzig region

	1993	1997	2001
	Urban land (ha / % of total area)	Urban land (ha / % of total area)	Urban land (ha / % of total area)
Outer fringe/new Fringe	ca. 8,281 **	9,441	9,903
Inner fringe	ca. 3,333**	ca. 3,800	12,729
'Old' Leipzig	8,208	8,693	
<i>** Estimate (data basis: Stadt Leipzig 2003a).</i>			
<i>Data: German land use statistics provided by Statistisches Landesamt Sachsen (Saxon Department of Statistics)</i>			

(b) GIS analysis of satellite images

A few GIS analyses based on satellite images have been carried out for the territory of the city of Leipzig in order to determine the extent and the patterns of land 'consumption' (cf. Haase/Magnucki 2004, Haase/Nuissl 2004). These analyses have revealed that within today's city limits the amount of urban land has increased by more than 50 sq km since 1945, an increase of about 20%.

Table 2: Land use change in Leipzig (ha) (GIS data)

	1940–2003 (ha)
Urban land (residential, industrial, traffic)	+5,501
Urban green space (parks)	+5,064
Non-urban land (agricultural, woods, water)	–5,956
<i>Data: Calculation by UFZ Department of Applied Landscape Ecology</i>	

For the most part this increase is due to developments on the fringes of the urban structure; however, the densification of inner city areas has also contributed to the loss of non-urban land in the city of Leipzig. Concerning the patterns of land consumption, the GIS analysis of satellite images shows an interesting specificity of recent urban sprawl in Leipzig. Whilst it is hardly surprising that urban sprawl took place almost solely at the expense of agricultural land (as is usually the case with land consumption in Germany), the increase in green space of about 370 ha since 1990 is remarkable (cf. URGE 2002: Chapter 4.6). First of all, this indi-

cates that there has been no loss of forestland – although it should be borne in mind that woodland is rare in the surroundings of Leipzig, which are characterised by intensive agriculture, and Leipzig’s ‘green lung’ in the heart of the city – the wetlands along the rivers Elster and Pleisse (cf. Haase/Magnucki 2004) – is protected by environmental law. The actual increase in green space is thus due to de-industrialisation and the renaturalisation and re-use of brownfield sites for recreation. In particular a vast open-cast mining field south of Leipzig has been closed down and converted into a lake surrounded by parkland.

(c) Planning data

The federal states in Germany are obliged to collect data on the development plans drawn up by the local authorities. This data source provides information on the nature and sizes of these plans, and thus provides indications of potential (albeit not actual) land use changes. It distinguishes between plans in two different stages: firstly, plans for which the upper authority (of the federal state) has already granted permission; and secondly plans waiting for final approval. Note however that development plans are mainly intended to prepare residential, industrial or commercial development, and the development of green space is hardly their main aim, although parts of the area covered by the plans are often designated for green use. This however means that only where these green areas are big enough to figure in the statistics could they be subtracted from the figures on urban uses. Another problem of the statistics on development planning is that no information on the former use of the land subject to planning is included – i.e. no distinction is made between land ‘consumption’ and the reuse of brownfield sites or previously-developed land.

However, at an aggregated level (as shown in Table 2) the estimate is fairly precise (and has been verified in a couple of areas in western Saxony by the regional state authority’s department of regional development) that around one third of the land for which development plans have been prepared is already urban, whereas two-thirds of this land comprises ‘typical’ greenfield sites which are being legally prepared for development. Thus, an interpretation of planning data is both possible and instructive.

Table 3: Area subject to development planning in Leipzig and adjacent places since 1990 (ha)

	Total area of approved development plans	Area of development plans 1990–2002 (W, M) without large green spaces	Area of development plans 1990–2002 (G, SO) without large green spaces	To be added: Area of approved development plans not yet approved (W, M)	To be added: Area of approved development plans not yet approved (G, SO)	Total area	Total pop. 2001
	A	B	C	D	E	F	G
Surroundings	4099 (52.0%)	1102 (52.3%)	1914 (57.5%)	425 (32.1%)	658 (58.6%)	74400 (71.3%)	161592 (24.7%)
Leipzig's new fringe	1656 (21.0%)	648 (30.7%)	739 (22.2%)	138 (10.4%)	131 (11.7%)	15400 (14.8%)	69112 (10.6%)
Old Leipzig	2126 (27.0%)	359 (17.0%)	674 (20.3%)	760 (57.4%)	333 (11.7%)	14600 (14.0%)	423940 (64.8%)
Total	7881 (100%)	2108 (100%)	3327 (100%)	1323 (100%)	1122 (100%)	104400 (100%)	654678 (100%)
W, M = Residential and mixed land use; G, SO = mainly commercial land use							
<i>Data: Regional State Authority of West Saxony; own calculations (see Nuissl/Rink 2004: 29)</i>							

The analysis of planning data illustrates two things in particular. Firstly, comparison of Tables 3 and 1 indicates that the amount of land designated to become urban land is much higher than the land already 'consumed' or in use. Observe that there is even more land 'in the pipeline' which is to become legally prepared for development in the near future (columns D and E in Table 3). Secondly, more than half the land in the Leipzig region dedicated to urban development by planning regulations between 1990 and 2000 has been designated as industrial and commercial land or land for special uses, such as large infrastructure facilities (column C in Table 3). This land includes a couple of vast enterprise zones which are ready for building but at present remain almost completely empty (see Table 16). Concerning residential development, 'unfinished' development areas are not such a common feature since development usually only starts when the entire area is about to be built up. Instead, we have a high rate of 'unrealised plans' here since many local authorities prepared plans for huge residential areas and enterprise zones in the 1990s without any demand by either investors or residents.

02. Surface sealing

The mere amount of land whose function has been changed from non-urban to urban purposes does not necessarily say anything about the environmental consequences of this land use change. These consequences are largely dependent on the actual features of land use – most importantly the share of land that is being sealed, because surface sealing reduces both groundwater recharge and the water storage capacity of soils, and (especially in connection with the improvement of the drainage network) augments the risk of flooding (cf. Verworn/Harms 1984; Berlekamp/Pranzas 1992). Recently, the heavy flooding of the River Elbe in 2002 raised awareness of the risks associated with the unregulated increase in urban land use in wetlands in eastern Germany in the 1990s (cf. Vorholz 2002) (although the Leipzig region is well protected from flooding by the opencast mining pits in the south, which can until about 2011 serve as large reservoirs).

Together with the growth of urban land, the amount of sealed land has increased tremendously in and around Leipzig. The sealing of land has been particularly intense in some areas of the urban region, above all in the north and north-west, where the airport and a few of huge enterprise zones are located. Unfortunately, exact data on surfacing is available not for the entire urban region but only for the city of Leipzig (in its current limits), where it has been calculated on the basis of the GIS analysis of satellite images (Haase/Magnucki 2004). This data shows that around 80% of the urban land developed in Leipzig since the Second World War has a degree of surfacing exceeding 20% (the other 20% being green space, such as parks or cemeteries), around half of which even exceed more than 50%. Urban land use change is thus not identical with surface sealing, although by and large urban development (still) means ‘land consumption’ in terms of paving the natural surface of soils. Note that many inner city plots which are not actually in use (though they mostly still contain ruins) and – in a shrinking city like Leipzig – will probably remain brownland sites for a long time to come and so provide a potential for unsealing activities. Correspondingly, more and more plots have recently been converted into inner-city ‘micro-parks’ (a re-naturalisation of urban land which however won’t show up in the official land use statistics).

Various studies on the ecological effects of surface sealing in and around Leipzig have been carried out within the last decade (cf. the studies in Breuste 1996; and Keidel/Mayr 2001; Krönert 1994; Müller 1997; Wagler 1998). However, as these studies adopt a small scale ap-

proach and scrutinise ecological dynamics in rather limited areas, an overall assessment of the effects and impacts of surface sealing in Leipzig and the Leipzig region has not been undertaken yet. Such an assessment would require additional monitoring and modelling work at the city and regional scales (cf. Haase/Nuissl 2004).

03. Changes in mobility patterns and the growth of traffic

The following section discusses another aspect of (potential) consequences of urban sprawl: sprawl as a driver for change in mobility patterns and growth in traffic, leading to harmful environmental effects (e.g. pollution, sealing for transport uses and so forth; see Chapters 5 and 7e) and to increased ‘individual’ or ‘private’ costs of urban sprawl in terms of time and of money (‘transaction costs’; see Chapter 6b).

It is a common place in the scientific sprawl discussion that sprawl is leading to a change in mobility patterns with partly severe consequences for the environment and human health: huge amounts of land being used for transport purposes, emissions of harmful gases and particles, leading to a steady increase in pollution, allergies, exzema and so forth. In the following section, we try to find evidence for such causes and effects in the Leipzig case. For a discussion of the environmental effects of the sprawl-induced changes in mobility patterns and the respective growth in traffic, please see the following chapter.

Changes in mobility patterns and the growth of traffic flows caused by urban sprawl can be investigated by three ways: i) by comparing mobility patterns in inner-city and outer fringe districts; ii) by analysing time-line data on the growth of traffic flows and on individual and general trends in mobility patterns (e.g. the development of car-ownership, modal split, etc) ; iii) by measuring the growth of the transport-related economy.

(a) Comparison of inner-city and suburban mobility patterns

Inner-city and suburban mobility patterns can be compared by using data that is recorded on a district scale. For the Leipzig districts data is available on the following subjects: car ownership in the inner-city and the outer fringe districts and the share or the number of urban and suburban commuters (see Table 7). A comparison of these data for Leipzig (cf. Stadt Leipzig 2004) shows a significant difference in car ownership numbers between districts in the inner

city and the outer fringes, indicating different mobility patterns of ‘urbanites’ and ‘suburbanites’.

