SCATTER

Sprawling Cities And TransporT: from Evaluation to Recommendations

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FOREWORD

SCATTER is a research project within the Fifth Framework Programme of the European Commission. It makes part of the Thematic Programme "Energy, Environment and Sustainable Development" and of the Key Action "City of Tomorrow and Cultural Heritage". It has been co-funded by DG Research and national organisations from Belgium, Finland, United-Kingdom, Germany, France and Italy. The project started in January 2001 and finished in September 2004.

SCATTER tackles the issue of urban sprawl, in particular in the context of cities implementing new suburban public transport services. Urban sprawl is one of the major challenges that European metropolitan areas are facing and will have to face in the next decades, together with congestion, emissions, and preserving or enhancing the quality of life of their inhabitants. It lies at the crossing of highly topical issues: urban governance, environmental concerns (emissions, biodiversity, etc), and quality of life of the inhabitants of the urban areas.

The starting point of SCATTER is that, in order to reduce the harmful effects due to a first wave of urban sprawl (congestion on radial roads, CO_2 and pollutant emissions due to transport), authorities of many urban regions are implementing new high quality public transport services linking the suburban areas and the urban centre. But by improving the accessibility, the authorities simultaneously create an incentive for a new wave of urban sprawl. There is therefore a need to design and implement accompanying measures to these new public transport services, in order to counter-balance their negative effects on the spatial pattern.

The objectives of SCATTER were therefore to analyse the mechanisms and effects of urban sprawl, to evaluate measures aiming to control or reduce sprawl, and to provide policy recommendations to cities, in particular in the context of cities implementing new suburban public transport services.

SCATTER is thus in line with various EU policies and topical reflections, like the Sixth Environmental Action Programme and the Thematic Strategy on Urban Environment.

To reach its objectives, SCATTER has achieved various tasks: statistical analysis with original indicators, interviews of local authorities, interviews of US experts, review of policies in a dozen of cities, analysis of mechanisms of inter-institutional cooperation, simulations of policies and impact assessment.

The message of SCATTER is that one cannot implement new transport services between suburban areas and urban centre without being aware that this will encourage the out-migration of the households and that therefore this requires an accompanying strategy. The package of policies recommended by SCATTER combines fiscal measures on suburban residential developments and offices choosing inadequate locations (i.e. locations poorly served by public transport), and transport pricing: increase of car use cost and reduction of the fare of public transport, but in the urban centres only. SCATTER also recommends to have more recourse to innovative housing design (intermediate between collective and individual housing) in order to meet simultaneously the individual household aspirations and the collective density criteria.

Finally, SCATTER also recommends soft measures. Further to the technical policy recommendations, the key success factors to tackle urban sprawl are: integrated strategies, coordination, and cooperation, between municipalities and between institutions and players in general. In this clearly multi-dimensional, multi-disciplinary issue, each player holds a part of the solution. Soft measures like symbolic measures should

contribute to create a common culture at a supra-municipal level, to enable consensus building, a consensus about the objectives and the ways to reach them. These points are key elements to achieve a more sustainable urban development.

The SCATTER consortium wants to express his special gratitude to all the local and national authorities involved for their help and guidance, and to Dr. Eric Ponthieu, Scientific Officer of DG Research, for his constructive attitude and actions which have always encouraged them in their work.

The SCATTER consortium

EXECUTIVE SUMMARY

Starting point and objectives of SCATTER

SCATTER tackles the issue of urban sprawl, in particular in the context of cities implementing new suburban public transport services.

Urban sprawl is a common problem encountered in Europe. It is usually defined using three key concepts: low density, uncoordinated urban growth, spatially segregated land uses[1]. Sprawl is positioned against the concept of compact city, with high density, centralized development and a spatial mixture of functions. Generally speaking, the spatial pattern which results from sprawl is unfavourable to the development of public transport and other sustainable transport modes. On the contrary, urban sprawl induces high level of private car use. The negative effects of urban sprawl on transport are therefore an increase of trip lengths, congestion on the radial roads giving access to city centres, increase in fuel consumption and in air pollution.

Other negative effects are due to urbanisation and land consumption themselves: loss of high quality agricultural land and open space, destruction of biotopes and fragmentation of eco-systems[2], change of the water streaming coefficient. Urban sprawl also generates higher costs of new neighbourhood equipments, infrastructures and public services.

Now, in order to reduce the congestion and the CO_2 and pollutant emissions due to a first wave of urban sprawl (mostly due to networks of motorways), authorities of many urban regions are implementing new high quality public transport services linking the suburban areas and the urban centre (like the future RER in Brussels). But by improving the accessibility, the authorities simultaneously create an incentive for a new wave of urban sprawl. Therefore *there is a need to design and implement accompanying measures to these new public transport investments*, in order to counter-balance the negative effects of these new public transport services on the spatial pattern (and to reinforce their positive effects, e.g. modal shift). The SCATTER project tackles this issue.

In this context, the objectives of SCATTER were to analyse the mechanisms and effects of urban sprawl, to evaluate measures aiming to control or reduce sprawl, and provide policy recommendations to cities facing that phenomenon.

Overall methodology

The approach followed consists of three stages:

- first stage: improving the understanding of the mechanisms of sprawl and its effects. This first stage includes:

    - (i) a state-of-the-art review of urban sprawl effects

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[1] E.g. homogenous single family residential development; shopping centres, retail and services; freestanding industrial areas.

[2] See the programme CORINE Land Cover of the European Environment Agency which highlights the evolution of the territorial fragmentation between 1990 and 2000, in 31 countries.

- o (ii) a systemic analysis of urban sprawl on the basis of interviews of experts and local/regional authorities in 6 case cities (Bristol, Brussels, Helsinki, Milan, Rennes, Stuttgart)
  - o and (iii) a statistical analysis of time series data in these 6 cities;
- second stage: reviewing and assessing policy measures aiming to tackle urban sprawl or its negative effects. This second stage includes:
  - o (i) a review of policies, including policies experienced in the USA
  - o (ii) a critical analysis of institutional barriers and solutions
  - o (iii) a quantitative assessment of the efficiency of policies (as regards the control of urban sprawl), on the basis of simulations carried out with land-use/transport integrated models, in 3 case cities (Brussels, Helsinki, Stuttgart);
- third stage : setting up recommendations for local and regional authorities. Three tasks were carried out in this third stage:
  - o (i) providing general recommendations to European cities
  - o (ii) design of an "urban sprawl monitoring tool" intended for local/regional authorities
  - o (iii) setting up a practical programme of policy measures for the 6 case cities.

What is urban sprawl ?

A comprehensive review of the existing literature has been performed in SCATTER covering the recent debate on the topics of urban growth and urban sprawl. Maybe for the first time, a review about sprawl in both United States and Europe was achieved.

Urban sprawl is usually defined using three key concepts: low density, uncoordinated urban growth, spatially segregated land uses (e.g. homogenous single family residential development ; shopping centres, retail and services ; freestanding industrial areas). Sprawl is positioned against the ideal of the compact city, with high density, centralized development and a spatial mixture of functions. In terms of urban forms, a variety of forms are covered by the term "urban sprawl", ranging along a continuum of more compact to completely dispersed development: contiguous suburban growth (i.e. a contiguous expansion of existing development from a central core – this was identified as sprawl earlier but is no more classified as sprawl now), compact growth around a number of smaller centres, linear patterns of strip development, leapfrog and scattered development. "Urban sprawl" must clearly be distinguished from "urban growth": the latter may and should be sustainable, while the first is considered as being not.

Perceptions by local authorities

Interviews of local authorities and experts were performed in the 6 case cities (26 interviews in all). A synthesis has been drawn from these interviews, based on a recursive process of contents analysis. Common factors emerged in the 6 cities, related to the perception of the causes of urban sprawl, the level of awareness regarding sprawl, and the awareness of institutional barriers to the implementation of policies. Using the contents of the interviews, four different types of sprawl were identified that are frequently referred to and identified with urban sprawl.

Some perceptions shared by most of the interviewees are as follows:

- the need for an improved coordination between land-use and transport planning as well as for a more effective control of the production of the built environment are perceived as crucial steps in the struggle against urban sprawl ;

- urban sprawl is mainly originating in situations when new demands arising for the increase in households' incomes are met mainly by the private sector. The housing and land market and the lack of measures to control the increasing use of private means of transport are the main causes ;

- sprawl is also perceived as relating mainly to housing rather than to an 'ill' structure of land-use distribution and planning ;

- there is a call for mixed land-use planning as a possible solution in particular to the mobility problems induced by sprawl, but the attention to the possibility offered by economic and fiscal measures is still scarce. (Costs and benefits have been since long investigated by the American literature but planning practice in Europe has focused mainly on the possibility to control sprawl by means of land-use and transport planning.)

Indicators and statistical methods to measure urban sprawl

How to measure urban sprawl ? In SCATTER, an original framework of statistical analysis has been developed in order to identify and quantify urban sprawl. This framework has been applied to the six case cities and highlighted the fact that they had different de-concentration patterns.

The statistical framework consists of :

- a specially designed generalized shift-share analysis ;
- a new measure of spatial de-concentration, called H- indicator ;
- local spatial autocorrelation statistics (e.g. Moran's I) ;
- as well as more traditional indicators like densities, shown on maps.

The variables investigated were :

- total population and total employment, for all the cities
- income per capita, number of commuters, commuter trip length, house prices, number of dwellings, residential buildings, and number of jobs directly induced by the population, in some cities.

The analysis was applied on time-series data, covering a 20-years period or more, for most of the cities (10 years period for one city).

This statistical framework allowed to show that the 6 case cities could in fact be clustered into three groups having three different de-concentration patterns:

- Milan, Bristol: continuing and rather strong spatial de-concentration of activities (activities include population and employment), with local specificities such as:
    - Milan: population and employment are out-migrating to areas which are more and more distant from the centre;
    - Bristol: it exhibits a more polycentric pattern, with 2 other urban poles included in the hinterland;
- Stuttgart, Brussels: moderate spatial de-concentration of activities, tending towards a stagnation of the pattern;
    - in the case of Brussels: it seems that the sprawl, as regards population, has slowed down these last years, and even stopped very recently;
    - in the case of Stuttgart: sprawl can be stated for population on a low level but in case of employment sprawling seems to stagnate;
- Rennes, Helsinki: continuing spatial concentration of activities: these two metropolitan areas do not exhibit all conditions of urban sprawl, but the growth of the population and of the employment is nevertheless scattered to a certain extent. In both areas, there is in the same time an out-migration of the rural population towards the urban centre and especially the outer urban ring, and a scattered growth pattern, but at a lower level than in the 4 other cities.

Qualitative evaluation of policies aiming to reduce urban sprawl or its negative effects

A literature review and a qualitative analysis of 11 European case studies (including the 6 case cities of the project) have been performed, to get insights into the theoretical and practical implications of the design and implementation of policy measures to control urban sprawl. The literature review on innovative methods and practices was combined with an analysis of case studies in order to overcome the sectoral approach of the former with the more integrated and operational approach of the latter.

In the review, policies have been classified according to issues, namely environmental policy, land consumption, mobility, adaptability of physical infrastructure and social segregation.

The case studies have shown that policies targeting sprawl are inseparable from policies which deal with the problems of modern urban growth. There is a strong emphasis on integrated policies which tackle a series of related issues, and a focus on a regional approach. The other overarching concept is the promotion of the compact city or a form of decentralized concentration.

All the case studies show some degree of policy (e.g. land use/transport) or institutional integration and coordination. Integration in these cases is the response to the acknowledgment that interactions between policies and between the different effects of policies must be dealt with. Integration is therefore recognised as a key success factor.

The analysis also highlighted that new forms of planning practice are emerging which represent an adaptive response of local and regional authorities to the challenges posed by the changes in the scale and type of urban growth, demographic migration and economic activities relocation. Besides innovating the contents of planning policies, public institution and organisations are also changing the practice, the "how to" of planning (e.g. more entrepreneurial approaches ; regional planning strategies coupled with local regulations and detailed plans ; bottom-up approaches ; institutions building coalitions).

A essential challenge for cities, which are undergoing processes of significant urban growth or change, is the necessity to balance the promotion of economic competitiveness (both against other cities in the metropolitan area or region and at the national or international level) with the control of spatial growth and its impacts (land and natural resources consumption, social segregation). In this field EU regulatory framework can play a key role.

Finally, in order to highlight ways of identifying sprawl on the ground in a context like the US where sprawl and anti-sprawl measures have a longer history than in Europe, interviews were conducted with academic experts from United States (Portland, Oregon and New Jersey). These interviews bring insights among others on successful instruments implemented in Portland, the concepts of growth management and Smart Growth, the costs and benefits of sprawl as they are perceived in United-States

Quantitative evaluation of policies aiming to reduce urban sprawl, through simulations with integrated land use/transport models

To perform policy impact assessment, scenarios of policy measures have been simulated in 3 case cities (Brussels, Helsinki and Stuttgart), using integrated land use/transport models. Besides, a common evaluation framework was set up. The indicators of this evaluation framework mainly tackle concentration/de-concentration of population and employment, mobility pattern, and CO_2 emissions.

The common policies simulated in all 3 cities are fiscal measures applied to suburban residential developments, regulatory and fiscal measures applied to offices, increase of car use cost, cordon pricing, reduction of fare of public transport , and combinations of these measures.

First, the simulation results confirm that public transport investments indeed generate urban sprawl if they extend to the suburban or rural areas.

Moreover, the simulations have shown that new radial rail services cause a significant lengthening of the home-work trips (increase by 8% due to the implementation of the RER in Brussels ; increase by 12 % in the scenario of local investment plan + speeding up the rail services by 25 %, in Helsinki). On the other hand, the rail investments lead to an improvement of the indicators related to the modal share: decrease of the car mileage and increase of the public transport share. In the two scenarios mentioned above, the decrease in CO_2 emissions is by 8 % (Brussels) and 2 % (Helsinki). However, the potential total "short-term" improvement (i.e. the improvement which would have occurred if there was no change in activity location, neither lengthening of the trip distances) would have been even higher. In other words, one negative effect of sprawl is to "consume" a part of the potential benefits of the public transport investments, with regard to the reduction of car mileage and emissions.

Secondly, the simulation results led to select the following package of measures, to be recommended as accompanying measures to new public transport services linking the urban centre and suburban areas:

- increase of car use cost
- reduction of the fare of public transport only on the territory of the central agglomeration
- fiscal measure ("impact fee") on new suburban residential developments
- fiscal measure to incite offices to locate in areas well served by public transport (e.g. rail stations).

The policies were assessed with indicators reflecting two main criteria: on one side, urban concentration and land consumption, and on the other side, CO_2 emissions and air pollution.

Institutional issues: from barriers to cooperation

Institutional barriers and new ways of cooperation between institutions have been tackled through the analysis of 6 structures of inter-institutional cooperation existing in the 6 case cities. The analysis was carried out through the framework of the "institutional square" and showed that there is in practice a great variety of institutional solutions. It highlighted the issues of balance and consistency, between the features of an institution and its objectives. The institutional obstacles occurring in the context of management of urban sprawl were identified and different types of response to such obstacles were described and analyzed. As a conclusion, it is obvious that a strong metropolitan institution, with strong democratic legitimacy and strong action instruments, will be more efficient. However, the creation of a strong metropolitan institution, depriving partly other authorities of their powers, can be very difficult in practice because of historical and/or political reasons. In such cases, a less formal structure of cooperation between existing institutions is the only feasible solution. This type of solution should not be neglected for that all, because it can generate a permanent dialogue between municipalities or other institutional levels, contribute to raise awareness among decision-makers (awareness of the need of cooperation on at least some matters), and can be the first step on which progressively a stronger structure could build on. Stabilisation of political arrangement needs time and non formal cooperation helps to define collectively rules, identities, references or values which make possible a political integration in a later stage.

Besides, the range of appropriate responses to any situation can vary greatly from one urban situation to another, because of local specificities, as mentioned above. Each territory has its own resources. Configurations of political leadership (collegial, individual) represent opportunities, or constraints, for the feasibility of the settlement of a new political institution. Mobilisation of private interests organisations on institutional aspects depend also from the locality. Presence of social values shared by inhabitants, like consensus or collective action capacity, is a specific resource which can make possible the creation of a new political institution.

An Urban Sprawl Exploratory Tool available on Internet

An Urban Sprawl Exploratory Tool (USET) has been developed in Scatter. The Urban Sprawl Exploratory Tool is an interactive tool implemented on Internet, intended for local authorities and planning actors involved in decision making. Its objectives are to inform and raise awareness about urban sprawl (especially among authorities of small and medium-size cities), and to explore and monitor variables related to sprawl. The final objective is to provide some help in making a diagnosis about sprawl and building a strategy.

The USET is the perspective of SCATTER on: local governments information needs, what is essential to know about urban sprawl (indicators), what local governments should do to act strategically on urban sprawl.

Practically, USET gives:

- definitions of concepts related to urban sprawl
- a set of relevant indicators, and the possibility to calculate some of them, if input data are provided by the user
- values for these indicators, calculated in the 6 SCATTER case cities
- a policy database referring to the policies evaluated by simulations or by case studies in the project.

USET is available on www.casa.ucl.ac.uk/monitor.

Recommendations to local and regional authorities

Finally, recommendations to local and regional authorities have been elaborated on the basis of the outcomes of the whole project. Some policy recommendations are directly derived from the policy simulations: those policies were therefore quantitatively evaluated. Some other policies recommended are derived from the case studies ; they were not quantitatively evaluated and look rather like "best practices". They were selected because they contain innovative aspects or should become more generalised. Finally, some recommendations related to the institutional matters derive from the analysis on inter-institutional cooperation.

The recommended policies are as follows:

- tax on the suburban residential developments ("impact fee"), possibly combined with a tax reduction for housings in urban areas
- tax on all offices located in zones not served or poorly served by public transport
- increase of the cost of car use, through congestion pricing
- reduction of the fare of public transport *only* in the urban centres
- land use and land rent regulation by the public authorities, through negotiations, exchanges and public-private partnerships
- alternative housing forms, intermediate between collective housing and individual single-family housing, and innovative urban design
- setting up mechanisms for inter-institutional cooperation
- symbolic and cognitive actions, to build a consensus on the objectives and the ways to reach them.

