Chapter 1
Planning Support Systems: Content, Issues and Trends

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1.1 Introduction

Since we edited *Planning Support Systems in Practice* (Geertman and Stillwell 2003), we have become increasingly aware that successful applications of geo-technology by planning practitioners to support their activities are far from commonplace. It is disturbing, in fact, to observe the extent to which new computer-based support systems are developed by researchers to the point of adoption but are never implemented in planning practice or policy making. Similarly, there is evidence to indicate that systems which are made operational are not extensively used, after the initial novelty has passed, by those planning organizations for which they have been developed in the first instance. In terms of application, it is possible to point to more failures than successes, i.e. to more cases where systems have not been implemented than examples where they are used routinely. Moreover, many state-of-the-art systems appear to take a long time to reach the 'market' and this is often a process requiring considerable financial resources. There are a number of reasons for this state of affairs that we will explore in Section 1.2 of this chapter after providing some initial clarification of what we mean by Planning Support Systems (PSS) and how they are distinguished for Geographical Information Systems (GIS) and Spatial Decision Support Systems (SDSS).

In these rather disappointing circumstances, it becomes very important to identify examples of 'best practice' where systems have been developed that are doing the job that they were designed for and have become effective tools for policy makers or practitioners to utilize on a regular basis. This identification process is one of the primary aims of this book and several of the chapters report on systems that fall in this category, that have been applied successfully and that are used as a matter of

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S. Geertman, J. Stillwell (eds.), *Planning Support Systems Best Practice and New Methods*,
DOI 10.1007/978-1-4020-8952-7_1, © Springer Science+Business Media B.V. 2009

routine to support some planning process or assist the policy maker in reaching a decision on which option to adopt.

We are also conscious of the pace of change in recent years and the way in which technology is driving forward developments at a rapid rate in the face of massive volumes of data and information of relevance to planning becoming more available and more accessible. This is occurring at a time when government pre-occupations with fashionable concepts like sustainability, participation, performance and evaluation are making new demands on human resources, in terms of both skill requirements and technological tools. Thus, in Section 1.3 of the chapter, we provide a discussion of some of the disparate trends that are taking place in the context in which PSS are developed and used. Implicit in this is that new methodologies are being developed continuously and, consequently, it is the second major aim of the book to illustrate the type of innovative technological developments and new processes of using geo-technology in different planning situations that are taking place in different parts of the world. In Section 1.4, we offer a rationale for the remainder of the book and present some introductory comments on each of the chapters, before drawing a short conclusion in the final section.

1.2 What's up with PSS?

In this section, we consider initially the concept of PSS and how this genre of systems is distinguishable from similar geo-technological instruments like geographical information systems (GIS) and spatial decision support systems (SDSS). Thereafter, we focus our attention on their hitherto rather restricted applications in planning practice, the reasons that underlie this disappointing and unsatisfactory situation and the lessons that can be learned from experience to date and applied to improve this state of affairs.

1.2.1 The PSS Concept

PSS are a relatively recent phenomenon, emerging onto the planning scene in the mid-1990s as geo-technological instruments fully dedicated to support and improve the performance of those involved in undertaking specific planning tasks (Batty 1995; Klosterman 1997). In a sense they are related to GIS, but while the latter are general purpose tools for capturing, storing, manipulating, analysing and displaying spatially referenced data, applicable for many different spatially-related problems, PSS distinguish themselves through being focused on supporting specific planning tasks. On many occasions a PSS will contain a GIS, particularly if the task in hand requires geographical/spatial data. PSS are also related to SDSS, although the former generally pay particular attention to long-range problems and strategic issues, while SDSS are generally designed to support shorter-term policy making by isolated individuals or by business organizations (Clarke 1990). Moreover, the prime dedication of SDSS is towards supporting operational decision making rather than strategic planning activities which is the prime focus of PSS. Consequently, PSS usually consist of a combination of planning-related theory, data, information, knowledge, methods and instruments that take the form of an integrated framework with a shared graphical user interface (Geertman and Stillwell 2003). Many regard PSS as valuable support tools that will enable planners to better handle the complexity of planning processes, leading to plans of better quality and saving a lot of time and resources. In this respect, it seems that a new, more positive attitude concerning PSS has emerged since the turn of the century. At present, much more attention is focused on planning support and its technological instruments than has been the case in the past, a trend that appears to be evident from the volume of studies that are being undertaken, the dedicated conferences that are taking place, and the diversity of articles and books that take PSS as their prime focus.

It is important to acknowledge how the definition of what is considered here as PSS has evolved. Harris and Batty (1993) were really the first to associate the concept of PSS with combining a range of computer-based methods and models into an integrated system used to support a particular planning function. More precisely, in their opinion, a single PSS forms the framework in which three sets of components are combined: the specification of the planning tasks and problems at hand, including the assembly of data; the system models and methods that inform the planning process through analysis, prediction and prescription; and the transformation of basic data into information which, in turn, provides the driving force for modelling and design (through a cyclical process). In a similar vein, Klosterman (1997, 1999) and Brail and Klosterman (2001) have more recently described PSS as information technologies that are used specifically by planners to undertake their unique professional responsibilities. They suggest that PSS have matured into frameworks of integrated systems of information and software that synthesize the three components of traditional DSS – information, models, and visualization – and deliver them into the public realm. Earlier, Batty (1995) had suggested PSS to be a subset of geo-information technologies, dedicated to supporting those involved in planning to explore, represent, analyse, visualize, predict, prescribe, design, implement, monitor, and discuss issues associated with the need to plan. Geertman and Stillwell (2003) considered PSS to be geo-information technology-based instruments that incorporate a suite of components (theories, data, information, knowledge, methods, tools, meta-information) which collectively support some specific parts of a unique professional planning task. Brail (cited in Batty 2005), on the other hand, has drawn attention to the fact that many PSS are developed and used to provide projections forward to some point in the future or may involve some estimation of the impacts that result from some form of development. In summary, this kaleidoscopic review indicates that whilst there may be no strict uniform definition of PSS at the moment – a conclusion reached also by Klosterman and Pettit (2005) in their 'Update on PSS' – all definitions tend to coincide by including or touching upon the same kind of required functionalities within this category of support instruments. Many commentators regard PSS as being capable of improving the handling of knowledge and information in planning processes, a function that provides huge assistance to those involved in handling the ever-increasing complexity of planning tasks.