Table 4: Car density in selected districts of Leipzig: Private passenger cars per 1000 inhabitants in 2004

Inner-city districts		Outer fringe	
District (location)	Car density	District (location)	Car density
Zentrum (centre) (A)	233	Plaußig-Portitz (B/C)	575
Zentrum-West (A)	292	Mölkau (C)	504
Zentrum-Süd (A)	314	Baalsdorf (C)	490
Südvorstadt (A)	301	Althen-Kleinpösna (C)	497
Connewitz (B)	294	Holzhausen (C)	549
Anger-Crottendorf (B)	320	Hartmannsd.-Kn. (C)	573
Plagwitz (B)	295	Burghausen-Rückm. (C)	560
Altlindenau (B)	276	Seehausen (C)	548
Gohlis-Süd (B)	329	Wiederitzsch (C)	476

A = inner-city districts; B = districts incorporated in c. 1900; C = districts incorporated in the 1990s.
Source: Stadt Leipzig (2004b): 248.

The aggregation of these figures reveals that the number of cars is significantly higher in sub-urbia (see Table 5).

Table 5: Number of cars per capita (2002)

	Number of cars/capita
Municipalities adjacent to Leipzig	0.53
Areas (former municipalities) incorporated into Leipzig since 1990	0.50
Leipzig (in its 1990 borders)	0.37

Data: Statistisches Landesamt Sachsen; Stadt Leipzig, Amt für Statistik und Wahlen; own calculations.

However, these figures do not provide cast-iron proof of a change in mobility patterns, because car-ownership is influenced by incomes and lifestyles, too. In fact, apart from the central districts (along with Südvorstadt and Gohlis-Süd), low car-ownership rates coincide with low average incomes. We therefore have to draw on other data to make our point. Data on the shares of commuters in inner-city and outer fringe districts are available from two sources: firstly, the statistical yearbook published by Leipzig City Council, and secondly, the results of some of the surveys carried out among the local population at regular intervals (*Bürgerbefragungen*). The drawbacks are that the statistical data makes no distinctions on a district scale or between ‘urbanites’ and ‘suburbanites’, and the surveys (which differentiate between boroughs) are only based on questionnaires answered by a few thousand Leipzig citizens, so this data is not representative when it comes to a differentiation between different locations. What

this boils down to is that beside data on car-ownership, no reliable data is available on different mobility patterns in urban resp. surburban realms.

(b) Growth of traffic

To measure the growth of traffic flows, the following sources could in theory be used: data on car ownership or petrol consumption per capita, on the development of the transport infrastructure (growth of the land used for traffic), counts of km/inhabitant, of traffic flows (“Verkehrszählungen”), or of time spent for commuting. However, in the Leipzig case the data basis is rather thin. Besides data on car ownership, reliable data is available only on the number of commuters living or working in Leipzig, while traffic-count data is rare (traffic counts have only been conducted at a few ‘hot spots’) and no representative surveys of the use of time are available. Moreover, since no time-line studies have been carried out, data must be accounted ‘by hand’.

The number of cars owned by Leipzigers has increased tremendously since 1991. True, this may be partly due to pent-up demand, but it is also an indicator of the effect of sprawl. Note that the significant rise in 1999 and 2000 is normally explained by the incorporation of the new suburban housing areas, indicating different mobility patterns of urbanites and suburbanites. Furthermore, as reported above, the number of cars per capita is much higher on the outer fringe than in the city of Leipzig. Table 6 contains data on the increase in car-ownership since 1990.

Table 6: Development of car-ownership since 1990.

	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03
Passenger cars per 1000 inhabitants	143	274	375	393	393	383	372	362	378	381	385	386	387
... of which private cars	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	326	342	343	348	350	353
<i>Source: Stadt Leipzig (2003a): 147; Stadt Leipzig (1998): 151; Stadt Leipzig (1994):141. Own calculation.</i>													

Although commuter traffic counts are not available either, time-line data on the numbers of commuters can give us an idea of the development of traffic flows for commuting. Between 1994 and 2003, the number of commuters increased steadily, including in absolute numbers, despite dwindling employment, making this rise even more conspicuous when considering the share of commuters among all employees. Table 7 provides the respective data.

Table 7: Employment and numbers of commuters

	1994	1996	1998	2000	2002
Employees (in Leipzig)	212,000	199,000	208,000	207,000	196,000
Incoming commuters	63,000	70,000	71,000	73,000	75,000
Share of incoming commuters	30%	35%	34%	35%	38%
Employees (living in Leipzig)	185,000	170,000	172,000	166,000	156,000
Outward commuters	37,000	41,000	35,000	35,000	35,000
Share of outward commuters	20%	24%	20%	21%	22%
<i>Source: Stadt Leipzig (2003a): 107, Stadt Leipzig (1998): 119, Stadt Leipzig (1996): 118. (Data is recorded since 1994.)</i>					

At the same time mobility figures, in particular commuting figures, increased sharply and mobility patterns became more dispersed as the ‘classical’ pattern (‘suburbanites’ driving to work in the cities) was broken by people from the city working at the fringes or ‘suburbanites’ working in other (remote) suburban places.

There is still a noticeable amount of inward commuting from the fringes to the offices and shops in the centre; in fact two-thirds commute to Leipzig. However, nowadays there is also a noticeable amount of outward commuting from the city of Leipzig to the new industrial and commercial areas in the periphery in response to new jobs in ‘suburbanised’ production and retail facilities (see Chapter 7c).

What’s more, there are now also many commuters whose daily journeys don’t touch the city’s territory at all. Approximately a third of the ‘suburbanites’ who moved from Leipzig to the urban fringe in the first half of the 1990s didn’t work in Leipzig but were employed somewhere else in the urban region. And the same was true for youngsters and their respective schools or trainee posts (cf. Herfert 1996).¹ But as Keidel/Mayr (2001: 24) and Franz (1997: 167) have showed, there is much more retail and industrial space (but not employment) on the fringes than in the city. In terms of employment, the specific trend in Leipzig is the opposite: data on changes in employment comparing the number of employees in the city and in suburbia indicates that in the Leipzig case employment in the city fell lower than in the fringe, at least from 1994 to 1999 (cf. Franz 2002: 129).

Besides commuting as a source of traffic flows, we also need to touch upon the problem of ‘mall-induced’ mobility. The extent and the effects of traffic attracted by a single facility in the urban fringe have been reported in the literature. For instance, in the urban region of Leip-

¹ Commuting patterns in the Leipzig region indicate the general problem that an increase in jobs in one place won’t usually be accompanied by any significant reduction of commuters there but will instead make that place a new destination for commuters from elsewhere. Thus, the provision of jobs in suburban areas is no guarantee that the amount of out-commuting will decrease; in fact the opposite seems to be true. The work-related road traffic within the periphery of Leipzig has grown considerably since people started living and working in the urban periphery – because they often do so in very different parts of the suburban realm far away from each other. Thus, efforts to support the immediate neighbourhood of dwellings, industry and retail around Leipzig haven’t succeeded in reducing car traffic significantly (cf. Paatz/Kuhlpfahl 2000, 92f.).

zig, case studies on the (effects of) car traffic related to new, large shopping malls (between 30,000 and 125,000 m² of retail space) have been carried out (Freyer et al. 1996; Wagler 2000). The traffic generated by the malls increased the volume of car traffic on the surrounding roads by between 23% and almost 50%.

Moreover, thorough calculations have shown that the malls have led to a considerable increase in pollution (CO₂, benzene and others), especially in those parts of the urban region crossed by mall shoppers. It is, however, very hard to prove that the malls actually create additional traffic (cf. Wagler 2000). If all the malls' shoppers suddenly took their custom to the inner city, an increase in car traffic would still be likely (at least as long as the 'habits of shopping' continued to be linked to the use of cars) since more than a third of the visitors to the inner-city shopping-centres come from towns and villages outside Leipzig. If on the other hand retail was less concentrated and mainly located in various urban and suburban sub-centres, shopping-related car traffic would probably be much lower.

(c) Growth of the transport-related economy

Proving a direct relationship between urban sprawl and the transport-related economy in general is virtually impossible. It is striking, however, that the transport-related economy has appeared as an *agent* of urban sprawl in the Leipzig region in more than one respect. Firstly, a good deal of the sprawl in the industrial sector that has occurred around Leipzig has been engendered by car manufacturers. In fact, the most promising industrial investments in the Leipzig region have been made by the automotive industry (such as the huge new BMW plant currently being built to the north of Leipzig), and thus an economic resurgence of the whole region is above all expected from this sector.² Secondly, many transport-related firms and facilities have been built on the fringes of Leipzig, such as one of Germany's biggest warehouses for a major mail-order company, a large distribution centre for the German post office, and several carriers and hauliers have settled there. Since most of these investments have taken place north of Leipzig, they are highly likely to have been attracted by the enormous investments in the region's transport infrastructure concentrated there (such as the airport and motorway interchange). In 2004, the transport-related economy received another boost when international air freight company DHL decided to base its European hub in Leipzig because of its modern airport and unlimited flight times (especially night flights).

² The opening of a car production plant in the 1960s in Liverpool triggered similar hopes of successful regional restructuring.

(d) Discussion and conclusion

Much work has been done to show that a sprawled settlement structure creates traffic, especially car traffic (e.g. Kagermeier 1997). However, pinpointing scientific evidence of a causal relation between the two variables is rather tricky (cf. Gassel et al. 1997). In Leipzig, for example, almost all the households (more than 90%) that have moved to the urban fringe within the last 13 years already had a car when they left the city. But on arriving in the periphery they often bought a second car – indicating a ‘car-oriented suburban way of life’. On the other hand, there is no evidence that the households concerned would not have bought a (second) car if they had stayed in the inner city. Furthermore, it must be taken into account that due to suburbanisation and urban sprawl, public transport in ‘suburbia’ has gained new passengers, too – although its increase by no means compensates for the growth in car traffic.