Some of these recommendations can be implemented at the local, municipal level ; some others require coordination at a supra-municipal level.

These recommendations are intended for any small, medium-size or large cities implementing new public transport which will improve the accessibility with suburban areas, for cities simply facing sprawl, for suburban municipalities involved in a sprawl process, or any cities concerned by sustainable urban development, like whose which committed in the Aalborg process[3].

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[3] The Aalborg Charter is a Charter about sustainable urban development and was adopted at the First European Conference on Sustainable Cities and Towns, that took place in Aalborg, Denmark, in 1994. The 4th European Sustainable Cities and Towns Conference, which took place in 2004 ("Aalborg +10"), adopted the "Aalborg + 10 Commitments", which are seen as an important step from theory to real actions. Cities having signed the Commitments agree to make a environmental review of their city, identify targets and monitor progress.

ACKNOWLEDGEMENTS

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Kari Lautso	LT Consultants	evaluation framework, Helsinki case study
Claude Noël	CERTU	land use and transport policies
Angelo Martino	TRT	Milan case study
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Paavo Moilanen	STRAFICA	policy simulations, Helsinki case study
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Project web site : *www.casa.ucl.ac.uk/scatter*

Urban Sprawl Exploratory Tool (developed in Scatter): *www.casa.ucl.ac.uk/monitor*

Table of contents

APPENDICES

Appendix 1 : Description of the integrated land-use transport models of Brussels,
Helsinki and Stuttgart

Appendix 2 : Simulation results of the common policy scenarios in Brussels,
Helsinki and Stuttgart

Appendix 3 : Definition of the indicator "Productivity gain from land-use"

1. INTRODUCTION: THE OBJECTIVES AND OVERALL METHODOLOGY OF SCATTER

1.1. The starting point and objectives of SCATTER

SCATTER tackles the issue of urban sprawl, in particular in the context of cities implementing new suburban public transport services.

Urban sprawl is a common problem encountered in Europe. It is usually defined using three key concepts: low density, uncoordinated urban growth, spatially segregated land uses[4]. Sprawl is positioned against the concept of compact city, with high density, centralized development and a spatial mixture of functions. Generally speaking, the spatial pattern which results from sprawl is unfavourable to the development of public transport and other sustainable transport modes. On the contrary, urban sprawl induces high level of private car use. The negative effects of urban sprawl on transport are therefore an increase of trip lengths, congestion on the radial roads giving access to city centres, increase in fuel consumption and in air pollution.

Other negative effects are due to urbanisation and land consumption themselves: loss of high quality agricultural land and open space, destruction of biotopes and fragmentation of eco-systems[5], change of the water streaming coefficient. Urban sprawl also generates higher costs of new neighbourhood equipments, infrastructures and public services.

Now, in order to reduce the congestion and the CO_2 and pollutant emissions due to a first wave of urban sprawl (mostly due to networks of motorways), authorities of many urban regions are implementing new high quality public transport services linking the suburban areas and the urban centre (like the future RER in Brussels). But by improving the accessibility, the authorities simultaneously create an incentive for a new wave of urban sprawl. Therefore *there is a need to design and implement accompanying measures to these new public transport investments*, in order to counterbalance the negative effects of these new public transport services on the spatial pattern (and to reinforce their positive effects, e.g. modal shift). The SCATTER project tackles this issue.

In this context, the objectives of SCATTER were to analyse the mechanisms and effects of urban sprawl, to evaluate measures aiming to control or reduce sprawl, and provide policy recommendations to cities facing that phenomenon.

1.2. The overall methodology

The approach followed consists of three stages:

- first stage: improving the understanding of the mechanisms of sprawl and its effects. This first stage includes:

    - (i) a state-of-the-art review of urban sprawl effects

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[4] E.g. homogenous single family residential development; shopping centres, retail and services; freestanding industrial areas.

[5] See the programme CORINE Land Cover of the European Environment Agency which highlights the evolution of the territorial fragmentation between 1990 and 2000, in 31 countries.

- o (ii) a systemic analysis of urban sprawl on the basis of interviews of experts and local/regional authorities in 6 case cities (Bristol, Brussels, Helsinki, Milan, Rennes, Stuttgart)

- o and (iii) a statistical analysis of time series data in these 6 cities;

- second stage: reviewing and assessing policy measures aiming to tackle urban sprawl or its negative effects. This second stage includes:

  - o (i) a review of policies, including policies experienced in the USA

  - o (ii) a critical analysis of institutional barriers and solutions

  - o (iii) a quantitative assessment of the efficiency of policies (as regards the control of urban sprawl), on the basis of simulations carried out with land-use/transport integrated models, in 3 case cities (Brussels, Helsinki, Stuttgart);

- third stage : setting up recommendations for local and regional authorities. Three tasks were carried out in this third stage:

  - o (i) providing general recommendations to European cities

  - o (ii) design of an "urban sprawl monitoring tool" intended for local/regional authorities

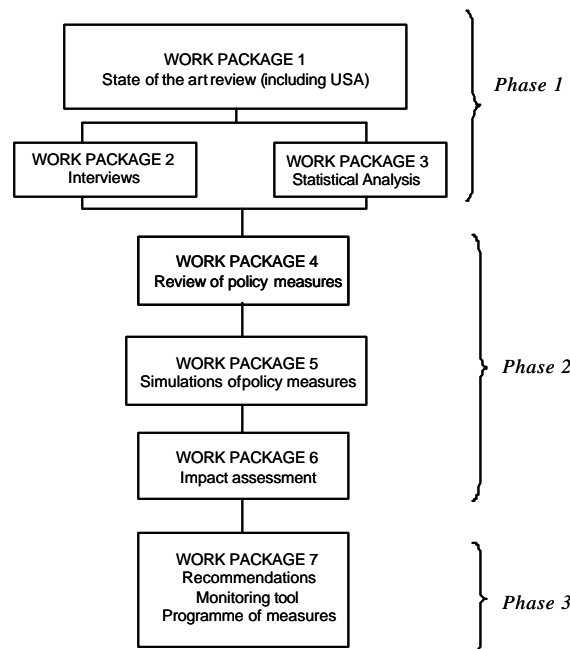 - o (iii) setting up a practical programme of policy measures for the 6 case cities.

Figure 1.1 Project flowchart

The main results and conclusions of these various stages and tasks are presented in the following sections. Furthermore, all the reports presenting the detailed results are downloadable from the project web site: www.casa.ucl.ac.uk/scatter.
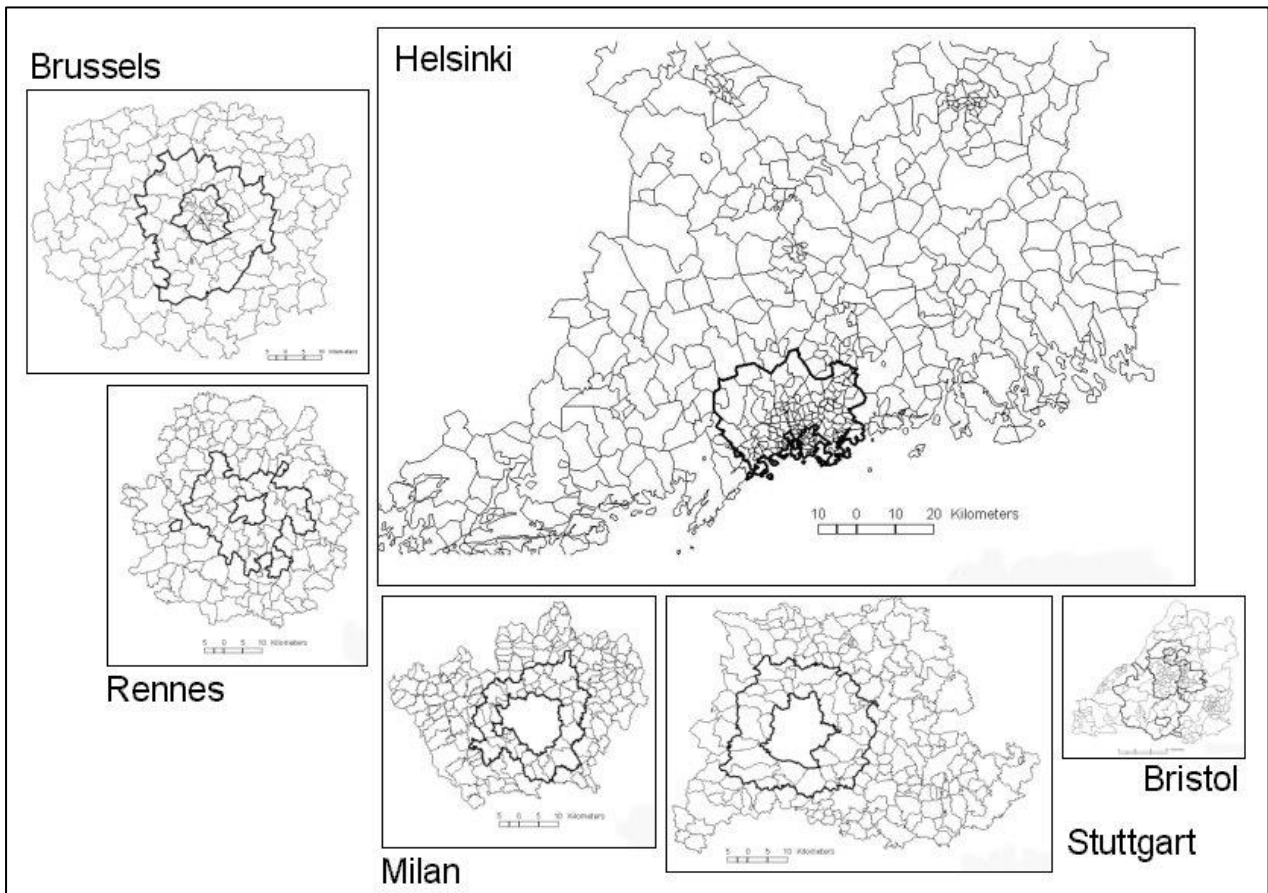
Figure 1.2 The six SCATTER case cities presented at the same scale

2. WHAT IS URBAN SPRAWL, CONCEPTS AND PERCEPTIONS

The phenomenon of urban sprawl has received extensive attention in the literature particularly since the 1980's, but despite this wealth of information the nature of sprawl and its impact on city form and urban function remains un-illuminated. Much of this debate assumes an ideal urban form - of the compact, self sufficient city- the roots of which can be traced to cities of the past, including the Mesopotamian city, the Greek polis, and the medieval walled city, despite their diverse nature certain common elements can be extracted. These cities had small populations by modern standards, were limited in physical size with a clear demarcation between rural and urban, and provided the focus of economic and cultural life.

Sprawl is compared to this ideal, and for the most part, emerges as a poor loser. Whether justified or not, sprawl is perceived as a negative urban form with costs including un-aesthetic development, poor access to services for those with limited mobility such as the young and elderly, increased trip lengths, congestion and increase in fuel consumption due to low densities, overwhelming dependence on automobile use, higher costs of neighbourhood infrastructure and loss of agricultural land and open space. These perceived negative effects are tackled with growth management policies which attempt to restore a more compact urban form by channelling development to the downtown, and attempting to set physical limits to growth through growth boundaries and land preservation.

2.1. Definitions

Sprawl has become an umbrella term, encompassing a wide range of urban forms, indeed, "the term has become so abused that it lacks precise meaning, and defining urban sprawl has become a methodological quagmire" (Audirac, Shermyen, & Smith, 1990). Given that there is no agreed definition, it is not surprising that there is also little agreement on the characteristics, causes and impacts of sprawl. It is agreed that sprawl occurs on the urban fringe in rapidly growing areas but apart from this there is little consensus.

It is also difficult to make a clear distinction between the causes, conditions, and consequences of urban sprawl. The literature reveals a world of contradictory causal and temporal relationships between several events, sprawl being often just one of them. Furthermore, beyond defining urban sprawl, a key issue is how to make a distinction between urban growth and sprawl.

2.1.1. Urban sprawl and urban growth

As soon as cities began to grow, there was concern about their size. In the ancient world, Rome was the first city to reach a population of one million with the consequence that in the first and second centuries AD, the city was subject to series of Imperial edicts limiting its growth, but to little avail. The same kinds of pronouncement were made by the Courts of the Tudor Kings and Queens for 16th century London, where the notion of some sort of cordon, not only to protect the countryside but to stop the plague, was seriously proposed (Morris, 1994). But it was only when the industrial revolution began in the mid 18th century Britain that the explosive growth of cities around their edges really began.

Bristol, UK   *Brussels, Belgium*   *Helsinki, Finland*
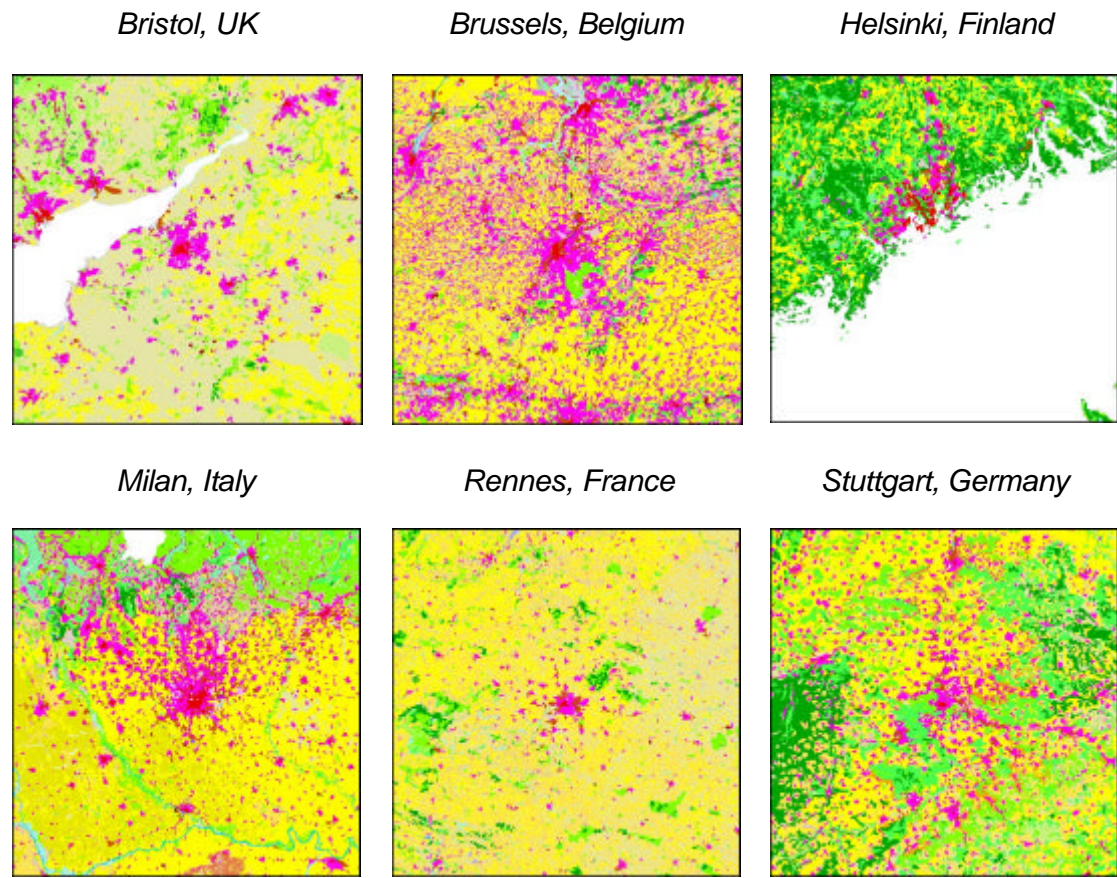
Milan, Italy   *Rennes, France*   *Stuttgart, Germany*

Figure 2.1 : Urban Land Use (Purple) from Remotely Sensed Data (Corine 1990) in the Six SCATTER City Regions

Such growth is often taken to be sprawl but in modern times, sprawl has acquired a much more specific connotation, being defined as 'uncoordinated growth': the expansion of community without concern for its consequences, in short, unplanned, incremental urban growth which is often regarded unsustainable. This was recognised by commentators watching London grow in the early 19th century. William Cobbett (1762-1835), author of Rural Rides (published 1830), riding west from London, declared that "all Middlesex is ugly", a sprawl of "showy, tea-garden-like houses". 70 years later William Morris, founder of the arts and crafts movement, said: "Need I speak to you of the wretched suburbs that sprawl all round our fairest and most ancient cities?" (William Morris, Art Under Plutocracy, date unknown, between 1870 and 1896).

Sprawl is directly identified with urban growth. As cities get bigger, they clearly have to expand around their peripheries for it is much more difficult to increase central densities. What makes this possible is better transportation from the core to the edge. This is the typical chicken and egg conundrum of what comes first: better transportation or population growth; or population growth followed by better transportation? If the industrial revolution had not occurred, would we have got better transportation without the population growth that has occurred in western cities over the last 200 years? Probably not for population growth was and is intimately bound up with higher standards of living that are accelerated by technological innovation.

2.1.2. Uncoordinated growth and low density

Urban sprawl is usually assumed to refer to the uncoordinated growth of cities, particularly around their edges or peripheries. The role of population density in urban areas is clearly central in the definition of sprawl. There may be pockets of high density in a sprawling landscape but the key issue is that uncoordinated growth leads to piecemeal development which in general is low density development. Therefore, sustainable planning which aims to reduce the problems of sprawl is essentially dependent upon the control of densities.

In the United States and in United-Kingdom at least[6], the argument about sprawl has been significant for at least 100 years if not longer. In the early and mid 20th century, sprawl was often confused with suburban development and there was considerable disquiet with the way lower density urban living was becoming the dominant way in which peoples' aspirations about living in cities were moving. But in one sense this was a reaction to something new and the early suburbs now appear to be considerably more coordinated than the kinds of developments which have taken place in the last 25 years, particularly in North America.

