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Project funded by the European Commission under the « Energy, Environment and Sustainable Development Programme » of the 5th Framework Programme, Key Action 4 : City of Tomorrow and Cultural Heritage



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Sprawling Cities And Transport: from Evaluation to Recommendations

Annex to D2 and D3 (Work packages 2 and 3)

Monographic report Case city Stuttgart

Contract number: EVK4-CT-2001-00063

Date: 15th October 2002
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1 OVERALL PRESENTATION OF THE CITY

1.1 Study Area

The case study Stuttgart covers the whole Stuttgart Region and is situated in the south-west of Germany. The Stuttgart Region exists of six state districts (Kreise, NUTS3) called Boeblingen, Esslingen, Goepfingen, Ludwigsburg, Rems-Murr and the City of Stuttgart with a total of 179 (Gemeinden, NUTS5) communities (Figure 1 and Figure 2). The overall population of the Stuttgart Region is about 2.6 million inhabitants. Together with its state capital, the City of Stuttgart, it represents the economic and cultural centre of the Federal State of Baden-Wuerttemberg. With an area of 3,700 km² this region is one of the most densely populated regions of Germany.

The Region of Stuttgart has only a few geomorphologic constraints (horseshoe-like hills of about 200m – 250m above the city centre level in the south). Therefore, the urban development is almost uniformly spread over the whole area. This is reflected in the location of many medium size and big communities (sub-centres) organised almost uniformly around the City of Stuttgart (see Figure 1). In summer often a high concentration of ozone and nitrogen oxides can be found.



Figure 1: Map of the Stuttgart Region (120 km x 80 km)

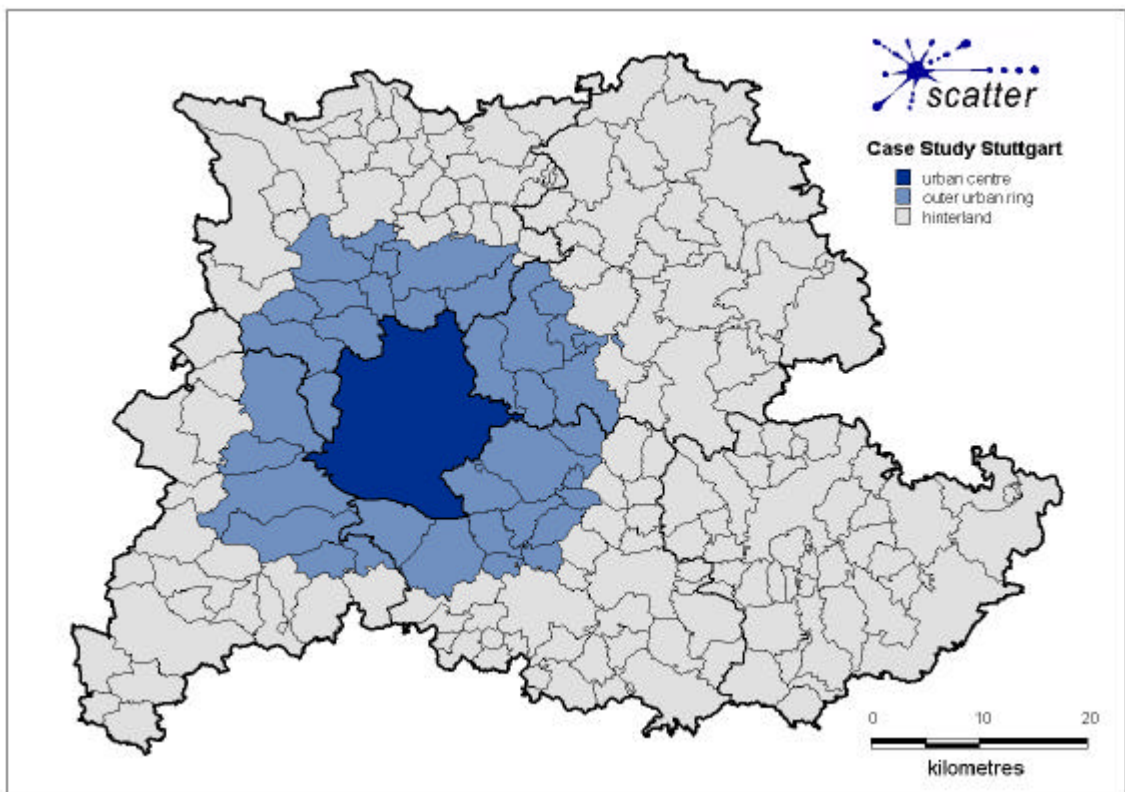


Figure 2: Definition of the urban centre, outer urban ring and hinterland of the case study Stuttgart

1.2 Population

There are about 584,000 inhabitants concentrated in the City of Stuttgart. This corresponds to 22% of the total population of the Stuttgart Region. Taking into account the adjacent communities within a small circle (about 15 km) around the centre of the City of Stuttgart (outer urban ring and urban centre) about 55% of the total population of the Stuttgart Region can be found.

Both the City of Stuttgart and its neighbouring communities are densely populated. The population density is depicted in Figure 3. In the Stuttgart Region the average population density counts 570 inhabitants per km². In the city centre there are about 2900 inhabitants per km², in the outer urban ring 1100 inhabitants per km², and only about 440 inhabitants per km² in the hinterland. The development of the population in the Stuttgart Region during the last few decades is characterised by a strong growth in the periphery (outer urban ring) of the City of Stuttgart (IHK 1990, 1991). In Figure 4 the development of the population numbers of the five state districts and of the total population of the Stuttgart Region between 1992 and 2003 are depicted¹. The total population of this metropolitan area has grown by about 3% since 1992, beside the enormous decrease in the scaled population of the City of Stuttgart of about 4.5%. Especially the neighbouring districts Boeblingen (7.1%), the Rems-Murr-Kreis (5.5%), and Ludwigsburg (5.0%) are gaining inhabitants, Esslingen (2.4%) and Goepfingen (2.9%) seem to follow the general trend (Haag 2002).

¹ Between 1992 and 1999 empirical data are presented, after 1999 forecasted population numbers are shown (STASA 2001).

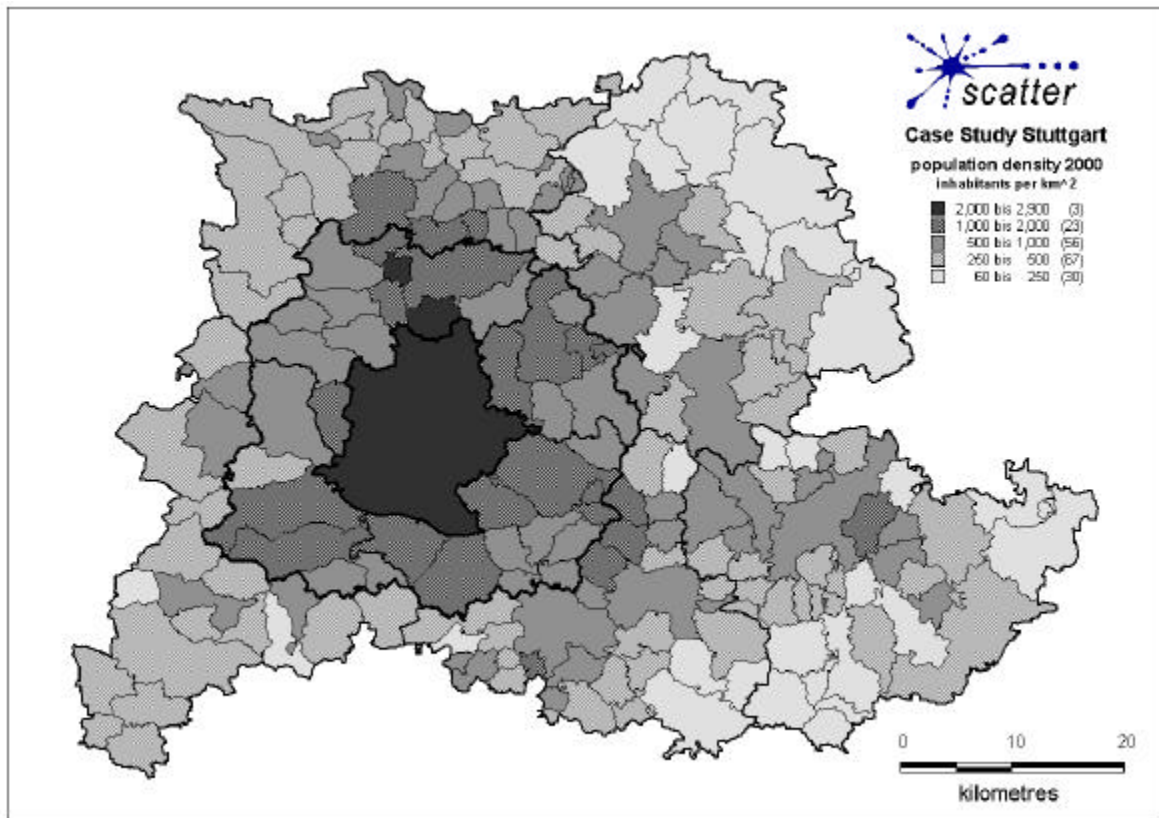


Figure 3: Population density of the case study Stuttgart (urban centre: 206 km², outer urban ring: 760 km² and hinterland: 2690 km²)