Due to the difficulty of relating a certain volume of traffic to distinct settlement structures, intense discussion is being waged on this point in the disciplines of urban geography and planning. The view of those who refute that urban sprawl can be held responsible for the general increase in car traffic is gaining the upper hand trends (since the change of mobility patterns is a societal phenomenon which cannot just be attributed to a particular kind of urban environment) (cf. Bahrenberg 1999; Camagni/Gibelli/Rigamonti 2002; Hesse 2001). To put it somewhat simplistically, in highly developed societies it seems almost impossible to prevent people from getting around by car, regardless of the spatial structure they inhabit. On the other hand, the extension and dispersion of urban functions (see Chapter 10a) is definitely tantamount to both an increased need for mobility and a diversification of mobility patterns. To this extent, urban sprawl undoubtedly means an increase in private costs for mobility purposes. However, it proves difficult to define the sprawl-induced part of this increase and scholars haven’t come to an agreement on this point, yet.

04. Changes in energy consumption

When investigating the impact of urban sprawl on energy consumption patterns, changes in housing/working and/or transport/mobility patterns might be expected to affect the environment. More precisely, changes in housing patterns (e.g. detached housing, alternative technology) may lead to a change in the amount of energy consumed. In detail, one might expect urban sprawl to lead to:

(a) an increase in the overall consumption of fuels due to regional growth in terms of inhabitants, houses, industry, etc;

- (b) an increase in the consumption of household fuels per household (since a household in a detached house will consume more energy than a household in a block of flats);
- (c) a change in the overall energy mix, including the mix used for heating (e.g. due to a change in heating patterns caused by use of more advanced heating technology);
- (d) an increase in the consumption of gasoline due to higher transport activities (especially for commuting).

For the Leipzig case, data is available on the different energy sources used in absolute numbers and the shares accounted for by domestic households. Table 8 presents these data, which are discussed below in connection with the expected consequences mentioned above.

Table 8: Energy consumption by energy source in Leipzig (GWh/year)
(Figures apply to population increases between 1999 and 2001 following the incorporation of suburban townships.)

	1990	1997	1998	1999	2000	2001
Electricity	1,494	1,455	1,390	1,382	1,799	1,980
Of which: domestic households	568	527	478	464	485	574
Heating (remote and home)	2,179	1,904	1,760	1,596	1,669	1,779
Of which: domestic households	1,090	1,008	950	862	834	784
Natural gas	1,733	1,578	1,710	1,685	2,190	2,396
Of which: domestic households	1,125	1,089	1,158	1,112	1,457	1,607
Coal	1,292	585	471	410	353	315
Of which: domestic households	1,037	457	401	350	316	295
Oil/gas	1,188	898	876	847	1,339	1,330
Of which: domestic households	201	183	196	197	306	304
Total energy consumption	7,886	6,420	6,207	5,920	7,350	6,800
" by domestic households	4,021	3,264	3,183	2,985	3,398	3,564
Total domestic energy consumption per capita (in MWh/year)	7.9	7.3	7.3	6.1	6.9	7.2

Source: Stadt Leipzig (2004a): 195; Stadt Leipzig (2000a): 33.

- (a) The amount of energy consumed in Leipzig considerably decreased in the 1990s in absolute numbers. This positive trend resulted mainly from the shrinking population and deindustrialisation. The ‘counterweight’ effect of urban sprawl cannot be measured because there are no detailed data on changes in energy consumption (e.g. detailed figures recording decreases due to deindustrialisation and increases attributable to less energy-efficient detached houses in the suburbs).

(b) The table above also provides data on the use of different fuels by private households. Apart from the increase in the use of natural gas and oil/gas, the overall consumption of fuels by domestic households in Leipzig decreased until 1999, the year when several suburban municipalities were incorporated. Afterwards, absolute domestic energy consumption rose, of course. It would be more informative to consider the figures of domestic energy consumption per capita, as this would provide evidence on the relationship between suburban detached housing and energy consumption. Interestingly, following the city's expansion in 1999, per capita energy consumption also rose. Although this might reflect the poor energy balance of suburban detached housing, for the most part this increase probably reflects a number of successful industrial estates with 'energy-hungry' plants in the newly incorporated municipalities.

(c) Table 8 also indicates the mix of fuels used in industry and commerce and by domestic households. It shows that the main change with respect to energy consumption in Leipzig and the surrounding region concerned energy sources. The 'dirty' domestic fossil fuels (above all brown coal) were largely replaced. (Unfortunately, the data shown here do not distinguish between brown and hard coal.) But this is attributable not to urban sprawl but instead to refurbishment activities (including the modernisation of heating systems), which were very intensive in the 1990s in response to the grants and tax cuts offered for energy-saving measures by federal, regional and local government, not to mention the pent-up demand for modernisation in the east German residential property sector.

(d) There are no data available on the consumption of gasoline by the people of Leipzig. Such data would be virtually impossible to provide since sales figures cannot distinguish between gasoline sold to residents and non-residents of Leipzig. Furthermore, gasoline sold to Leipzigers outside Leipzig would need to be added to the figures, an almost insurmountable task.³

In absolute numbers, the use of energy has declined and the mix of energy sources has changed to less 'dirty' sources. As shown, the observed changes in energy consumption are not necessarily caused by urban sprawl patterns but mainly by deindustrialisation and the shrinkage in population, along with the effects of German fiscal policy in the 1990s aimed at ecological modernisation. This policy followed two strategies: firstly, fuel taxation

³ Studies have been carried out on the relationship between housing densities and gasoline consumption (cf. Hesse/Trostorff 2000; Kagermeier 1999; Newman/Kenworthy 1989). But these numbers ground on empirical studies carried out in other countries (USA, Asia and some big middle-european cities) and cannot provide specific data on the Leipzig case.

(*Ökosteuer*), which made energy more expensive (at least for domestic households and most of the economy), and secondly subsidising the modernisation of heating systems and building insulation.

05. Pollution

Since extended, dispersed settlement structures ‘need’ more energy and traffic, air pollution caused by the combustion of fuels in cars and domestic heating systems is among the most severe consequences of urban sprawl (although as shown above it is difficult to precisely determine the extent to which a certain amount of energy consumption and its associated pollution can be attributed to urban sprawl). In addition, traffic also means noise pollution, while sprawled settlement structures lead to light pollution. However, in the Leipzig region problems of pollution can hardly be attributed to urban sprawl. The quality of the environment in Leipzig and the surrounding region was appalling during the lifetime of the GDR (East Germany). Air pollution was severe due to the regional industries (especially the chemical and energy industries), and the district around Leipzig was one of the most badly polluted regions anywhere in Europe. The maximum air-pollution limits for almost all relevant chemicals were exceeded, often several times over. Nowadays, this problem has almost completely disappeared: whilst the city was vibrantly sprawling, pollution significantly decreased – albeit not because of the settlement structures but due to almost complete deindustrialisation.

Table 9: Impact of pollution in central Leipzig (Leipzig Central Station) ($\mu\text{g}/\text{m}^3$)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	Critical threshold
SO₂	103	79	41	34	23	15	9	6	5	140.0 (TA-Luft)
NO₂	33	36	36	48	48	53	50	46	48	80.0 (TA-Luft)
Particulate	65	62	58	53	75	52	46	42	41	150.0 (TA-Luft)
<i>Source: Stadt Leipzig (2000a): 26.</i>										

Although correlating urban sprawl to pollution is difficult in quantitative terms, as far as pollution caused by car traffic is concerned some assumptions can be made on the basis of quantitative data on air quality in Leipzig. Whereas these days in Leipzig ‘classical’ pollutants such as sulphur dioxide and particulate no longer cause severe problems, pollutants emitted by traffic such as benzene, soot, nitrogen oxide and ozone still merit critical attention. (This is also true for carbon dioxide, although emissions have decreased enormously since 1990 due

to deindustrialisation and improvements in both the energy sector and transport technologies. Observe, however, that the emission of carbon dioxide due to traffic would have increased much more if cars hadn't become cleaner at the same time.) This doesn't come as a surprise as the motorisation rate has exploded in eastern Germany and car traffic has more than doubled.

Besides the continuous measurement of air quality, some empirical studies provide additional insights into the environmental effects of sprawl-induced mobility in Leipzig. These studies studied the extent and the effects of traffic attracted by a single large shopping mall on the urban fringe (Freyer et al. 1996; Wagler 2000) and found that the traffic attracted by malls increased the volume of car traffic on the surrounding roads by between 23% and almost 50%. Moreover, detailed calculations show that shopping malls lead to a considerable increase in pollution (CO₂, benzene, etc) in particular parts of the urban region crossed by mall customers. Notwithstanding this evidence of urban sprawl leading to an increase in pollution caused by car traffic, recent improvements in pollution have by far outweighed the simultaneous effects of urban sprawl on air quality. This situation is illustrated by Table 10.

Table 10: CO₂ emissions in Leipzig (tons/year/inhabitant)
(Incorporation of suburban townships and resulting population increase taken into account)

CO ₂ [t/y/inh.]	1990	1998	1999	2000	2001
Due to energy consumption	13.32	7.89	7.18	6.46	5.94
Due to traffic	1.09	1.39	1.99	1.80	1.81
Total	14.41	9.82	9.17	8.26	7.75
<i>Source: Stadt Leipzig (2002a): 32.</i>					

Many experts state that urban sprawl exerts a considerable environmental impact and causes air pollution; after all extended, detached settlement structures clearly 'need' more energy and traffic. All in all, it can be stated that urban sprawl together with a disintegration and spatial concentration of various functions necessarily entails a high level of (car) traffic, although admittedly it isn't possible to provide evidence that traffic would decrease if spatial structures were different.