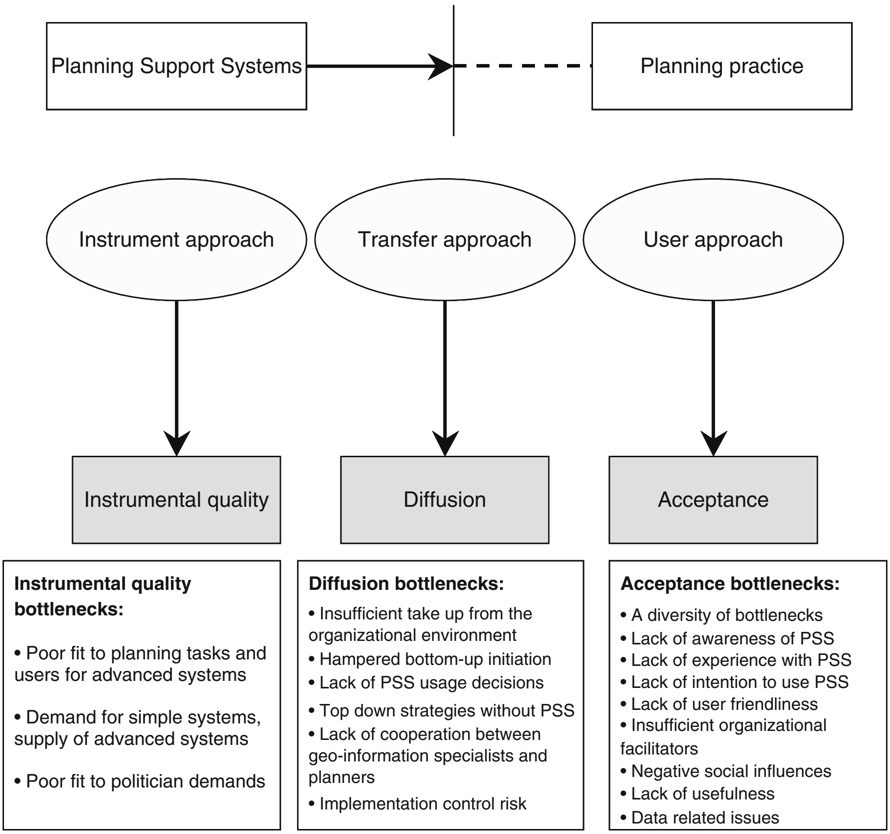
1.2.2 Bottlenecks

In spite of the apparent benefits that various PSS would appear to provide, they have not yet become widely used in planning practice (Brail and Klosterman 2001; Geertman and Stillwell 2003). This neglect or even antipathy is remarkable for at least two reasons. First, planning support instruments are increasingly finding their way from the scientific laboratories into the marketplace. An inventory by Geertman and Stillwell (2003) has concluded that some PSS can be considered 'off-the-shelf' products that can be purchased on the market at a reasonable price. Secondly, planning tasks characterize themselves increasingly by their growing complexity: an increasing number of fields of policy must be taken into account and integrated in order to produce balanced planning proposals. More and more people with divergent interests and agendas are closely involved in participatory planning processes; the involvement of participants is taking place at a much earlier stage in the planning process. In sum, there are plenty of reasons for professional planners to actively embrace all kinds of assistance, including planning support instruments, to enlighten and improve their procedures as the process of practice changes. However, there appear to be a number of important obstacles that hamper the use of PSS in practice and several studies have been undertaken recently to identify these so-called 'bottlenecks'. A brief synopsis of three studies will be summarized here, with more detailed explanation being available in Vonk (2006) and Vonk *et al.* (2005; 2007a,b).

First of all, the views of users of PSS have been gathered through a series of interviews held with 43 employees of 12 highly comparable Dutch regional spatial planning organizations. In particular, interviews were held with three archetypal users that currently fulfill an important role in (potentially) using and evaluating PSS: geo-information specialists, planners and managers. Secondly, given that the views of PSS developers concerning potentials and bottlenecks are well recorded in the scientific literature, a set of 58 PSS and their developers were examined on the basis of a literature review; these constitute a relatively accurate overview of system developers' perspectives. Thirdly, the views of experts in PSS have been gathered by means of conducting two additional World Wide Web (WWW) surveys based on 800 individuals with interests in PSS obtained from various listserv e-mail networks. The first survey had 96 respondents of which 86 were considered experts, since they were familiar with at least two PSS. The second survey had 40 respondents, of which 30 were experts, the majority of which appeared to be university researchers and employees in public planning research and/or advisory bureaux dealing with planning support. The findings of the literature survey, the interviews and the web surveys were combined in order to learn lessons on the usage of PSS, their potential and the bottlenecks leading to non-implementation or usage.

