1. Introduction

SCATTER is a project under the European Commission DG Research, Energy, Environment and Sustainable Development Programme (Key Action 4 – City of Tomorrow and Cultural Heritage) and is part of the LUTR cluster (www.lutr.net) which links different projects in the area of sustainable urban mobility, including land use, transportation and the environment. An overall objective underlying the LUTR cluster is to assist cities, national governments, international organisations, individuals and interest groups in obtaining maximum benefits from the research undertaken by the cluster projects and thus contribute to increase the effectiveness of sustainable measures by the dissemination and transferability of relevant practices.

SCATTER started in January 2002 and it is now in the middle of its project life. This paper then gives account of preliminary results of the study and is particularly focused on the outcome of the activities completed in the first stage. Updated information about the project can be found in www.casa.ucl.ac.uk/scatter/.

2. Overall project methodology

The project comprises six case cities: Brussels, Stuttgart, Bristol, Helsinki, Rennes and Milan and its methodology is based on three major stages:

- The first stage of the work aims to improve the understanding of the mechanisms of urban sprawl and its effects. This first stage includes a state-of-the-art review of urban sprawl impacts, a systemic analysis of urban sprawl on basis of interviews of experts and authorities in the 6 case cities and a statistical analysis of urban sprawl effects in the 6 cities.

- The second stage of the project aims to assess the impacts of policy measures aiming to wrestle with urban sprawl and their overall efficiency. Policy measures will be selected starting with a review of those measures already implemented (including the USA experience) and taking into account institutional barriers. These measures will be then simulated in three case cities (Brussels, Stuttgart, Helsinki) using integrated land-use/transport models and a quantitative assessment of their impacts of the measures will be produced.

- The third stage of the project will be the set up of concrete recommendations to European local authorities on policies to control urban sprawl, especially when a suburban public transport is implemented. A general “urban sprawl monitoring tool” will be designed and a practical programme of measures for each of the 6 case cities will be designed.

In parallel with the technical activities, 2 workshops are envisaged, which namely will gather together local authorities from the 6 case cities. The project flow chart (Figure 1) provides an overview of the technical activities.
3. A multi-dimensional definition of urban sprawl

Clearly, urban sprawl is a multi-dimensional phenomenon, and hence requests a multi-dimensional definition. It is also difficult to make a clear distinction between 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. Some of the main dimensions constituting “urban sprawl” are discussed below.

3.1 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, 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 development 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 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.

3.2 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 is 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”.

3.3 Different 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.

“Scattered” or “leapfrog” development lies at the 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 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.

3.4 Land uses
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 may exist: mixed or single land-use patterns, patterns of different rural-urban relationships, concentrated, clustered or dispersed patterns.

3.5 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 (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.

4. Contexts and causes of urban sprawl
According to 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.

4.1 The consumer demand for single family low density housing
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.

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 migration 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 population 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.

4.2 The influence of the transportation 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.

It is interesting to note that historically in United Kingdom the development of urban sprawl and suburban housing was related to the growth in the public transportation network.
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 bus.

4.3 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 generally considered 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.

5. Effects and costs of urban sprawl

It is 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".

As regards the ecological dimension of the sustainability concept, both the United Nations and the European Union have moved in favour of a 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".

5.1 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, social effects. In general, 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
- poor access to services for those with limited mobility such as the young and elderly.

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.
6. How do local/regional authorities perceive urban sprawl?
A number of interviews were conducted with local authorities’ representatives and experts in the six case cities of Bristol, Brussels, Helsinki, Milan, Stuttgart and Rennes to understand the local events and rationale involved in the emergence of urban sprawl, its relevance in the decisional agenda and the overall level of awareness of this particular urban phenomenon. The common factors having emerged are summarised below.

- In the perception of the interviewees, 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 a ‘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: planning practice in Europe has focused mainly on the possibility to control sprawl by means of land-use and transport planning.
- Finally, there is a need to define the ‘proper institutional level’ at which policies to control urban sprawl should be implemented. On this issue, the debate is still open.

The latter is demonstrated by the concerns on the necessity of an improved knowledge and analytical framework for urban sprawl. However, this generally high level of attention is hardly ever accompanied by a shared awareness that sprawling processes are careless of institutional boundaries. This is the source of undetected and unplanned processes of urban growth, which can lead to sprawl but also of institutional conflicts among the different local authorities affected. These 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 are one of the main barriers for inter-institutional cooperation.