Finally, many definitions of urban sprawl use the concept of low density to identify sprawl, however, what is considered low–density is relative and varies with each country cultural expectations. For instance, in the U.S. low density is development of

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[6] Historically, the urban sprawl phenomenon was first a peculiarly British and American phenomenon, due probably to the relatively lower density of cities in both Britain and America and to the notion that home-ownership with a garden are core values of the Anglo-Saxon heritage. In continental European, the conditions for urban growth have more recently begun to mirror those in Britain and North America. Towns in continental Europe have tended to remain more compact with higher and more uniform densities. As an illustration, between the 70s and 80s, 'growth management' legislation started in several American States leading to an attempt to control the spread of urbanisation. In the same time, in European countries, there was the first important wave of uncontrolled sprawl.

two to four houses per acre while in the U.K. low density would not consist of less than eight to twelve houses per acre.

2.1.3. The spatial scales relevant for research and action

One key issue relates to the scale at which urban growth and sprawl is identified. There is a strong disjuncture between thinking of cities as socio- economic nodes in a network and thinking of them as physical entities. This is reflected too in the literature on sprawl which spans the scales from low level physical concerns at the level of site development to much more abstract pictures of how cities are growing in terms of population and employment.

A typical example is the case of polycentric systems, which are often, described both as intra-urban patterns of clustering of population and economic activities (London, Paris, Milan) and inter-urban patterns such as the Dutch Randstad, the Flemish Diamond and the area of Padua, Treviso and Venice in Northern Italy.

This is not a trivial argument because the spatial scale at which urban sprawl is observed can heavily influence the identification of relevant issues and the selection and design of suitable indicators. It also crucial to select the proper territorial scale in policy design and implementation, to have a chance to reach the goals. Finally, this twofold issue of "various analysis scales/proper scale for policy" is also related to the question of institutional barriers and modes of cooperation between different institutional players : one of the first questions facing local/regional authorities who wish to set up a platform of cooperation is "how to define the proper area for tackling urban sprawl".

2.1.4. Definitions based on urban forms

A variety of urban forms have been covered by the term "urban sprawl" ranging from contiguous suburban growth, linear patterns of strip development, leapfrog and scattered development. In terms of urban form, sprawl is positioned against the ideal of the compact city, with high density, centralized development and a spatial mixture of functions, but what is considered to be sprawl ranges along a continuum of more compact to completely dispersed development.

At the more compact end of the scale, suburban growth (i.e. a contiguous expansion of existing development from a central core) was identified as sprawl in the early literature of the 1950's and 1960's, but this more compact form is no more classified as sprawl now.

"Scattered" or "leapfrog" development lies at the other end of the scale. This form exhibits discontinuous development away from an older central core, with the areas of development interspersed with vacant land.

Compact growth around a number of smaller centres which are located at a distance from the main urban core is also classified as sprawl. This is superficially similar to the poly-nucleated city (which is not referred to as sprawl) where the downtown is served by several more distant centres. The distinction between the two depends on the level of services offered by the centres and the level of interaction of the city centres with the surrounding suburbs. Linear urban forms, such as strip development along major transport routes have also been considered sprawl.

One problem with these definitions is that the resulting impacts of these different forms may be vastly different. As some other authors do, we would therefore suggest

to acknowledge that there are different levels of sprawl which require different policy measures.

Galster et al. (2001) have classified sprawl into distinct types that match those in Table 2.1. They define strip or linear development, development that leapfrogs over green space, and development that is continuous but scattered, interspersed with much vacant or non-urban land.

	High Density	Low Density
Compact Contiguous	Circular or radial using mass transit	Possible but rare ?
Linear Strip Corridor	Corridor development around mass transit	Ribbon development along radial routes
Polynucleated Nodal	Urban nodes divided by green belts	Metro regions with new towns
Scattered Discontiguous	Possible but rare ?	Metro regions with edge cities

Table 2.1: Types of sprawl

2.1.5. Definitions based on land use

Land use patterns are another element which can contribute to define sprawl. Sprawl is commonly associated with land uses which are spatially segregated.

In the common view of sprawl which applies in the United States, for example, the characteristics of sprawl are among others homogenous single family residential development, with scattered units ; non residential uses of shopping centres, strip retail, freestanding industry, office buildings, schools and other community uses ; and land uses which are spatially segregated. This pattern of segregated land uses in turn induces a high reliance on private car for transport.

However "less dense" patterns don't occur always and everywhere in the same way. As regards the distribution and organisation of land-use activities and urban functions, different patterns have been identified/may exist : mixed or single land-use patterns, patterns of different rural-urban relationships, concentrated, clustered or dispersed patterns.

2.1.6. Temporal dimension and urbanisation process

There is also a temporal dimension in the issue of urban sprawl. It is likely that the different forms and the different functional organisations mentioned above correspond to various "ages" of the phenomenon of sprawl. For example :

- first age: very scattered – only residential

- second age: progressive densification – addition of retail and public services (schools, etc), i.e. employment directly induced by the population
- third age: still densification – addition of jobs - evolution towards autonomous centres also providing jobs to their residents.

Urban sprawl can therefore also be considered as a (more or less long) stage in the evolution process of an urban region.

Urban population is still growing and the growth of cities is a significant phenomenon. As an example of what was suggested above, but at a broader temporal scale, there was some discussion at the United Nations (1998) of urban growth following a pattern of "urban transition" and urban sprawl corresponding to a phase of this growth. The first phase is of fastest growth in the core of the city, termed urbanization in the United Nations report ; the second phase is suburbanization with fastest growth just outside the city core; the third phase is counter urbanization, with population in the core and suburbs moving out to more rural areas, and the fourth phase is re-urbanization with an increase in population in the core of the city. According to this model, the phenomenon of urban sprawl would fall into the third phase of growth.

2.2. Contexts and causes

According most authors, the main causes of sprawl are as follows :

- the increase of income and the social demand for low density settlements
- the decrease in travel times and travel costs, from the periphery to the urban core
- the differences in housing market and the different tax rates, between the urban centre and the periphery
- the competition between administrative units (e.g. communes) to attract households or companies
- in some countries, national policies which favour low density settlements.

2.2.1. The consumer demand for single family low density housing

Some authors see the sprawl as a result of the consumer demand for low-density single family housing on large lots. According to this view, demand is driven by individual preferences : a strong desire for owning a single family home, having an adequate environment for raising a family, for privacy and for a rural ambiance.

Some authors also emphasize that, beyond the consumer preferences, this demand has been in some cases manipulated by public subsidies. In the United States for example, these took the form of federal assistance on mortgages.

In Europe, between the 70s and 80s, two simultaneous events opened the door to the first important wave of uncontrolled sprawl : the end of the welfare state, which dramatically reduced the level of national government subsidies to, among others, the housing sector; and the misinterpretation of demographic trends which, while showing a total decline of population (the end of the baby boom) were instead hiding an increase in the demand for new housing due to an unforeseen reduction in the size and lifestyles of households. The demographic explosion and immigration cycle of the post war period which had accelerated the concentration of population in towns and cities was now pushing towards the suburbs that part of the middle-class popula-

tion which, helped by the economic expansion, the increased levels of income, the change in life-styles, and the affirmation of an anti-urban ideal chose to relocate in the outer suburban areas.

2.2.2. The role of the transport system

A drastic change in the transport systems, by drastically decreasing travel times and travel costs, is perhaps the single most important enabling factor leading to urban sprawl. In many countries, the development of the private automobile and the corresponding growth of the highway system played that role. But, it should be noted that in United Kingdom for example, the development of urban sprawl and suburban housing was more related to the growth in the public transportation network than to the increase in car use. In London, for example, the growth of the suburbs began with the extension of the rail network to the suburbs in the 1860's, producing a radial pattern of growth along the lines of transportation. The latter development of a more widely spread, circular pattern of growth was also a result of the development of public transportation, in this case by motor bus. The private automobile played little part in the development of urban sprawl.

2.2.3. A lack of coordination between policies

An indirect cause of sprawl, or at least a cause of the incapacity of the authorities to control sprawl in its early stages, is the fragmentation of the political decision-levels, due to multiple institutional levels involved (local/regional/national or federal), multiple administrative territories covered, and multiple fields of competences (land planning, housing, transport, …) involved.

The fragmented planning systems and the parallel institutional fragmentation are considered by many authors the main barriers to an effective regulation of urban growth and therefore also urban sprawl. Countries with little or no spatial planning activity at the intermediate or regional level lack of the correct perspective to capture actual growth dynamics. Moreover, due to uncoordinated and fragmented planning, policies to prevent sprawl have usually little effect, as they are uncoordinated and not implemented over a wide enough area. The negative effects of this spatial fragmentation are clear, for example, in the case of fiscal policies.

In some countries, not only co-operation between administrative units is poorly practised, but also they compete with one another in the quest for collecting more population (i.e. housing) and jobs (i.e. business and industrial enterprises) as this will lead to higher public revenues (by means of local taxes). In such countries where each unit autonomously sets its own rates of taxes, less-urbanised communes in the peripheral areas will be likely to set low rates to attract economic activities and new residents.

2.3. Effects and costs

The effects of urban sprawl are one of the most hotly debated issues in the literature, with most usually focus on the negative effects.

2.3.1. The relation between urban form and sustainability

It is also now generally accepted that urban form has an effect on sustainability. However, at the level of the researchers, the current debate on the sustainability of different urban forms, roughly grouped into compact models and diffused models, is

still open, among others due to the complexity embedded in a concept such as "sustainability".

With regard to the ecological dimension of the sustainability concept, both the United Nations and the European Union have moved in favour of a the compact town model embracing the position, supported by research, that more dense cities consume the least amount of energy for transport.

At the macro-economic level, issues of economic efficiency and economic performance of cities emerge.

The European Union has pronounced itself in favour of the compact city model (European Commission, 1990) and of the polycentric regional systems (European Commission, 1997). In this sense the EU has embraced a successful approach adopted in some European countries where policies of urban containment have been balanced by strategies of "concentrated de-concentration".

2.3.2. Negative and positive effects

The effects of sprawl can be divided into five groups, namely : public and private capital and operating costs, transportation and travel costs, land/natural habitat preservation, quality of life and social issues.

Another approach is to divide the effects into 3 groups according to the three dimensions of the sustainability concept : ecological effects, economical effects, and social effects.

The usually admitted negative effects are listed below :

- consumption of land, loss of high quality agricultural land and open space
- destruction of biotopes and fragmentation of eco-systems
- higher costs of new neighbourhood infrastructures
- higher costs of public services and especially transport services
- land use patterns which are unfavourable to the development of collective and other sustainable transport modes ; hence, increase of the level of use of private car
- increased trip lengths
- congestion on the radial roads giving access to the urban centres
- increase in fuel consumption
- increase in air pollution
- contribution to the decay of downtown areas
- social segregation (concentric model of population distribution on the base of age, family size, social and professional class) and reduction of social interaction, but authors are not quite unanimous on this point ; anyway, note that the housing market plays a major role in nurturing the social segregation
- poor access to services for those with limited mobility such as the young and elderly.

The pattern of spatially segregated land uses also raises the issue of possible spatial mismatches within intra-urban poly-centricity: mismatch between population and jobs location, spatial mismatch of professional skills, where jobs and unemployment lie side by side and finally, the hypothesis that job decentralisation harms low-income residents of central cities because of barriers that limit their access to suburban labour markets.

Another effect, without "positive" or "negative" label, concerns the origin-destination distribution of transport: the part of "tangential traffic" (suburb-to-suburb) seems to increase constantly. Note that, in the last decades, investments in public transport were focussed on connecting inner and outer suburbs and peripheries to the central business district, thus supporting a centripetal transport model and a monocentric urban system. Little attention was given to the problems of transit within the emerging intra-urban polycentric systems, especially with regards to the so called "tangential" mobility.

On the other hand, the positive effects are mostly situated at the individual level :

- access to cheaper private residential developments : middle-class households have the possibility to become owners of single family housing, with enhanced personal and public open space;
- access to cheaper private non-residential developments : young SME and companies have more pleasant work environment than what they could have afforded in the urban centre.

2.3.3. Ecological sustainability

"The use of land for urban development and transport in the EU continues to harm the environment through, for example, loss of high quality arable land, destruction of biotopes and fragmentation of eco-systems. In some regions there are increasing spatial conflicts between additional housing requirements, commercial developments, agricultural use and protection of open space" (European Commission, 1997). Land consumption depends directly on the relative compactness of human settlements and on residential density. The amount of open space used by each inhabitant has been measured to have increased in the last 20 years by two or three times. However this measurement of land consumption is not always agreed upon.

Land consumption for residential use is not the only factor to be considered. Another factor is the high consumption of land for road infrastructure: 25% of the total urban area in Europe and 30% in the United States. Research carried out in the Paris region showed that the private car, which accounts for 33% of total trips, consumes 94% of road space/hour; while the bus, with 19% of total trips consumes only 2.3%: in other words, a bus in movement consumes 24 times less space per passenger than a single car.

2.3.4. Economic sustainability

The economic sustainability of the dispersed city model must be addressed at two different scales. On one hand there is the individual level. Urban sprawl tends to impose several and often hidden costs (notably transport costs) on individuals and households. A study on the area of Ile-de-France has shown strong correlation between the distance from the city centre and the percentages of the households' budget devoted respectively to housing and transport (Pumain, 2002). On the other hand, at the macro-economic level, issues of economic efficiency and economic performance of cities emerge. Urban sprawl is often associated with high costs of urbanisation. Due to the low density of housing and population and to the scattered pattern of urbanisation the economic feasibility of public services, especially transport services becomes difficult. Unfortunately data collection and a complex framework of interconnected factors make the economic analysis and modelling of the costs and benefits associated with urban sprawl particularly difficult.

Issues of economic performance and city size or form can also be raised, even though the debate remains still largely theoretical. If it is difficult to establish a causal link between the size of cities and their economic efficiency, it is even the more speculative to associate the latter with urban density. Recent studies (Prud'homme, 2000; Cervero, 2001), indicate that places with sprawling, auto-centric landscape are poor economic performers while economic advantages of agglomeration and of higher employment densities still persist for large cities and that various innovations (notably new information and communication technologies) can help overcoming the restrictions on growth related to congestion.

2.3.5. Social sustainability

In European cities mostly affected by dynamics of sub-urbanisation and sprawl, space has developed according to clear patterns of social ecology. These patterns can be described as a concentric model of population distribution on the base of age, family size, social and professional class. The degree of spatial demographic segregation of household and family structures vary sharply as one moves outwards from the central city towards the suburbs and has been greatly accentuated during the 1980s. The European city, the very place of social interaction, innovation and exchange, risks to lose this fundamental role as a result of the cumulative effect of decentralisation tendencies, of the increasing specialisation of land uses and of social segregation. However differences must be made with regard to the size of cities. Large cities display a different population distribution pattern from medium size cities while smaller cities show lower levels of segregation and sometimes trends of social mixing and inclusion in their suburban areas. Studies for the Paris area and other minor French cities (Berger, 1999) have demonstrated that professional qualification, households' size and income are among the variables which can describe location pattern. However location choices cannot only be explained by sociological factors. The role played by the housing market and policies in nurturing spatial segregation remains dominant to a point, which it has become the mean of social segregation in sprawling cities.

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3. THE 6 CASE CITIES

4. URBAN SPRAWL AS EXPERIENCED AND PERCEIVED BY LOCAL AUTHORITIES

4.1. Objectives and methodology

Quantitative data analysis (e.g. statistical analysis) and simulation modelling can only partially disclose the interactions between causes and effects, factors and consequences. This means that these approaches can investigate only some of the relationships between all the elements involved.

The purpose of this work package, dedicated to 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. Such goals are achieved by analysing interviews conducted with local authorities' representatives and experts in the six case cities of Bristol, Brussels, Helsinki, Milan, Stuttgart and Rennes.

A qualitative analysis approach based on semi-structured interviews was adopted, to offer an in-depth and complementary understanding of the mechanisms of urban sprawl, notably the local and inherent events that triggers urban sprawl and the actual role of planning interventions.

In total 26 interviews were carried out to local authorities representatives and experts in the 6 case cities. Fig. 4.1 shows the distribution of interviews among cities. In general, local authorities representatives have been selected for interviews on the base of their capacity to provide, altogether, an overall view of the study area. Where relevant, the interviews have tried to embrace different administrative levels (local, metropolitan, regional), thus supplying a wider range of perspectives and opinions on urban sprawl.
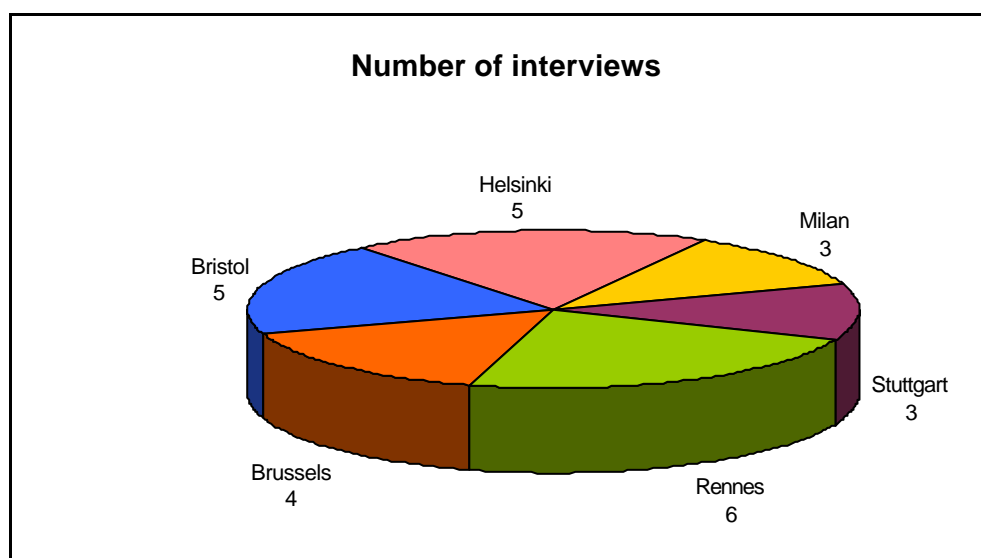
Figure 4.1: Number of interviews in each case study area

The synthesis is based on contents analysis, a procedure 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. This methodology is especially appropriate for the analysis of semi-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.

4.2. Analysis results

4.2.1. New concepts and descriptive categories for urban sprawl

The objectives are to detect and understand:

- the relevance of urban sprawl in the decisional agenda of local authorities;

- the local events and rationale involved in the emergence of urban sprawl;

According to this perspective interviews have been analysed in search of information that could be attributed to one of these two main sets of arguments.