In order to interpret the results of these studies in a structured way, three different viewpoints and their associated conceptual underpinnings were applied: the so-called 'instrument approach', the 'user approach' and the 'transfer approach' (Fig. 1.1). The instrument approach regards usage mainly in terms of the instrumental quality of the PSS, focusing particularly on fitness for use and user friendliness (Dishaw and Strong 1999; Dishaw *et al.* 2002; Goodhue 1995; Goodhue and Thompson 1995). The user approach considers usage in relation to the extent of user acceptance of the PSS, identifying the broader set of factors related to the accepting environment. Finally, the transfer approach explains usage in terms of the extent of diffusion, paying particular attention to the flow of information concerning PSS from the system developer to and among the user and the user community. In fact, the three approaches overlap in that they all look at the same issue of usage, but each emphasizes slightly different aspects.

The instrument approach which indicates instrumental quality is defined here as consisting of a judgment of: (i) how well the instruments are capable of carrying out the tasks that they were developed for; and (ii) how well they fit to



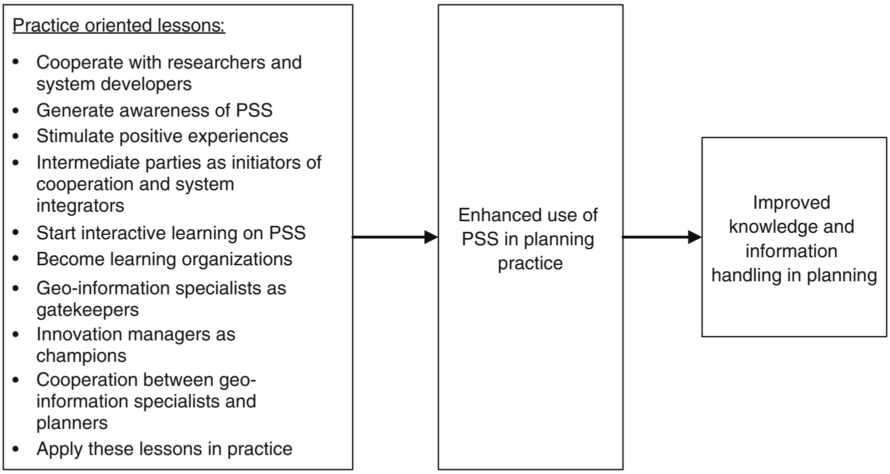
Source: Vonk (2006)

Fig. 1.1 Conceptual framework explaining under-usage of PSS from three different approaches the capabilities and demands of intended users. Goodhue and Thompson (1995) showed the importance of these characteristics as determinants of usage of information technologies in their model of 'Task-Technology-User fit' (Dishaw and Strong 1999; Dishaw *et al.* 2002; Goodhue 1995; Goodhue and Thompson 1995). The outcomes of the research suggest that PSS technology is still at an early stage of development, with a large variety of systems, very few standards, and characterized by large differences in instrumental quality. Moreover, it indicates that there exists a fundamental dichotomy between those PSS that are demanded for use in practice by potential users and those PSS supplied by system developers according to their perceptions of what is required. In short, while practice generally demands rather simple and straightforward PSS for exploratory tasks such as making an inventory of conditions or recording planning applications, the majority of PSS that have been developed focus on more analytical tasks, including modelling and projection. These more sophisticated systems are seen as a poor match with the demands of planning practice in reality. The instrumental quality of simple instruments is deemed to be acceptable whilst that of advanced instruments is generally considered to be poor. Results suggest that simple instruments have a relative advantage over manual operations; for many existing advanced instruments, the advantage is doubtful at least.

The user approach focuses in particular on characteristics of users that determine the acceptance of PSS. This approach emphasizes how users should change in order to enhance usage of PSS. Factors that influence acceptance include the characteristics of users, instruments, organizations, the social environment, the external environment and facilitating conditions. These factors that influence acceptance have been framed in the so-called 'Technology Acceptance Model' (TAM) as discussed by Davies (1986), Frambach and Schillewaert (2002) and Rogers (2003), for example. This user approach shows a large variety of obstacles blocking widespread acceptance of PSS in planning practice. The main bottlenecks are the following: (i) the lack of awareness of the existence of PSS and the purposes for which they can be used; (ii) the lack of experience with PSS, which leaves users unaware of the benefits of PSS and the conditions under which they can be used; and (iii) the low intention to start using PSS among possible users. The list of other high scoring bottlenecks includes insufficient user friendliness and usefulness, the absence of the required organizational facilitators and social influences and, moreover, data quality and accessibility problems.

The transfer approach explains usage of PSS in planning practice based on characteristics of the diffusion of PSS within planning practice. It is concerned with the process of moving from an innovation context to a practical context, through the acceptance by individuals, groups and organizations. Diffusion is envisaged as a process that takes the innovation from the system developers towards widespread usage in practice over various levels of aggregation (Rogers 1995). Studies adopting the diffusion approach show that diffusion of PSS in planning organizations is more likely to start bottom-up than top-down since geo-information specialists are more likely to spot PSS developments and adopt them as they emerge from the working environment. Nonetheless, lack of opportunity for innovation and personal characteristics often cause geo-information specialists at the bottom of the organization to be unable to transfer the technology from the external environment and bring it to the attention of top management. In addition, these individuals are not able to bring PSS to the attention of planners since geo-information specialists themselves are often unable to communicate effectively with spatial planners and set up cooperation networks. Innovative ideas are also poorly diffused due to differences in appreciation of PSS between individual geo-information specialists and others within the organization. Thus, for example, geo-information specialists often encounter a discrepancy between planners' questions and their offers. From this summary of bottlenecks, it is possible to derive some lessons for future action (Fig. 1.2).