ECONOMIC

The economic consequences and the 'real costs' of urban sprawl are a blind spot in the discussion on urban development and sprawl. Normally, urban sprawl fronts a growing economy, at least paradigmatically. Moreover, urban sprawl is often justified by its (expected) positive economic effects (investment by new firms, more construction work, rising rents, etc.). On the other hand, sprawl initially increases public-sector costs for the necessary infrastructure development. Of course, this public investment is expected to benefit the public sector in the long term via tax revenues etc. However, since no detailed research on the real public costs and benefits of urban sprawl has been carried out, reliable data are hardly available on the economic effects of urban sprawl.

06. Costs

When considering the costs produced by urban sprawl (patterns), a distinction has to be drawn between public (a), private (b) and externalised costs (c). Public costs are the costs borne by the public sector, e.g. costs for infrastructure (improvement) and development costs, maintenance costs, demolition costs (for public property or abandoned inner-city houses with no official owner) and so on. Private costs are the costs borne by private households and firms, mainly higher transaction costs (time and money spent on transport and commuting), higher transaction costs for supply because of longer journeys, and so on. Externalised costs are the costs that 'officially' have to be borne by private entities but in fact are passed on to the public sector (or the 'environment'!), e.g. remediation costs as well as other environmental and health costs.

(a) Public costs

Urban sprawl in general implies higher public investment and maintenance costs because of enlarged infrastructures. The following categories of public costs may be caused by urban sprawl:

- Costs for new infrastructure investments in suburban districts (roads, schools, public offices);
- Higher costs for infrastructure maintenance because of a higher number of roads, schools, etc, and their under-utilisation in inner-city districts (see Chapter 12), a spe-

cifically east German phenomenon (on the coincidence of sprawl and ‘shrinkage’, see Couch et al. 2005);

- Remediation costs for (brownfield) sites to be developed and abandoned hazardous sites;
- Restructuring and/or demolition costs in abandoned (inner-city) districts – another specifically east German phenomenon.

On the other hand, urban sprawl is expected to produce benefits for the public sector, too, e.g.:

- Higher tax revenues because of more taxpayers, more production and retail activities;
- Increase in the city’s attractiveness for potential investors;
- Higher government funding because of the number of inhabitants (*Länderfinanzausgleich*).

Finding evidence on the above costs and benefits is not easy, because the data are either not recorded or not collated. Calculating the real costs for the public sector would entail collecting and analysing both municipal and public services corporation budgets, which would have been too time-consuming in the course of the project. In the interests of accuracy, these costs would also have to be reduced by the revenue produced by this kind of urban development.

Like everywhere else, urban sprawl in and around Leipzig was only possible in the first place because the public authorities spent money on new roads, sewerage, electricity supply, playgrounds and so forth. It is thus obvious that urban sprawl has created costs for the public related to the need for new infrastructure. However, since urban growth is always tantamount to the need for more infrastructure, this is only an economic problem if the necessary investments entail a simultaneous decline of the infrastructure in other parts of the urban region. This is the case in particular in a shrinking context like Leipzig, which now has an oversupply of infrastructure in the declining parts of the inner city (e.g. schools, sewage capacity) which can no longer be fully maintained. This, however, is only partly due to urban sprawl, since it is an effect of general economic and population decline attributable to many different reasons. At any rate, there are no quantitative data on infrastructure investments in the Leipzig region in general, let alone sprawl-related infrastructure investments; nor has a ‘qualitative’ analysis been produced of public investments in the Leipzig region. Hence, no ‘hard’ facts are available about the public costs of urban sprawl. Moreover, it should be noted that in eastern Germany infrastructure investments during the past 12 years have generally been extremely high, with post-1990 policy aiming to close the ‘infrastructure gap’ in comparison to the west.

Remediation costs play a role in those cases, where municipalities are the owners of areas being or about to be developed, where they have a special interest in developing a certain

area, where they intend to offer sites ‘fully developed’ (as a competitive advantage), or where they are obliged to carry out remediation because of environmental or health concerns stemming from the respective sites (and no responsible owner or polluter can be blamed).

Restructuring or demolition costs have to be taken into account when cities need to cope with derelict inner-city districts and abandoned buildings. Restructuring costs in the Leipzig case are shouldered by federal restructuring programmes such as Soziale Stadt or Stadtumbau Ost as well as by European programmes (e.g. URBAN II) and do not burden the municipal budget (although they are indeed borne by other bodies of the public sector). Demolition costs for hazardous buildings have to be paid by the owners. As the city of Leipzig itself owns a relevant number of derelict buildings, this is also a relevant item in the public costs of sprawl. Furthermore, Leipzig’s town clerk’s office, which is responsible for public safety, has to intervene in cases when buildings are liable to collapse, thus meaning a public danger, and demolition cannot be afforded by a responsible owner. According to the head of the town clerk’s office in Leipzig, this will become especially acute over the next five years.

Although urban sprawl cannot of course be solely blamed for all these consequences, it has definitely accelerated these cost trends. For example, without urban sprawl or with reduced sprawl, more inner-city buildings would have been refurbished and more brownfield sites remediated at the expense of private investors. On the other hand, the structural fabric of Leipzig’s building stock was in a catastrophic condition in 1990, and a huge amount of refurbishment should have been done earlier – which was incompatible with GDR housing policy.

(b) Private costs

Urban sprawl may lead to increased private transaction costs in terms of time and money spent on commuting and supply. One way to measure these private costs may be the number of cars per capita (see above). Then again, the simple number of cars does not imply that people actually spend more time on sprawl-induced transport activities – for it is by no means certain that people have more cars because they need more cars. Cars are a status factor, too; they are an expression of lifestyle patterns. However, it has been shown in some specific cases that a suburban lifestyle implies more time spent on commuting and shopping. Therefore, we discuss the consequences of urban sprawl for private costs in terms of time spent on commuting and supply.

Unfortunately, there are no exact data available on the time and money spent on commuting and supply. Although German statistical offices provide data on the uses of time, they do not differentiate between time spent on working and time spent on commuting, for example (cf.

Statistisches Bundesamt 2004: 545ff). So, once again, we have to draw on other data to make our point, e.g. data on the number of commuters, which has been increasing in absolute numbers as well as in the share of all employees (see above).

Another empirical study (Holz-Rau 1997: 29) investigated the distances people make on a normal workday. The number of kilometres people from Leipzig spend on the road on a normal day is 23 kms. To make a somewhat speculative assessment, commuting thus always implies an average time budget for mobility or sprawl-induced mobility of at least about 45 minutes every day.

In actual fact, urban sprawl during the last decade has been synonymous with the redistribution of housing, work-places, retail and leisure facilities in the Leipzig region. All these functions have tended to shift in a suburban direction. For example, housing suburbanisation around Leipzig measured by Herfert's and Schulz's suburbanisation degree rose by 30 per cent between 1990 and 1998, against an increase in population of 20 per cent 1994–98 (cf. Herfert/Schulz 2002: 125). This indirectly proves an increase in commuting, which leads to an increase in the time and money spent on travelling to work.

On the other hand, costs caused by commuting to work don't need to be paid (entirely) by commuters, for German tax law reimburses commuting expenditure. The bottom line is that once again the taxpayer has to pay for these effects of urban sprawl via 'missing' taxes that need to be made up for by other taxes or loans.

Another private cost of sprawl is the additional time spent on shopping or more general supply activities with retail facilities moving outwards (cf. Franz 1997; Keidel/Mayr 2001; Herfert/Röhl 2001; Nuissl/Rink 2003). In the Leipzig case, this does not necessarily mean that Leipzigers have to travel outwards to meet their needs since sufficient inner-city retail space is available, including several hypermarkets and shopping-centres, e.g. the mall at Leipzig Central Station. Furthermore, Leipzig's city centre has become increasingly attractive in recent years. But this leads to the opposite effect, with 'suburbanites' travelling to the city centre to go shopping, thus creating even more traffic. This problem has been elaborated further in Chapter 3.

(c) Externalised costs

Externalised costs are costs which are not paid directly, i.e. by the party who caused them. Typical externalised costs caused by urban sprawl are remediation costs, the loss of biodiversity and green spaces, health costs, costs for waste treatment and disposal, etc. In the Leipzig case, externalised costs played a role as both a driver of urban sprawl (as the externalisation of

costs lowers prices for open land and green spaces) and as a consequence of sprawl (increase in externalised costs for demolition, remediation of abandoned sites, health impaired by traffic). Data on externalized costs cannot be recorded as by definition externalisation means that the costs have not been recorded or paid (yet). Hence below we can only discuss this problem at a theoretical level.

Externalisation strategies of private and municipal entities may favour open space developments, because the costs of brownfield recycling raise land prices in existing urban agglomerations. (On the other hand, infrastructure investments at the fringes ought to raise prices for suburban land, too. In fact, however, these costs usually are not passed on to the investors.) As a result, urban development took place at the fringes because the remediation of potentially attractive inner-city sites would have been too expensive for the developing authorities or developers.

As a consequence of sprawl, externalised costs tend to increase. This is due to a number of developments induced by urban sprawl, e.g. the growth of traffic flows leading to increased health hazards and costs, the loss of green spaces for recreation further heightening environmental and health costs, and so on. Furthermore, these trends can be aggravated by a simultaneous 'shrinkage' regarding the population and the economy, as can be observed in the Leipzig case. During phases of shrinkage, urban sprawl implies the abandonment of traditional living or working spaces. This leads to an increase in externalised costs because (polluted) inner-city sites may be abandoned and thus be passed on to public responsibility, and because remediation and demolition activities on inner-city sites can be 'relayed'.