Given the exploratory nature of the interviews and of the analysis methodology, new concepts, interests and concerns surrounding the issue of urban sprawl have had the possibility to emerge. This has lead to a redefinition of the original set of concepts and categories.

4.2.2. The scale of analysis

The analysis of interviews has revealed a general concern about the analysis framework that the SCATTER project has adopted. In particular, the geographical extent of the area of analysis, the spatial scale and the data sets (analysed via statistical modelling) were often considered unable to represent the actual dimensions and mechanisms of urban sprawl.

The geographical scale and extent covered in the SCATTER analytical framework and described fully in D3, explains urban sprawl as a centrifugal growth based on a structure of concentric rings of decreasing density that have their core in the main urban centre. Urban sprawl is a local process of population dispersion and growing land consumption and infrastructure congestion.

Several interviews suggest that a larger geographic extent should be used. Such scale would reveal more complex dynamics and interactions among the main and secondary urban centres of the region. At this scale other explanatory factors emerge: the role of population and jobs redistribution processes; the role of conflicting and/or cooperating planning interventions among the involved municipalities; the impact of regional, national or even international infrastructures investment. Moreover urban sprawl ceases to be only the cause of negative impacts and becomes also a virtuous phenomenon promoting local development of small and medium urban centres.

4.2.3. The relevance of urban sprawl in the decisional agenda of local authorities

To understand the level of awareness of local authorities with regards to urban sprawl, the analysis of interviews has focused on the relevance of the topic in the de-

cisional agenda of planning offices and on the level of knowledge exhibited by the interviewees.

The former has been assessed by the attention given in the design of policy measures or planning interventions to issues such as mobility and congestion, land consumption and the quality of the urban environment. With this regards there is a growing consideration among individuals responsible (in different ways and at different institutional levels) for planning to problems such as the increasing congestion and traffic not only within urban centre but also in peripheral areas and in the surrounding regions. The need for an improved coordination between land-use and transport planning as well as for a more effective control of the production of the built environment are perceived as crucial steps in the struggle against urban sprawl.

Local authorities, however tend to overlook the fact that urban sprawl due to its nature of unplanned urban growth, often trespasses local administrative boundaries: when this occurs, coordination between the different local authorities is essential to the design of a common strategic action but also to find consensus over the implementation of coordinated policies and to reduce the conflicts based on the competition among different areas and urban centres, which try to capture or reject population, employment, new development areas, wanted or unwanted land-uses.

These factors as well as the definition of a proper institutional arena for decision-making are crucial to the success of any policy measure designed with the purpose to mitigate the impacts of urban sprawl.

The debate on the 'proper institutional level' is still open. Opinions collected through the interviews range from the definition of a metropolitan or regional authority with land-use and transport planning competences to the formula of voluntary bottom-up cooperation among local authorities, which has been successfully tested in some cases.

4.2.4. Factors determining urban sprawl

A second objective of this work package was to understand the local events involved in the emergence of urban sprawl and its mechanisms. The analysis of the interviews has highlighted a wide range of factors responsible for the location and relocation of population and productive activities. These can be grouped into four main categories: planning regulations and interventions, the changing structure of population and households, the structure of employment of the economic sectors and the negative externalities associated with urban agglomerations. Table 4.1 shows the list of individual factors within each category.

Public policies and plans	The structure of population	The economic sector	Negative and positive externalities
■ Building and land-use regulation	■ Diversification and fragmentation of household's typologies	■ Restructuring and relocation of industrial activities	■ Reduced access to services in urban agglomerations
■ Location of business, industrial or commercial centres	■ Increase of incomes	■ Growth of the service and business activities and decline or restructuring of agriculture	■ Increasing pollution and criminality in urban centres
■ Investments and realization of transport infrastructures and services	■ Diversification of life-styles and work-styles		■ Increasing land values in central areas
■ Regeneration plans in the central areas	■ New ideological and cultural trends		■ Lack of open and green spaces in urban centres
			■ Reduced travel times and travel costs from urban centres to peripheral areas (and *vice versa*)
			■ Increased accessibility of peripheral areas

Table 4.1: Causal factors of location dynamics

Planning regulations and interventions

In all the six study areas, public planning has played a significant role in determining the current spatial and functional structure. However a distinction is needed between:

− planning and building regulations and laws that have set opportunities and constraints and have influenced the behaviour of households and productive activities and their decision to change location

− more localised interventions such as new residential, industrial or business development areas and transport infrastructure that influence where urban growth can take place.

The changing structure of population and employment

The analysis of interviews has highlighted how important changes in demographic and economic trends are as causal factors of urban sprawl. Global trends such as new lifestyles, migration, tertiarisation of economic base have a direct physical manifestation in residential patterns; they affect the distribution and composition of population and economic activities.

The main changes in the demographic regime have occurred in Europe in the last thirty or forty years. These can be described as follows:

Changing demographic profiles (multiethnic urban society, aging of population, shrinking family sizes);

Migration

Changing attitudes and lifestyles (higher incomes, from collective attitudes to more individualistic behaviours)

Negative externalities of urban agglomerations

European cities are not at risk of the 'doughnut effect' that is common in the United States. Central areas are still vibrant and they continue to attract jobs and population.

However, as mentioned above there is a 'natural' selection of which demographic groups and productive activities can locate in the core areas. Therefore de-urbanisation processes are still strong and similarly selective and they can be credited to the growing negative externalities of urban agglomerations. A part from the increasing costs of life in the central areas of cities other factors are at the origin of out-migration such as increasing pollution and criminality, reduced access to public services such as schools and health centres and lack of open and green areas

4.2.5. Four profiles of urban sprawl

Not all the functional and spatial patterns resulting from these location and migration dynamics have been described as urban sprawl by the interviewees. Four main ty-pologies of sprawl have been identified and the following sections give a profile of each. Profiles comprise a description of their spatial and functional structure, the most relevant impacts and an outline of the policies that either have been implemented or have been suggested by the interviewees to mitigate and control the problems connected to each typology.

Sprawl as an emergent polycentric region

When observed at the regional scale urban sprawl is characterised by the emergence or development of secondary urban centres. Population and jobs migrate out of the main urban centre of the region and tend to relocate in existing urban centre where agglomeration economies offer clear advantages to urban modes of living and working. The type and intensity of relationships among centres (and between these and the main centre) therefore design a polycentric spatial and functional structure of the region.

Relationships among centres can be based on varying degree of intensity and functional specialisation, on a hierarchical distribution of functions or on horizontal and equipotential links. Polycentric urban regions can evolve in different ways:

- A centrifugal mode where the continuous growth of the monocentric node impose such diseconomies that the most affected production and functions are squeezed out to alternative centres which in the long run may rival the original centre.

- An incorporation mode where a large urban centre expands its urban field and incorporates smaller centres, which were to that point self-sufficient in terms of employment and services. The system forms a powerful catalyst for extra non-residential activities with a stronger challenge to the original centre.

- A fusion mode with the fusion of previously independent centres of similar size and importance. The improvement of transport links plays a major role in this mode.

The main negative impact is a general quantitative increase of mobility and especially on transport infrastructure towards the main urban centre. Congestion on radial routes, rings of traffic jams and reduced accessibility to the central areas have been identified. In these areas transport policies based on an increase of the supply of infrastructure have failed in their goal to decrease, in the long term, travel times towards the main centre. On the contrary they have in the short-term, facilitated mobility, which has resulted in a subsequent further increase of the length of trips and of congestion. In the long run these secondary impacts have overcome the initial benefits of such policies and, by improving accessibility, they have often created an incentive for new waves of urban sprawl.

In terms of development of new infrastructure, several interviewees have suggested that the attention be given to horizontal/peripheral links in order to strengthen functional and spatial interactions among all the centres of the polycentric region and not only interactions with the main centre.

Although increasing, mobility is still organised according to a systematic structure of origin/destination patterns and on an orderly system of existing infrastructure, which makes it easier for public transport projects to reach economically feasible density thresholds. As a consequence, accompanying measures to reduce the number of trips by private car have been implemented and suggested. The possibility to increase the share of trips using public transport rests on the ability of the adopted policies to move as many users as possible from one mode of transport of the other. With this regard, the analysis of interviews has shown that 'variables' other than land use and spatial patterns can be considered such as road-pricing, park-pricing, congestion charges, tax on CO_2 emissions which tend to impact and modify individual behaviours by privatising the costs of car usage.

These patterns of urban sprawl have also been described by their positive impact. In fact by redistributing population and employment urban sprawl promotes local development in small and medium size cities. These can offer a better environmental quality and accessibility, more and better local public services such as schools and health centres.

Sprawl as a scattered suburb

This typology of urban sprawl is characterised by infill process by which scattered and low density housing developments locate between centres or between transport infrastructures. The quality of housing and of the residential environment is high but there is a limited supply of public services, mainly composed of commercial centres making this type of sprawl similar to the American suburb. The impacts are mainly due to the scattered and low-density nature of these developments.

Accessibility is mainly provided by private means of transport because of the fragmented character of trips. The multiplication of origins and destinations of trips and their high diversification (almost randomisation), make it impossible to reach feasibility threshold for public transport.

Moreover the low density of these developments generates high levels of land consumption both for housing and infrastructures and higher urbanisation costs.

This type of sprawl is mainly the result of the transition from altruistic, collective attitudes to more individualistic, self-gratifying behaviours with regards to living and working. This is demonstrated that despite the lack of a sense of community and of urban identity, these residential neighbourhoods are still the preferred location of the majority of young families with children and a medium to high income.

Solutions are mainly directed at promoting more compact and mixed land-use development. This goals can be reached, as suggested by the interviewees, by a more strategic and coordinated land-use and transport planning and by the definition of building regulations, laws and fiscal measures which promote more dense developments.

Planning and land-use control should move away from a traditional approach that focuses mainly on the control and regulation of the demand of land towards a more rigid control also of the supply of development areas.

In this concern, building regulations which impose a minimum and maximum size of building lots, define building typologies and control the distribution of urbanisation costs between private and public actors, can have a significant impact on density levels, on the balance between mono and multifunctional development and on the quality of the built environment.

Sprawl of peripheral fringes

Sprawl is not only about population groups who have and exploit the chance to relocate but also about those who have no other chance but to relocate because of the increasing costs of life in the urban centres. In some cases these population groups are represented by Illegal immigrants, students retired who do not have access to the residential suburbs described above. In other cases the process of peripheral growth that occurs in the first ring of available land around the main centre substitutes the previously described process of suburb formation and involves a wider range of types of population and households. This happens particularly in those situations where geographical, infrastructure or planning constraints limit accessibility to areas too far from the main centre. Anyhow peripheral fringes become the only possible location of these groups of population.

These take the form of the old public housing peripheries of the 50s and 60s and of the new peripheries, often poorly designed by a private sector seeking speculative interventions. They are characterised by higher densities than suburban developments and can be found not only around the main urban centres but also the secondary ones.

The obvious impacts are an increasing level of social deprivation or segregation and the degradation of the built environment. Possible solutions have been identified in regeneration programmes focused on peripheral areas rather than on the central areas of the main and secondary centres. In several cases, regeneration plans have also exploited an improved concern with regards to the coordination of land-use and transport planning at the neighbourhood scale.

Commercial strips and business centres

Another form in which urban sprawl manifests itself is the realization of commercial and service and business centres outside the compact city boundaries. These developments reflect the result of a planning approach that sees land-uses as mutually competitive and produce a system of market forces, which play a critical role in determining land price mechanisms. The location of these land-use functions follows a rationale based on accessibility, low cost of land and agglomeration economies. As a result these activities locate close to transport infrastructure like airports, ports, and motorways' junctions sometimes also in consequence of public or private/public planning decisions.

These developments generate induced mobility on main transport infrastructure. This is not only commuting but also 'random' mobility for leisure and shopping, hardly captured by public transport. High levels of land consumption are also a key feature due to the scarce attention of the public actor as a land provider. In fact the design of planning and fiscal measures to control the demand and supply of development areas is identified as one of possible solutions to the negative impacts of this typology of sprawl.

These areas also tend to attract further, unplanned housing development setting the ground for urban sprawl. These impacts, as suggested in the interviews, could be

better controlled through the strategic design of commercial plans in coordination with transport and land use plans

4.3. Conclusions

One of the main difficulties faced in trying to build a synthesis of the set of interviews carried out within this work package is the 'isolation' of structural and 'global' causal factors of urban sprawl from situated and local ones. As underlined originally in the state of the art literature review, local contexts (social, economic and spatial structure, planning systems, fiscal and regulative frameworks) play a significant role in the emergence of urban sprawl.

This general synthesis has tried to identify and highlight the key common factors and events.

To summarise these common factors the following statements can be made:

- Urban sprawl is mainly originating in situations when new demands arising for the increase in households' incomes are met mainly by the private sector. The housing and land market and the lack of measures to control the increasing use of private means of transport are the main causes.

- Sprawl is also perceived as relating mainly to housing rather than to an 'ill' structure of land-use distribution and planning. This is due to a tradition in planning analysis and practice that looks at spatial functions as alternative and mutually competing uses of scarce land. Although there is a call for mixed land-use planning as a possible solution in particular to the mobility problems induced by sprawl the attention to the possibility offered by economic and fiscal measures is still scarce. Costs and benefits have been since long investigated by the American literature but planning practice in Europe has focused mainly on the possibility to control sprawl by means of land-use and transport planning. To control the process and dynamics of urban sprawl is in so far very difficult, since often a mixture of the four different types of types of urban sprawl can be found. Finally, there is a need to define the 'proper institutional level' at which policies to control urban sprawl should be implemented. As mentioned above the debate is still open. With this regards, local authorities should be supported in the definition of a knowledge framework and in the identification of best available practices and in the selection of which success factors could be suitably implemented in local contexts.

- Several of the fundamental issues raised in this synthesis of the interviews were dealt further in the case studies on policies, which tackle the policy measures aiming to limit or control urban sprawl, their efficiency, and the institutional barriers to their implementation.

5. HOW TO MEASURE URBAN SPRAWL: STATISTICAL ANALYSIS AND EMPIRICAL EVIDENCE

The statistical analysis method is based on a comparison of basic statistical indicators and an advanced shift share procedure on the case cities.

5.1. Generalised shift-share-analysis

The standard shift-share analysis is a method of comparative statistics of estimating the relative importance of different elements in any growth or decline of regional industrial employment (Houston, 1967, Blair 1995, Blien, Wolf 2001). This change could be due to the national rate of change in manufacturing, or the industrial structure of the region itself and its locational advantages or disadvantages. In so far, the shift-share analysis examines the recent performance of a region's economy. It separates the growth effects explained by the mix of industries located within the region (e.g., the region's industrial structure) and the growth attributed to particular regional influences. Shift-share accomplishes this by comparing the actual growth rate of the region to the growth rate that would have occurred if every industry in the region under consideration had grown at the national growth rate for that industry.

The shift-share technique is only a descriptive tool (Stevens, Moore 1980). It should be used in combination with other analyses to determine a region's economic potential. Shift-share does not account for many factors including the impact of business cycles, identification of actual comparative advantages, and differences caused by levels of industrial detail. A shift-share analysis is a "snap-shot" of a local economy at two points in time. Thus, the analysis may not offer a clear picture of the local and national economies since the results are sensitive to the time period chosen. On the other hand, the shift-share technique provides a simple, straightforward approach to separating out the national and industrial contributions from local growth. It is also useful for targeting industries that might offer significant future growth opportunities.

For Scatter it is therefore necessary to generalise the shift-share procedure in order to deal with time-dependent and even cyclical socio-economic development effects and to separate regional disparities from national or regional trends. This means, that the method is shifted from an economic target towards a more geographic target, without specifying regional explanatory variables from the very beginning. In general, it can be assumed, that in case of sprawl, the growth factors of the peripheral regions are different from those of the city centre and exhibit a time-dependence. The next section is dealing with the estimation of time-dependent growth effects and the separation of regional and average growth factors.

5.1.1. Estimation of the growth factors and definition of growth indicators

Long-term data series are rather difficult to find, and data uncertainties may lead to fluctuations in the estimated growth rates. In addition, it is an empirical fact that the spatial development of a region, even without any specific investment or political intervention is not homogeneous. Homogeneous growth is rather an exception than the rule. Therefore, an appropriate estimation procedure of the impacts of urban sprawl should fulfil the following conditions:

- stable estimation algorithm (for different time series and zoning)

- flexible to the structure of the data base (stock data for different time steps, not necessarily equal time steps)

- introduction of as little parameters as possible

- estimation and separation of the average development (average growth effect)

In order to take into account the usual data restrictions and uncertainties as well as the further requirements mentioned above, the spatial dependency and the growth effect will be modelled as:

$$\vec{X}(t) = \vec{X}(0)\exp[\vec{\Lambda}(t)t]\xrightarrow{|\vec{\Lambda}(t)|<<1}\vec{X}(0)\,(1+\vec{\Lambda}(t))^t \tag{5-1}$$

where the vector of the zone specific growth factors

$$\vec{\Lambda}(t) = (\vec{\Lambda}^a(t)) = (\Lambda_1^a(t),\Lambda_2^a(t),...,\Lambda_L^a(t)) \tag{5-2}$$

consists of two components: a time dependent "average" growth rate $\boldsymbol{l}^a(t)$, characteristic for the study area, and a zone specific time depending factor $\boldsymbol{g}_i^a(t)$, representing zonal deviations from the average growth path.

$$\Lambda_i^a = \boldsymbol{l}^a(t) + \boldsymbol{g}_i^a(t) \quad \text{for} \quad t = 0,1,2,...,t_0,...,T \tag{5-3}$$

In so far $\boldsymbol{g}_i^a(t)$ describes beside zonal particularities possible spatial effects, e.g. because of specific regional policies to mitigate zonal disparities, or the decreasing impact with distance of a specific investments. Of course, urban sprawl may have different impacts on the considered bundle of socio-economic indicators of the different case studies. This is reflected via the index $\boldsymbol{a}$.