As far as instruments are concerned, there is a desire and an intention to improve the instrumental quality. However, those in practice willing to use PSS are often unable to improve the instrument quality of PSS on their own. Nonetheless, if they cooperate with researchers and system developers, they can at least contribute to PSS quality improvement. This requires that the demands expressed by potential users should be taken much more seriously than has been the case thus far. With regard to the users, much more awareness of and subsequent experience with PSS is needed. For those willing to start using PSS in planning practice, it is recommended that they actively spread the news of the existence of PSS and their potentials through the appropriate communications channels. Furthermore, they should make the PSS message better suited to the receivers. Good examples of applications and best practice will help to overcome some of the bottlenecks associated with lack of awareness and experience. As for transfer bottlenecks, a distinction can be made between diffusion towards planning organizations and diffusion within planning organizations. Some intermediate actors can fulfill the role in the diffusion towards planning organization. Of these actors, governmental research agencies



Source: Vonk (2006)

Fig. 1.2 Lessons to enhance usage of PSS to improve knowledge and information handling in planning and consultant organizations usually have greater knowledge of and accessibility to planning practice than scientists working within universities. They are expected to be capable of getting the actors of the PSS innovation network working together to engage in cooperative development. In terms of diffusion within planning organizations, managers of planning organizations are advised to adopt the management paradigm of the ‘learning organization’ (Senge 1990) and adopt knowledge management strategies (Nonaka and Takeuchi 1995). Managing information technology adoption and implementation in complex environments is challenging. The adoption of the managerial paradigm of the learning organization can change this because it stimulates the flow of knowledge towards and within organizations, thereby stimulating innovation, acceptance and diffusion of PSS. This allows geo-information specialists to function as gatekeepers, matching innovations in the organizational environment with internal demands, and subsequently, innovation managers can then function as champions. This last role entails bringing the PSS innovation further into the organization towards utilization of the opportunities that PSS have to offer. To achieve this innovation, these champions need to convince planners of the use of PSS in their daily practices and persuade other managers to decide on adoption or at least provide room for some experimentation.

In conclusion, the instrumental quality of PSS, the awareness and experiences of potential users, and the transfer of these instruments towards and within planning organizations, all need improvement to overcome the bottlenecks that are known to exist and to fulfill the potential of the PSS to its fullest extent. Therein, spreading the news about good applications and best practice and improving cooperation (e.g. between geo-information specialists and planners) can be considered as key activities in what has to be undertaken to enhance PSS use in practice. Whilst best practice examples and cooperation are key, we must also acknowledge that the environment of planning practice, as well as the technological infrastructure and resources available to support planning are under continuous change and it is this dynamic which we consider in the next section.

1.3 Developments in PSS Context

In recent years, it seems that the speed and intensity of change continues to increase in virtually all aspects of economic, social and environmental development. Governments demand more evidence on which to base more effective policies, require better means of evaluating action or more strategic planning at different spatial scales, and encourage more stakeholder participation in major infrastructure projects as well as local community developments. Knowledge continues to accumulate as increasing amounts of information are extracted from ever-increasing volumes of data. Developments in technology are a key driving force in relation to the capture, storage, manipulation, analysis, generation, display and interpretation of data. In this section of the chapter, we explore some of these developments insofar as they impact on PSS.

1.3.1 Participation in Planning Processes

There is an increasingly widely held view that encouraging citizens and stakeholders to participate in planning and decision making is an essential ingredient for healthy and democratic development. Whilst many developed countries have seen a growing disinterest in local and national politics and extensive disillusion with planning in a capitalist environment, many governments have recognized that public involvement in the process of planning has potential value in renewing community interest and rekindling trust. Furthermore, there is no doubt that public participation has had a longstanding presence in the planning process but the trend in recent years is for governments, sometimes in the face of community breakdown, to develop new ways of getting the public actively involved in deciding the future of the places where they live, work and play. It can be argued that a major cultural shift is required to an ethos in which citizens feel empowered to create an environment over which they have some control. Moving to a system in which planning is not left entirely to a cadre of professionals but which involves citizens and other stakeholders presents a whole range of problems, yet collaboration involving a wide range of organizations and individuals is seen as making much better use of the resources and expertise that are available and therefore creating a higher potential for success. Collaborative problem solving and collective decision making are seen as a means to resolve confrontation at 'grass roots' and generate solutions that are more tailored to what local communities require. In many countries, of course, participation and collaboration in the planning process are required by law.

It is therefore not surprising that, over the past decade, considerable attention has focused on what has been termed Participatory Geographic Information Systems (P-GIS) or Public Participation Geographic Information Systems (PP-GIS) or Participatory Planning Support Systems (P-PSS) or Public Participatory Planning Support Systems (PP-PSS) for use in planning contexts where there is an explicit geographical or spatial dimension. Each type of system may have distinctive hallmarks but all of them have been developed to support democratic decision making and enable the opinions of local people to be channeled into proposals that will ultimately lead to an improvement of their own livelihoods. Consequently, these systems aim to facilitate greater stakeholder or public involvement in decision making, enhance effective communication and understanding, and monitor the impacts of policies and management plans on local communities more effectively.