07. Amount of space

Sprawl is sometimes defined as inflation over time in the amount of space available for human activities such as housing, driving, shopping and so on. Sprawl increases the amount of space per person or unit devoted to human needs. The amount of space is considered to be an indicator of individual affluence and social welfare.

(a) Living space

The number of rooms and the amount of floor space the ‘average inhabitant of Leipzig’ has at their disposal has increased considerably in recent years. This reflects the profound improvement in housing conditions throughout eastern Germany enabled by the investments of the 1990s. Table 11 shows this development (although the actual improvements may be somewhat less than indicated there since the figures in the table are based on the total housing stock of Leipzig, including unoccupied and/or uninhabitable dwellings).

Table 11: Dwellings and floor space in Leipzig (1971–99)
(Incorporation of suburban townships and resulting changes in number of dwellings taken into account)

Year	Number of dwellings	Total floor space (in 100 sqm)	Average size of dwellings (in sqm)	Inhabitants per dwelling	Floor space per inhabitant (in sqm)
1971	216,551	13,497	62.3	2.7	23.1
1981	240,568	15,278	63.5	2.3	27.3
1989	257,399	16,208	63.0	2.1	30.6
1991	258,324	16,308	63.1	1.9	32.4
1993	261,445	16,423	62.8	1.9	33.2
1995	268,247	17,285	64.4	1.8	36.7
1997	277,812	17,836	64.2	1.6	39.9
1999	310,329	20,176	65.0	1.6	41.2

Source: Stadt Leipzig (1997, 2000b).

Table 12 shows the actual (2002) average floor space per inhabitant subdivided by its distance from the inner-city.

Table 12: Floor space per inhabitant in the Leipzig region

	Living space per inhabitant (in sqm)
Municipalities adjacent to Leipzig	34.98
Townsend villages incorporated into Leipzig since 1990	33.18
Leipzig (in its borders of 1990) excluding central district	41.71
Central Leipzig	41.96

Data: Statistisches Landesamt Sachsen; Stadt Leipzig, Amt für Statistik und Wahlen; own calculation.

In ‘suburbia’ the respective figures have also increased, albeit at a slightly lower level: whereas in 1999 inhabitants in Leipzig occupied more than 41sqm per head on average, ‘suburbanites’ only had around 36sqm at their disposal. This is due to both the inclusion of uninhabitable dwellings in the statistics (which are more frequent in Leipzig) and the higher share

of families in 'suburbia'. Apart from this, the development in average floor space in the Leipzig region may be described as moderate. East Germans on average still only occupy around 80% of the floor space of west Germans, and there is no indication that this difference is about to diminish (cf. Steinführer 2002: Chapter 6). However, the recent increase in floor space in eastern Germany on the one hand and urban sprawl on the other are of course closely corresponding phenomena, as also shown by data for Dresden (cf. Müller et al. 1997). However, it would probably be misleading to interpret these phenomena as necessarily causing each other; instead it seems to be the case that many east Germans were keen to improve their housing conditions, irrespective of where this desire could be met (it was first and primarily met on the urban fringe).

(b) Retail space

Shopping malls were the pioneers of suburbanisation in the Leipzig region (cf. Nuissl/Rink 2004: 22). The GDR's first (and last) shopping mall – at the border of the federal states of Saxony and Saxony-Anhalt – was granted planning permission on October 2nd 1990, one day before unification. (West) German planning law might have not allowed the huge scale of Saale Park, which still is one of the biggest retail trade estates in eastern Germany. In the early 1990s, a circle of shopping malls was built around Leipzig – including two malls within the borders of Leipzig adjacent to the city's two major prefabricated housing estates (see Table 13).

Table 13: Shopping malls in the Leipzig Region (more than 15000 sqm)

Shopping centre	sqm	Location
Paunsdorf Center (Leipzig East)	85,620	B
Saale-Park (Güntersdorf, Saxony-Anhalt)	68,500 (1992) 105,000 (2004) (125,000 incl. IKEA)	A
Moebel Walther (Taucha)	34,500	A
Loewen Center (Rückmarsdorf)	29,330	B
Sachsen Park/Messe (Seehausen)	28,670	B
Moebel Erbe (Schkeuditz)	26,000	A
Allee Center (Leipzig West)	25,925	C
Moebel Porta (Wiedemar)	25,500	A
Poesna Park (Grosspoesna)	23,693	A
Center Wachau (Markkleeberg)	22,554	A
Center Staedtelner Strasse (Markkleeberg)	15,391	A
<i>Leipzig Central Station: Bahnhof Promenaden</i>	<i>17,770</i>	<i>(central)</i>
Suburban locations: A = municipalities adjacent to Leipzig, B = towns and villages incorporated into Leipzig since 1990, C = Leipzig (in its 1990 borders) without central district.		
<i>Source: Industrie- und Handelskammer Leipzig (2002).</i>		

In contrast to other east German cities, Leipzig has managed to revitalise its inner city since the mid-1990s. The construction of a shopping mall inside the huge main station (with ‘standard’ shops) could be regarded as complementary to the city centre’s shopping area, which tries to offer higher quality standards. As a result, central Leipzig has a unique large-scale retail trade mix compared to the rest of the region. As a consequence, for instance, Saale Park’s management is presently about to revamp itself with a ‘waterworld’ attraction (and for this purpose to expand further), because of losing significant numbers of customers to central Leipzig.

In addition to the ‘shopping mall problem’, the proportions of retail segments in the various parts of the Leipzig region show distinctive differences. While department stores are concentrated in inner city, the density of supermarkets is highest in the outskirts of ‘old’ Leipzig. This simply means better provision on the ‘inner urban fringe’ compared to the ‘suburban fringe’. In suburbia, specialist stores predominate – all the more so the farther one gets away from the city (see Table 14).

Table 14: Proportions of large-scale retail segments in the Leipzig region

	Super- markets	Specialist Stores	Department Stores
Leipzig, central district (CBD)	1 (10%)	3 (30%)	6 (60%)
Leipzig in its 1990 borders, excluding CBD	3 (33%)	5 (55%)	1 (11%)
Towns and villages incorporated into Leipzig since 1990	1 (25%)	3 (75%)	0
Municipalities adjacent to Leipzig	1 (20%)	4 (80%)	0.01
<i>Source: Industrie- und Handelskammer Leipzig (2002); own calculation.</i>			

The spread of large retail facilities (including shopping malls) around Leipzig has thoroughly changed the profile of suburban municipalities. In order to measure this change, we calculated the ratio of floor space (for residential purposes) and retail space (in large-scale retail trade facilities) for the municipalities (i.e. former municipalities) in the suburban region (Table 15). The higher this index, the more dominant the retail trade function of a municipality (due to either a large amount of retail trade space or the presence of large-scale retailers in a municipality with limited dwelling space). It is evident that the aforementioned shopping malls have considerable impact on this index.

Table 15: Ratio between retail floor space and residential floor space in Leipzig's suburbia

Municipality (with large-scale retail outlets)	Location	Index residential/retail floor space *100
Wiedemar	A	51.07
Seehausen	B	44.23
Burghausen-Rueckmarsdorf	B	32.30
Grosspoesna	A	10.10
Taucha	A	9.39
Markkleeberg	A	5.76
Schkeuditz	A	4.72
Luetzschena-Stahmeln	B	3.78
Naunhof	A	3.42
Engelsdorf	B	2.89
Boehlen	A	1.99
Machern	A	1.80
Markranstaedt	A	1.47
Pegau	A	1.38
Zwenkau	A	1.35
Belgershain	A	1.20
Brandis	A	0.95
Jesewitz	A	0.70
Moelkau	B	0.67
Holzhausen	B	0.55
Lindenthal	B	0.37
Boehlitz-Ehrenberg	B	0.30
Borsdorf	A	0.28
Locations: A = Municipalities adjacent to Leipzig; B = Towns and villages incorporated into Leipzig since 1990		
Data: Statistisches Landesamt Sachsen; Industrie- und Handelskammer Leipzig (2002); own calculations (cf. Nuissl/Rink 2004).		

(c) Space for industry and services

Suburbanisation processes in the production sector started in 1991, when huge commercial and industrial zones were permitted throughout eastern Germany in anticipation of high growth rates due to a need to catch up, an ‘eastern boom’ attitude and reconstruction subsidies under the Aufbau Ost-programme. In Leipzig, industrial suburbanisation, despite having started after retail suburbanisation, began to stagnate at a relatively low level (30–200ha per year) in 1994 (1991: 600ha; 1992: 1,100ha, 1993: 600ha; 1994: 200ha) (cf. Herfert/Röhl 2001: 155f). All in all, ‘only’ 45% of the industrial zones permitted between 1990 and 2000 in the Leipzig region (> 7,000ha) were situated on the fringes (ibid.).

Industrial suburbanisation has been re-accelerating in recent years, with car plants being built for Porsche and BMW along with other sites still under construction (but not yet needed) as well as leisure and transport facilities. In 2000 alone, Porsche to the north accounted for 270 ha, the new runway at Leipzig–Halle Airport for 420 ha, and the Belantis leisure park to the south for about 130ha. With BMW alone having caused the additional dedication of 350 ha land for industrial use in 2002, industrial suburbanisation seems to regain drive and is bursting through the old ‘boundary’ of Leipzig’s development, the motorway(s) – for both the BMW plant and the new runway are situated north of the motorway. Hence the traditional border for industrial development in the north has been shifted. However, it is not just the major investments that are leading to a re-acceleration of industrial suburbanisation, but also the ongoing planning for the presupposed need for commercial estates **and enterprise zones**.

