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Defining the pattern of the sustainable urban region

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Preface

Urban areas produce a series of environmental problems arising from the consumption of natural resources and the consequent generation of waste and pollution. These problems that continue to grow in our society require the development of new solutions for those urban areas to function at levels of quality of life desired by the community. The solutions should not have adverse effects outside as well as inside the urban boundary.

The problems are compounded by the growth of urban areas in the last two hundred years. By the beginning of the XIX Century, only 3% of the world's population lived in cities and there were no more than 20 urban areas with more than 100,000 inhabitants. At the start of the XX Century, the figure grew to 10% of the world's population living in cities. The figure has now increased to 50% and the United Nations has estimated that by the middle of our century, 62% of the world's population will live in big cities.

These figures represent an average for the whole world but they are much higher for Europe. From a report by the European Community, 80% of the European population already lived in cities in 1997; 20% of them in urban centres with more than two and a half million, another 20% in middle sized cities and 40% in those of 10,000 to 50,000 in habitants. These statistics give an idea of the magnitude of the problem discussed in this book and the importance of finding sustainable solutions.

This book comprises most of the papers presented at the 2nd International Conference on Sustainable City, held in Segovia in 2002. This Conference addresses the above points and the many inter-related aspects of the urban environment with particular reference to the topics listed in the table of contents of this book ie :
Strategy and development; planning, development and management; restructuring and renewal; cultural heritage and architectural issues; land use and management; environmental management; the community and the city; public safety and security; traffic and transportation; transport environment and integration; agriculture and the city; energy resources.

The Meeting, which follows the first conference held in Rio de Janeiro in 2000 was very successful, attracting a large number of contributions from many different countries. This led to a very fruitful exchange of views and to many discussions among the participants, who came from a wide variety of backgrounds. The success of the Conference was in great part due to the variety of experience amongst the participants.

The Editors are grateful to all the participants for having attended the conference and to the authors for their excellent presentations. They are indebted to the members of the International Scientific Advisory Committee who contributed to the reviewing of the papers.

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Defining the pattern of the sustainable urban region

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Abstract

Past efforts to define, describe, and advocate the spatial pattern of sustainable cities and towns have rested largely on the urban core. However, discussion of the relative effects of sprawl and sustainable development patterns must rest on a regional perspective since sprawl, by definition, includes land area other than the traditional urban core. Continued focus on the urban core has neglected the critical interaction of urban, suburban and rural land use patterns which is necessary for a comprehensive understanding of the regional system. In order to assess the relative resource efficiency of various urban/regional land use patterns, this paper explores the link between spatial form and land cover pattern of urban regions, and their levels of resource efficiency. A typology of regional form is developed, which leads to a framework for regional sustainability assessment. The secondary key to advancing this investigation is the development of a series of indicators that bridge the acknowledged boundaries of political divisions, watershed boundaries, and transportation systems.

1 Introduction

Efforts to define, describe, and advocate the spatial pattern of sustainable cities and towns have been a part of the land use planning debate for more than a decade. Sprawl, or the decentralization of cities, has become a primary issue in both Europe and the United States [1]. Between 1982 and 1997, the amount of urbanized land in the United States increased by 47 percent, while the nation's population increased by only 17 percent [2]. Throughout the debate, much of the focus surrounding sprawl and sustainable land use patterns has been on the urban core. Particularly in the United States, with theoretical and media focus on neo-traditional communities, the focus for sustainable cities has been on the urban, largely irrespective of the land matrix surrounding.

However, the focus on the urban core neglects the critical interaction of urban, suburban and rural land use patterns. A discussion of the effects of sprawl and sustainable development patterns must rest on a regional perspective since sprawl, by definition, includes land area other than the traditional urban core. Without a typology that defines and evaluates these regional land patterns in their entirety and complexity, it is difficult to adequately differentiate between the land use patterns that will variously enhance or degrade sustainability.