When digital spatial data and software are made available to community groups and individuals using specially designed P-GIS or P-PSS tools, this type of activity is frequently referred to as PP-GIS or PP-PSS since it involves the participation of local people. Moreover, there is a trend towards increasing use of the internet to experiment with the development of online PP-GIS or PP-PSS, particularly in North America (Ventura *et al.* 2003; Al-Kodmany 2003) and in Europe (Carver *et al.* 1999; Kingston *et al.* 2003). These approaches offer huge potential for enhanced participation as online systems and web mapping software mature and as the public's experience of the internet grows in countries that have the required infrastructure. However, the systems and their use are not without certain shortcomings: they require significant technological investment in the first instance; they are not likely to be accepted by less technologically skilled participants; and there are a range of problems in representing people's opinions, beliefs, perceptions and value judgements in a PSS and then incorporating and using them in GIS together with more quantitative data. Whilst PP-GIS/PP-PSS is one of the areas embraced by the new wave of researchers promoting critical GIS (C-GIS) and examining how practices of GIS and mapping are fundamentally political, (Elwood 2005, 2006), we should acknowledge that the importance of a human-centred approach and the focus on human-computer interaction were major drivers towards the development of Collaborative Planning Systems (CPS) as outlined by Shiffer in the early 1990s (Shiffer 1992, 1995).

Public participation is one of the dimensions that have to be embraced by those public sector organisations charged with planning or policy making responsibilities. Different institutions carrying out different functions at national, regional or local levels have various requirements in terms of the data sets relevant to their functions and the technical tools that they need to process the data. Increasing importance is attached to providing the 'evidence base' to underpin policy decisions; there is increasing emphasis on performance of individuals, teams and institutions as well as policies; more comprehensive monitoring and auditing of processes is required as well as better evaluation of methods and outcomes; and public organisations are under increasing pressure to make their data sets more available and accessible. In the context of the last of the latter, Campagna and Delano (2004), for example, provide an interesting evaluation of the geographic information that public sector bodies provide on their websites. These issues raise concerns about the lack of awareness of what is best practice and the need for more and better trained staff with rising expectations as far as technology is concerned and how it can be applied. In the case of public participation in planning, this means an awareness of whether new forms of visualisation, animation, interactivity, customisation and prediction can be used in each particular planning context.

1.3.2 Information Provision and Data Integration

Virtually every sector of planning has seen an expansion in the volume of relevant information extracted from secondary sources whilst researchers strive to create and identify new primary quantitative and qualitative data sets that give fresh insights into their fields of interest. Large corporations are encouraged to be more transparent in their information holdings, to share data with others, to avoid the data silo mentality and to maximise the value of administrative information and data that they hold through linkage with other existing public or private data sets. The theme of data integration has been particularly important in the last decade both at an individual micro scale as well as at more aggregate macro scales, although there are frequently constraints on data integration at the micro level due to confidentiality issues. The use of administrative data in different planning contexts is also increasingly important in countries like the UK where the decadal Census of Population assumes huge importance in the absence of a population registration system. The 2001 Census in the UK is the most reliable and comprehensive source of socio-demographic data on small geographical areas throughout the country (Rees *et al.* 2002) but, as the years pass by and census data become more out-of-date, social commentators and researchers turn to alternative sources to establish changing trends and new social phenomena that planners must deal with. For example, administrative registers of births and deaths enable insights to be gained into the components of natural population change whereas re-registration data of National Health Service patients enable internal migration flows to be monitored and worker registration or national insurance data provide some indication of international immigration, a trend with economic and social implications that challenge policy makers and service providers across the country in both urban and rural environments.

Owing to the exponential increase in computing power and communication bandwidth, the past decade has also witnessed a spectacular growth in volume of data 'born digital'. This includes digital image data captured by sensors and satellites, but it also includes data generated by telephones and mobile phones as well as internet traffic, and has become an increasingly important focus of attention by social and computer scientists working on new e-social science initiatives.

One responsive trend to the proliferation of data sources and data sets has been the emergence, throughout the world, of national and international spatial data strategies linked to standards and integration. In many countries, there are various national databases and strategies that are relevant for planning. However, fragmentation of datasets and sources, gaps in data availability, lack of harmonisation between datasets at different geographical scales and duplication of information collection all make it difficult to identify, access and use data that are available. In response, at national and international levels, more and more initiatives are undertaken to tackle these problems. For instance at an international level the *Infrastructure for Spatial Information in Europe* (INSPIRE) initiative has been undertaken that aims to stimulate the creation of a European spatial information infrastructure that delivers to the users integrated spatial information services, allowing users to identify and access spatial or geographical information from a wide range of sources, from the local level to the global level, in an interoperable way for a variety of uses. INSPIRE is targeted at policy makers, planners and managers at European, national and local level and the citizens and their organisations. It has a geoportal at www.inspire-geoportal.eu/index.htm which is the gateway to geographic data and services, distributed around Europe, allowing users to search, view or, subject to access restrictions, download geographic data or use available services to derive information. Other examples of gateways to improve access to resources available on the web are ESRI's Geography Network (www.geographynetwork.com) the U.S. Bureau of the Census's American FactFinder (http://factfinder.census.gov/), the Social Science Information Gateway (SOSIG), an online catalogue of thousands of internet resources relevant to social science education and research, and the Census

Programme in the UK sponsored by the Economic and Social Research Council has a census portal (http://census.ac.uk/) that provides one stop shop access to all census resources used by the academic research community.