1st step (estimation of the average growth rate)

The estimation procedure of the average annual growth rate $\boldsymbol{l}^a(t)$ is based on the definition of the growth rate (5-1), leading to

$$X^{a\,(emp)}(t+\boldsymbol{t}) = X^{a\,(emp)}(t)\exp\left[\sum_{t'=0}^{t-1}\boldsymbol{l}(t+\boldsymbol{t}')\Delta t_{t+t'}\right] \tag{5-4}$$

where $X^{a\,(emp)}(t)$ represents the total volume of the variable $\vec{X}^a(t)$ for the whole study area[8], if $\vec{X}^a(t)$ is a stock variable (e.g. total population of the study area). In case $\vec{X}^a(t)$ is a density variable (e.g. income per capita), $X^{a\,(emp)}(t)$ represents the spatial average of the considered variable $\vec{X}^a(t)$. As result of the first estimation step, (5-4) finally leads to the average annual growth rate $\boldsymbol{l}^a(t)$ of the study area:

$$\boldsymbol{l}^a(t) = \frac{1}{\Delta t_t}\ln\left(\frac{X^{a(emp)}(t+\Delta t_t)}{X^{a\,(emp)}(t)}\right) \tag{5-5}$$

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[8] "emp" means "empirical" (observed)

The time step Δt_t takes into account that the length of the time intervals may differ. These growth rate $I^a(t)$ can be compared with the national growth rate or other specific growth rates in order to identify general evolutionary trends of the economic system.

2nd step (estimation of zonal growth differences)

The determination of the zonal deviations $g_i^a(t)$ of the average growth can be computed via

$$g_i^a(t) = \frac{1}{\Delta t_t} \ln\left(\frac{X_i^{a\,(emp)}(t + \Delta t_t)}{X_i^{a\,(emp)}(t)} \right) - I^a(t) \tag{5-6}$$

3rd step (moving average of $I^a(t)$ and $g_i^a(t)$)

The estimated parameters via (5-5) and (5-6) may exhibit some noisy structure, e.g. due to possible data uncertainties. Therefore it seems to be appropriate to filter the mean growth rates and the deviations of the growth rates in order to smooth out such artefacts. Hence, in the following a Gaussian moving average procedure is applied, according (5-7) to (5-10):

$$\tilde{g}_i^a(t) = \sum_{t'=0}^{T-1} g_i^a(t') \cdot gauss(t,t') \tag{5-7}$$

$$\tilde{I}^a(t) = \sum_{t'=0}^{T-1} I^a(t') \cdot gauss(t,t') \tag{5-8}$$

$$gauss(t,t') = \frac{1}{N(t)} \exp\left(\frac{1}{2}(t-t')^2 \right) \tag{5-9}$$

$$\sum_{t'=0}^{T-1} gauss(t,t') = 1 \quad \text{for} \quad t = 0,\ldots,T-1 \tag{5-10}$$

The smoothed parameters will be indicated by the sign „~". All further calculations and considerations are base on those smoothed variables.

5.1.2. Temporal mean growth rate

As indicators of growth, the temporal mean growth rates $\tilde{I}^a$ and $\tilde{g}_i^a$ are introduced. The mean growth rate of the study area and the mean deviation of the zonal growth rate are the result of a temporal average procedure, according to (5-11) over the whole time interval

$$\tilde{I}^a = \frac{1}{T}\sum_{t=0}^{T-1} \tilde{I}^a(t) \qquad \tilde{g}_i^a = \frac{1}{T}\sum_{t=0}^{T-1} \tilde{g}_i^a(t) \tag{5-11}$$

These indicators give some hints about the "stability" of the average and zonal growth processes. Since the temporal development of the growth rates for the six case studies differ considerably, those temporal mean growth rates are measures which can be listed in tables for comparison purposes.

5.1.3. The concentration-measure *H*: a new indicator for the identification of urban sprawl

Urban sprawl has a spatial and temporal dimension. Therefore, it is worthwhile to analyse the process of creation of sprawl by introducing a general spatial-temporal typology.

The *H*-measure quantifies concentration or de-concentration effects in the urban system. The *H*-measure is based on the observation that the process of densification is rather inhomogeneous in space and depicts quite different growth rates in time and space. Furthermore, the densification and the effect of urban sprawl is a phenomenon occurring rather on the margin of a city, than homogeneously distributed over the total area under consideration. Inspired by physics, the *H*-measure is introduced

$$H = \int \boldsymbol{r}(\vec{r})\,\vec{r}^{\,2}\, dA(\vec{r}) \qquad (5\text{-}12)$$

where the density (e.g. population density) $\boldsymbol{r}(\vec{r})$ at distance $\vec{r}$ from city centre is weighted with distance^2 from the city centre. The integration $dA(\vec{r})$ has to be performed over the whole case study area (*A* being the urban area).

In discrete terms we have:

$$H = \sum_{\vec{r}} \boldsymbol{r}(\vec{r})\,\vec{r}^{\,2}\, A(\vec{r})$$

$$= \sum_{i=1}^{L} \boldsymbol{r}_i\, \vec{r}_i^{\,2}\, A_i = H_X + H_Y \qquad (5\text{-}13)$$

with $\qquad H_X = \sum_{i=1}^{L} \boldsymbol{r}_i\, x_i^{\,2}\, A_i \quad$ and $\quad H_Y = \sum_{i=1}^{L} \boldsymbol{r}_i\, y_i^{\,2}\, A_i \qquad (5\text{-}14)$

As origin of the coordinates $\vec{r}$ the centre of gravity of the city areas is used. The *H*-measure is performed for the following quantities:

a) density indicator $\qquad \boldsymbol{r}(\vec{r},t) = \dfrac{X_i^{\,a}(t)}{A_i} \qquad (5\text{-}15)$

b) relative density indicator $\qquad \boldsymbol{r}(\vec{r},t) = \dfrac{1}{A_i}\dfrac{X_i^{\,a}(t)}{\dfrac{1}{L}\displaystyle\sum_{j=1}^{L} X_j^{\,a}(t)} \qquad (5\text{-}16)$

From the definition (5-12) it follows that an increase in the relative concentration-measure H^{rel} with time, using (5-16), indicates that the outer urban ring or the hinterland is growing in relative terms faster than the urban centre. For a temporal constant relative concentration-measure H^{rel} the development in space is homogeneous. This does not imply that *H* remains also temporally constant. In case of a temporally growing (declining) H – and a temporally constant H^{rel} – the considered total stock or density variable would homogeneously increase (decrease) over the total conurbation area. Spatial concentration effects in the urban centre lead to a decrease of the relative concentration-measure H^{rel}. The absolute values of *H* and H^{rel} for a selected variable represent the current state of the urban system with respect to its spatial concentration. If the temporal development of sprawl for a specific urban system is considered *H* and H^{rel} have to be compared for different points in time. Therefore, it is indi-

cated to scale the concentration measures H and H^{rel} to the first year t_0 of the analysis, according (5-17) and (5-18).

$$\hat{H}(t) = \frac{H(t) - H(t_0)}{H(t_0)} \tag{5-17}$$

$$\hat{H}^{rel}(t) = \frac{H^{rel}(t) - H^{rel}(t_0)}{H^{rel}(t_0)} \tag{5-18}$$

In case of $\hat{H}(t) > 0$ sprawl is likely to occur, for $\hat{H}(t) < 0$ concentration effects may dominate. However, an increase of the $\hat{H}$ – measure in the course of time is only a necessary condition for the occurrence of urban sprawl, and not a sufficient condition. For example, in case of a homogeneous growth process of a suburban ring-like structure, the H-measure may also increase. This kind of a decentralisation is rather related to a diffusion process, formed by centrifugal forces typical for a city meeting the conditions of a central place (Lösch 1962, Christaller 1933). Therefore, additional local measures, such as population density have to be considered in parallel, in order to be able to identify further typical spatial structures, which are related to urban sprawl.

5.1.4. Global and local indicators of spatial autocorrelation (LISA)

In order to get additional hints for the existence of urban sprawl, it is necessary to determine whether or not identifiable spatial pattern exist. In so far the identification of urban sprawl can be seen as a pattern recognition problem. Nevertheless, beside the morphological aspects the spatial organisation and its function are of importance. Of course, the spatial organisation of the urban system is reflected, at least partially, in its spatial structure, due to cyclical interactions.

To identify local spatial-temporal evolutionary pattern the correlations between nearby values of the statistics are derived and verified by simulations. One of the most popular test for the existence of spatial correlation pattern is Moran´s I statistics. It is used to test the null hypothesis, that the spatial autocorrelation of a variable is zero. If the null hypothesis is rejected, the variable is said to be spatially auto-correlated.

Some other standard global statistics and new measures of local spatial statistics have been developed recently (LISA). These methods include Geary C (see Cliff and Ord 1973, 1981), G statistics (Getis 1992), local Moran's I (Anselin 1995) and GLISA (Bao and Mark 1996). There are two aspects in common for all those spatial analytical techniques. First, they start from the assumption of a randomised distribution of spatial pattern. Second, the spatial pattern is derived from the statistical data only, without any pre-conceived theoretical notion (Bao 1998).

In identification of local spatial patterns, there are usually two issues in concern:

1) Is the observed value at location i surrounded by a cluster of high or low value?

2) Is the observed value at location i associated positively with the surrounding observations (similarity) or negatively with the surrounding observations (dissimilarity)?

The G statistics (Ord and Getis 1992; Getis and Ord 1994), and LISA (Anselin 1995) provide measures for the tests of the local spatial association which are of importance in the identification process of urban sprawl for the six case studies. The G-statistics can be used to identify spatial agglomerative patterns with high-value clusters or low-value clusters. The local

Moran's $I_i(d)$ identifies pattern of spatial autocorrelation within the spatial system independent whether or not high or low value clusters are considered. This specific property of local Moran's I is of importance for the identification of specific spatial pattern which can be related to urban sprawl and will be considered in the next section.

5.1.5. Local and global Moran's *I*

The local Moran's $I_i(d)$ for each observation *i* is defined as (Anselin 1995)

$$I_i(d) = z_i \sum_{j, j \neq i}^{L} \widetilde{w}_{ij} \, z_j \quad \text{with} \quad \widetilde{w}_{ij} = w_{ij} \bigg/ \sum_{j, j \neq i}^{L} w_{ij} \tag{5-19}$$

where the observations $z_i = \dfrac{x_i - <x>}{s(x)}$ and z_j are in standardized form (with mean of zero and variance of one). The spatial weights $\widetilde{w}_{ij}$ are in row-standardized form. We use here for the spatial weights w_{ij} an exponentially decreasing distance function, according to

$$w_{ij} = C \cdot \exp(-\frac{d_{ij}}{d_{1/2}}) \tag{5-20}$$

where $d_{1/2}$ describes the distance of influence of the zones and C is fixed by

$$\sum_{j=1}^{L} w_{ij} = 1 \ \text{(row- standardized)}. \tag{5-21}$$

So, $I_i(d)$ is a product of z_i and the spatial average of z_j in the surrounding locations.

The local Moran's $I_i(d)$ indicates the spatial correlation of a zone *i* with all other zones whereas the neighbouring zones have the strongest influence. Therefore the local Moran's $I_i(d)$ can be seen as a Local Indicator of Spatial Autocorrelation (LISA). A significant high value $I_i(d)$ (e.g. $I_i(d) > 1$) of the region indicates a high value of autocorrelation, $I_i(d) \approx 0$ indicates a heterogeneous or inhomogeneous neighbourhood of the zones, significant negative values of $I_i(d)$ (e.g. $I_i(d) < -0.2$) indicate that the neighbouring regions are quite different in its values (possible indication of "hot spots" or poles, e.g. like an urban employment pole in a rather rural hinterland).

Global Moran's $I_0(d)$ is defined as spatial mean value of the local measure, by

$$I_0(d) = \frac{1}{L} \sum_{i}^{L} I_i(d) = \frac{1}{L} \sum_{i}^{L} z_i \sum_{j, j \neq i}^{L} \widetilde{w}_{ij} \, z_j$$

$$= \frac{\sum_{i}^{L} \sum_{j, j \neq i}^{L} w_{ij} \, (x_i - <x>)(x_j - <x>)}{s^2(x) \sum_{i}^{L} \sum_{j, j \neq i}^{L} w_{ij}} \tag{5-22}$$

The expectation value $E(I_0(d))$ and variance $s^2(I_0(d))$ of global Moran's $I_0(d)$, for a sample size *n*, can be calculated on the basis of the spatial data distribution (Cliff and Ord 1981, Goodchild 1986).

The test on the null hypothesis, namely that there is no spatial autocorrelation between the observed values (*n* locations) can be calculated based on the standardized statistics via

$$Z(I_0(d)) = \frac{I(d) - E(I_0(d))}{\sqrt{s^2(I_0(d))}} \qquad (5\text{-}23)$$

The Moran $I_0(d)$ is significant and positive when the observed values for locations within a certain distance *d* tend to be similar, negative when they tend to be dissimilar, and close to zero when the observed values are arranged randomly and independently over space (Goodchild 1986). Therefore, global Moran's $I_0(d)$ can be seen as a measure of spatial autocorrelation within the whole study area.

5.2. Statistical analysis of the case cities

5.2.1. Spatial aggregation and zoning system of the case studies

For the comparative analysis of the occurrence of urban sprawl, and the detection of socio-economic similarities and differences between the six case studies, two different zoning systems were used:

1. Subdivision of the case study area into three macro-zones. This zoning system gives some more aggregate hints, with respect to the dynamics of the urban and regional system. For this aim a subdivision into

   – urban centre,

   – outer urban ring,

   – hinterland.

   was chosen[9]. The first zone deals with the urban centre of the study area. The second zone concerns a more or less concentric ring around the urban centre (outer urban ring), the hinterland (third zone) represents the remaining areas of the study area. It depends on the case study, if the outer urban ring is defined by commuter trips (e.g. average commuter length and/or time) or by administrative boarder lines of the communities of the study area. The general framework has been adjusted to fit, as far as possible the local particularities and interest of each case city.

2. Spatial breakdown of the catchment area (case study area) into *L* spatially disaggregated zones (regional units, cells, e.g. traffic cells). This spatial subdivision must allow specifying spatial dissimilarities and differences in the space-time development of zones in order to identify disaggregated growth differentials as possible sources of urban sprawl. It is obvious that the spatial breakdown should comprise at least 20 regional units, surrounding the city centre of the case study under consideration.

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[9] Based on the definition of urban rings by Pumain, Guérois (2001) "Urban Sprawl in France (1950-2000)", FrancoAngeli, Milan

5.2.2. Spatial-temporal data used for the statistical analysis of the case studies

All spatial data were to be provided in a minimum of five time steps, in order to be able to identify general spatial development effects. This means that a minimum of four development periods can be considered. In addition, the whole time series had to cover a period of at least 10 (better 20) years, for the possible extraction of urban sprawl.

The economic data used can be combined into 3 sets of indicators:

indicators of urban development

- population development

- development of the number of dwellings

- development of the number of residential buildings

- development of land use

indicators of the labour marked development

- development of workplaces/jobs and/or employees registered at the workplace

- development of labour force and/or employees registered at the place of home

- development of commuters

- development of commuter trip length

indicators of economic development and welfare

- development of annual income per capita

- development of land prices and house prices

- development of rents of housing units and offices

Not all case studies were able to provide all the data sets. Other data sets like environmental and land use data were not analysed for the case studies. Environmental data sets are based normally on a much bigger aggregation level (regions or states) than cells.

5.3. Comparison of the results of the shift-share analysis for the six case cities

The insights obtained by considering some basic statistical indicators on the case cities have to be combined with the results of the shift-share analysis in order to provide convincing hints for the existence of urban sprawl.

The annual temporal mean growth rates $\tilde{I}$ for population, workplaces, income, number of commuters, trip length, house prices, dwellings, residential buildings and jobs directly in-duced by the population show strong temporal variations for all variables and in all case studies over the last decades. Comparing those growth rates with the corresponding national economic situation shows clearly that the European cities Milan, Brussels, Stuttgart, Bristol, Helsinki and Rennes are participating in the general socio-economic growth process.

In more detail, comparing the yearly growth rates of population on the national level with the average growth rates of the study areas shows that Rennes and Helsinki are growing 3 times larger than their national level (France and Finland). With respect to population, Helsinki (1.2%) and Rennes (1.4%) show the strongest stable growth rates. In relation to this evolution, these two cities show an over-proportional increase in its commuter flows, but also an increase in its corresponding trip length. In addition, the growth rate of the average income per capita in the study areas of Rennes and Helsinki were above 3% over the last ten years. The yearly growth rate of population of the Brussels case study is comparable with its national level. The growth rate of the Stuttgart Region is also clearly above its national average, but follows rather strictly the national up- and downs of the population growth rate. Between 1990 and 2000 a small population growth (0,2% per year) in Italy must be stated. Contrary to this development the study area of Milan has lost population (average growth rate per year - 0,1%)[10]. This suggests that the city region of Milan is much wider than the used case study area.

The growth rate of employment and the growth of the GDP are considered next. In Rennes the growth of employment is on the same level as the growth rate of the GDP of France. In Brussels the growth of employment follows more or less directly the development of the growth rate of the GDP of Belgium. The annual growth rates in employment (workplaces) are 1.2% and 1.3% in Brussels and Rennes, at least double as high as in the other case cities. A strong increase in the growth of employment in Helsinki and the GDP of Finland must also be stated. The development of the growth rate of employment in the Stuttgart Region exhibits a clear cyclical movement, much more enhanced as the growth rate of the GDP in Germany, which lags behind the EU-15 average. This shows the strong dependence of the Stuttgart Region on export activities. The growth rate of employment in Milan in the long time average (1961 – 2001) is about 0,7%, since 1986 it about 0% and lags behind the GDP growth rate of about 2% of Italy.

Furthermore, for all case studies, the average growth rates of the urban centre lag behind the average growth of the region. This applies for population growth and employment growth for all cities.

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[10] The time series of population growth for the Bristol study area are to short to be comparable with the data of the United Kingdom.