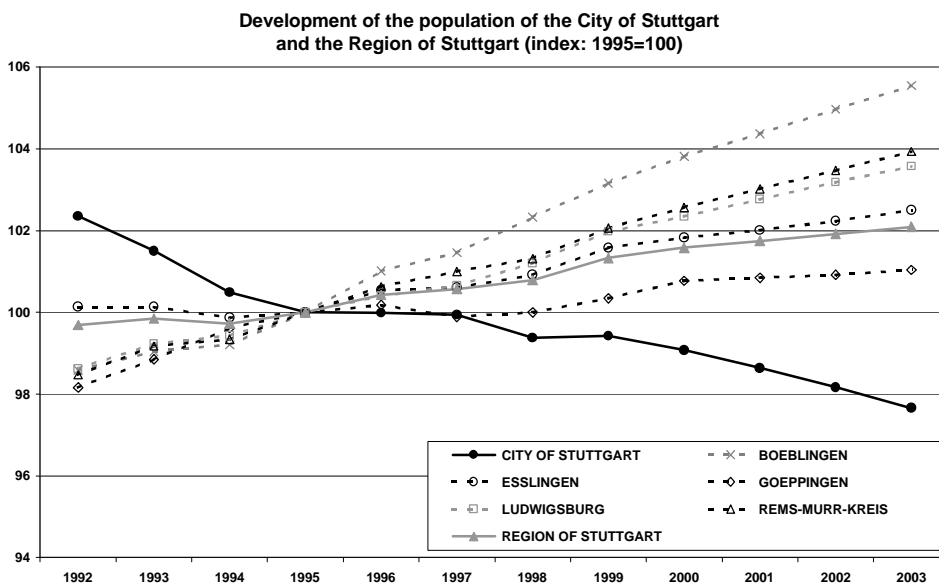


Figure 4: Development of the scaled population shares of the Stuttgart Region (Index: 1995=100)

In addition, an enormous growth in industrial and business zones took place in the peripheral zones, which, besides its traffic-generating impact on commuting and passenger transport in general, surely affects freight transport as well and has led to a dramatic increase in population and workplace redistribution.

1.3 Social Features

Increasing demand for available floor space led to a disproportionate enlargement of the settlement area and its corresponding land use. Forty years ago the available floor space per person was merely 26 m², in the year 2000 it was about 39 m². In addition the required areas for production and services expanded also dramatically. Both effects are still much stronger than population growth in this particular region. The result is a corresponding decrease of contiguous areas and a related increase of scattered areas (urban sprawl).

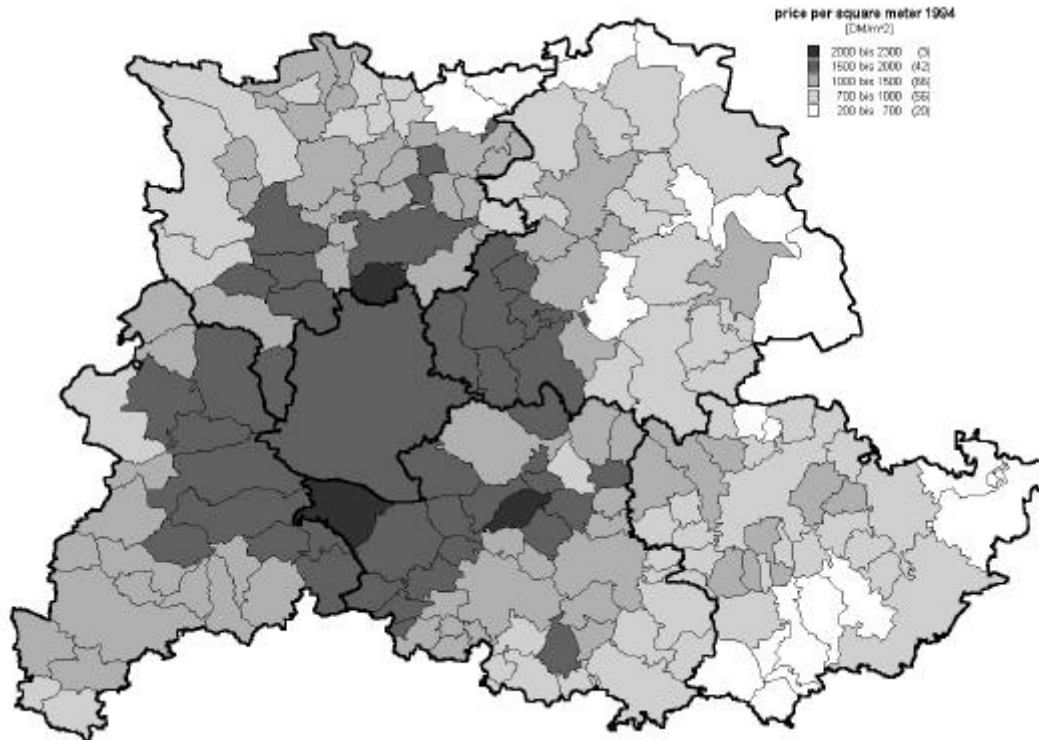


Figure 5: The distribution of land-prices per m² for the Stuttgart Region

1.4 Land Prices and Rents

In Figure 5 the distribution of land prices for the Stuttgart Region is depicted. After a period of population increase in the suburban ring due to strong out-migration processes from the City of Stuttgart, the land-prices in the suburbs (outer urban ring) increased dramatically. High rent can be found along the main transport axes north-east to south-west, along the motorway A81 and the primary roads B29, B14 and B10. Communities in the neighbourhood of the radial main transport axis exhibit a good accessibility and are favoured by firms in the location choice process. These communities are also attractive places of residence for individuals.

1.5 Economy

In the production sector an out-migration of enterprises from Stuttgart during the last decades can be found, mainly into the adjacent districts of the city (90% of all firms which fully changed their location, 100% of companies which opened an additional production place). This redistribution on the level of firms has led to corresponding shifts in the work place distribution. The chosen city-near shifts of firms indicate that not only the centre of Stuttgart did not lose its economical importance as a whole but also that firms are interested to be located close to the heart of the Stuttgart Region.

During the 1970s and 1980s the focus of manufacturing activity shifted from the City of Stuttgart to its surrounding communities. Also a growing population was accommodated in the suburban areas. This can be seen e.g. in the gap of attractiveness between the cities Heidelberg/Mannheim and the Rhine/Neckar-district, the urban districts of Karlsruhe and Heilbronn and the corresponding rural districts. Among the explaining factors of the observed gaps between urban and their closely linked rural districts, differences in the rent level and the prices of land must be mentioned, as well as the rather good accessibility of many urban centres, due to high investments in the transport infrastructure, especially in the radial elements of the transport network.

In 1995 the number of workplaces in the Stuttgart Region was about 1.34 million. In this year 513 workplaces were available to 1,000 inhabitants. It is worthwhile to emphasise that about 30% of the economic power of Baden-Wuerttemberg is concentrated in the region.

A long tradition of industrial manufacturing exists in the Stuttgart Region. The emphasis is given to export oriented branches like the car industry (yearly turn-over in 1994: € 2.4 billion), electrical equipment industry (yearly turn-over in 1994: € 7.1 billion) and mechanical engineering (yearly turn-over 1994: € 1.4 billion).

Modern manufacturers like DaimlerChrysler AG and Porsche in the car sector and firms like Siemens Nixdorf, IBM, Hewlett Packard and Kodak are concentrated in the City of Stuttgart and the outer urban ring as well as 100 different credit institutes and 133 publishing houses. Therefore, the Stuttgart Region belongs to one of the strongest economic regions in Germany. About 35% of the GRP (gross regional product) depends directly on export.

Research and development are important location factors of the Stuttgart Region. The City of Stuttgart houses two universities (University of Stuttgart with about 25,000 students, University of Hohenheim with about 15,000 students) as well as six academies and colleges and several non-university research centres like the German Aerospace Centre DLR, the Fraunhofer- and two Max-Planck-Institutes.

1.6 Transport

The Stuttgart Region represents an important traffic node within the Trans-European Network (TEN). As to the traffic infrastructure, network elements on all spatial levels are represented: in private vehicle traffic they range from city streets to motorways, and in public transport from city buses, light rail systems (S-Bahn) and subway system (U-Bahn) to high-speed trains (ICE). All modes are present: pedestrian, bicycle, bus, light rail transport, suburban rail, car, as well as intermodal transport opportunities like P&R (park-and-ride).

An important east-west link in the international traffic, namely the motorway A8, between Austria and France via Salzburg, Munich, Stuttgart and Karlsruhe exists. The motorway A81 is an important element in the Northern-Europe-Germany-Switzerland-Italy chain. The railway lines run in parallel to these links and connect the capital to the wider regions mainly by radial elements.

Due to urban and regional traffic, the motorway network around the City of Stuttgart is highly overcharged. The consequences are overloading (congestion) leading to serious obstructions in long-distance traffic, as well as high environmental pollution in the adjacent areas of the motorways.

The causes of the heavy regional traffic are suspected to be related to the interactions within the traffic system as well as with the settlement structure (SACTRA 1994,1998, Batty

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1970). There are a bundle of well constructed secondary roads connecting the City of Stuttgart with the sub-centres of the other five state districts of the Stuttgart Region. The interactions within the traffic system include traffic diversions from the secondary road network, as well as extensive diversions from parallel major roads. In addition, there are also possible diversions in public transport at the time of the installation of the S-Bahn.

The Stuttgart Region is served by an international airport located in the south of the City of Stuttgart. This airport is well connected to the region by the S-Bahn (light rail system S2, S3) and a junction to the motorway A8.

Currently 6 S-Bahn lines (light rail system) serve mainly the radial axes of commuting traffic directed towards the centre of Stuttgart. In addition those lines connect the ICE-link Mannheim-Munich, as well as the Stuttgart Airport through the city's central railway station. The existing lines are extremely overburdened in the peak hours - just like the parallel street network - although it still have potential capacity reserves.