So, with increasing volumes of data becoming available, the need for standards, harmonisation and metadata becomes more and more essential. It is important for those who develop PSS in the public sector to be aware of the infrastructures that exist and the pressures to conform to national and international standards both in terms of the PSS inputs and outputs that might be used by others.

1.3.3 Technology Developments

The technology that underpins PSS is also developing rapidly and those who commission PSS are confronted with a host of important questions: Do we need a local or a national information system? Should the system be simple or more sophisticated? Should it be static or interactive? Should it contain tools for analysis as well as visualisation? Whilst the technology is getting easier to use it is also getting more sophisticated in what it can do. The impact of ICT and geo-technology on the visualisation of spatial data has been as remarkable and the pace of change is unrelenting with the new developments taking place in grid technologies, web mapping, interactive web services and advent of *Google Earth* and *Google Maps*.

These new developments have been made possible through the existence of the internet and the web using new languages such Hypertext Markup Language (HTML), the predominant markup language for the creation of web pages that provides a means to describe the structure of text-based information in a document by denoting certain text as headings, paragraphs, lists and so on, and by supplementing that text with interactive forms, embedded images and other objects. The Extensible Markup Language (XML), on the other hand, is a general-purpose markup language, classified as extensible because it allows users to define their own tags, whose primary purpose is to facilitate the sharing of data across different information systems, particularly via the internet. XML is a simplified subset of the Standard Generalized Markup Language (SGML), and is designed to be relatively human-legible. By adding semantic constraints, application languages can be implemented in XML that include XHTML, RSS, MathML, GraphML, Scalable Vector Graphics (SVG), MusicXML and many others. XML is recommended by the World Wide Web Consortium (W3C); it is a fee-free open standard. Geography Markup Language (GML) is an XML-based encoding standard for geographic information developed by the OpenGIS Consortium (OGC), designed to allow internet browsers the ability to view web-based mapping without additional components or viewers.

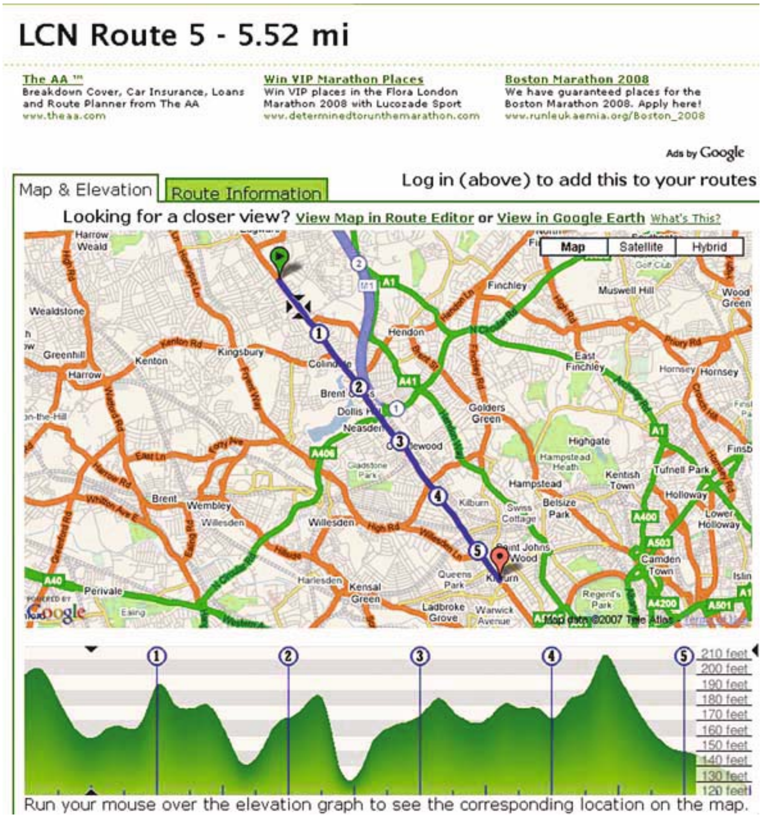
A major technological development is the evolution of the ‘grid’, known increasingly as ‘e-infrastructure’. The grid comprises networked, inter-operable, scalable computational tools and services that make it possible to locate, access, share, aggregate and manipulate digital data seamlessly across the internet. Grid computing is distributed computing that involves a number of dispersed computer resources (platforms, hardware/software architectures, computer languages) that can be used to tackle large, time-consuming tasks, providing large amounts of computing power more economically than costly high-end computers and more effectively than the most powerful supercomputers. This has led to the development of open standards and the virtualizing of computing resources. There are computational grids which focus on computationally-intensive operations, data grids that involve sharing and management of large amounts of distributed data and equipment grids where a primary piece of equipment and data produced are used remotely. By linking digital processors, storage systems and software on a global scale, grid technology has the potential to transform computing from an individual and corporate activity into a general utility (Foster 2003). The grid offers potential for PSS that are designed to support 'big science' and involve major use of computing resources such as the simulation of mega-events like earthquakes or tsunamis or the modelling of major weather events like hurricanes, where the simulation task is too big for any single supercomputer. Grid computing also provides a multi-user environment and in this respect also has potential for collaborative PSS. Grid infrastructure is also available for video-conferencing. Considerable research progress has been made in providing grid-enabled versions of High Performance Computing (HPC) tools. In the USA, grid services are being developed by the National Science Foundation (NSF) Cyberinfrastructure project at the University of Chicago using their Social Informatics Grid (SID Grid) infrastructure. The SID Grid will be deployed as part of the larger TeraGrid, a suite of grid computing resources available to the scientific community at large (http://www.teragrid.org/).