Figure 5.1 : Change in density of population by small zone in the 6 SCATTER case cities

Helsinki 1990-1994	Inner Helsinki 1990-1994	Legend (relative change in %)

Legend (relative change in %)
- -71 - -50
- -49 - -30
- -29 - -1
- 0
- 1 - 20
- 21 - 70
- 71 - 170
- 171 - 240
- 241 - 390
- 391 - 919

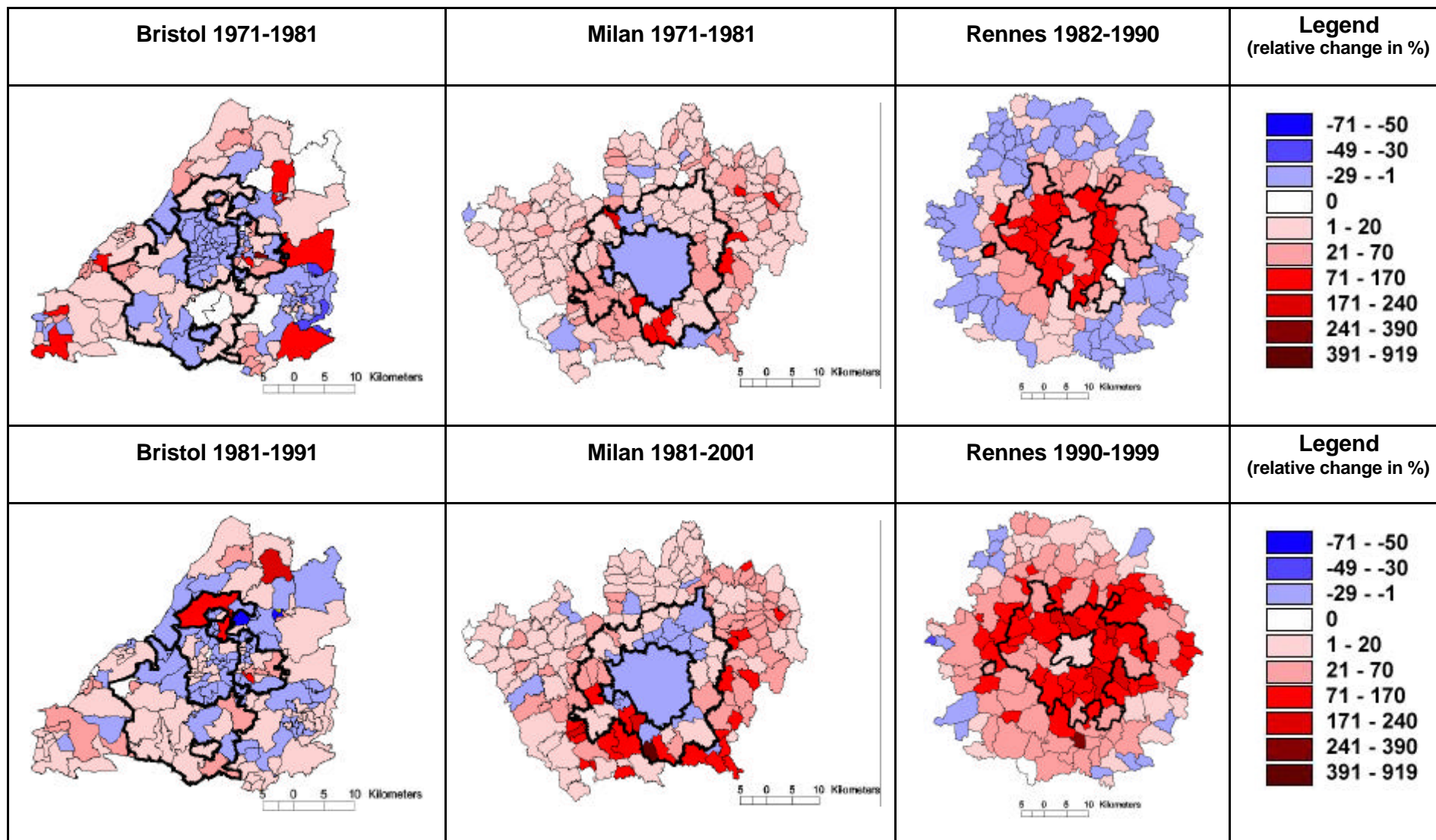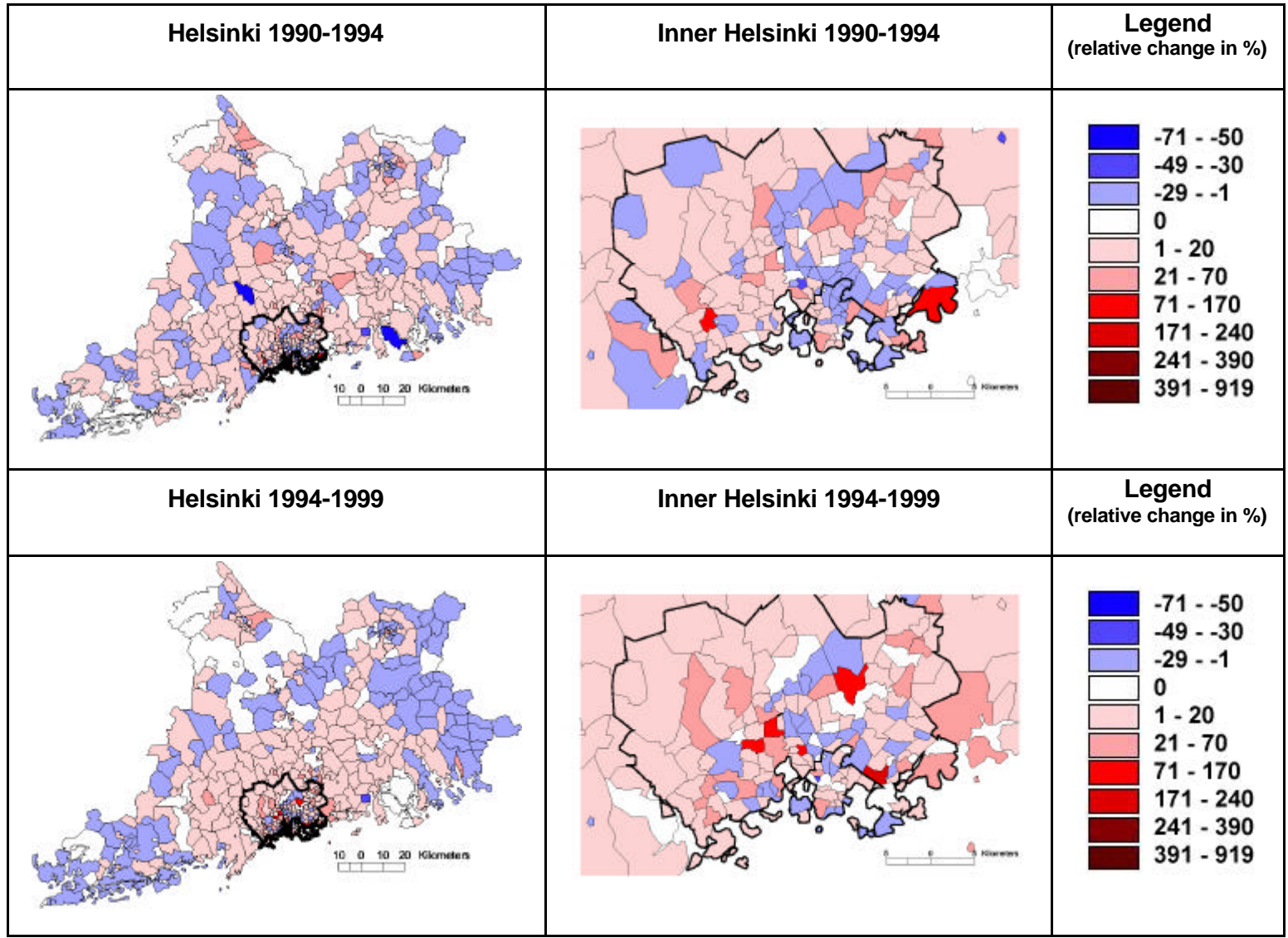| Helsinki 1994-1999	Inner Helsinki 1994-1999	Legend (relative change in %)

Figure 5.2 : Change in density of population by small zone in the 6 SCATTER case cities (cont.)
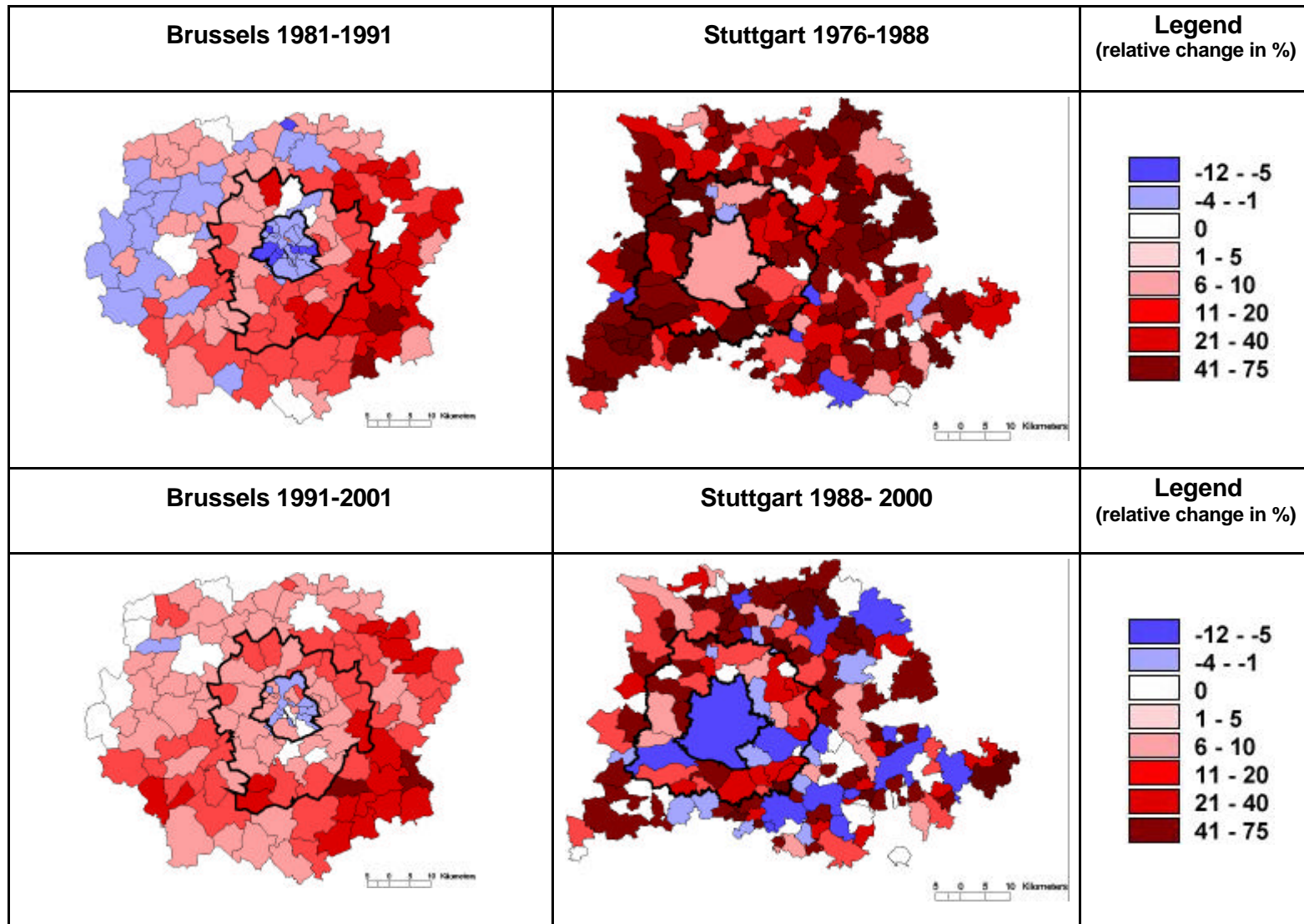
Figure 5.3 : Change in density of population by small zone in the 6 SCATTER case cities (cont.)

In the urban centre, the mean deviations from the average growth path $\tilde{g}$ of dwellings is also negative[11] and, as expected, the growth rate in the number of commuters of the urban centres of Milan, Bristol, Helsinki and Rennes are decreasing as well[12]. This statement means that there is less population from the centre of the case study area commuting to the outer urban ring and the hinterland. In contrary, in most of these case studies, the number of commuters from the hinterland and the outer urban ring are increasing.

Beside the smaller average growth rates in the urban centres of the six case cities, their corresponding outer urban ring and hinterland are above the average growth rate of the whole region and also in general of the national level. Only Helsinki shows a different development. In the study area of Helsinki the outer urban ring is gaining population and also urban centre for some years, whereas the hinterland is losing population during the whole time period 1992 – 1998. This means, that a population redistribution towards the outer urban ring must be stated. In case of employment, Helsinki behaves more similar as the other case cities. Only during the last years (1996) a stronger increase in workplaces in the outer urban ring and simultaneously a decrease of workplaces in the hinterland can be observed, also indicating a shift of employment from the more rural areas towards the more industrial organised areas.

In case of Stuttgart a strong competition between its hinterland and its outer urban ring with respect to employment must be stated, and between its urban centre and its hinterland in case of population.

The outer urban ring of Rennes is growing with a growth rate at least twice as high as in the other case studies, but also the urban centre lags far behind the average growth path (-0,7%). In so far within the study area of Rennes a strong reorganisation of the urban system is under way.

The shift-share analysis indicates that in all case studies the main growth poles of population and employment are situated in the outer urban ring or the hinterland or in both. This leads to an increase of the investigated stock variables (population, employment, commuters, dwellings, residential buildings and directly induced jobs) mainly in the outer urban ring accompanied by an increase of the investigated density variables (income per capita, commuter trip length and house prices) in some not all zones belonging to the outer urban ring and the hinterland. Milan is in so far an exceptional case, since total population and commuters are decreasing (stagnating). However, this could be related to the fact that the conurbation area for Milan is too small.

5.3.1. Comparison of the results of the concentration measure *H* for the six case cities

From the development of the *H*-measure it becomes obvious, that the six case studies can be clustered into three groups: 1) Milan and Bristol showing a permanent and strong de-concentration, 2) Stuttgart and Brussels with small to moderate spatial shifts, and 3) Helsinki and Rennes still favouring population and employment concentration effects (Figure 51, 5.2).

In detail: despite the almost zero growth of total population and the small increase in total employment in the Milan case study, a strong permanent de-concentration must be stated. This de-concentration effects of population and workplaces are dramatic and were already

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[11] Data for Milan, Stuttgart and Rennes

[12] There are no data available for Stuttgart and Brussels

on the way at the beginning of our data base in 1961. Only during the recession in Italy (1992 – 1994) the redistribution of workplaces in space was stagnating.

Bristol follows the same de-concentration process in both, population and employment. The development of H exhibits the same slope as in case of Milan, also Brussels follows the same spatial employment de-concentration pattern (the same slope).

In contrary to all the other case studies, the spatial re-organisation of Rennes and Helsinki seems to favour the concentration of population and employment towards the city centre. This is pointing to an increase of concentration of activities in the inner regions of the study areas (urban centre and urban ring). The main growth centres of the case city Helsinki and Rennes are situated in the outer urban ring. The negative temporal mean value of $\hat{H}^{rel}$ is therefore based mainly on the evolution of population and employment pattern of the hinterland with its negative growth rates. Furthermore the negative $\hat{H}^{rel}$ for all variables of Helsinki may be based on the very short time intervals were data are available (only 10 years) and the huge rural hinterland.

Compared with Milan and Bristol the case study areas of Stuttgart and Brussels show only a moderate spatial de-concentration of population. Stuttgart shows almost no de-concentration in its employment figures. This may indicate that the whole Stuttgart Region is developing in a similar way.
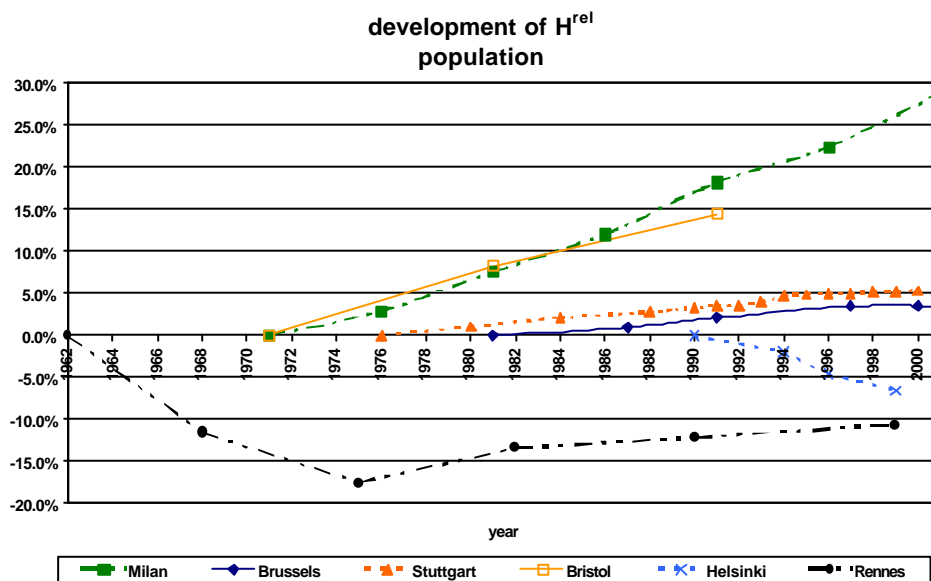

Figure 5.1 :   Concentration measure H^{rel} for population for all case studies
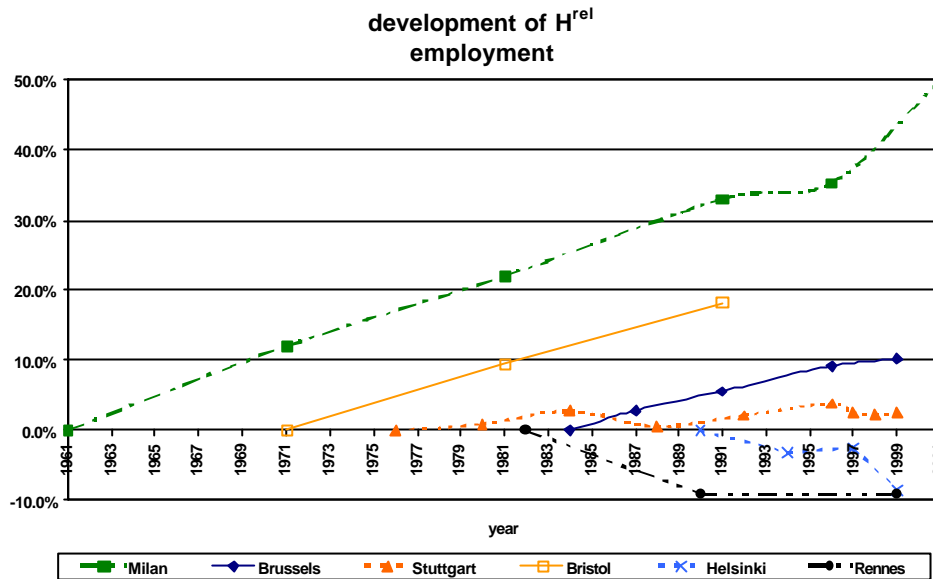
Figure 5.2 :   Concentration measure H^{rel} for employment for all case studies

5.3.2. Indicators of spatial autocorrelation

For all case studies, the spatial distribution of Local Moran's *I* of population and employment density are depicted in Figures 5.3 and 5.4. The development of global Moran's *I* is shown in the Figures 5.5 and 5.6.