In the Stuttgart Region there are about 1.6 million listed cars, leading to a car density in the total area in 2001 of 557 private cars per 1,000 inhabitants (653 vehicles per 1000 inhabitants). The road network of the Region of Stuttgart consists of approx. 150 Km motorways and about 3,400 Km of secondary roads.

2 STATISTICAL ANALYSIS

2.1 Development of the average growth rates

In Figure 6 the development of the (smoothed) average annual growth rates of population, the number of employees registered at the place of home, the number of dwellings and the number of residential buildings are depicted. Rather big economic cycles in almost all variables can be observed.

The development of growth rate of employment (employees registered at the workplace) reflects the economic business cycle of the Stuttgart Region with its strong dependence on the export activities. About 35% of the GRP (gross regional product) depends directly on export. After the recession in the early 80th, many new workplaces in the production sector have been installed. The big boom in employment² between the years 1984 and 1998, reached its climax in 1992.

The growth rate in population development shows a similar temporal behaviour as the growth rate of employment, but with a time delay of about 2 years. However, since the growth rate of population remains positive, even after the year 1992, the population number of the Stuttgart Region started to increase in 1984 for almost one decade. However, one has to take into account, that the increase in the growth rate of population between 1984 and 1994 is partially caused by huge migration flows starting in 1989 from the former East Germany (GDR) to West Germany (FRG) and in so far also to the Stuttgart Region, after the reunification of Germany.

The maximum in the growth rate of dwellings exhibits a much bigger time delay of about 6 to 8 years behind employment development, reflecting the planning, development and construction phase in building industry.

The development of new residential buildings shows a small but rather stable annual increase of about 1%. Because the total population of the Stuttgart Region was always increasing during the last twenty years, there was always a demand for new residential buildings. Therefore, the stable increase in the number of residential buildings reflects partially the idea of continuity in residential policy and planning.

² The climax in employment is in 1992, when the growth rate of employment becomes zero. The climax of the growth rate of employment, however, is in 1986/1987

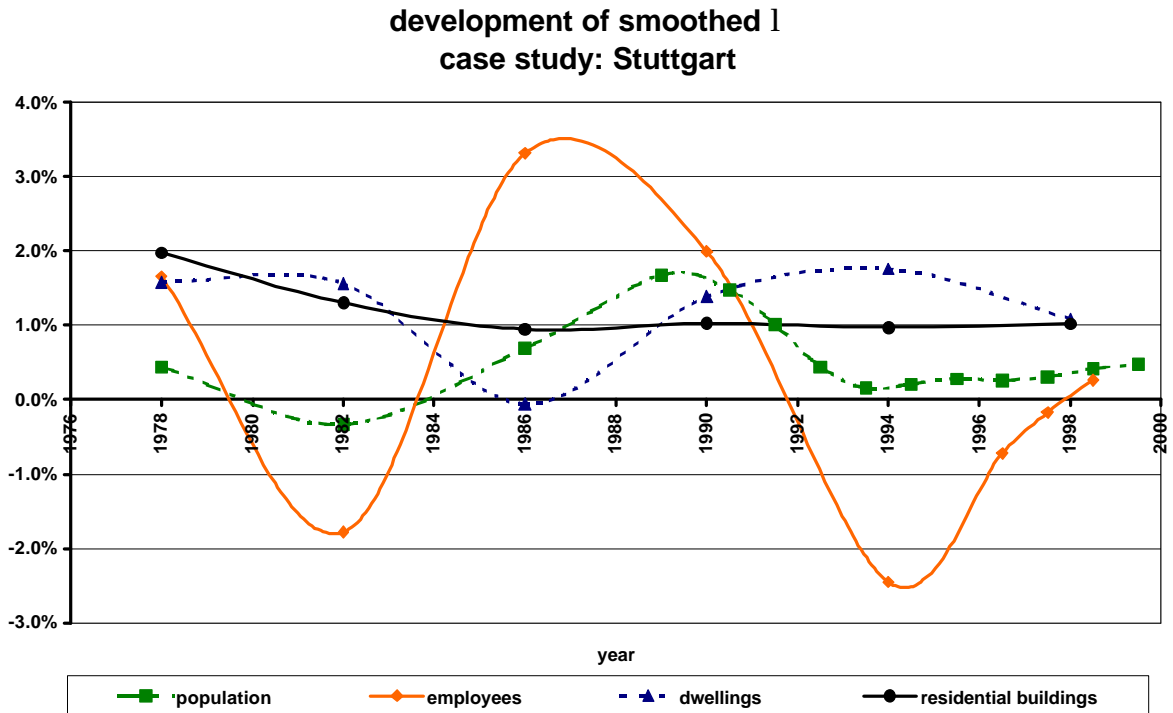


Figure 6: Average annual growth rate of $\tilde{I}^{population}(t)$, $\tilde{I}^{employees}(t)$, $\tilde{I}^{dwellings}(t)$ and $\tilde{I}^{buildings}(t)$

2.2 Development of the deviations from the average growth path

The development of the deviations from the average growth path \tilde{g} for the urban centre, the outer urban ring and the hinterland are depicted in Figure 7.

The deviations from the mean development of population (Figure 7 left above) $\tilde{g}^{population}(t)$ shows, that especially the hinterland areas are growing faster than the average over the Stuttgart Region, whereas the outer urban ring follows more or less the average population development and the urban centre lost population in relative as well as in absolute values. Only during the population boom between 1989 and 1992 (reunification boom) the population of the urban centre was increasing. This observation confirms the hypothesis of a process of decentralisation (of population) in the Stuttgart region during the past two decades.

With respect to employment (Figure 7 left below) a strong competition between the hinterland and the outer urban ring must be stated. It is also obvious, from this figure, that the number of workplaces of the urban centre was decreasing during the whole period under investigation.

The hinterland was less effected, by the recession of the early 80th and with a time delay, compared with the outer urban ring. In the following upswing of the economy the outer urban ring has profited at most. The temporal development $\tilde{g}^{employees}(t)$ of the hinterland behaves anti-cyclical to the average growth rate $\tilde{I}^{employees}(t)$ in contrast to the outer urban ring. This indicates that employment of the outer urban ring increases during an economic boom. During a recession phase the employment development of the hinterland behaves much more stable than in the urban centre and neighbouring communes.

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The deviations of the average growth rate of dwellings $\tilde{g}^{\text{dwellings}}(t)$ of the urban centre city follows directly the economic cycle, in contrary to the hinterland (Figure 7 right above), showing a competition between the urban centre and the hinterland. The development in the outer urban ring is dominated by the trend (average development).

Figure 7 (right below) shows that residential building activities of the urban centre are during the whole time period below average, follow the trend in the outer urban ring and are above average in the hinterland of Stuttgart. This also can be seen as a hint of decentralisation.

The temporal mean growth rates of $\tilde{g}^{\text{population}}(t)$, averaged over the period 1976 to 2000 on the level of communities is depicted in Figure 8. The spatial pattern indicates that the above average growing zones (communities) are scattered mainly over the hinterland of the Stuttgart Region. However, the urban centre and some adjacent communes which can be seen as strongly linked to the city of Stuttgart, via the transport network, have declined (are developing below average).

The same outcome yields Figure 9 with respect to average growth of employment development on the level of communities $\tilde{I}^{\text{employees}}(t)$ between 1976 and 2000.. Nevertheless, the patterns of Figure 8 and Figure 9 are not congruent. This can be seen as an indication of an ongoing specialization of the individual municipalities, referring to trade or industrial areas or living municipalities. The growing communes (above the average) are mainly situated along the main transport axes of the whole Stuttgart Region. In the urban centre and in old typical industrial communes an employment development below the average growth path can be identified.

All those indicators have shown, that the development of the urban centre lacks behind the average growth path, while the outer urban ring and the hinterland are mostly above the average growth path. Especially the spatial patterns of the temporal mean growth rates of employment and population over the last two decades are very scattered and show the main growth centres of the region. This can be seen as a hint for urban sprawl.

However, in order to demonstrate that urban sprawl exists in the Stuttgart Region and not only a scattered development of some socio-economic variables, one has to show that clear de-concentration effects in the study area exist. This will be done in the next subsection.