Table 16: Industrial sites (*GE Flächen*) actually available (or in planning) with year of permission/development. Permission from 1990 to 2002

Site/commercial estate	Size	Location*
GE Torgauer Str.	65 ha net	C
GE Nordost	67 ha net	C
GE Baalsdorf	13,5 ha net	B
GE Alte Messe	500.000 sqm (50ha) overall; 115.000 sqm net (old buildings)	C
GE Weidenweg	48 ha net	B
GE Breitenfeld Ost	21.4 ha net	B
GE GVZ	Overall size 250 ha; 150 ha net; extension site 100 ha	B
GE Althen	28.5 ha net	B
GE Böhlitz-Ehrenberg	10 ha net	B
GE Stahmeln	47 ha net	B
BMW site	230 ha net + 120 ha for suppliers	B
Total	600.4ha (950.4ha incl. BMW); of which 435.4ha (BMW and suppliers: + 350 ha = 785 ha) on the outer fringe	
*Locations: B = Towns and villages incorporated into Leipzig since 1990, C = Leipzig in its borders of 1990.		
Source: Stadt Leipzig (www.leipzig.de).		

In addition, in the early 1990s large office complexes were built in Leipzig and on the fringes, mainly near the motorways north and west of the city, e.g. Fuggerpark with 11,000 sqm of office space. Within a few years, the volume of office space had almost doubled, from about 1.5 million sqm in 1991 to 3.3 million sqm in 2002. Due to the huge surplus on the market, attractive office space is available relatively inexpensively in the centre and nearby, but nevertheless suffers from vacancy rates of 15–25%.

Table 17: Office space in Leipzig

	2000	2001	2002	2003
Vacancy of office space (in sqm)	800,000	770,000	760,000	755,000
Quota of vacancy (in %)	24.0	23.3	23.0	22.7
Stock of office space (Mio sqm)	-	-	3,3	-
<i>Source: Aengevelt-Research (2004).</i>				

In recent years, vacancies have shifted from the city centre to the fringes. With inner-city office space becoming more popular and less expensive since 2000, peripheral sites have had to cope with vacancies rising to 50% or even more (with the exception of the industrial and service complex between the airport and the Leipzig Fair in the north).

(e) Land for transport purposes

Another kind of (public) land that has been increasing in the last years is land used for transport – the increase of which is also an indicator of changing mobility patterns (see Chapter 3). This operationalisation implies the assumption that the provision of new traffic infrastructure should normally meet demand (or create new demand). But it is an elegant way to measure changes in mobility patterns because both detailed and general data are available. The share of land designated for transport use has indeed increased tremendously since 1990, especially since the incorporation of suburban municipalities in 1999 – giving evidence that suburban, and less dense, structures certainly need more space for traffic.

Table 18: Share of transport and communication zones in Leipzig

	1993	1995	2004
Share of land used for transport	3.3%	3,2%	6.4%
<i>Source: Stadt Leipzig (1993b): 10; Stadt Leipzig (1995): 7; Stadt Leipzig (2004): 5.</i>			

Then again, these data are not hard and fast because the growth in the share of land designated for transport use is also due to the delayed modernisation of the transport infrastructure.

08. Land prices and the housing market

Suburbanisation and urban sprawl generally lead to growing supply on the markets for urban land and housing which, in principle, means the moderation of prices on these markets. In reality, however, this effect is rarely visible. The main reason is that urban sprawl itself is mostly a result of growth, i.e. rising prices on the land and housing markets initiating investment in new developments. Moreover, urban sprawl may prompt land speculation concerning the agricultural land on the urban fringes which hasn't yet been changed into urban land. In addition, the land market and in particular the housing market are usually highly segmented, and so prices in the same region vary highly. The effects of urban sprawl are thus typically limited to certain – upper – market segments. In a situation without growth such as in the Leipzig region, however, urban sprawl can be expected to exert a pronounced calmative effect on the housing and land market.

As is always the case with market developments, associating the recent changes in the prices of land and housing in the Leipzig region with particular developments is speculative. However, by and large we can observe decreasing prices and, at least as far as the housing market is concerned, there is no doubt that the huge oversupply in housing created by the simultaneity of urban restructuring and urban sprawl (cf. Nuissl/Rink 2003) have largely contributed to this development.

(a) Rents

Prior to 1990, there was no free housing market in the Leipzig region but instead a regulated system of housing. Subsequently, during the course of post-socialist transformation, several institutional precautions were taken to protect the housing market from being immediately opened up. For the existing housing stock (but not for new developments), rents remained under legal control in the early 1990s and were raised gradually. In addition, the vast majority of the housing stock remained in the ownership of a few (partly municipal) housing associations. Thus, for several years a comparatively small 'private' segment of the housing market with high rents existed alongside the more regulated majority of this market. In the mid-1990s for instance, rents for a suburban apartment were as high as for a modernised flat in the inner city.

In the meantime, the regulation of the housing market⁴ has ceased while the growing supply of suburban dwellings (together with efforts in urban regeneration and population decline) has reversed the housing shortage. At present there are more than 50,000 empty dwellings available for rent in the city of Leipzig alone, accounting for around 15% of the city's housing stock. Consequently, a kind of 'over-relaxed' housing market has developed: in the upper market segment rents have decreased tremendously and even the big housing associations have had to adapt rents to the moderate level of the market. Note, however, that this effect hasn't 'reached' the lower segments in the housing market, where prices have slightly increased (cf. Steinführer 2002) (albeit at a very moderate level compared to other European cities) (Table 19).

Table 19: Average rents in different types of dwellings in Leipzig in 1998, 1999, 2001⁵

	Average rents per sqm in DM (median)		
	1998	1999	2001
Built since 1993	15.08	13.00	12.15
Built before 1919 – good standard	12.35	10.99	10.00
Built 1919–1945 – good standard	11.83	10.10	9.50
Built 1961–1991 – good standard	8.62	8.79	8.91
Built 1961–1992 – average standard	6.32	6.81	7.65
Built 1961–1992 – low standard	5.57	5.83	6.15

Source: Stadt Leipzig (2002b): 4 (according to the 'Mietspiegel' guide to rent levels for the city of Leipzig).

Strikingly, the differences between different segments of the housing market (as to both standard and location of dwellings) are becoming deeper not only in the inner city but also in the suburban realm. Especially the less attractive residential areas suffer from high rates of vacancy. In some places signs of the social decay of even new suburban housing estates can be observed (Herfert 2000). Thus, urban sprawl has helped to somewhat spoil the housing market (from the investors' point view) – an unintended side-effect of the efforts to gear rent-seeking money (from western Germany) to the east German housing market.

(b) Land and house prices

As is to be expected in a situation of urban sprawl without growth, there have been no signs of land speculation on the urban fringes in the Leipzig region. Instead, prices for urban land and

⁴ For the first ten years after unification, the increase of rents for dwellings rented out under GDR law had been restricted (*Mietpreisbindung*).

⁵ There are no data on average rents before 1997. This is mainly due to the fact that then the housing market was for the most part still regulated. However, analysis of advertisements for rented flats in the local newspaper indicates that in the 1990s rents for modernised flats were at least as high as in 1997, in fact mostly higher (cf. Heydenreich 2000; Steinführer 2002).

real property have fallen over the past few years. Prices for both refurbished apartments in the inner city and detached family houses in suburban areas have decreased by around 10% since the late 1990s. However, this reduction has been less pronounced than has been the case with rented housing. Only non-refurbished tenements in former working class areas have become much cheaper – but these buildings are hardly marketable at the moment anyway, and sales in this segment are few and far between (cf. Stadt Leipzig 2000c). The land market shows a similar pattern with only a slight reduction in prices (cf. Nuissl/Rink 2003: Table 9). Then again, as the number of land and real property transactions has dropped sharply, the relative stability of prices since the 1990s seems to indicate the hopefulness of many property owners rather than the actual value of their property. This is especially apparent when families who achieved their ‘suburban dream’ in the 1990s are forced to sell their homes (for instance due to unemployment or divorce) and frequently fail to realise the price they paid in the first place. On the whole, in some areas prices can be expected to drop further in the future, whereas in others, especially in the former middle-class areas in the inner city, they look set to at least remain at their current level.

09. Local tax revenue

Suburban municipalities benefiting from the influx of inhabitants and business in terms of tax revenue is a typical feature of urban sprawl. Analysis of local tax revenue per capita in the urban region of Leipzig, however, reveals no direct correlation between growth and tax revenue. In fact, many of the local authorities which have grown the most since 1990 show a ‘poor’ performance regarding their tax income. (Note that Table 20 indicates the pure tax revenue of local authorities and doesn’t say anything about the costs incurred by a municipality due to growth). Rackwitz, for instance, actually suffered negative tax revenue despite hosting the development of a new enterprise zone which attracted a number of firms.

Table 20: Local tax revenues (*Steuereinnahmekraft je Gemeinde*) 2001

Municipality	Population 2001	Change in Pop. 1997–2001 (%)	Local tax revenue 2001 (€)	Local tax revenue '01 per capita (€Cent)
Belgershain	3,575	+6.1	901	25,20
Brandis	9,905	+7.1	5,168	52,18
Borsdorf	8,060	+5.2	2,052	25,46
Naunhof	8,851	+7.6	1,992	22,51
Machern	6,710	+4.8	3,566	53,14
Grosslehna	2,517	+7.7	930	36,95
Zwenkau	8,982	+2.0	3,166	35,25
Markranstaedt	13,167	+11.2	5,136	39,01
Kitzen	2,154	+0.5	455	21,12
Pegau	4,963	-5.1	1,193	24,04
Markleeberg	23,087	+3.7	7,854	34,02
Boehlen	7,214	-9.2	2,169	30,07
Roetha	4,050	+5.5	1,544	38,12
Grosspoesna	5,462	+10.6	1,816	33,25
Espenhain	2,819	+0.8	1,453	51,54
Jesewitz	3,135	+8.9	888	28,33
Krostitz	4,110	+5.3	2,134	51,92
Taucha	14,706	+2.6	5,319	36,17
Rackwitz	3,281	-5.8	-337	-10,27
Zschortau	2,324	+0.6	750	32,27
Zwochau	1,166	+8.2	818	70,15
Wiedemar	2,327	+3.7	1,820	7,82
Schkeuditz	19,027	-1.9	10,466	55,01
Leipzig	493,052	-1.7	220,413	44,70

Data: Statistisches Landesamt Sachsen.