Local Moran's *I* indicates areas of high or low spatial autocorrelation or without any correlation. A high value does not indicate that the evolution in a certain area is worse or better than in an other area. It only shows, for example, areas with similar behaviour or with similar development. For example, communes belonging to rural areas are spatially correlated, or communes showing the same behaviour in close neighbourhood of a city are expected to be highly correlated, too. In contrary those communes which are located at the transition region between growing and declining or stagnating zones may have quite different growth rates and are therefore only marginally or not spatially correlated with its neighbourhood.

In Milan the population density of the city centre and northern communes are highly correlated, also population and employment of communes belonging to the west-southern part of the study area. The development of communes located in the south of the city centre of Milan seems to be spatially uncorrelated, in other words showing a rather scattered behaviour.

If, as in the Stuttgart case study, the urban centre is highly correlated with some neighbouring communities (Figure 5.3, 5.4), it can be stated, that the "field of influence" of the urban centre is growing. This can be seen not only in the Stuttgart and Milan case study very clearly, but also in the other case studies on a less high level. The spatial pattern of the study areas of Milan and Stuttgart look quite similar. Both study areas must be considered as metropolitan areas showing rather high values of densification over space.

It can be seen that rural areas also develop very similar. Therefore, rural areas within the conurbation field also exhibit rather high values of spatial autocorrelation. Here, the case studies of Brussels and Helsinki provides a good example. The urban centres of Brussels and Helsinki and some neighbouring communities show strong spatial autocorrelation in population density and density of workplaces. The hinterland, on the other hand provides a

very homogeneous and spatially medium high correlated area. The outer urban ring in-between, however, exhibits very low spatial autocorrelation, since in this active area the transition between urban and rural spatial and economic structure appears. Strong zonal and socio-economic differences are typical and determine this transition area.

The "transition area" in the case studies Milan, Stuttgart and Rennes are not so much extended as in case of Brussels, Helsinki and Bristol. In addition those transition areas are not showing a full undistorted ring like structure, rather a scattered pattern.

Almost the same spatial structure can be identified for Rennes and Bristol. In this area of transition all indicators of the shift-share analysis have shown, that an increase in the different growth rates occurred during the last decades and must be expected, at least in the near future. A strong and scattered densification process has already started and must be expected to continue.
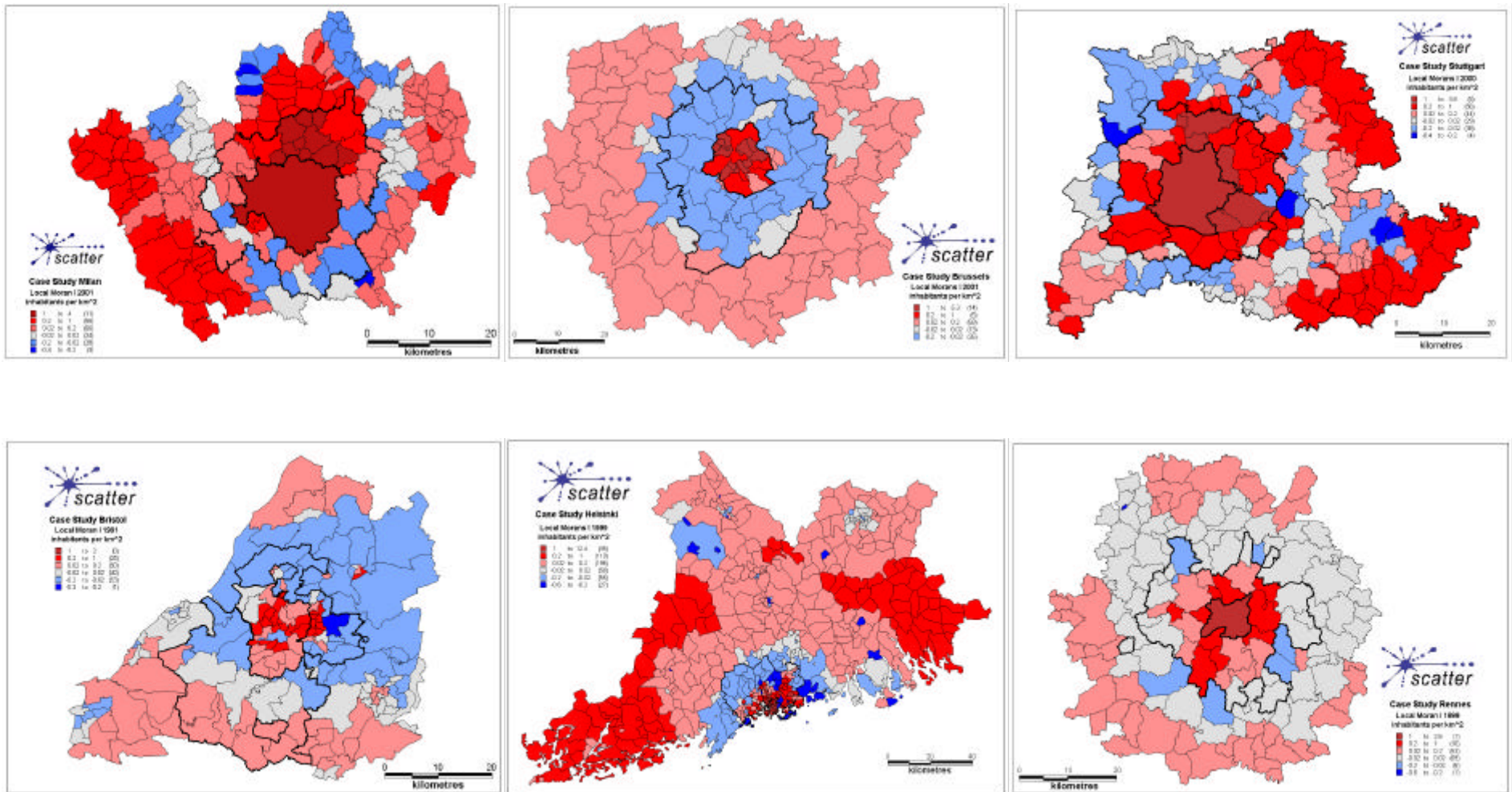
Figure 5.3 :   Spatial distribution of Local Moran I *for inhabitants per km²*
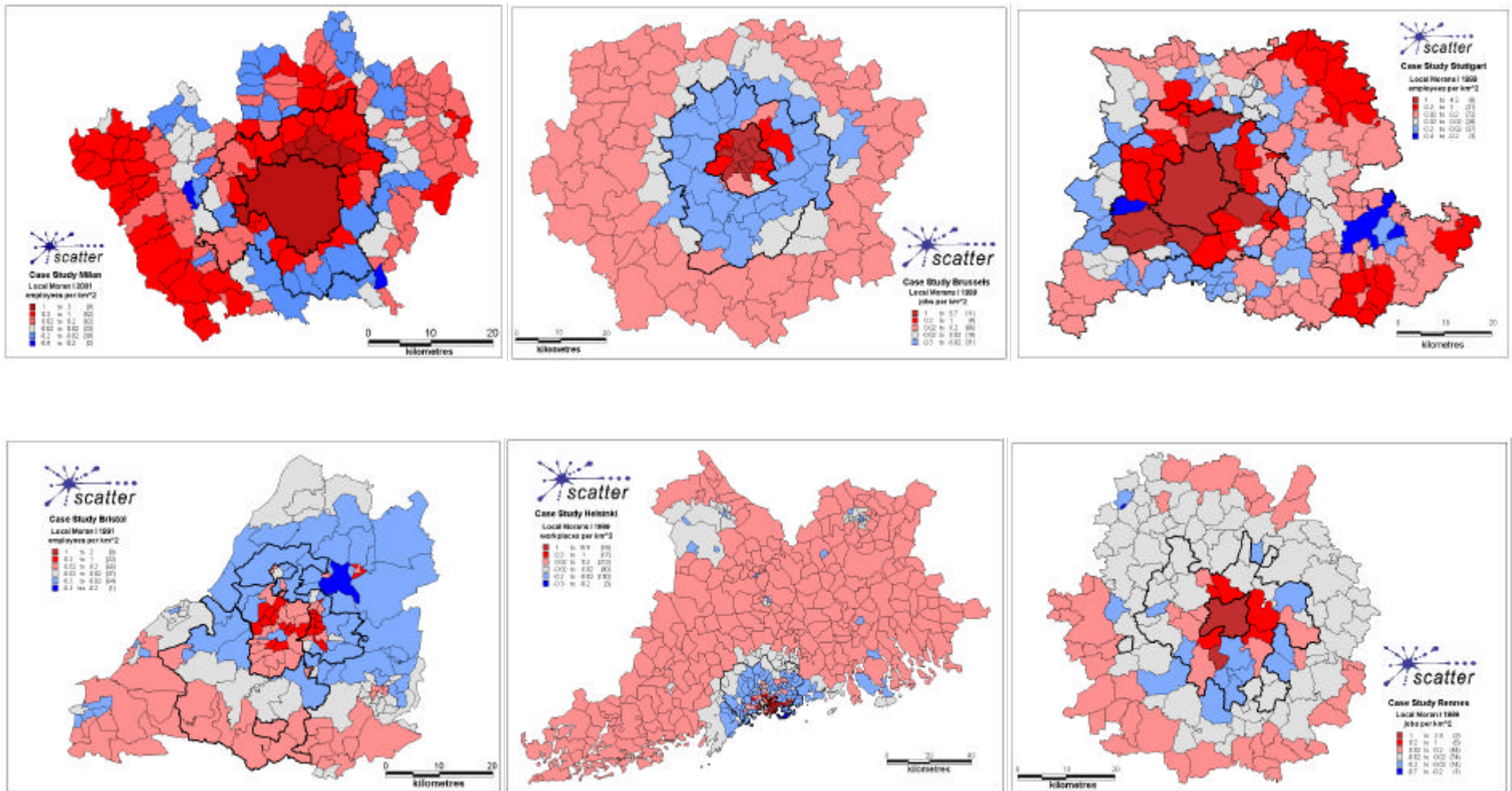
Figure 5.4 :   Spatial distribution of Local Moran I *for workplaces, jobs and/or employees registered at the place of work per km²*

The development of the global Moran's *I* for the different case study areas (Figure 5.5 and Figure 5.6) give some indication of the spatial autocorrelation within the whole study area. In so far, it is obvious that the communes belonging to the Brussels study area are much more similar in population density and workplace density than communes of Rennes and Bristol. Milan, Helsinki and Stuttgart are in-between. With the exception of Bristol, all other study areas develop towards more homogeneous spatial structures.
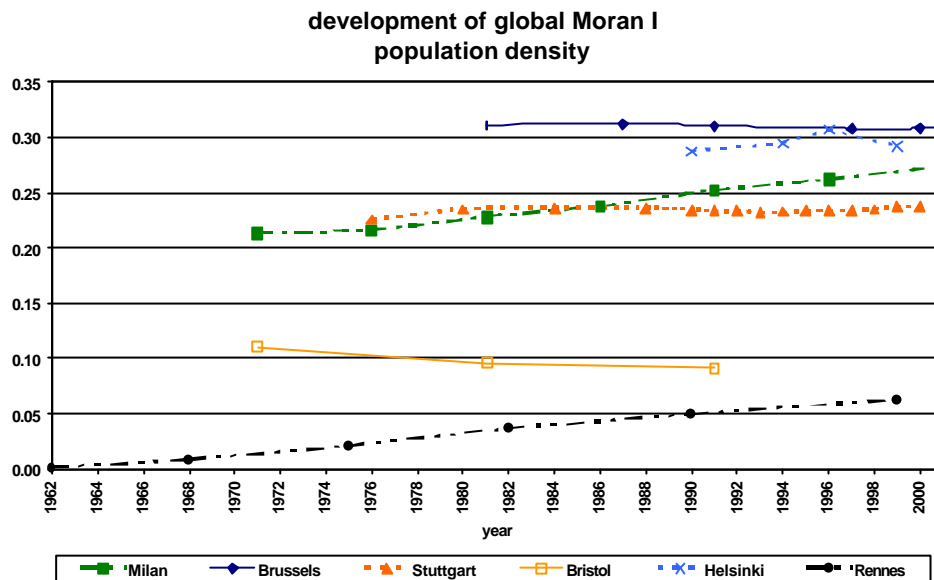

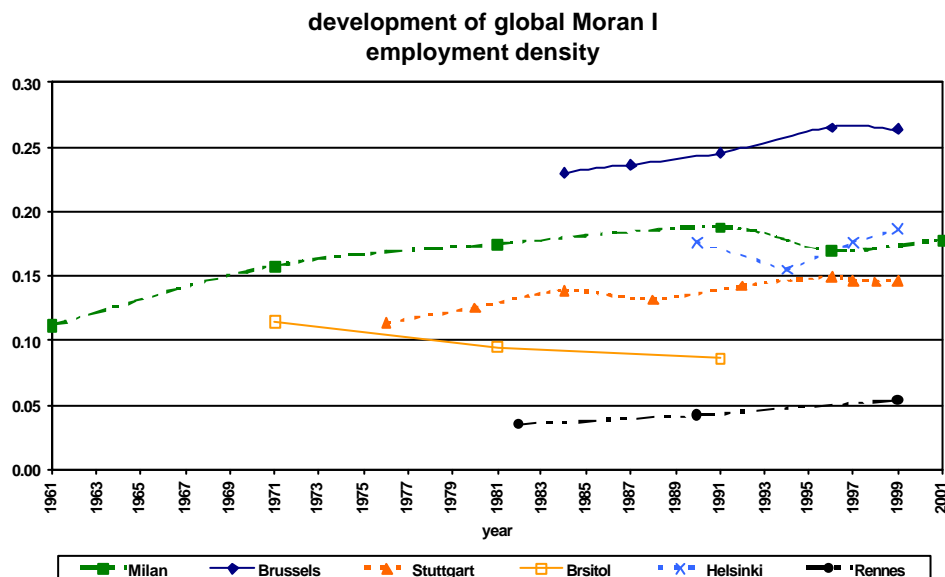*Figure 5.5:* *Global Moran's* I *for inhabitants per km^2 for all case studies*

Figure 5.6: *Global Moran's I for workplaces, jobs and/or employees registered at the place of work per km^2 for all case studies*

5.4. Synthesis of the results of the statistical analysis

The statistical analysis has shown, using shift-share analysis and the *H*-measure, as well as more traditional indicators like density, that the six case study areas can be clustered according to its (de-)concentration behaviour into three groups:

- Milan, Bristol: ***continuing and rather strong spatial de-concentration of activities*** (activities include population and employment), with local specificities such as:
    - Milan: population and employment are out-migrating to areas which are more and more distant from the centre;
    - Bristol: it exhibits a more polycentric pattern, with 2 other urban poles included in the hinterland;

- Stuttgart, Brussels: ***moderate spatial de-concentration of activities, tending towards a stagnation of the pattern***; in the case of

    - Brussels: it seems that the sprawl, as regards population, has slowed down these last years, and even stopped very recently;
    - Stuttgart: sprawl can be stated for population on a low level but in case of employment sprawling seems to stagnate.

- Rennes, Helsinki: ***continuing spatial concentration of activities***: these two metropolitan areas do not exhibit all conditions of urban sprawl, but the growth of the population and of the employment is nevertheless scattered to a certain extent. In both areas, there is in the same time an out-migration of the rural population towards the urban centre and especially the outer urban ring, and a scattered growth pattern, but at a lower level than in the 4 other cities.

With the exception of Bristol, which has a more or less constant spatial autocorrelation, all other study areas develop towards more homogeneous spatial structures.

The pattern of local Moran's *I* indicate that the urban centres of Brussels and Helsinki and some neighbouring communities show strong spatial autocorrelation in population density and density of workplaces. The hinterland, on the other hand provides a very homogeneous and spatially medium high correlated area, whilst the outer urban ring in-between, exhibits very low spatial autocorrelation, since in this active area the transition between urban and rural spatial and economic structure appears. Strong zonal and socio-economic differences are typical and determine this transition area.

The "transition area" in the case studies Milan, Stuttgart and Rennes are not so much extended as in case of Brussels, Helsinki and Bristol. In addition those transition areas are not showing a full undistorted ring like structure, rather a scattered pattern.

In Milan the population density of the city centre and northern communes are highly correlated, also population and employment of communes belonging to the west-southern part of the study area. The development of communes located in the south of the city centre seems to be spatially uncorrelated showing quite different rather scattered behaviour.

As an outcome of the shift-share analysis the average growth rates of the different case study areas as well as its local spatial deviations of the average path are determined. The average growth rates of e.g. population and employment are beside regional effects determined by the national and international socio-economic development.