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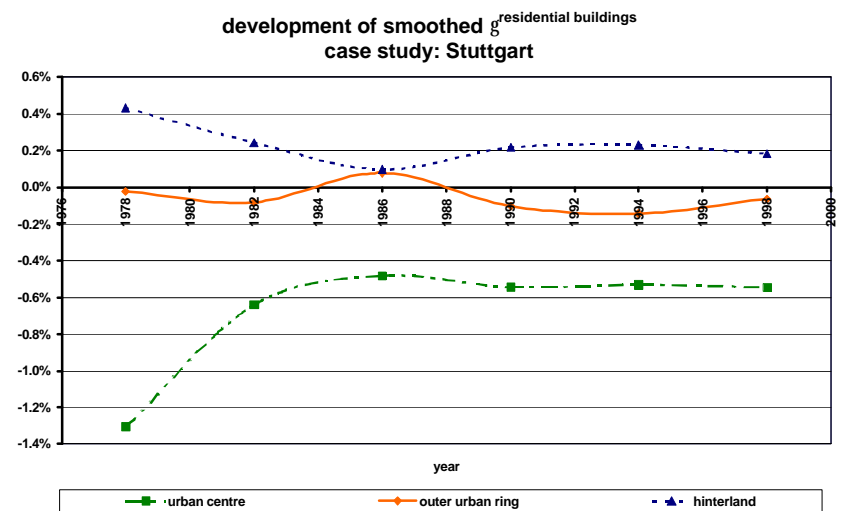
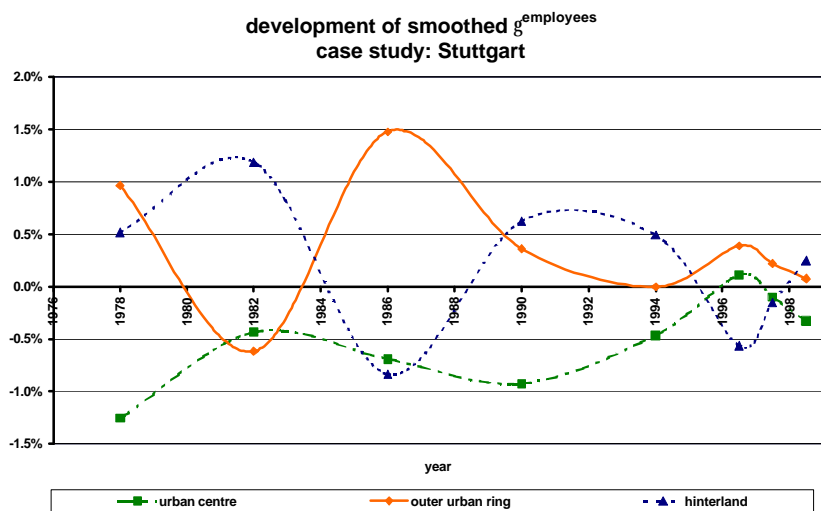
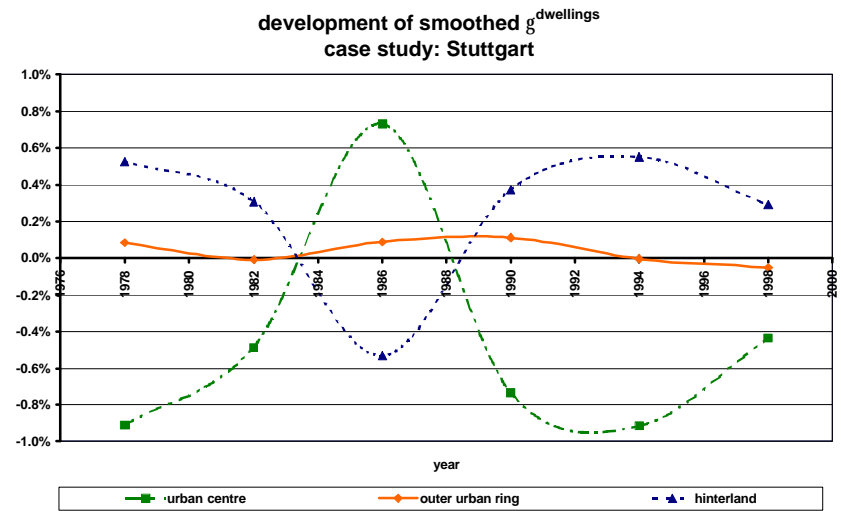
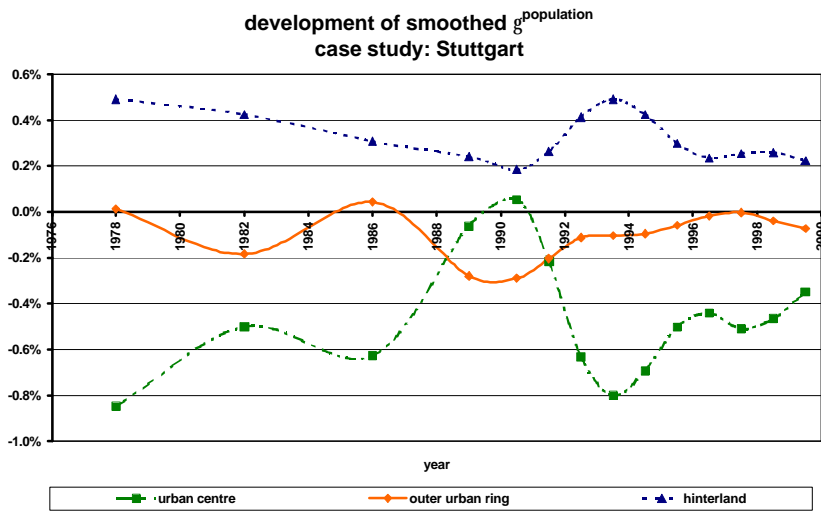


Figure 7: Annual deviations from the average growth rate $\tilde{g}^{population}(t)$, $\tilde{g}^{dwellings}(t)$, $\tilde{g}^{employees}(t)$ and $\tilde{g}^{buildings}(t)$

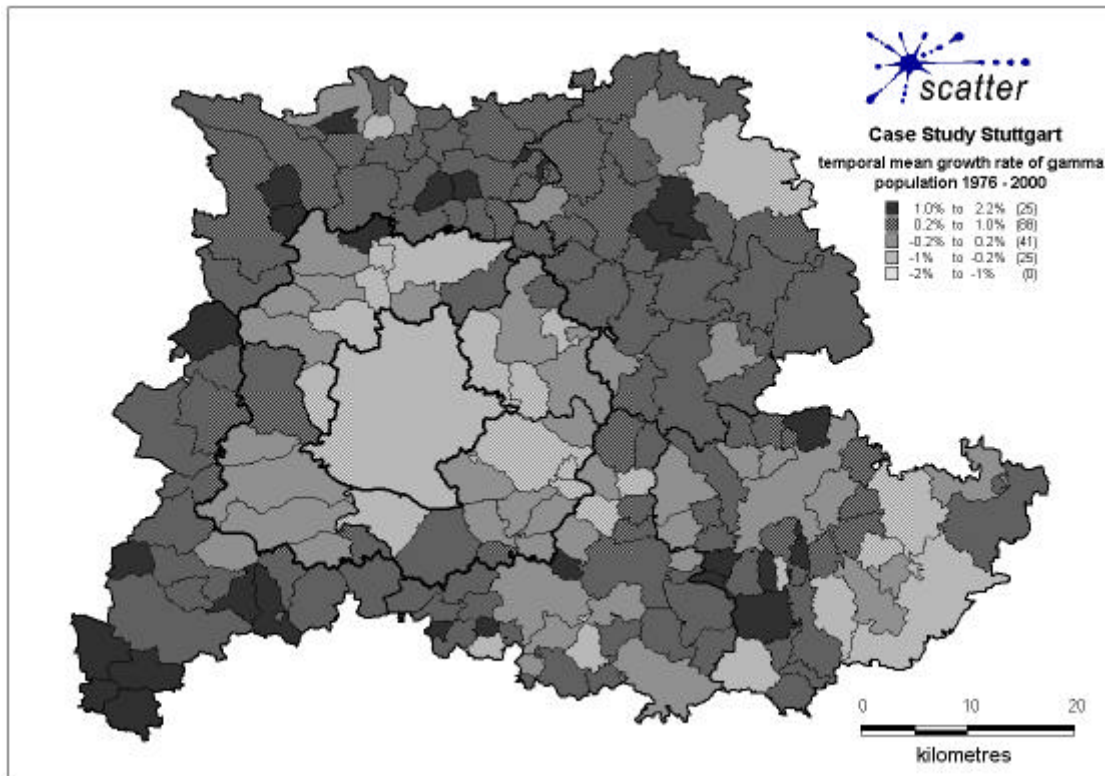


Figure 8: Spatial distribution of the temporal mean growth rate of $\tilde{g}^{\text{population}}$

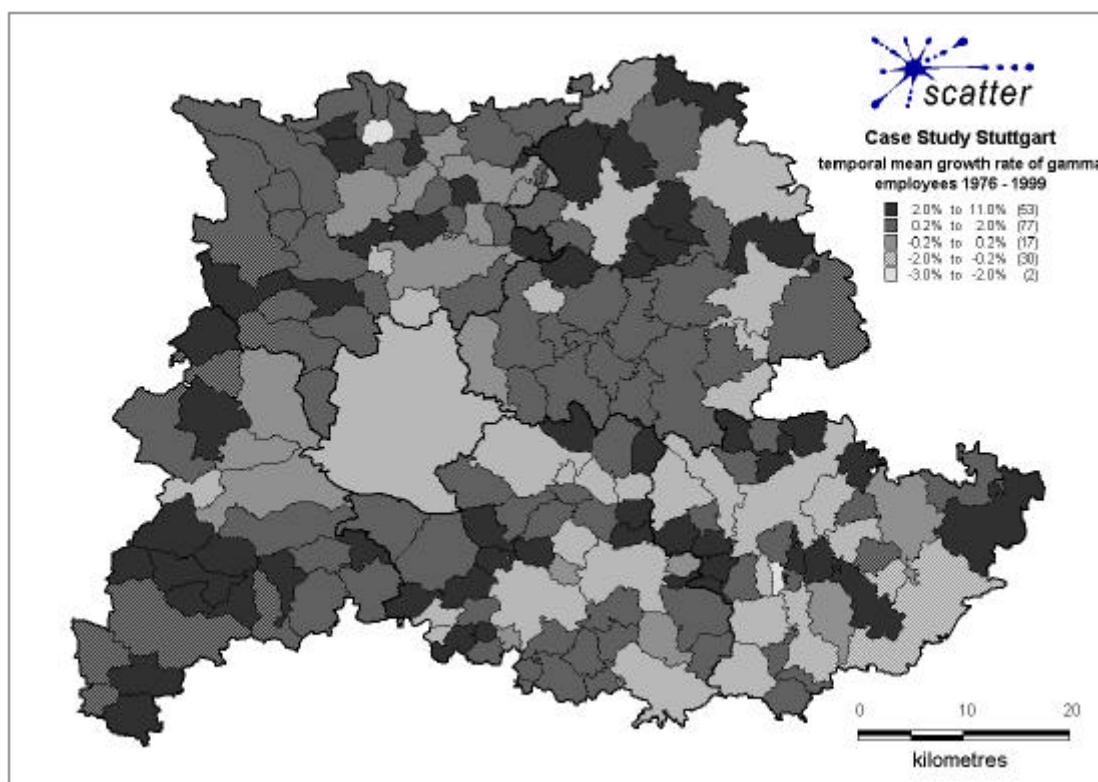


Figure 9 : Spatial distribution of the temporal mean growth rate of $\tilde{g}^{\text{employees}}$

2.3 Development of the concentration-measure H

From the definition (3-17) with (3-20), (3-21) it follows, that an increase in the relative concentration-measure H over time indicates, that the outer urban ring or the hinterland is growing in relative terms faster than the urban centre. For a constant relative concentration-measure H the development in space is homogeneous. Spatial concentration in the urban centre leads to a decrease in the relative concentration-measure H .