Both the terms 'sprawl' and 'sustainability' have become elusive catchwords in the popular media. For the purposes of this paper, sprawl is defined as low density development, a land use pattern in which land is consumed at a faster rate than population growth would indicate [2]. Sustainability is defined in physical, economic, political, social and cultural terms throughout the literature. Since the goal of this research effort is to assess the effects of land use patterns on natural resources or natural capital [3], sustainability is defined here only in terms of its physical impact on ecological and natural resources; the comparative resource efficiency of the region.

Sprawl has been linked to costly economic, social, and environmental effects [4,5,6,7], as well as being presented as the optimal solution to urban congestion [8]. In order to assess the relative resource efficiency of urban/regional land use patterns, this paper will explore the link between the spatial form and land cover pattern of urban regions, and the resulting levels of resource efficiency. The key to advancing this investigation is to develop a series of indicators that bridge the acknowledged boundaries of political divisions, watershed boundaries, and transportation systems. Therefore, the paper will link regional form to a series of indicators that cross boundaries to measure the resource efficiency of each typological group. The resulting framework can then be applied in future efforts to provide empirical evidence for the debate regarding the comparative resource efficiencies of regional development patterns.

2 Defining Sustainability and Resource Efficiency

As stated previously, the term sustainability has a rather broad meaning, having been variously defined in physical, economic, political, social and cultural terms throughout the literature. In terms of this research effort, sustainability is defined only in terms of its physical impact on the environment and natural resources; the comparative resource efficiency of the urban regional system. Why is this focus key to sustainable land use planning? At present, both human population and average consumption are increasing while the total area of productive land and stocks of natural capital are fixed or in decline [9]. This increasing consumption can be defined in terms of energy: "In 1790 the estimated average daily energy consumption by Americans was 11,000 Kcal. By 1980, this had increased almost twenty-fold to 210,000 kcal/day" [10]. It can also be defined in terms of consumption of land by the urban system: "...most metropolitan areas are consuming land for urbanization much more rapidly than they are adding population" [2]. While "the land use system has not traditionally been seen as a major player in achieving urban sustainability," [11] results from a variety of recent articles provide support for the contention that land pattern is a major contributor to physical sustainability of the urban system [12,13,14].

"Carrying capacity is usually defined as the maximum population of a given species that can be supported indefinitely in a defined habitat without permanently impairing the productivity of that habitat" [9]. However, if carrying capacity is, as redefined by Rees [9], maximum load that can be imposed, then the issue of increasing individual consumption becomes primary. While Rees focuses on the idea of ecological footprint, the area of terrestrial and aquatic ecosystems needed to sustain a defined population indefinitely [15,16], the issue of carrying capacity can similarly be applied to assessing regional resource efficiency.

Ecological footprint analysis and theory plays a role in illustrating how dangerously overconsumptive we are, particularly in the United States and other developed nations. However, to analyse our spatial land use patterns and come up with a rationale for being less consumptive, we must look to other theoretical models. Some difficulties with the ecological footprint method are 1) it is aspatial - the resultant equivalent land area is no place in particular and so it ignores critical spatial interactions within an ecosystem, 2) it is highly aggregated, and 3) it measures only one point in time so trends are not apparent.

Cities and other areas developed by humans are complex, highly ordered (thermodynamically low entropy) systems that are maintained in that state by inflows of matter and energy from outside their borders. Reliance on these external flows to maintain local complexity and order increases the entropy (disorder) of the system globally [17]. Cities thus act as 'dissipative structures', maintaining their form and function by continuously dissipating energy drawn from the larger system in which they are embedded. Complete assessment of 'sustainability' for a city or developed area requires evaluation of the largest system affected by the developed area under study.

Determination of the extent of the 'largest system' depends on the particular flow being considered, i.e. water, energy, Big Macs, Porsches, etc. This 'largest system' may in many cases be global, given the currently low economic cost of transport and the continuing trend toward more open world trade. However, the focus of this research effort is the relative resource efficiency of regional patterns so we will look at regional, not global, systems and regional, not global, indicators of sustainability.