In the UK, the National Centre for e-Social Science (NCeSS) has a research programme that aims to build upon grid technologies and tools developed by researchers in centres of expertise around the UK and apply them to the particular needs of the social science research community in order to generate new solutions to social science research problems. The NCeSS nodes include those at University College London where the overall aim is to provide grid-enabled virtual environments within which users are able to link spatial data about cities to GIS software to create *Geographic Virtual Urban Environments* (*GeoVUE*). *GeoVUE* will provide decision support for a range of users from academics and professionals involved in understanding cities, to planners and urban designers who require detailed socio-economic data in plan preparation. It will provide geographic information for a more general public involved in viewing problems and policies associated with the impact of change in cities. Demonstrator VUEs include 'MapTube', a system where users can link conventional map and socio-economic attribute data to open source spatial analysis software linked to GIS where the focus is on better scientific understanding of spatial patterns of deprivation, income distribution and demographic ageing in cities. Other projects include pollution monitoring, building on existing virtual cities work (Batty 2006; Batty and Hudson-Smith 2006), where air pollution monitoring and visualization are linked to impacts on resident population through the medium of 3D-GIS using real time sensing of air pollution, and constructing VUEs, building on 3D-GIS applications in central London (Hudson-Smith *et al.*

2005) and enabling small segments of the city to be modelled and then populated by users from the various geographic databases that are available, with a view to assessing the impact of urban planning proposals. Another NCeSS node is based at the University of Leeds where the objective is to develop representation of the entire UK population as individuals and households, together with a package of *Modelling and Simulation for e-Social Science* (*MoSeS*) tools which allow specific social research and policy issues to be addressed. Microsimulation techniques are used to create synthetic population of the whole of the UK. Variants of this approach have been developed in various different contexts (Ballas *et al.* 2005a,b; 2007a,b).

The 'Maptube' idea mentioned above involves the use of *Google Earth* and *Google Maps,* both of which have changed the nature of sharing geographical information. *Google Earth maps* the whole earth by superimposing images obtained from satellite imagery, aerial photography and GIS 3D globe. *Google Maps* is a free web mapping service application and technology that underpins many map-based services including the *Google Maps* website, Google Ride Finder and embedded maps on third-party websites via the *Google Maps* application programming interface (API). *Google Maps* provides high-resolution satellite images for most urban areas across the world which are at least a year old and in some cases date back to 2001. A large amount of JavaScript was used to create *Google Maps*. The term 'mash-up' refers to a new breed of web-based applications that allow the mixing of data from at least two different services from disparate web sites. A mash-up, for example, could overlay traffic data from one source on a map from Google. Tools are available to introduce custom location icons, location coordinates and metadata, and even custom map image sources into the *Google Maps* interface. It is possible to add your own set of locations, scripts and photographs to create memory maps or image annotation features. The *Google Maps* API was created by Google to facilitate developers integrating *Google Maps* into their web sites, with their own data points. Worldwide, more and more local authorities are using maps on their web sites and are increasingly using Google to create mash-ups of information rather maps from national mapping agencies. They are moving to *Google Maps* as the primary interface for casual use by public users, leaving GIS systems for more specialist users because this provides a better user-friendly interface which is easy to use, has integrated aerial imagery, is attractive and does not require training or large manuals. For example, a group of citizens in Brent Borough in Greater London has used the local authority service to create interactive running and cycling routes (Fig. 1.3) which allows the user to run the mouse over an elevation graph to see the corresponding location on the map.

The up and coming semantic web technology provides a common framework that allows data to be shared and reused across application, enterprise and community boundaries (Berners-Lee *et al.* 2001; Hendler *et al.* 2002; Hendler and De Roure 2004). It is a collaborative effort led by W3C with participation from a large number of researchers and industrial partners and is based on the Resource Description Framework (RDF) used to represent information and to exchange knowledge in the web. Web Ontology Language (WOL) is used to publish and share sets of terms called ontologies, supporting advanced web search, software agents and knowledge



Source: http://www.runstoppable.com/routeoverview.php5?route_id=737044006

Fig. 1.3 Map view of Brent's runstoppable website (See also Plate 1 in the Colour Plate Section)

management. So, the semantic web is about common formats for integration and combination of data drawn from diverse sources, where the original web mainly concentrated on the interchange of documents. It is also about language for recording how the data relates to real-world objects that allow a person, or a machine, to start off in one database, and then move through an unending set of databases which are connected not by wires but by being about the same thing.

The sharing of information, data and resources is therefore a key factor in technology change in recent years and is responsible for driving the development of the semantic web and also the concept of a federated set of web services. Sharing applications over the internet with partners requires trust between two applications in different identity domains. Establishing this trust in user-machine interactions is challenging, and harder still in machine-to-machine environments. In order that a client application in one domain can request information from a web service in a different domain, the client will need to present proof of identity by presenting credentials trusted by the web service. The receiving service will need to be able to understand and evaluate these credentials to assess an identity's validity while also having evidence that the credentials were not tampered with or spoofed during transit. One challenge, therefore, is in finding a way to both federate identity and establish trust between machines in disparate identity domains.