In Figure 10 the concentration-measure H^{rel} for the four variables population, employment, number of dwellings and number of residential buildings are shown. All data are scaled to the first year of the data set.

In the Stuttgart Region the temporal development of the relative H -measure of population $H^{\text{population}}(t)$ indicates an increasing de-concentration over the whole investigation period.

The relative concentration-measure H of employees $H^{\text{employees}}(t)$ indicates a growing tendency of concentration of employees in the outer urban ring and the hinterland between 1978 - 1984 and 1988 - 1996. Nevertheless a concentration of employees in the urban centre must be stated between 1984 - 1988 and for a short period of time between 1996 and 1998. However, in the long-run the de-concentration effect of work places dominates. It is worthwhile that the effect of population de-concentration is rather strong compared with the de-concentration effect of employees. The conclusion is that the urban centre is keeping its labour force unlike its population. As a consequence commuting and transport related emissions have increased and are still increasing.

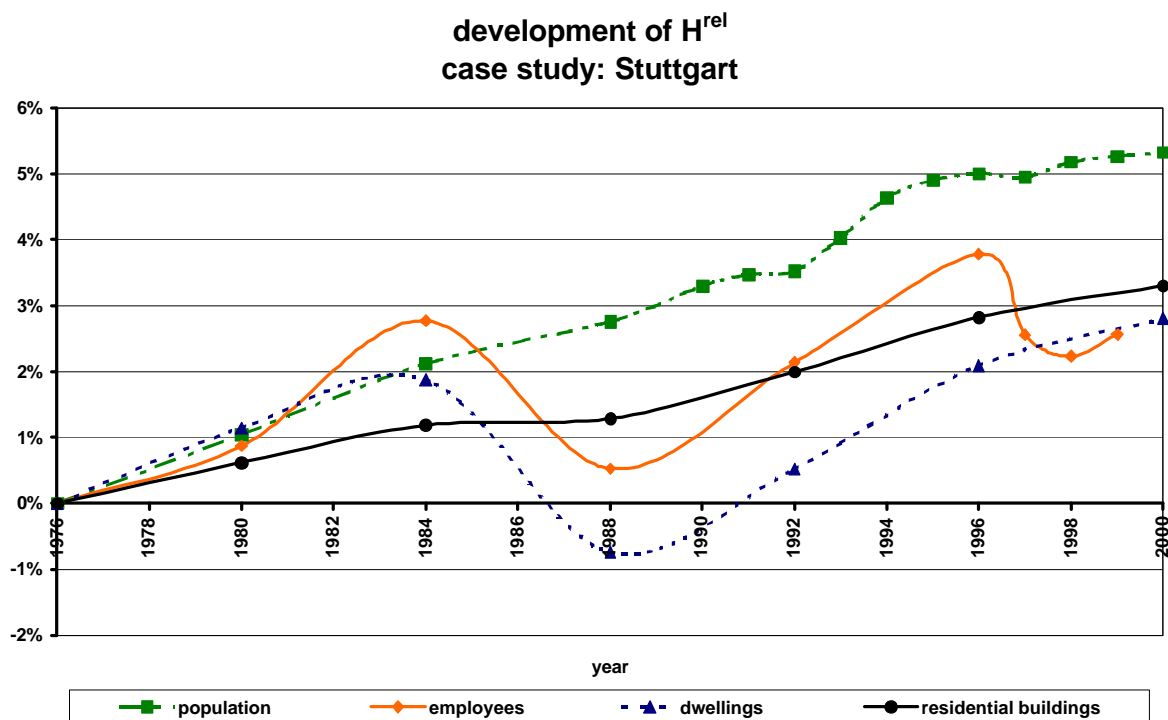


Figure 10: Development of the relative concentration measure $H^{\text{population}}(t)$, $H^{\text{dwellings}}(t)$, $H^{\text{employees}}(t)$ and $H^{\text{buildings}}(t)$

The relative concentration-measure H of residential building $H^{\text{buildings}}(t)$ show a stable effect of de-concentration, whereas the relative concentration-measure H of dwellings $H^{\text{dwellings}}(t)$ exhibit also a period of concentration of apartments closer to the city centre in 1984 – 1988, imbedded into a period of de-concentration. Workplaces and dwellings show a similar behaviour.

The conclusion is, that a spatial de-concentration effect of all variables (indicators) under investigation in the Stuttgart Region exist. Looking for spatial autocorrelations will conclude the statistical analysis of urban sprawl for the Stuttgart case study.

2.3 Development of global and local Moran I

The trajectories of global Moran's I of inhabitants per km^2 (population density), employees per km^2 (workplace density), dwellings per km^2 and residential buildings per km^2 , within the Stuttgart Region are shown in Figure 11. The development of Moran's I of population density, dwellings per km^2 and residential buildings per km^2 show a very similar behaviour, with a medium positive level of spatial autocorrelation.

The global Moran I of the workplace density shows a lower but a steadily increasing spatial autocorrelation. The increase of the spatial autocorrelation during the last twenty years indicates, that within the Stuttgart Region the economic interactions between the certain communities have spread out and slightly increased. The whole area of the Stuttgart Region has become more homogeneous, since the sprawling effect of the workplaces statistically diminish the differences between rather rural and urban communities.

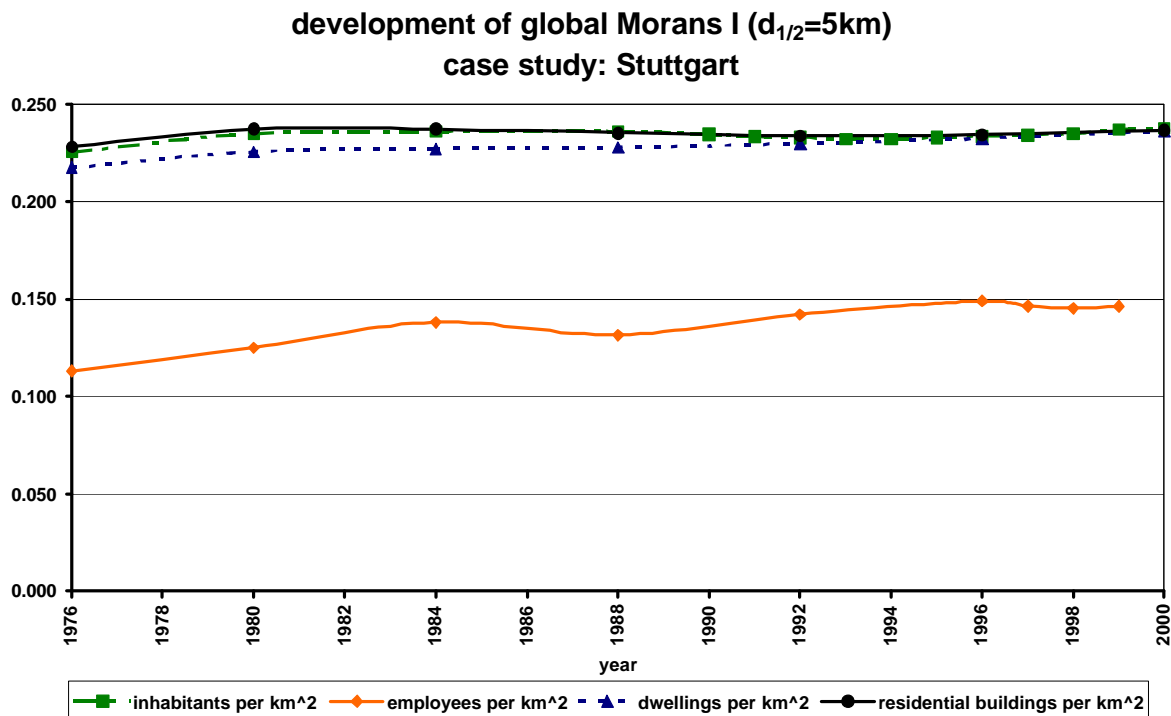


Figure 11: Development of global Moran I of population, employees, apartments and residential buildings

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The global Moran's I is computed by summing up the local Moran's I indicators (2-30). In the Figures 12 and 14 the spatial distribution of the local Moran's I of population and employees are depicted. It can be stated that a clustering of communities with high spatial autocorrelation around the core city Stuttgart exists. The local Moran's I of communes near the border of the outer urban ring are very low, because the differences of these communes with their neighbours are very high. High values of local Moran's I in the hinterland can be found e.g. in case of rural areas.

In the case study of Stuttgart the changes of the local Moran's I of population density is presented in the Figure 13. An increase of spatial autocorrelation for the population can be stated in the northern and southern part of the outer urban ring and in the eastern part of the hinterland.

Figure 15 shows the spatial distribution of the changes of the local Moran's I for workplaces per km² over the last two decades. Nearly all communes of the urban centre and outer urban ring state an increase in its spatial autocorrelation .

Therefore, an assembly of correlated and uncorrelated communities within the Stuttgart Region can be identified for the different socio-economic variables under consideration.