3 Urban form and regional pattern

The distinct pattern of cities is obvious to even the most casual observer. Beatley [1] indicates clear and immediate differences between the basic land use patterns and spatial forms of American and European cities. Researchers have also found direct relationships between the form of cities and their resource efficiency, whether in global studies [6,18], or in comparisons of various North

American cities [2,6]. Past efforts to compare European and North American cities, land use systems, and their resulting regional forms, have focused on a typology of urban form [e.g. 19,20] and on the strictly urban area. However, the typological structure defined for the city can be expanded in concept to apply to a discussion of regional development patterns.

Lynch [19] defined city form with five factors: size, density, grain (or land use pattern), shape and internal pattern. The first two have direct relevance to a regional typology: both the total population size and the actual density on the ground are critical variables in defining regional form. Grain and internal pattern are also significant aspects of urban typology that can be readily appropriated by a regional model. The land use pattern or grain, including size of use areas, the clarity or diffusion of use area boundaries and the level of integration of uses within zones define regionally as well as within the city, how easy it is to access places of work, school, play and the goods and services necessary for day to day life.

It is in the shape of the city that the greatest difficulty for a parallel structure of typology is found. Typical typologies for urban systems have focused on the outline of the urban area and have been defined as much by their historical development as by their existing form. Thus, the shapes of nuclear, linear, stellar and constellation [19] have become common in discussions of urban form and can provide the basis for a typology of regional spatial form. Bacon [20] describes development form as having an essential inner and outer space. The outer space is the "broader milieu within which its inner, more intimately related spaces function" [20]. He further defines four essential forms of design movement that can easily be transferred to regional form and have a specific relevance since they deal with both the inner and outer, urban to rural, space of the regional system. Development forms include 1) the inward looking, or the circumscribed geometric object (often a circle), 2) outreach or star pattern, 3) outgoing or the thrust "that penetrated the boundaries of the inner space, that extended outward indefinitely, over the horizon seemingly to infinity" [20]; and 4) involvement that includes "not only the penetration of the inner space by an outward push, but concurrently a counter-movement of outer space influences penetrating inwardly toward the source" [20].

Taken in concert with Lynch's typology of urban form, Bacon's analysis can be extended to a typology of regional form, as shown in Figure 1. The classic urban regional form, the focus of the neo-traditional movement, is the compact, nuclear city. Taken in regional context, the nuclear city has as its outer space, a low density, rural matrix surrounding the higher density urban core. The boundary between urban and rural is clearly defined, and the type is exemplified by such medieval cities as Carcassonne, France. The second, the outreach pattern, is the linear or star form, wherein two or more fingers of development have extended out from the urban core to expand the urban area into the rural matrix. This expansion typically occurs along a railroad, mass transit, or highway corridor and is exemplified by early railroad towns across the U.S.

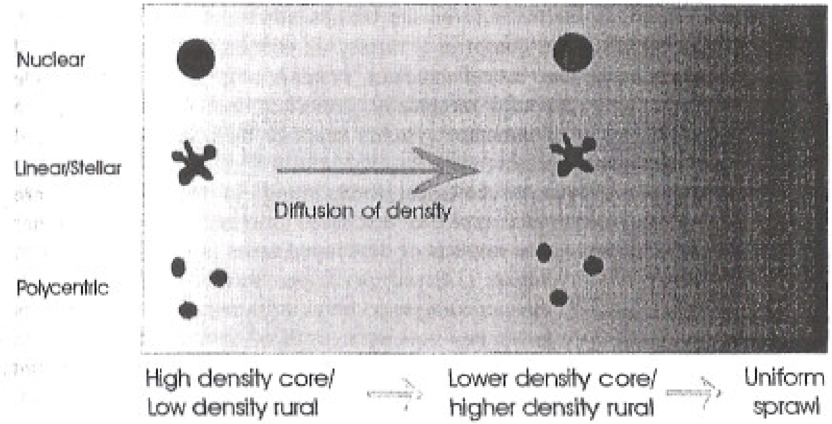

Figure 1: Extended typology of regional form illustrating the continuum from high density urban core in a rural matrix to uniform sprawl.