Almost all the respondents have proved sensitive to recognizing that a common understanding of what urban sprawl is and how it works is crucial to build a strategic, shared and far-sighted vision of the future of their urban areas and regions. These factors as well as the definition of the proper institutional level for decision-making are crucial to the success of any policy measure designed with the purpose to mitigate the impacts of urban sprawl.

6.1 The level of awareness
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 decisional 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 necessity to provide for a better coordination of land-use and transport planning also at the neighbourhood scale as well as to control the production of the built environment to prevent land-use and social segregation and the impoverishment of the urban quality are perceived as crucial steps in the struggle against 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.

Four profiles of urban sprawl

Another interesting aspect arising from the analysis of
interviews is the necessity to structure further research and the design of policy measures around different types of urban sprawl. Four main types of sprawl were identified:

- sprawl as an emergent polycentric region: characterised by the emergence or development of secondary urban centres;
- sprawl as a scattered suburb: characterised by infill process by which scattered and low density housing developments locate between centres or between transport infrastructures;
- sprawl of peripheral fringes: characterised by higher densities than suburban developments and inhabited by groups of population who have to relocate because of the increasing costs of life in the urban centres;
- commercial strips and business centres: located following a rationale based on accessibility, low cost of land and agglomeration economies.

![Figure 2. Example of statistical analysis: change in density of population by zone](image)

**7. A statistical analysis to quantify urban sprawl**

The objective of this activity was to design a statistical analysis framework aiming to quantify urban sprawl on the basis of the six case cities database. In addition to existing measures, a new measure for the quantification of urban sprawl, the H-measure, was introduced and tested.

A fundamental problem in the comparison of different case studies is the subtraction of general trends from specific regional peculiarities, based on e.g. inhomogeneous developments, specific investments in a region or regional policy programs. To bypass such obstacles, an improved shift-share analysis framework was developed covering a 20-years period or more. The framework was then applied to the six case cities: Bristol, Brussels, Helsinki, Stuttgart, Milan and Rennes.

For each case city, the features and effects of urban sprawl were studied by performing a statistical analysis of time series of socio-economic data: households, jobs, retail shops and other services, etc. When possible, the related effects on trip demand patterns were also analysed.

The design of the common analysis framework started by selecting a common definition for the three macro-zones: urban centre, outer urban ring, hinterland. 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.

![Figure 3. The Six Cities subdivided into macro-zones representing the urban centre, outer ring, and hinterland (all maps are in the same scale)](image)

The three main aspects of the statistical analysis were:

i. The generalised shift-share framework which consists of calculating an average annual growth rate (λ), for the whole study area, at each year, for each considered variable; calculating the annual deviation (γ) from this average annual growth rate for three macro-zones at each year, for the same considered variable and doing all this using a smoothing procedure, in order to smooth noisy patterns which would be due e.g. to possible data uncertainties.

ii. The new concentration-measure called H was inspired by physics and is defined as:

\[
H = \int \int \rho(\vec{r}) \vec{r}^2 \, dA(\vec{r})
\]

where the density (e.g. population density) \( \rho(\vec{r}) \) at distance \( \vec{r} \) from city centre is weighted with the square of distance from the city centre. The integration \( dA(\vec{r}) \) has to be performed over the whole case study area (A being the urban area). This formulation translated in discrete terms leads to:

\[
H = \sum_{i=1}^{n} X_i r_i^2
\]

with:

- \( i = 1, 2, \ldots, n \) being the zones of the study area
- \( X_i \) being the value of the stock variable X in i (e.g. population, employment)
- \( r_i \) being the distance between the centre of gravity
of each zone $i$ and the centre of gravity of the whole study area.
The indicator $H_{rel}$ is then defined on the same way than $H$, but considering relative values $X_i/X_{average}$ instead of $X_i$.

iii. The indicators of local and global spatial autocorrelation allow to estimate whether, as regards the value of a particular variable (e.g. population density), a zone is surrounded rather by zones exhibiting close, similar values, or on the contrary, very dissimilar values, or is surrounded by a heterogeneous, patchy pattern of similar and dissimilar values. As an example, when local spatial autocorrelation statistics is applied to population density, it may highlight a pattern as follows: the urban center (high autocorrelation - similar high densities), the rural hinterland (high autocorrelation - similar low densities), possibly including urban poles (low autocorrelation - urban poles surrounded by rural zones, with much lower densities), and finally a zone in-between characterized by very low spatial autocorrelation, because it corresponds to the suburban area, which is a mix of more or less recently urbanized communes and other still rural communes.