Generally speaking, local tax revenue appears to be only weakly linked to processes of urban sprawl.

SOCIAL

Urban sprawl is blamed not only for its environmental impacts but also for negative social repercussions. Although in the literature social segregation is discussed as the most important of these social consequences, the separation of functions such as housing, working and shopping and the loss of social cohesion also figure in the debate on the social impact of sprawl. Furthermore, the disintegration of different types of land use is among the main 'traits' associated with sprawl.

10. Spatial segregation

(a) Spatial separation of functions

In the Leipzig region, the process of urban sprawl in the 1990s was tantamount to a fundamental reorganisation of functional-spatial patterns, i.e. how residential and commercial land uses are distributed. However, the allocation and relocation of facilities in suburbia was only partly responsible for this development. Another major reason was that economic transformation deprived Leipzig, which used to be a very mixed city with a strong industrial base, of almost all its industrial workplaces. Huge areas of mixed neighbourhoods (built in the late 19th and early 20th centuries) are now completely dominated by residential use and often include vast brownlands. The city centre and also some more peripheral estates (such as the new Leipzig Fair exhibition centre) have become ‘hotspots’ of the service sector, whilst at the urban fringe (in particular to the north-east and north-west), a new, albeit much smaller ‘industrial face’ of Leipzig has re-emerged. However, although the inner-city districts have clearly undergone a process of functional ‘de-mixing’, at a regional level the separation of functions is still moderate. Yet since we are unaware of any attempt to provide a (quantitative) account of this separation, assessing the process of functional-spatial development more precisely is difficult.

(b) Spatial separation of social strata

Residential suburbanisation and, accordingly, urban sprawl is regarded as a major reason for social segregation because – roughly speaking – it is usually tantamount to people with the necessary wherewithal moving out of the city, leaving the less affluent behind. In the Leipzig region, however, this characteristic feature of urban sprawl is far less pronounced than is usually assumed to be the case in the literature (e.g. Jackson 1985). The main reason for this specificity is probably the high proportion of apartment blocks that have been built in the course of recent urban sprawl, in contrast to the detached or semi-detached homes that ‘traditionally’ dominate suburbia. Only more recently these apartment blocks have been adequately complemented by a similar quantity of ‘traditional’ suburban single family housing (Herfert/Röhl 2001). In correspondence to these two housing types we find a kind of dichotomous residential suburbanisation. The inhabitants of the suburban apartment houses are fairly mixed in terms of both their socio-economic status and their demography. They in particular have helped the suburban zone to gain population from the urban core in all demographic groups – i.e. including single-person households and elderly people, who wouldn’t normally be conceived of as ‘typical suburbanites’ – although young couples aged 25–34 are clearly over-

represented. By contrast, as to the privately owned, suburban single-family homes, we observe the demographic structure to be expected, with families with one or two children (i.e. the 5–15 and 30–45 age groups), higher education and above-average income prevailing (Herfert 1996: 36; 1997: 25; Herfert/Röhl 2001).

The mixed demographic structure of Leipzigers who have recently become ‘suburbanites’ does not back up the common assumption of increasing social (-spatial) polarisation in the course of suburbanisation and urban sprawl (cf. Herfert 1997). This is also apparent for instance in the labour market figures in Table 21; although unemployment is higher in the core city than in suburbia, the difference is by no means remarkable and is in fact negligible compared to the ‘intra-suburban’ variances. (Note that the share of people capable of gainful employment is generally lower in suburbia due to the higher proportion of large households, i.e. families.) Among the various areas in ‘suburbia’, the number of unemployed per 1,000 inhabitants is 68–109 (compared to as few as 30 in some recently incorporated parts of Leipzig!), indicating some kind of small scale-segregation, although not along the dividing line between the city and suburbia. However, the extreme relaxation of the housing market in the course of urban sprawl has arguably accelerated the emergence of this pattern (cf. Wiest/Hill 2004).

Table 21: The labour market in the Leipzig region (2001)

	Employees per 1000 inhabitants	Unemployed persons per 1000 inhabitants
Municipalities adjacent to Leipzig (‘suburbia’)	330 (150–680)	80 (68–109)
Leipzig (in its current limits)	410	88

Data: Statistisches Landesamt Sachsen; Stadt Leipzig, Amt für Statistik und Wahlen; own calculations.

At the upper end of the housing market, the massive increase in the housing supply could of course be judged to be a remedy for socio-spatial polarisation because the low level of rents usually also allows the less well-off to stay in the more attractive and more affluent parts of Leipzig whose social structure is (still) fairly mixed. However, at the ‘other end’ of the market, the result is a situation in which only the most disadvantaged social strata remain in the less attractive parts of the city. In these areas, mainly in the (outer) west or east of the city, accelerating dynamics of erosion can be observed, the most visible sign of which is a high number of vacant buildings (i.e. ruins) and the cutback of infrastructure facilities (schools, shops, services and municipal offices, etc) due to the lack of uptake (i.e. consumers) – to the further detriment of local attractiveness. At the same time, the image of the areas concerned

has deteriorated. Moreover, the long-expected stigmatisation of large housing estates and an increasing trend of middle-class strata to leave these estates have recently begun. Thus, these estates contribute disproportionately to the current migration from Leipzig to both 'suburbia' and the refurbished areas in the inner city. Nonetheless, the dynamics of socio-spatial differentiation in the urban region of Leipzig are still on the whole more moderate than in the urban regions of western Germany, even though they undeniably exist.

11. Urbanisation of the countryside and the deterioration of landscapes

Urban sprawl leads to a change in the visual and aesthetic appearance of the outer fringes. The main trends are (a) processes of the urbanisation of the countryside and (b) a deterioration of ancient landscapes.

(a) In some areas, residential suburbanisation has led to the tremendous demographic growth of towns and villages around Leipzig. This brings about the problem of integrating new inhabitants, whose number sometimes exceeds the former population. Little has been done to investigate this problem. However, in a study from the mid-1990s some evidence was gathered that most new residential areas are not only somehow disconnected from the suburban realm's older settlement structures in terms of morphology, but that they are also at best weakly integrated into the local milieu in terms of social life (cf. Empirica 1996). Often there's hardly any contact between their residents and people who have been living in a respective place for long. This, of course, is a problem that typically occurs in the course of urban sprawl (e.g. Matthiesen 2002) and is evidently more pronounced in the surroundings of big cities such as Berlin, Rome and Moscow. In the Leipzig case, however, the suddenness of urban sprawl as well as the rather particular architectural appearance of many new housing estates may pose particular difficulties for overcoming this problem. And while there has been an obvious process of urbanisation of the countryside, we can also observe processes of the 'countryfication' or 'suburbanisation' of inner-city districts, with the lowering of densities and greening of open spaces in the ancient core districts. These trends are discussed in the next chapter.

(b) The vigorous urban sprawl of the 1990s has changed the appearance of the Leipzig region considerably. The urban fringe has been extended outwards and a 'typical suburban mixture' has emerged. Large amounts of agricultural and also mining land have been used for housing, production, retail and leisure purposes. In fact, the changes in visual appearance are perva-

sive: huge retail facilities, residential estates, highway interchanges, enterprise zones, large petrol stations and drive-ins have sprung up that were totally unknown before 1990. The surroundings of Leipzig, formerly dominated by agricultural use, have been put to alternative use (see Chapter 1), sealed (see Chapter 2), and now offer large amounts of space for every purpose (see Chapter 7). This development, however, is hardly perceived as the deterioration of the landscape since the immediate surroundings of Leipzig have since long been almost devoid of 'valuable' natural or semi-natural countryside. Instead, intensive farming has long been practised there, resulting in a rather monotonous landscape (in an area with almost no relief), along with open-cast mining. Consequently, the landscape around Leipzig is mostly regarded as being fairly unsightly. The changes resulting from the recent transformation processes are hence usually positively perceived as signs of the region's upturn – especially with the flooding of mining pits creating new recreation zones.

12. Deterioration of the inner city

Urban sprawl is usually blamed for leading to the decline of the inner city. The situation in Leipzig, however, does not neatly fit into this diagnosis. The inner city of Leipzig has undergone rather positive development since the mid-1990s. Huge parts of the housing stock have been refurbished and entire quarters have seen a revival and were rediscovered as attractive areas to live in. A similar change has taken place with respect to the retail sector in the city centre: whilst in the early 1990s city-centre retail suffered severely from the new competitors on the urban fringe, new investments have greatly enhanced the city centre's attractiveness in terms of shopping. However, large sections of Leipzig's 'outer inner city' (especially west and east of the city centre) appear not to be taking part in this kind of 'post-socialist' re-urbanisation. There, large parts of the housing stock are dilapidated and the huge industrial sites characteristic for these quarters have almost entirely become brownfields covered by ruins. All this would probably have happened without any kind of urban sprawl, too, albeit to a lesser extent. Urban sprawl has aggravated the problem of decline by contributing to an oversupply on the regional housing and office market, making the less attractive locations even more negligible.