The third regional form, the outgoing thrust that extends outward indefinitely is of course classic urban sprawl. Development of the city expands in a relatively uniform mass, with little differentiation, to cover the former rural land matrix, leaving little or no boundary definition. Los Angeles, Phoenix and Houston exemplify a sprawling regional form. The fourth regional form occurs with a equivalent push and pull of the urban and rural forces, the city and its surrounding mass of green space. Thus in the regional perspective, ribbons of urban development move out into the rural matrix while at the same time, ribbons of rural land and green space move into the urban core. Bath, England is the prototypical green city.

Lynch's constellation city form, provides the basis for the fifth type of regional development form. This is the polycentric city, the focus of considerable current research [e.g. 8]. The polycentric city can be either a series of interrelated nuclear cities, joined by transport and proximity to form a functional whole, or a series of core areas joined by a matrix of urban sprawl to form a new urban region. Therefore, polycentric regions can be either nuclear in form, or based in a matrix of sprawl such as the suburban region surrounding Washington, D.C. In the regional context, it is important to see this typology of five regional forms not as individual prototypes, but as a continuum along which any region may be identified.

4 Indicators of regional sustainability

The desire to assess 'sustainability' necessarily leads to the desire for measurement. Well-defined indicators serve as feedback signals on our collective actions, to tell us 'where we are' and 'how we are doing' in relation to our goals, both as individuals and as a society. Depending on the geographic scale of the region of interest and on the parties and organizations involved, these indicator systems can comprise a variety of economic and/or ecological ('environmental') measures. Local indicator systems (e.g. Sustainable Seattle [21]) tend to be more focused on locally important issues relevant to the community, while national indicator systems seem to be biased more toward broad economic measures [21].

One indicator approach is ecological footprinting, in which impacts are converted into equivalent land areas as discussed previously [16]. Another framework for considering the impacts of developed areas is urban metabolism first discussed by Abel Wolman [22] and developed further by Baccini [23]. This framework considers developed areas to be akin to organisms that process energy and materials into waste and heat as a result of their existence. As in ecological footprinting, calculating an urban metabolism requires a large amount of relatively detailed data on energy and material flows through the study area, data that are frequently difficult or impossible to get.

4.1 Some representative measures of resource efficiency

Defining key measures or indicators of resource efficiency is a central aspect of regional sustainability assessment. Several of these indicators are similar to indicators used in other studies to identify sustainable land use patterns: transportation, energy, and water. However, two additional indicators must be added to fully assess a regional system: agriculture and habitat. Work must be done to reconcile the differing regional boundaries of these indicators. However, the methods for inclusion of these indicators and for collecting relevant data have been developed in other studies.

Meeting the caloric requirements of a population is of such primary importance that some measure of the ease and cost of making food available is a central measure of regional resource efficiency. Local agricultural land is a significant component in food security. The farms tend to be more family-run and produce organic products resulting in local economic benefits and a reduction in toxic/hazardous inputs compared to large-scale corporate agriculture [24,25]. In addition, local farm production resulting in a reduction in transportation costs and impacts is a *prima facie* good thing. As indicators of the presence of agricultural land, both the percentage of total land in agriculture and the percentage of land in agriculture per capita are representative measures of regional resource efficiency related to food production.

Land available as habitat for species besides humans is a significant factor in the healthy ecological function of a region. In fact, the amount of forested land in a region has been linked to overall watershed health [26,27]. Undeveloped land (again as percent land area and percent land area/capita) is a simple first cut at a measure of available habitat in a region. There is also an opportunity to use patch-based metrics to assess the quality of undeveloped land as habitat [28]. These metrics include such measures of patch size, density, variability, diversity, contagion, and interspersion and are one way to understand and measure the quality and connectivity of undeveloped land as habitat.