![Figure 4. Concentration measure $H_{rel}$ for population for all case studies](image)

![Figure 5. Concentration measure $H_{rel}$ for employment for all case studies](image)

7.1 Main results
As a first conclusion, the application of the statistical analysis method showed that the development of the urban centres of all six case studies Milan, Brussels, Stuttgart, Bristol, Helsinki and Rennes are behind the average growth path of the whole conurbation areas over the last decades, while the deviations of the outer urban ring and often also of the hinterland are above the average growth path.

The shift-share analysis indicated 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 and residential buildings) 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 but 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 study area adopted for Milan could be too small.

Urban sprawl can be identified per definition, if the growth of the investigated indicators is more or less scattered over the whole region, with the urban centre of the region as source. The detailed statistical analysis indicates urban sprawl in the case studies of Milan and Bristol. Here, the necessary condition for urban sprawl, namely a strong de-concentration effect must be stated as well as scattered growth rates, distributed over the whole study areas.

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 (associated to the urban growth) with some implemented scattered structures. Several poles exist in Brussels periphery. A moderate sprawl phenomenon of jobs and population can be identified.

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 development 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 global spatial autocorrelation indicators (global Moran's $I$) for the different case study areas provided a ranking of spatial autocorrelation: 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.

The pattern of local spatial autocorrelation indicators (local Moran's $I$) indicated that the urban centres of Brussels and Helsinki and some neighbouring communities show strong
8. Qualitative assessment of current policies

In order to draw a first qualitative assessment of the comparative overall efficiency of current policies aiming to mitigate urban sprawl, a review of the European and USA experiences has been completed.

The work makes reference to different types of policies - legal and regulatory land use measures, land use plans and schemes, tax and pricing policies, urban design strategies, housing policies, transport policies - and combines a literature review on innovative methods and practices 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.

This qualitative evaluation is mainly based on the acknowledgment of the growing relevance of urban sprawl on the planning agenda due to its contribution to unsustainable land use and consumption. Urban sustainability, a key goal in the European urban policy agenda, can then provide a general context for the evaluation of policies to combat sprawl.

An innovative approach is adopted to the assessment of policies, which is based on the use of a reference matrix that identifies policy measures at the crossing between, on one side, the sustainability issues and impacts resulting from sprawl and, on the other, policy categories such as fiscal measures, land use and transport planning instruments, mobility management and urban design (see table 1).

However, there is a growing awareness, among planners and decision makers that impacts and issues of urban sprawl increasingly interact with one another and with implemented policies as well. As a result local authorities are developing integrated approaches in policy design and implementation and they are trying to overcome institutional barriers that often limit the success of anti-sprawl policies through new forms of institutional cooperation. This issue has emerged mainly from the analysis of case cities where theoretical frameworks clash into the reality of decision-making, local opportunities and conflicts.

The review of case studies covers different demographic scales and includes, besides the SCATTER case cities, also Vienna, Copenhagen, Strasbourg, the Ruhr region, Amsterdam, Madrid and Portland (USA). The results of the analysis have been grouped under three areas that can be considered as answers to the following research questions:

- Is urban sprawl and, in general, unsustainable urban growth promoting innovations in the planning practice?
- Which, among the available policies, are actually being implemented to tackle urban sprawl and mitigate land consumption and increasing traffic congestion?
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Table 1. Policy Framework for inhabitants per km²

- Which are the most interesting (and successful) features of the implementation process that should be taken into account?

8.1 Planning against sprawl

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. In cases where urban sprawl and its impacts are the problem, the only application of tight land use control regimes, which has been the traditional way of containing urban growth, loses out against economic and political interests or just against the unpredictability of social and economic changes.

The investigated case studies show the emergence of a general trend in local and regional authorities to structure and contain the impacts of urban sprawl by means of innovative ideas and measures that promote sustainable development. These include higher density mixed use and infill development, proactive containment of urban growth through the reduction of land available for development and its designation to green and public service uses, the adaptive reuse of abandoned industrial structures and brownfields, a wider range of alternative modes of transportation, public transport oriented urban development.