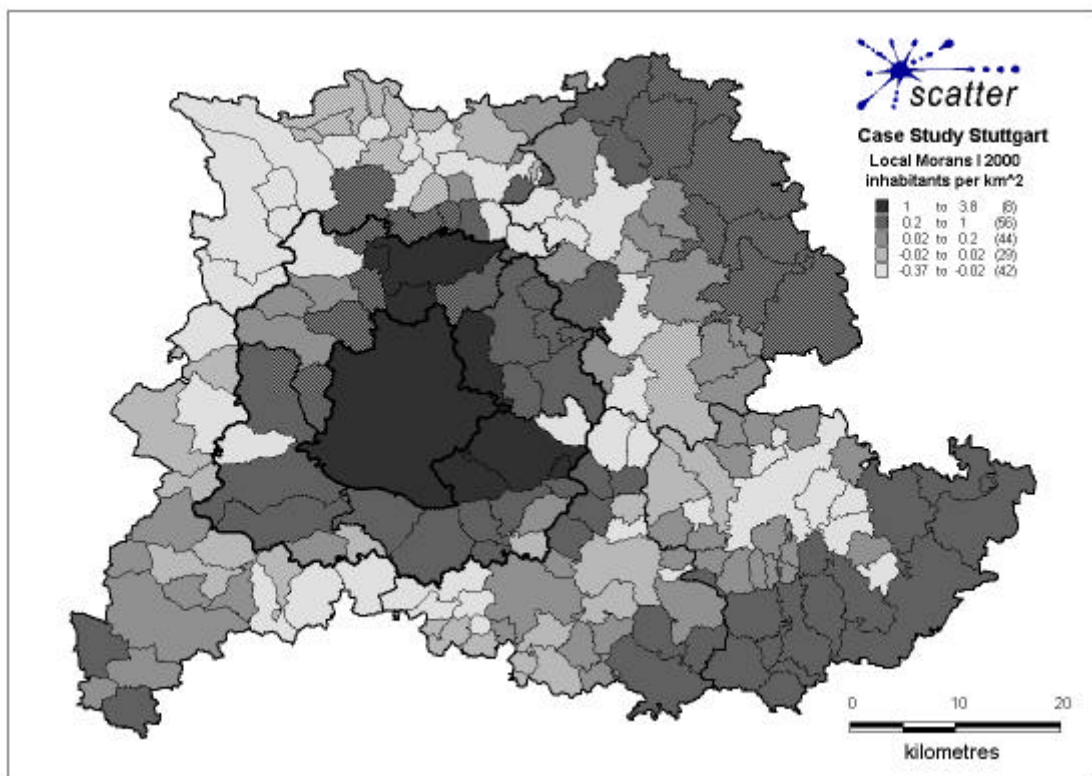


Figure 12: Spatial distribution of Local Moran I for inhabitants per km²

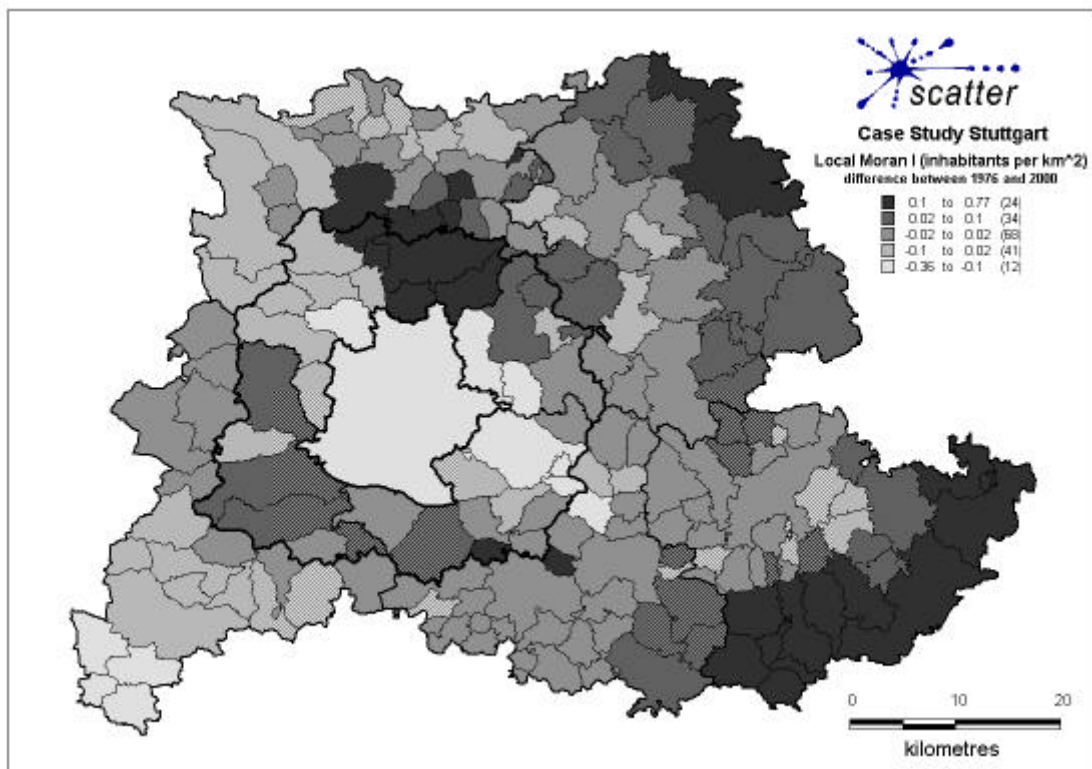


Figure 13: Changes of Local Moran I for inhabitants per km²

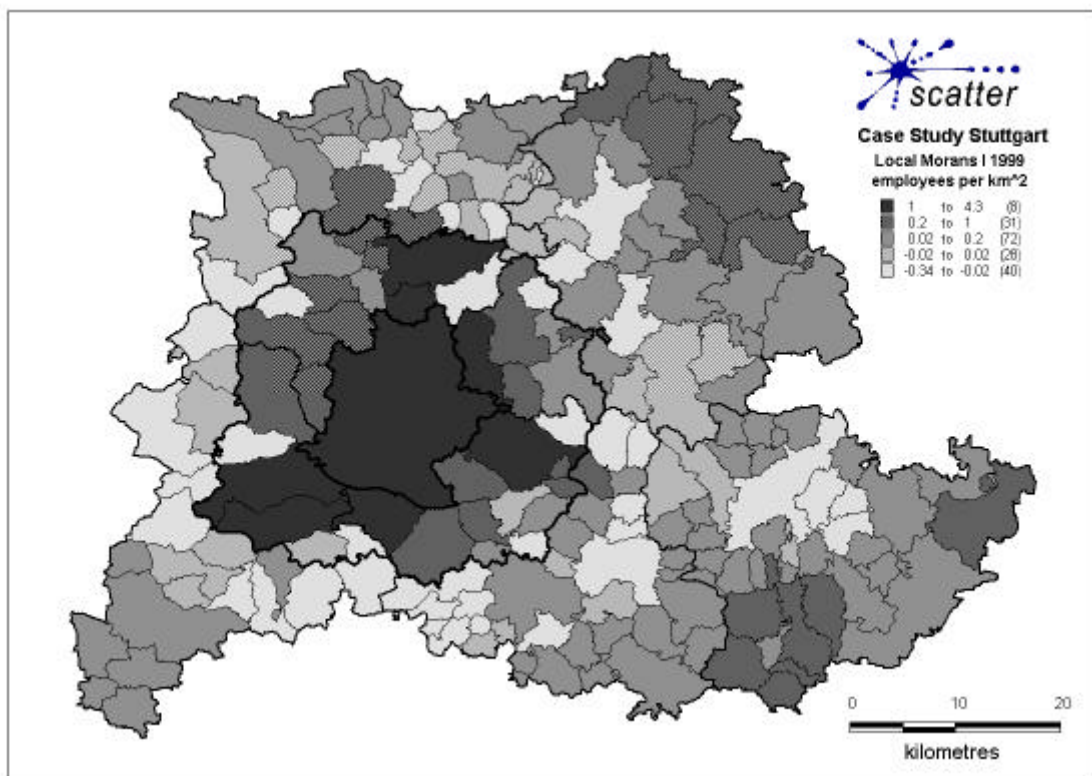


Figure 14: Spatial distribution of Local Moran I for employees per km²

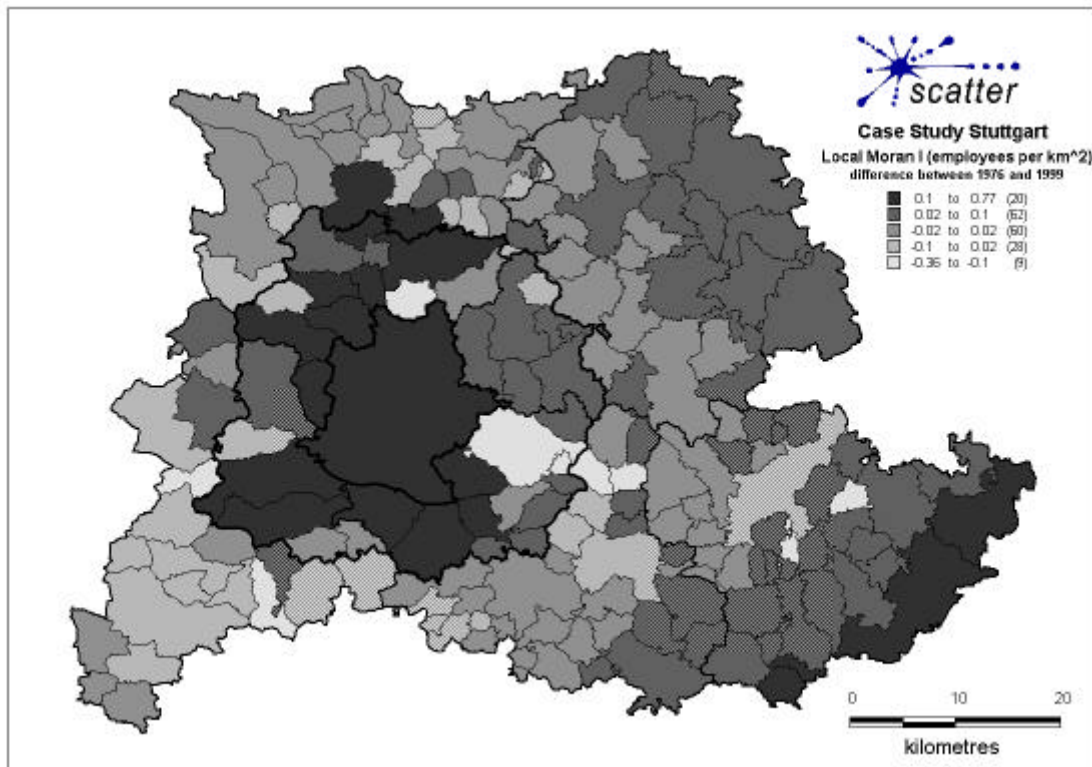


Figure 15: Changes of Local Moran I for employees per km²

2.4 Summary of the Stuttgart Case Study

The temporal development of all indicators have shown, that the development of the urban centre lacks behind the average growth path, while the outer urban ring and the hinterland are mostly above the average growth path. The conclusion is, that a spatial de-concentration effect of all variables (indicators) under investigation in the Stuttgart Region exist. Especially the spatial patterns of the temporal mean growth rates of employment and population over the last two decades are very scattered and show the main growth centres of the region. Furthermore, the analysis of spatial autocorrelation also identifies an assembly of correlated and uncorrelated communities within the Stuttgart Region for the different socio-economic variables. From a visual point of view the whole pattern look very scattered in agreement with the outcome of the *H*-measure analysis.

The statistical analysis on the basis of the shift-share analysis, development of the *H*-measure and consideration of spatial autocorrelation indicate clearly, that urban sprawl must be stated in the Stuttgart Region, at least since the beginning of the investigation period in 1978.

3 PRESENTATION OF THE PLANNING SYSTEM

3.1 Political Organisations

The region acquired its own political organisation in 1994, namely the Verband Region Stuttgart, consisting of a directly elected regional assembly. It has become a model for other regions in the state and in the Federal Republic of Germany itself. Its competences cover regional, infrastructure, landscape and transport planning as well as economic development, local public transport, waste management, and tourism. The central goal of the Verband Region Stuttgart is the co-ordination of policies among the 179 independent communities. This regional institutional structure, based on 23 districts, each grouping several communities, promotes a structured well planned development of the region.

3.2 Planning Regulations and Policies

The Stuttgart 21 Plan aims at rebuilding the Stuttgart – Ulm – Augsburg rapid rail line, comprising improvements in regional and long-distance transportation; excellent connections to the Filder Area and the airport; development of new urban neighbourhoods in the city centre; enlargement of park areas and creation of new jobs at the centre of the Stuttgart Region. This aim will be achieved by rerouting a part of the tracks through underground tunnels and lowering the station, it is possible to significantly reduce the inner-city area required for tracks. This opens up urban development opportunities and space for new development (about 1 km²) right in the heart of the city.

Regeneration projects, especially focused on the re-use of dismissed military activities, are also a factor determining the formation of new 'centres of gravity' for urban growth.

4 SYNTHESIS OF THE INTERVIEWS OF EXPERTS AND LOCAL AUTHORITIES

4.1 Introduction

This section is a synthesis of the contents of the interviews that have been carried out to investigate changes occurred in the Stuttgart region. The purpose of the interviews was to detect and understand the local events and rationale involved in the emergence of urban sprawl, its relevance in the decisional agenda of local authorities and experts, and the overall level of awareness of this particular urban phenomenon.

The synthesis is based on a recursive process of contents (or text) analysis and concept mapping according to which elementary concepts found in the interviews' transcripts and relevant to the synthesis purpose are first selected and then grouped together into higher-level thematic categories. The latter are built during the analytical process on the basis of the map of relationships drawn by the interviewees among the different concepts. This methodology is especially appropriate for the analysis of semi- and un-structured interviews as those used in this project. The contents of each interview are treated as a different commentary of the same subject and during the analysis emerging themes, correspondences and contradictions can be detected. The final report however does not detail the interviewees' individual comments by means of references or quotations but it organizes and delivers their perspectives on the complex network of issues surrounding the concept of urban sprawl.

The local authorities and experts interviewed were (in alphabetic order):

- Prof. Dr. F. Englmann, Director of the Centre of Infrastructure Planning, University of Stuttgart, Stuttgart,
- E. Frank, Director of the Statistical Office, City of Stuttgart
- Th. Schwarz, J. Eicken, U. Lindemann, Co-workers of the Statistical Office, City of Stuttgart
- D. Lenz, Mayor for Urban Planning, Filderstadt/Plattenhardt

Of the three interviews with six experts involved, conducted for the Stuttgart case study, only two referred to the urban region, whereas one focused on the southern suburban district of Filderstadt. The latter has therefore been included in the analysis since the phenomena of urban sprawl is clearly identifiable in this area.