Water is another resource of primary importance to a population. A primary indicator of both surface and subsurface water quality is the amount of impervious area within a given region [29,30,31,32]. Impervious surfaces are a physical result of the spatial development pattern, therefore both the density and location of the impervious surface areas will change between the various regional types. Area of impervious surface is relatively easy to measure from aerial photos (both as a percentage of land area and a percentage of land area per capita) [33,34,35,36,37,38]. There are also methods linking impervious area to population [30].

A fourth significant component of regional resource efficiency is transportation. Regional form influences the impacts resulting from transportation primarily from the use of fossil-based energy in vehicles but also through the expansion of the area of impervious surfaces noted above. A significant amount of research has been done linking urban form to transportation impacts and efficiency, a parallel which we would expect to continue in a regional context [6,11,14] Two measures of regional transportation are the number of miles of road per capita and the number of vehicle or passenger miles traveled by the different transportation modes available in a region.

The representative measures discussed above are based on data that are relatively easy to collect. An important measure of regional resource efficiency for which data are more difficult to obtain is energy use in buildings. Energy used in buildings integrates climate, building construction type and quality, and occupant behavior [39,40,41], and it is modified by building density and arrangement and the presence, location, and type of surrounding vegetation [42,43,44,45]. Identifying the separate effects of these different factors is difficult, and not necessarily required to assess resource efficiency. If these data are available, either on a per capita basis or aggregated over some area (census tract, for example), they should be incorporated into the assessment.

5 Conclusions

The decentralization of cities and the primacy of sprawl as a development pattern has become an issue of global proportions. Because of this, the identification of urban development patterns which are more sustainable and resource efficient is a pressing issue in the planning profession. In order to accurately assess the relative resource efficiency of urban regions, this paper has presented an argument for including the hinterlands of urban areas in any consideration of sustainability thereby making urban sustainability a regional concept.

In order to define regional development patterns in a typology for the purposes of assessment, the vocabulary previously used in the literature to describe urban form and morphology is extended here and applied to regional form. By identifying the relative size, density, land use pattern, internal structure and physical form of the region, it is possible to assign any urban region a position in the regional typology. Then with the collection of indicator data, the regional forms can be compared for relative resource efficiency across a broad range of indicators.

We have defined five primary indicators of resource efficiency based on existing literature, and their relevance to spatial form: water, transportation, energy, agriculture, and habitat. By applying these to actual urban regions in future phases of this research, a body of quantitative support can be developed towards the implementation of sustainable regional forms.

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A comparative study on urban land use planning system between China and Taiwan

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Abstract

This paper compares the urban land use planning mechanism that operates within Taiwan and China. In contrast to Taiwan's policy of private land ownership, all urban land belongs to the state and land use rights are different from land ownership in China. This study revealed that although planning systems in Taiwan and China are different from each other, both confronted challenges in pursuit of sustainable urban development. China needs to devote much attention to the environmental and to public participation issues. The dual land use system and the coordination between master and detailed plans needs to be improved in China. Taiwan faces the challenges of coordinating zoning and development permit systems, more equitable compensation schemes, and more public participation in the planning process. The study suggests that coordination between tiers of government, transparency of decision-making procedures, accountability or liability of the decision-makers and an enforceable regulatory framework are also needed both in Taiwan and China.

1 Introduction

In the democratic world, most land is owned privately and trading is freely allowed. Therefore, without land use planning, land would be apportioned between competing uses by the price mechanism and the interaction of supply and demand. But the mechanism of the free market can cause ill-conceived and short-sighted ways, which may create almost insurmountable problems for generations to come. Land use planning has considered as necessary schemes for governments to manage urban lands. Since 1980, a growing awareness of sustainable development in the world has sought to adopt policies on sustainability in many topic