8.1.1 Reducing land consumption

Land consumption is mainly a result of low-density development, which is one of the key feature of urban sprawl both in Europe and in the USA. Policy measures to limit consumption of land focus on two approaches: the setting of constraints to the extent to which a city can expand such as in the greenbelt and growth boundaries measures and the promotion of more compact, dense and possibly mixed use development. The preference assigned to one or the other approach depends often on the more general planning systems of the local and national contexts and to the possibility of the public authorities to enforce binding regulations. The underlying objective of these policies is the achievement of the compact city model, perceived generally as more sustainable. While there is debate over the attainability of the compact city focused around a single centre, there is an increasing consensus that some form of targeted development is the key to containment of urban sprawl, most often discussed in ideas of decentralized concentration and settlements around transport corridors.

Two are the most common approaches presented by the case studies: control of land consumption by a reduction of the supply of land available for development and one based on promoting or imposing urban growth only in selected location and with selected land-use structure and density levels. The first one includes policies such as the greenbelts and green corridors (Vienna, Copenhagen) which are commonly used as instruments for the preservation of natural resources especially by those countries and cities with a long tradition of regulations for environment protection. Land banking policies are also
implemented, through which land is made unavailable for development and only later released according to scheduled planning, therefore providing local authorities with an instrument to control when, where and what is happening in their urban areas.

The second approach includes policies which regulate the location of land uses in order to reduce land consumption. These are, usually, a particular form of more traditional zoning practices. They are specifically targeted to promote development based on the criteria of mixed land uses and high density. They also target the problem of accessibility and car dependency and in this sense can be grouped under the category of policies that promote a general reduction of car usage and an increase in accessibility to jobs and housing. The existing literature emphasises how the success of the policy lies not merely in the generation of housing around transport hubs, an approach that can exacerbate urban sprawl, but also in the creation of a mixture of uses — workplaces, services, shopping and leisure in the neighbouring area. Without this, accessibility and car dependence are likely to continue and the policy merely increases the spread of housing further out into the outer urban rings.

8.1.2 Mobility

The mobility related problems of urban sprawl are generally perceived as increased inaccessibility to employment and services and increased dependence on the private car over public transport. The policies implemented in the case studies acknowledge the fact that while mobility must be eased and promoted both within and between urban centres, the use of cars must be reduced and the use of public transport must be increased as much as possible. Mobility is the key to the economic and social development of a region, but if mobility is only or mainly supported by private cars, environmental quality is deemed to be irreversibly damaged in the long term.

The Scatter project recognises that the extension of transport infrastructures can be one of the causes of urban sprawl. However there are cases reviewed by the project, that show how spatially strategic extensions of railway, light railway and underground infrastructures (Vienna, Madrid, Strasbourg) can successfully support the development of a more polycentric structure by improving access to secondary urban centres and help to remove isolation of peripheral areas and centres suffering social deprivation and economic decline.

The realisation of ring roads coupled with the supply of parking areas that adopt park&ride schemes in connection with public transport nodes located outside the city centre are also a successful measures to reduce the number of cars entering the city centre therefore promoting a higher environmental quality of the urban core. However, in order to reduce car usage, it is necessary to provide end-users with an economical and dependable public transport alternative. These can and has been successfully achieved at the local level. However commuters and daily mobility patterns are increasingly occurring at the regional rather than local and urban scale. The management and supply of public transport services must take into account the need to coordinate different scales and therefore different public transport networks and agencies.

Coordination has been achieved in different ways in the case studies: the harmonisation of local and regional fares in the case of Madrid, the unification of public transport providers in a single agency in the case of Vienna, coordination of time tables between different modes of transport at interchange nodes (Strasbourg).

Finally, measures based on incentives have also been successfully implemented to promote the use of public transport service. Transport-for-all marketing measures are based on the definition of a flexible design of fare systems, sensitive to the needs of different end-users (commuters, students, unemployed), to the different motivations for trips (shopping, work, flexible working timetables) and to seasonal events (Christmas shopping, sport and cultural events).

8.1.3 Urban regeneration and social segregation

The discussion in the current literature on urban regeneration strategies is focused firmly on the core urban areas. The policies in all cases attempt to reverse the decline of jobs, services and housing in these areas. There is little focus however on the reduction of suburban housing demand, as to some extent this is due to the broader, deeply rooted changes in the demographic and economic structure.