The contents of the interviews' transcripts have been associated in the following themes, which represent the structure of the report:

1. Factors, which have influenced location choices, namely demographic, economic, plans, regulations and policies;
2. Spatial and functional structure of the Stuttgart region;
3. Structure of mobility patterns;
4. Impacts, which can be attributed to the spatial, functional and mobility structure;

5. Existing, implemented and suggested policies.

The issue of the awareness of local authorities has been investigated in different ways:

1. Through implicit references to the issue of urban sprawl;
2. Through the general level of awareness displayed by the interviewees.

Due to a rather stiff use of the interview framework, many of the advantages of the unstructured approach (namely emergence of concepts, unbiased associations among concepts by the interviewees, inference of awareness) have not been achieved. The analysis has led to the definition of several concepts but relationships among them remained blurred. Moreover, due to the lack of clear relationships, several concepts found no proper positioning with regards to the purposes of the synthesis. A last remark should be made with regards to the lack of distinction between the interviewees' references to Stuttgart as a region, city or urban area. This has led to several contradictory identifications of location trends and mobility patterns.

4.2 Location Choices in the Stuttgart Region

4.2.1 Demographic Factors

Accounts on the demographic trends for the city of Stuttgart are contradictory. However there is agreement on a recent slowdown of population growth compared to the higher rates of growth that occurred in the 90s. These were mainly due to immigration flows from the eastern Germany and eastern European countries. More recently emigration flows of selected group of populations, namely Bosnian, has led to a great number of vacant dwellings and to a decrease of commercial activities mainly serving these groups of population. These trends are spatially very selective and have different impacts in different parts of the city.

Another element to be considered is the changes in the structure of population and its impacts in the choice of housing location. The existing population is facing aging trends in the central areas and family size is shrinking due to a decrease in the number of children per households.

Family's life cycle is another factor determining location choices: single member households locate closer to the city centre where their life-style's requirement can be more easily met; nuclear families choose outer, more suburban areas in search for a better and healthier environment. Women usually remain at home for children care therefore decreasing the need for families with children to be close to jobs' locations. This determines a spatial distribution of population according to age, family status and incomes: older and younger people in the city centre, families with young children or with members in their 40s and 50s, with relatively higher incomes in the suburbs, garden peripheries and secondary centre.

4.2.2 Economic

After a phase of industrial restructuring during the 80s, characterised by a loss of jobs in the manufacturing industries, productive activities moved from the more industrial parts of

the city core to the outer urban rings (for instance in the areas of Vaihingen, Moehringen, Feuerbach) where service activities and start-up companies have developed. Accordingly, land prices for those central areas decreased – or did not increase - and the latter became an economically viable location for new offices and businesses. As a result, one of the reasons behind the expulsion of residential land-uses from the city is the higher level of land rents which commercial and service related land uses can make available.

4.2.3 Planning regulations and policies

The urban planning has shifted in two main directions. On the one hand the development towards the southern part of the Stuttgart region: the new fair complex in the Filder area, the ICE station and the expansion of the airport have acted as attraction centre of further residential and industrial developments. In addition, a cluster of leisure and service activities close to the motorway in the southern periphery of Stuttgart has developed. On the other hand, the Stuttgart 21 Plan aims at rebuilding the Stuttgart – Ulm – Augsburg rapid rail line, comprising improvements in regional and long-distance transportation; excellent connections to the Filder Plain and the airport; development of new urban neighborhoods in the city center; enlargement of park areas and creation of new jobs at the center of the Stuttgart region. This aim will be achieved by rerouting a part of the tracks through underground tunnels and lowering the station, it is possible to significantly reduce the inner-city area required for tracks. This opens up urban development opportunities and space for new development (about 1 km²) right in the heart of the city.

Regeneration projects, especially focused on the re-use of dismissed military activities, are also a factor determining the formation of new 'centres of gravity' for urban growth.

Regional planning laws strictly regulate land-use changes and the conversion of fallow, agricultural and water catchment's areas into urban uses, thereby controlling urban growth. However in the last years the infilling processes characterising the growth of suburban areas have occurred mostly unplanned and attempts to convey the most part of new developments along the transport infrastructure failed.