Correspondingly, the under-utilisation of the municipal infrastructure in the old city has become one of the major problems for Leipzig City Council (see Chapter 6a). Depopulation in many parts of the city is the most important cause of decreased infrastructure usage, and resi-

dential suburbanisation has largely contributed to the loss of inhabitants in general and the low birth rate in the inner city in particular. Consequently, first preschool facilities, then elementary schools and finally middle schools and high schools have been closed. The 'catchment area' of many of the remaining schools has therefore considerably increased and the distance that children must commute to school has similarly grown. Because of the selective departure of families with children, in certain suburban areas schools and kindergartens have had to expand or even be established from scratch. Since no new use has normally been found for the closed schools in the inner city, the buildings have remained empty and the local authorities continue to pay for their upkeep. Similar problems surround the municipal libraries in Leipzig. At the time of German unification, there were 30 such public libraries in the inner city districts, 17 of which have been closed or merged so far, while four more libraries are due to close down in 2005. Here again, the departure of residents caused by urban sprawl is only one reason. Library usage has also declined because of the introduction of a usage fee, the reduced supply of the libraries with new books, and changes in cultural interests (such as a sharp increase in the use of the internet, computer games and videos). The library closures currently planned have been necessitated by cuts to the public arts budget. Other examples of the reduction of the municipal infrastructure include the closure of all the district offices of Leipzig City Council in 1997/98.

13. Reaction of local and regional government to urban sprawl

Whereas urban sprawl was regarded as a problem of minor importance (if it was regarded as a problem at all) in eastern Germany in the first half of the 1990s, various attempts have been made to contain it. The federal states and their planning institutions, regional planning boards and some local authorities, primarily the big cities, are now trying to combat sprawl.⁶ The catastrophic freak flooding in 2002 raised public awareness of the problems related to land-use change. However, what remains is a latent conflict between the idea of sustainable land use and pro-sprawl interests which are still powerful in some suburban municipalities (and which are sometimes supported by other public authorities). For instance, hot debate is now raging between Güntersdorf, the fairly small municipality about 15 km away from Leipzig in

⁶ One reason behind the territorial reform act in Saxony, under which the city of Leipzig was able to almost double its area by the turn of the millennium, was to enable the core cities to better control the exuberant land-use change in their (former) surroundings. Thus, in a legal sense the problem of urban sprawl has at least partly been made up for since many residential and enterprise zones as well as retail facilities in 'suburbia' have been 'recaptured' by the central city. (Incidentally, the recent reorganisation of local authorities creates enormous problems for the analysis of statistical data.)

the federal state of Saxony-Anhalt where Saale-Park had been established. The regional planning authorities and the district to which Güntersdorf belongs on the one hand, and Leipzig City Council and the planning authorities in the federal state of Saxony on the other concerning the modernisation and further enlargement of this mall. What's more, due to the difficult economic situation in eastern Germany, almost all local and regional decision-makers are prone to set aside their scruples to promote urban sprawl whenever there is the prospect of attractive industrial investment. This is apparent with the development of the BMW site to the north of Leipzig in an ecologically sensitive area, where the local authorities worked hard to quash any objections. In the near future, a similar development is likely to be observed in connection with the expansion of Leipzig-Halle Airport.

Conclusions

The above analysis of the ecological, economic and social consequences of sprawl in our research region demonstrates how difficult it is to prove the extent to which cause-effect relationships exist between urban sprawl and certain environmental, economic and social phenomena and processes – a problem that has been widely discussed in the literature on urban sprawl (e.g. Cieslewicz 2002). These difficulties primarily stem from the lack of accurate data on urban development and spatial patterns.

Firstly, there is a lack of representative data on for example petrol consumption, infrastructure investments and maintenance costs, traffic flows and so forth. Besides, existing data often lacks comparability because of changes in the data bases, i.e. the areas of reference.

Secondly, the data available do not differentiate between several causes or consequences which are important when considering urban sprawl. For example, it is not possible to measure e.g.

- the exact effect of sprawl on the pollution situation, because a distinction is not drawn between pollution caused by industry and by domestic households and so reductions due to deindustrialisation or shrinkage and increases due to urban sprawl cannot be identified;
- the share of transport within pollutants (with the exception of CO₂ emissions).

Thirdly, data on several aspects of sprawl are not sufficiently differentiated, e.g. statistics do not distinguish between:

- housing and transport areas (*Siedlungs- und Verkehrsfläche*)
- the amount of office and industrial space

- emissions by industry, housing and transport
- time spent working and that spent commuting
- time spent on housework and that spent on supply activities
- the use of hard and brown coal

Fourthly, in many cases no time-line data are available and so such analyses would have to be carried out from scratch – a task too time-consuming to be accomplished in this study for all aspects of urban sprawl. For example, time-lines on transport areas, on the development of car-ownership, and on the numbers and share of commuters had to be compiled ‘by hand’.

In addition, as repeatedly stated above, it is generally difficult to establish unambiguous relationships between processes of urban sprawl and particular phenomena that could clearly be identified as consequences of these processes. Attempts to ‘measure’ impacts and results of urban sprawl are typically subject to the danger of ‘ecological fallacy’, i.e. the danger of purporting causal interrelations where co-variation of different variables is observed. (In fact it seems that the kind of positivistic methodology prevailing in research into spatial developments tends to lead to somewhat speculative conclusions since it is always rather difficult to prove that observations of complex processes are causally interlinked. What we perceive as causes, patterns and consequences of urban sprawl is in fact dependent on our interpretation of the data.) This problem is more pronounced with some issues than others. It is usually possible to clearly establish (and sometimes also to quantify) the relationship between urban sprawl and environmental problems directly related to land-use change and sealing such as increased water runoff, changes in biodiversity and habitat fragmentation. However, when it comes to the more complex environmental effects of urban sprawl such as its contribution to climate change or its impact on global material flows, gathering empirical evidence becomes fairly tricky. The same holds for the – immaterial – consequences of urban sprawl on social and economic processes.

In the case of the Leipzig region examined here, an additional problem occurs: the interaction and intricacy of transformation, deindustrialisation, depopulation and urban sprawl make it particularly difficult to clearly delineate the research object of urban sprawl in order to identify its consequences. Since almost all parameters of urban development suddenly changed after unification, it is nearly impossible to attribute particular developments to urban sprawl as their sole reason. For instance, the enormous improvement in environmental quality in and around Leipzig has made increases in air pollution due to urban sprawl (e.g. rising CO₂ emissions) appear marginal. In view of the grave economic and social problems entailed by post-

socialist transformation, these new ecological impacts have been considered acceptable by both local politicians and the public. Another example is the pattern of socio-economic segregation of the population in the Leipzig region which, although partly a result of urban sprawl, is largely attributable to the deepening of social differentiation and inequality after German unification. On the whole, the influence of the transformation process in general can hardly be distinguished from the consequences of urban sprawl in particular.

The case of Leipzig is particularly instructive since it shows that urban sprawl can occur at the same time as urban shrinkage and is not necessarily caused by economic or population growth. In connection with this, the most obvious consequence of urban sprawl in the Leipzig region is probably its contribution to the abandonment of buildings, the sheer scale of which has only recently become clear. The decline of parts of the inner city is a direct result of the oversupply of space for housing, industry, services and retail on the urban fringes. It cannot be ruled out that the number of buildings destroyed in the inner city will equal that built in the process of urban sprawl. Thus, sprawl is directly responsible for the intense discussion of and research into the necessity and difficulty of urban restructuring in eastern Germany. However, when generally assessing the impact of urban sprawl in the Leipzig region, it should be noted that 'the amount of sprawl' in Leipzig, though rather impressive in places, is still moderate compared to North American cities and even most cities in western Germany, which have a much longer 'sprawl record'.

Given the simultaneity of urban sprawl and urban decline in the Leipzig region, further investigation into some aspects of urban development seems to be particularly important.

Firstly, urban sprawl in declining cities appears to bring about a particular kind of urban form with a somewhat 'perforated' structure of the inner city which may prove to be a burden in the future. On the other hand, the increase in vacant plots in the inner city may open up new opportunities to improve the environmental quality of urban spaces and thus to make the inner cities attractive places to live in (again). Although initial insights have been achieved into the emerging urban form of declining and sprawling cities (cf. Couch et al. 2005), more attention should be paid to this problem, which will become important to a growing number of cities in the industrialised world in the future.

Secondly, little is known about how socio-economic segregation in stagnating or shrinking but nevertheless spatially growing cities will develop in the future. Although the extent of segregation will arguably increase, more empirical evidence is required. Therefore, more so-

ciological studies on how suburbanisation changes the demographic structure of areas would be desirable.

Thirdly, even less is known about the (real) costs of urban sprawl (irrespective of whether a region is declining or growing) than on the relationship between sprawl and segregation. More expertise in economics seems to be needed to achieve a deeper insight into the overall consequences of urban sprawl. First of all, case studies on the actual costs land development causes in terms of (additional) infrastructure ought to be instructive to local decision-makers, who are often dazzled by the idea of extending the local tax base. Then, developing methods to calculate the hidden (often non-monetary) costs entailed by urban sprawl would be of further help. This research should also tackle the externalised costs of sprawl.

Finally, even though discussion among urban policy-makers and spatial planners on how urban sprawl can be steered and contained (i.e. what instruments can be used) has long been intense, we still do not know enough about this field. In shrinking regions in particular, the existing strategies and instruments of urban development and planning seem to be insufficient since they are largely geared to the organisation of growth. What's more, in other fields of policy apart from urban and regional development and planning, incentives are often set in favour of urban sprawl which outweighs potential efforts to bring sprawl under control. Eastern Germany has been a particularly good example of this problem (e.g. Nuissl/Rink 2005). Hence, the reform of legal, fiscal and planning instruments must be a central political 'consequence' regarding the regulation of sprawl.

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