The case studies prove that despite a common disbelief in the capacity of piecemeal approaches to control urban growth, regeneration programmes owe their success to the containment of the scale of intervention. Both in the city centre and in peripheral areas regeneration is used to reduce social segregation and promote economic vitality. By so doing they provide the entire city with areas to accommodate demographic and economic growth that would otherwise need to locate in the suburbs. The scale of regeneration schemes is of concern because the success of the projects is linked to two major issues: their financial feasibility and the public consensus (via public participation) generated by the projects.

Regeneration measures must, as much as possible, avoid eviction and relocation of inhabitants and economic activities and the onset of gentrification processes. These can be avoided by involving residents at all levels of the project from concept to urban design. Subsidies to purchase or rent of the renovated dwellings have also been implemented.

8.2 Integration of policy measures

All the case studies presented in the review show some degree of policy or institutional integration and coordination. Integration in these cases is a response to the acknowledgment that, regardless of the scale of the urban area and of the issues
to be tackled, interactions between policies and between the different effects of policies must be dealt with. Integration is therefore recognised as a key success factor.

The case studies offer some interesting examples of how the mutual interactions between land use and transport policies have been dealt with in order to successfully tackle urban sprawl.

Greenbelt measures to control urban growth for instance would only end up relocating urban sprawl outside the belt if an accompanying policy for the regeneration of secondary centres outside the belt is not implemented. The requirement of a compact growth of all the centres of a polycentric region to avoid the sprawl of the main urban centre can only be met if accessibility to the different urban centres is improved by means of public transport. Greenbelt policies, per se are not successful in tackling urban sprawl but only in protecting a limited part of the natural resources surrounding the urban centre. Effective control of urban growth is only achieved by complementing the policy with regional development and an efficient public transport regional network.

In cases were urban growth is oriented in the proximity of transport corridors and hubs for the purpose of reducing car usage, the supply of highly dependable public transport should be improved, otherwise cars will remain the most "economical" alternative for transport. Transport hubs can play a key role in attracting development and simultaneously reducing car use if great attention is given to criteria such as the calibration of the amount and cost of available parking spaces to make car use more costly and difficult; the flexible and accurate management of inter-modal exchange via timetables harmonisation.

8.3 Cooperation among institutional players
As acknowledged in many studies and confirmed in the review, there is often a lack of coordination, or even competition, between various decision-levels, various territorial units, and/or various fields of competences (e.g. land planning, transport, tax policies, etc). Thus an analysis of the institutional barriers to the design and implementation of efficient integrated policies to tackle urban sprawl has been completed.

Within such analysis, various ways of cooperation between institutional players have been compared. There is in fact a whole range of ways of cooperation, from formal institutionalisation (e.g. the creation of new institutions, like the "urban communities" in France - communs urbaines) to rather informal cooperation between existing institutions (without the creation of a new formal institution), including, somewhere in-between, forms like "contractualisation" ("contract" between two institutional players).

9. Further work
Project activities are now devoted to the policy measures to be evaluated, on the basis of their relevance with regard to the mechanisms of urban sprawl and of their expected efficiency. Particular attention is being devoted to the problems related to the lack of coordination, or even competition, between various decision-levels, various territorial units, and/or various fields of competences and in general to the analysis of the institutional barriers to the design and implementation of efficient measures.

Such measures are then to be evaluated as accompanying measures in cities implementing suburban public transport services, through simulations with integrated land-use/transport models in the three case cities (Brussels, Helsinki and Stuttgart), assessing the impacts of the measures in terms of urban structure (population and jobs location), transport and trip demand pattern, air pollution.

The third and final stage of the project will be the provision of recommendations and guidelines to European cities about measures aiming to tackle with urban sprawl. A general "urban sprawl monitoring tool" will be prepared and a practical programme of measures for each of the 6 case cities will be designed.

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References
SCATTER Deliverable 4.1 (2003), "Review of policy measures aiming to tackle urban sprawl", May 2003


ENDNOTES

1 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 USA and to the notion that homeownership with a garden are core values of the Anglo-Saxon heritage. 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, while in the same time in European countries, there was the first important wave of uncontrolled sprawl.

2 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 (i.e. it compares the actual regional growth rate to the growth rate that would have occurred if every industry in the region had grown at the national growth rate for that industry); such analysis can be seen then as a “snapshot” of a local economy at two points in time and its results are sensitive to the time period chosen. For SCATTER it was 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.

3 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.