Comparing the yearly growth rates of population on the national level with the average growth rates of the study areas within the last decade shows, that Rennes and Helsinki are

growing 3 times larger than their national level (France and Finland). With respect to population, Helsinki (1.2%) and Rennes (1.4%) show the strongest stable growth rates. In relation to this evolution, these two cities show an over-proportional increase in its commuter flows, but also an increase in its corresponding trip length. In addition, the growth rate of the average income per capita in the study areas of Rennes and Helsinki were above 3% over the last ten years. The growth rate of the Stuttgart Region is also clearly above its national average, but follows rather strictly the national up- and downs of the population growth. The yearly growth rate of population of the Brussels case study is comparable with its national level. Between 1990 and 2000 a small population growth (0,2% per year) in Italy must be stated. Contrary to this development the study area of Milan has lost population (average growth rate per year –0,1%).

The average growth rate of employment and the growth of the GDP on the national level shows that for Rennes the growth of employment is on the same level as the growth rate of the GDP of France. In Brussels the growth of employment follows more or less directly the development of the growth rate of the GDP of Belgium. The annual growth rates in employment (workplaces) are 1.2% and 1.3% in Brussels and Rennes, at least double as high as in the other case cities. A strong increase in the growth of employment in Helsinki and the GDP of Finland must also be stated. The development of the growth rate of employment in the Stuttgart Region exhibits a clear cyclical movement, much more enhanced as the growth rate of the GDP in Germany, which lags behind the EU-15 average. This shows the strong dependence of the Stuttgart Region on export activities. The average growth rate of employment in Milan in the long run is about 0,7%, since 1986 it about 0% and lags behind the GDP growth rate of about 2% of Italy.

Moreover, the results of the shift-share analysis for the urban centre, outer urban ring and hinterland for all case studies are summarised. All case studies show, that the development of the urban centres of all six case studies Milan, Brussels, Stuttgart, Bristol, Helsinki and Rennes are behind the average growth paths over the last decades. This applies for population growth and employment growth. Beside the smaller average growth rates in the urban centres of the six case cities, their corresponding outer urban ring and hinterland are above the average growth rate of the whole region and also in general of the national level. Only Helsinki shows a different development. In the study area of Helsinki the outer urban ring is gaining population and also the urban centre for some years, whereas the hinterland is losing population during the whole time period 1992 – 1998. This means, that a population redistribution towards the outer urban ring must be stated. In case of employment, Helsinki behaves more similar as the other case cities. In case of Stuttgart a strong competition between its hinterland and its outer urban ring with respect to employment must be stated, and between its urban centre and its hinterland in case of population. The outer urban ring of Rennes is growing with a growth rate at least twice as high as in the other case studies, but also the urban centre lags far behind the average growth path. In so far within the study area of Rennes a strong reorganisation of the urban system is under way.

The shift-share analysis indicates that in all case studies the main growth poles of population and employment are situated in the outer urban ring or the hinterland or in both. This leads to an increase of the investigated stock variables (population, employment, commuters, dwellings, residential buildings and directly induced jobs) mainly in the outer urban ring accompanied by an increase of the investigated density variables (income per capita, commuter trip length and house prices) in some not all zones belonging to the outer urban ring and the hinterland. Milan is in so far an exceptional case, since total population and commuters are decreasing (stagnating). However, this could be related to the fact that the conurbation area for Milan is too small.

Urban sprawl can be identified per definition, if the growth of the investigated indicators are more or less scattered over the whole region, with the urban centre of the region as source.

Combining the statistical results of the shift-share analysis and the statistics of the spatial autocorrelation for all the six case studies, together with the more general statements contained in the classical maps, a significant improvement in the quantitative determination of urban sprawl can be given. Essential for this statement is the combination of different statistical methods and the growth of a new innovative measures such as the improved shift-share analysis and the *H*-measure.

Most of the investigated variables in the six case studies show a scattered spatial behaviour on the level of zones (communes) and exhibit spatially scattered growth rates which manifest themselves in growing specialisation of zones, since the pattern of distribution of the growth rates of different activity pattern and variables are often not spatially identical. In other words, the observed development leads to a spatial diversification, to a spatial concentration of activities, e.g. concentration of population, dwellings, residential buildings in several zones (communities), other communes are specialised in working activities (production and services).

The detailed statistical analysis of the six case studies indicates that in the case studies of Milan and Bristol in addition the necessary condition for urban sprawl, namely a strong de-concentration effect must be stated. As one conclusion of the statistical analysis Milan and Bristol are considered as strongly affected by urban sprawl.

In the case studies of Stuttgart and Brussels only a moderate to stagnating de-concentration is observed. The scattered growth rates of all indicators of Stuttgart and the spatial autocorrelation pattern exhibits that urban sprawl in the Stuttgart Region exists but is rather moderate. The spatial re-orientation of Brussels follows more a diffusion pattern ("normal" growth phenomenon of a city) with some implemented scattered structures. Several poles exist in Brussels' periphery. A sprawl phenomenon of jobs and population can be identified.

In contrary, Helsinki and Rennes still tend to concentrate its activities close to their city centres. In so far both case studies do not exhibit all conditions of urban sprawl. Nevertheless, Rennes and Helsinki show some typical aspects of urban sprawl, e.g. scattered spatial growth of population and of workplaces. However, the spatial autocorrelation analysis and the shift-share analysis shows that for both variables only around the rather small urban centre a high spatial correlation can be found, despite the unbalanced and widely spread growth of population and workplaces in the outer urban ring of Rennes and Helsinki. The whole process gives hints to suppose a superposition of different effects. On the one hand an out-migration of rural population towards the urban centre, and especially the outer urban ring. This process can be better described by a centripetal force. On the other hand Rennes and Helsinki show first typical scattered pattern with a centrifugal part in its driving force, but on a low level compared with the other case studies. The superposition of these two "forces" constitute the spatial pattern of Rennes and Helsinki.

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6. INSTITUTIONAL ISSUES: FROM BARRIERS TO CO-OPERATION

6.1. Objectives

The objectives of this task were to identify institutional barriers which raise when tackling urban sprawl and analyse new ways of cooperation between institutions.

6.2. Case studies

The analysis is based on 6 case studies performed in the 6 SCATTER case cities. In each city, the case study was focused on *one particular policy or policy package* which was envisaged or implemented by the local authorities, and which was related to urban sprawl, either because it attempted to control or reduce sprawl, or because it was aimed to decrease some negative effect(s) of sprawl (e.g. congestion). The case study consisted in describing and analysing the particular institutional issue encountered, the mechanism(s) which was (were) implemented to tackle the issue, the actors involved, the dynamic of co-operation and, if possible, elements for evaluation of the implemented solution. Then a transversal analysis of the 6 case studies was performed.

For convenience, we call below "metropolitan institution" the formal structure of co-operation between institutions (e.g. municipalities) which was set up to manage urban sprawl, transport, land use, or another related matter, at a metropolitan level.

The 6 metropolitan institutions and forms of cooperation which were analysed in the case studies are as follows:

- Bristol: Joint Strategic Planning and Transport Committee (1996) (brings together 4 counties)

- Brussels: Brussels-Capital Region (created in 1989 along with the 2 other Regions - comprises 19 communes) ; cooperation agreement and convention (January 2003) between the 3 Regions and the federal state about the future Regional Express Railway

- Helsinki: Helsinki Metropolitan Area Council (created in 1970 - covers 4 cities)

- Milan: North Milan Development Agency (created in 1996 - brings together 4 municipalities and private partners)

- Rennes: Pays de Rennes (created in 1999 - includes 61 municipalities)

- Stuttgart: Verband Region Stuttgart (created in 1994 - covers 179 muncipalities).

These 6 cases are quite formal structures of cooperation, but in the description of the cases and of the processes, other informal or less formal forms of cooperation were also highlighted, such as: associations, specific places dedicated to political agreement building, etc. Of course these two forms, formal and informal, are not exclusive. In several metropolitan areas, they co-exist, but usually at different scales. This point already lets foresee that it does not exist one single "best" solution to bring a response to the institutional fragmentation in urban planning. In this view, another crucial point is taking into account the specificities of the local context: locality appears

as a set of resources and constraints which clearly influences the choice of a type of response to develop new ways of cooperation between political institutions.

6.3. The framework of the "institutional square"

These 6 metropolitan institutions have been analysed through the framework of the "institutional square". This framework highlights the 4 main features of any institution:

- the *democratic legitimacy* (political composition): directly elected representatives, representatives elected at another level, members appointed or chosen by another non-elective process;

- the *power* (action instruments): legislative power, regulatory power (executive power), intermediary stage regulatory power, consultative role (providing recommendations). Other action instruments to be mentioned are planning instruments and instruments of financial nature (fiscal instruments, financial aids, etc);

- the *matters of competence*: in the case of the control/reduction of urban sprawl, 6 matters are related to the main goal : land use, housing, transport, economic policy, environment, social affaires;

- the *territory* on which the institution has authority: entire metropolitan area or only part of it.

Democratic legitimacy and action instruments determine the *degree of authority*, while competences and territory determine the *scope of authority*.

The sample of 6 metropolitan institutions or "ways of co-operation" analysed here shows that in practice, there is a great variety of institutional solutions which are experimented, from institutions having only a consultative role, but being the place for a dialogue between municipalities and being initiator for innovative solutions (e.g. Milan) to institutions with directly elected members, having authority for voting laws, several important competences, and covering the whole urban area (e.g. Stuttgart).

The analysis emphasises that the main institutional issue is a question of balance and consistency: the most important condition for efficiency of an institution is balance and consistency, first, between the 4 features themselves, and secondly, between the institution as it is characterised by these 4 features, and the objectives that it has to achieve.

At another level, consistency is also requested between the policies envisaged by the metropolitans institutions, and policies decided at a higher institutional level (e.g. national-level policy as regards the fuel price).

Examples of imbalance within an institution are:

- imbalance between territory and objectives (frequent when tackling urban sprawl)

- imbalance between matters of competence and objectives

Table 6.1 Main features of the 6 metropolitan institutions analysed

City	Institution	Public / private	Composition/ democratic legitimacy	Power	Competence	Territory
Bristol	Joint Strategic Planning and Transport Committee	public	delegates from four authorities (elected at another level)	planning instruments, binding if adopted by all four authorities	land-use, housing, transport	four authorities covering most of the urban area
Brussels[13]	Brussels-Capital Region	public	directly elected members	laws	economy, employment, energy, environment, housing, transport, public works, town planning	19 municipalities covering part of the urban area
Helsinki	Helsinki metropolitan area council	public	representatives from four cities (elected at another level)	regulations (waste management, public transport, air quality), recommendations on other matters	waste management, public transport, air quality, housing, public works	four cities covering part of the urban area
Milan	North Milan Development Agency	public/private	delegates from municipalities and private partners	recommendation	various matters concerning local development	four municipalities covering the northern part of the urban area
Rennes	Pays de Rennes	public	representatives (elected at another level) from municipalities and Rennes District	planning instruments, binding if adopted by the municipalities	urban planning, land-use, transport	61 municipalities covering the urban area
Stuttgart	Verband Region Stuttgart	public	directly elected members	laws	land-use, economy, transport, waste management, tourism	179 municipalities = the urban area

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[13] The urban area of Brussels does not have a metropolitan authority. The Brussels-Capital Region, which constitutes an autonomous Region of the federal state of Belgium, covers only the central part of the metropolitan area.

- imbalance between political composition and matters of competences or objectives: e.g. representatives elected at a municipal level and delegated in a supra-municipal institution: locally elected people tend to defend their local interests sometimes to the detriment of the interests of the supra-municipal institution ; e.g.: mistrust towards the representatives of the city centre

- imbalance between action instruments and objectives: e.g. shortcomings in the fiscal instruments; note however that institutions having only a consultative role can sometimes have a reflection on broader matters

- etc.

As regards the *legitimacy* of metropolitan institutions, these institutions generally have low visibility, and technocratic legitimacy rather than a high symbolic or historic legitimacy (compared to states and towns).

Another feature often pointed out is *complexity* of the institutions involved in metropolitan management. Complexity comes from the multiplicity of the actors, processes, instruments, etc, but complexity does not necessarily constitute an obstacle or handicap. For example, the intervention of a multiplicity of actors can mean that a number of problem areas are taken into account, with each institution having its own competences. If completed with adequate interaction and cooperation, this could be synonymous with financial power and effectiveness. On the other hand, some authors have a tendency to put some obstacles under the category "complexity" while they can be of a really different nature. The temptation is then to conclude wrongly that this complexity must be reduced.

Finally, it is also worthwhile noting that the grid of analysis of the "institutional square" is more appropriate to describe the features of formal institutions (such as our 6 cases) than informal scenes of negotiation. Indeed these latter ones do not meet the 4 classical criteria (legitimacy, instruments, competences, territory). Nevertheless, cooperation and arrangements are also taking shape on these informal scenes.

6.4. Institutional obstacles and types of solutions

Where are institutional obstacles raising from ?. In fact, there are two major types of institutional obstacles. The first type is related to the nature of the institution itself. Examples are: imbalances as seen above, shortcomings, inadequacy (notably regarding the territory covered and the spatial scale of the urban issues whose most take place on large functional areas), too much territorial fragmentation, multiplicity of actors, dissipation of power, inadequate sharing of costs and charges, etc. The second type comes from conflicts between institutions. Examples are: competition between actors competent on connected matters on the same territory, conflicts of interests, deliberate lack of cooperation, lack of an higher-level institution able to arbitrate and regulate conflicts between municipalities, etc.

The various responses to such obstacles can be categorised in 3 types:

- *creation* of a new institution: in charge of policies, coordinating policies, or "only" generating dialogue and a prospective reflection,

- more or less deep *transformation* of the existing institutions: e.g. creating a common service between 2 or more institutions, transferring fiscal power from one level to another, designing a flexible revising mechanism for the territory over which the metropolitan institution acts, modifying the political

composition of the metropolitan institution so that it holds the general interest as a priority, etc.

- *improvement of cooperation mechanisms* between existing institutions, e.g. limited technical agreements, general cooperation, creation of a specific "institutional scene" to tackle urban sprawl (permanent discussion and dialogue instrument), etc

- plus: *combination* of 2 or 3 types mentioned above.

6.5. Evaluation of the different forms of co-operation and conclusions

Finally, when coming to the evaluation of these different, more or less formalised, forms of co-operation seen in the case studies, two elements come under consideration: *efficiency* of the institution and *feasibility* of the creation and functioning of such an institution.

As regards efficiency in controlling urban sprawl or reducing its negative effects, it seems obvious that, the strongest the institution, the most efficient it will be. An institution with full democratic legitimacy, with legal power, having competences in all the matters related to sprawl and on the whole territory concerned by the phenomenon will in principle be able to decide and implement more efficient policies.

Some experts even argue that such strong institutions with full democratic legitimacy are the only possible institutional solution to the question of the management of metropolitan areas, to overcome the territorial fragmentation, the fragmentation of competences and the divergent local interests. According to them, the municipal institutional level is an heritage from the past which is no more adequate to the current cities and the problems they face.

This latter point can be partly true. However other political experts consider that the creation of a political institution is only one way among several ones to build a capacity for action in the management of large metropolitan areas. According to them, it is crucial to take into account *locality*, and the local specificities, in the definition of the new modalities of government. Territories bring specific resources (political resource, expertise, budget) whose stock and characteristics influence the choice of most appropriate modalities of political cooperation. These experts take as example the legislative reform concerning the government of metropolitan areas in Italy (1993). The main Italian cities should have been concerned by the settlement of a metropolitan political institution with large powers and a strong legitimacy. But the implementation of this legislative framework has been dependent on local configurations. It has been possible where a tradition of cooperation, or an integrated political leadership and social values of consensus, of collective action, was existing. In a context of traditional fragmentation, legislative decision didn't manage to change the situation. Elected representatives of political institutions (city, province, region) acted in order to stop the implementation of the institutional reform.

Thus the creation of a strong metropolitan institution, depriving partly other authorities of their powers, can be very difficult in practice because of *historical and/or political reasons*[14], or, less often, because of the strength of the institutional barriers them-

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[14] Not to be confused with actual institutional reasons.

selves. In such cases, an intermediary solution, i.e. a structure of cooperation with low power or medium power, is the only feasible solution. *This type of solution should not be neglected for all that*, because it can generate a permanent dialogue between municipalities or other institutional levels, contribute to raise awareness among decision-makers (awareness of the need of cooperation on at least some matters), and can be the first step on which progressively a stronger structure could build on. Stabilisation of political arrangement needs time and non formal cooperation helps to define collectively rules, identities, references or values which make possible a political integration in a later stage.

Besides, the range of appropriate responses to any situation can vary greatly from one urban situation to another, because of local specificities, as mentioned above. Each territory has its own resources. Configurations of political leadership (collegial, individual) represent opportunities, or constraints, for the feasibility of the settlement of a new political institution. Mobilisation of private interests organisations on institutional aspects depend also from the locality. Presence of social values shared by inhabitants, like consensus or collective action capacity, is a specific resource which can make possible the creation of a new political institution.

Two more points have to be noted.

As regards the competition between local authorities, an element which could contribute to overcome the conflicts of interest between these authorities could be a better knowledge of the real stakes underlying urban sprawl, a better knowledge of the negative effects of urban sprawl and of their collective costs. Municipalities for example are often well informed about the potential revenues that they could get from new residential developments (through the income tax) or new economic activities (whether from the tertiary or the industrial sector). However they are maybe not as well aware about costs generated by these new developments.

A German researcher for example showed that in the case of Greater Hamburg, new housing developments in most of the suburban locations have no fiscal effect on the municipal revenues, as additional revenues and additional expenditures more or less match[15]. He emphasised that this is in contradiction with the high expectations that the individual communities have regarding the fiscal surplus that new developments are supposed to generate. This example is closely depending on the German fiscal system, but more generally, a better knowledge of the negative effects of urban sprawl and of their collective costs, by local authorities, could contribute to overcome, at least partly, the inter-municipal competition.

Finally, the 6 case studies and other examples in Europe also illustrate the fact that *institutions can change*, contrary to the widespread idea that holds that institutional structures can only transform themselves with great difficulty, because of the strength of tradition, because conflicts of interest lead to prefer the *status quo*, or because constitutions or other legal texts limit institutional possibilities. Movements in this matter can be slow or difficult but examples also exist of profound and rapid institutional changes.

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[15] Jens-Martin Gutsche, "The role of the municipal fiscal system in the traffic increase in conurbations", Technical University of Hamburg-Harburg, paper presented at the European Transport Conference, Strasbourg, October 2003.