To summarise, the high costs and reduced availability of areas, houses and apartments in the city centre together with the processes of economic restructuring are at the basis of the first wave of sub-urbanisation. These first relocation trends from the central to the peripheral areas of the city of Stuttgart have also been facilitated by the significantly **shorter travel times** of trips from core to peripheral areas and by the radial extension of the road and rail networks. At present the high levels of traffic congestion surrounding the city of Stuttgart are one of the reasons behind decentralisation trends of both residential and productive activities.

A further factor has been and still is the housing market and housing supply, which are, in turn, affected by the economic cycles.

Spatially located and planned interventions have also played a significant part in setting the direction of new developments: the Stuttgart airport, the cluster of entertainment industries, and the economic poles of attraction in the Vaihingen and Wallgraben areas have all shifted new settlements towards the southern part of the region.

The Filder area is an outstanding example of the effects of growth and relocation factors on suburban centres. During the 1980s the population of the city of Filderstadt has grown of nearly one third as a result of migration flows from the city of Stuttgart, while since the mid 1990s saturation effects have slowed growth rates down. The area is in a favourable

location with regards to the accessibility to all major transport networks and proximity to the airport and the southern employment areas and the quality of life, environment and services is generally very high. All these elements have attracted population from the city of Stuttgart. Differently from the city of Stuttgart, the population of Filderstadt is mainly characterised by an increase of young families (ages ranging between 15-35) with children and a loss of older population.

4.3 Spatial and functional structure

In general urban sprawl, described as low-density developments based on individual housing typologies, is occurring mainly in the periphery of the urban centres.

Despite the attempt to keep new developments along the transport infrastructure these have mainly occurred as densifications of areas between transport axes. These areas are less subject to noise and air pollution. More dense, more noise-polluted areas along transport axes are also far less expensive and therefore have become inhabited by lower income population.

Population density is homogeneously high in the Stuttgart region, with an average population density of 570 inhabitants per km². In the city centre there are about 2900 inhabitants per km², in the outer urban ring 1100 inhabitants per km², and only about 440 inhabitants per km² in the hinterland.

Higher urbanisation densities can be found along transport infrastructure while “natural” infilling processes of low-density settlements are occurring in the areas between transport axes. Land prices decrease with the distance from the city centre and are more relevant than rent prices in the choice of housing location. Land prices are also related to the quality of the natural landscape, hilly sites being among the most attractive and therefore expensive locations. The city centre is characterized predominantly by commercial land-uses, while the outer rings have more mixed patterns. These patterns also include recreational and open, green areas. These facilities are therefore at close travel distance and travel time from the city.

A general increase in incomes resulted in a corresponding increase in the demand of more floor-space per person. However restrictions on multi-storey buildings in the city of Stuttgart forced new housing settlements to meet such dimensional requirements by horizontally extended housing typologies resulting in a higher consumption of land, and in less dense developments.

Such low densities have acted as a barrier to the economic feasibility of an extension or improvement of the public transport system and have generated an increase in the use of private cars for the majority of trips originating or ending in areas outside the city centre.

Both within the city of Stuttgart and its region, residential and productive functions are highly interrelated and evenly distributed. Excellent housing locations can be found close to industrial areas. The latter are not concentrated but scattered over the region due to the absence of a localising source as of mineral resources in the 19th century

Again an example of the sprawl processes in the Stuttgart region is the Filder area. The area is organised around several small urban centres characterised by commercial and service land-uses in the central areas and residential and agricultural land-uses in the periphery. Here the fragmented institutional structure of the area has not allowed for a comprehensive planning of urban growth, which has resulted in high levels of agricultural land consumption and scattered patterns of development, higher costs of infrastructure

developments. Advantages of the decentralised system are mainly referred to the preservation of a high quality of the natural and built environment.

4.3.1 Structure of Mobility

The unbalanced distribution between, on one hand, service and commercial activities in the centre of Stuttgart and on the other hand residential areas in the outer rings, has generated a dramatic increase in the number of commuters and therefore in trips, traffic, congestion and travel times, along radial transport axes connecting core and periphery. Travel distances for commuting have also increased. Reasons can be found in the spatial redistribution of jobs but mostly in the prolongation of radial transport infrastructures. At the same time the high levels of traffic congestion surrounding the city of Stuttgart are one of the reasons behind the growing decentralisation trends of both residential and productive activities.

At present travel times have sensibly increased due to the ring of traffic jam surrounding the central areas of Stuttgart. However congestion represents a problem mainly for commuters travelling from the outer urban centres to Stuttgart. Trips within or outside the city boundaries are not as effected. Pollution due to congestion, instead, remains a problem for the entire areas.

Due to low-density of the new settlement's patterns and to the hilly topography of the region transports by bus and rail in these areas are highly under-used and therefore not profitable and the use of the car prevails. However the increase in traffic congestion is not only related to the low density and scattered distribution of urban growth but also to the growing rate of cars per households as part of a general increase of incomes.

Thanks to the expansion of the inter-urban rail system travel time by public transport has decreased and the modal split of commuting trips is slowly changing towards public transports. However the costs of public transport have increased. A secondary effect of these infrastructure policies is the increase of land prices in the areas immediately surrounding the inter-urban rail stations.

4.4 Impacts of Dispersed and low-Density Developments

Most of the impacts are related to the low density and decentralised patterns of developments in the region. Such development patterns are a major cause of further CO2 emissions.

With regards to costs, development costs, infrastructure and public transport costs are sensibly higher than in the central areas of Stuttgart whereas commuting and individual travel costs have increased less due to the simultaneous distribution of workforce and workplaces in the outer rings.

Land consumption manifests itself as a growing fragmentation of agricultural land and open areas, which has made them respectively less productive and unusable. This has occurred especially in the Filder area.

Low density and detached housing typologies are also a cause of energy consumption.

4.5 Implemented and Suggested Policies and Measures

Policies affecting mobility. The suburban light rail system and the subway network have been and are currently being extended and improved. The streetcar system has been updated to improve speed and therefore transport capacity.

The road network has also been extended towards the north and east of Stuttgart. Despite the initial goal of these interventions to reduce congestion along the radial transport infrastructures, a continuous increase of induced traffic and traffic density has prevailed over the increased road capacity. As a result travel times are now as long as they were before any intervention of the road network.

The main goal of implemented transport policies is sustainable mobility. This goal has been pursued by a new traffic plan, which aims at:

- Separating long distance traffic from regional mobility;
- Reducing the level of congestion and pollution along transport routes leading toward the city centre by the realisation of an eastern by-pass and the introduction of speed limits to control CO2 emissions.
- Increasing the number of trips by public transport and reducing the use of cars.

Political and pressure groups have different opinions on the relevance and efficiency of the traffic plan and this has hampered its implementation.

Future transport policies should focus on local-level policies such as road-pricing measures and the promotion of alternative means of transport, such as cycling and walking as well as on interregional policies such as the improvement of the overall accessibility of the city to the European transport network.

With regards to overall **measures to reduce air pollution**, the city is promoting the use of natural gas for heating purposes. All new urban developments are equipped with natural gas heating systems.

Spatial planning has aimed at the development of agglomeration nodes around decentralised industrial centre and at the regeneration of peripheral urban centres, which have become less attractive due to the development of commercial centres and the leisure clusters. A solution to the further dispersal of settlements and to a more systematic planning of transport infrastructure could be the adoption of a regional land-use and spatial plan supporting the development of mixed land-use settlements around existing urban centres.

In general the city is looking for a stronger definition of its role in the competitive and international urban market.

4.5.1 Institutional System

The region acquired its own political organisation in 1994 as the Verband Region Stuttgart and has a directly elected regional assembly. It has become a model for other regions in the state and in the Federal Republic itself.

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Its competences cover regional, infrastructure, landscape and transport planning as well as economic development, local public transport, waste management, and tourism. The central goal of the Verband Region Stuttgart is the co-ordination of policies among the independent municipalities. This regional institutional structure, based on 23 districts, each grouping several municipalities, promotes a structured well planned development of the region.

The **reform of local government** in 1974 left the municipal boundaries of the city of Stuttgart unchanged. Since then urban growth and industrial relocation have moved outside these boundaries, therefore reducing the possibility for the city to manage spatial and functional evolution and taking taxes collected on income and productive activities away from the city.

The eventual proclamation of the Stuttgart Metropolitan region, in August 2002, has set an important frame for the competitive positioning of the Stuttgart region in the international context. This is seen to have positive effects in the evolution of the city and region of Stuttgart, as one of the problems of the region is the extreme fragmentation of the governing system.

BIBLIOGRAPHY AND REFERENCES

Batty 1970: "Models and Projections of the Space Economy: A Subregional Study in Northwest England", *Town Planning Review*, 41, 121-148

Haag 2002: "Sprawling Cities in Germany", FrancoAngeli, Milano

IHK 1990: "Die Wirtschaftsregion Stuttgart, Strukturen und Entwicklungen", Industrie- und Handelskammer der Region Stuttgart

IHK 1991: "Stuttgart im Standortwettbewerb, Acht Städte und Regionen im Vergleich", Industrie- und Handelskammer der Region Stuttgart

SACTRA 1994: The Standing Advisory Committee on Trunk Road Assessment: "Trunk Roads and the Generation of Traffic", Response by the Department of Traffic to the Standing Advisory Committee on Trunk Road Assessment, the Department of Traffic, London

SACTRA 1998: The Standing Advisory Committee on Trunk Road Assessment: "Transport Investment, Transport Intensity and Economic Growth" , Response by the Department of Traffic to the Standing Advisory Committee on Trunk Road Assessment, the Department of Traffic, London

STASA 2001: "Modellgestützte Analyse zur regionalen Entwicklung von Beschäftigungsvolumen, Lohnsummen und Beitragseinnahmen", study in order of Institute of Labour and Employment Research (IAB), Nürnberg