In addition to the development in computing technologies associated with the web, there have also been significant advances in analysis and modelling techniques. One particular example is the *Epidemiological Simulation System* (*EpiSims*), the largest individual-based epidemiology simulation model ever created, built at Los Alamos National Laboratory with support from the U.S. Departments of Energy, Homeland Security, and Health and Human Services, with the purpose of providing an experimental testbed for analysing proposed responses to natural or intentionally caused disease outbreaks (Barrett *et al.* 2004; 2005a,b). *EpiSims* models the spread of disease in urban areas, allowing for the assessment of prevention, intervention, and response strategies by simulating the daily movements of synthetic individuals within an urban region. It allows the user to specify the effects in detail of a pathogen on a specific person, and to assign different effects to various people based on demographic characteristics. In conjunction with population mobility models it can represent behavioral reactions to an outbreak, including official interventions. Spatial micro simulation is one of a series of techniques used for spatial analysis, simulation modelling or prediction. Other new techniques include Geographically Weighted Regression (GWR) (Fotheringham *et al.* 2002), structural equations modelling (Smith *et al.* 2007), agent-based models optimised using genetic algorithms (Heppenstall *et al.* 2007), cellular automata models that incorporate fuzzy logic rules (Al-Ahmadi 2007) and other new land-use planning methods as reported in Koomen *et al.* (2007).

Some of the trends that have been identified in this section are exemplified in the chapters of the book that follow and which we now review in the final section of this introductory chapter.

1.4 Structure of the Rest of the Book

In producing an up-to-date overview of PSS, it is our primary aim to demonstrate that examples of best practice using proven methodologies are available in certain planning contexts but that new methods and approaches are being developed all the time. This compendium has been assembled with the ultimate goal of seeking to exchange proven knowledge, thoughtful insights and new experiences associated with the implementation, operation and evaluation of PSS among those people directly involved in planning. In so doing, our intention attempts to prevent repeated ‘reinvention the wheel’ and to emphasize the new and exciting developments in the application of geo-information technologies in diverse planning practices that are taking place.

The chapters have been divided into four parts. Part I is a collection of contributions that illustrate the application of existing PSS, demonstrating the range of useful functionalities. Part II contains chapters that focus on various PSS that have been developed in recent years for use in a variety of planning contexts, some of which have been implemented whilst others still are in prototype form. There is an emphasis on design issues, particularly when the systems have been constructed to fulfil a number of objectives, contain a wide range of data and incorporate a number of components. Part III contains chapters concerned with the development of a particular method into a planning support tool for analysis, evaluation or visualization and Part IV is comprised of a series of chapters that consider issues and processes of user engagement, stakeholder participation and the integration of analytical and participatory techniques.

1.4.1 Part I: Application and Assessment of Existing PSS

Chapter 2 is the first of three that constitute Part I in which several PSS are introduced that are likely to be known to many readers familiar with the PSS literature. *Deal* and *Pallathucheril* explain the functionality and operation of the *LEAM* model (Land-use Evolution and impact Assessment Model), a simulation model developed to forecast and evaluate land-use change over space and time that will enable planners and stakeholders to view and assess the future outcomes of decisions and policies before putting these into action. A range of applications have been performed with this model, some of which are described in detail, providing valuable lessons from which we can learn a great deal. Of particular note is the fact that *LEAM* evolves as an iterative process of data collection, model building, and dialogue in close cooperation with local planners, policy makers and stakeholders. It is argued that such a use-driven, embedded approach to local model development best suits an evolutionary process in which complex PSS will gain acceptance into practice by becoming an integral part of local and regional planning.

In the following chapter by *Nijs*, a model-based evaluation of a new Dutch National Spatial Strategy is presented, exemplifying the application of the so-called *Environment Explorer*, a land-use simulation model based on cellular automata with which *ex ante* assessments of proposed policy decisions can be performed. The model has been calibrated and validated initially before being applied to simulate new spatial developments. Thereafter, a probability map of future urban developments has been estimated for two scenarios using a Monte Carlo simulation approach. With the help of the scenarios, the objectives of the new Dutch National Spatial Strategy have been evaluated and potential problem areas identified. The study reveals that using the *Environment Explorer* to evaluate strategic spatial planning in the Netherlands provides detailed insights into the feasibility of the policy goals and potential problems arising in meeting those goals. Moreover, *Nijs* concludes that proper calibration and validation of the model is restricted – as is often the case with PSS – by the confined availability of data sets of appropriate quality. As a consequence and outcome, future research will be directed towards reducing the uncertainties in the results of the land-use model by taking advantage of better (remote sensing) data for monitoring change.

In the last chapter of Part I, *Pettit* and *Wyatt* present the outcome of an assessment of four different but relatively well-known PSS (*SLEUTH, What if? Google Earth* and *Preference Prediction*). These were tested for their functionality and capability in modelling, visualizing and evaluating a number of land-use change scenarios up until 2030. From this assessment it appears, perhaps not surprisingly, that each PSS has its strong and weak points but, especially in combined applications, they provide a remarkably useful toolbox for planners. *SLEUTH* and *What if?* function as instruments to build a range of future land-use scenarios and appear to be appropriate tools for improving the understanding of the policy implications of these scenarios. *Google Earth*, as an exponent of virtual globe products, provides a novel way to visualize landscape futures and thus helps to better engage planners, politicians and communities in discussing the outcomes of complex models. Finally, *Preference Prediction* is capable of performing *ex post* evaluation and helping to create more participatory and consensus-based planning practice.

1.4.2 Part II: Design, Development and Implementation of Recent PSS

In the first chapter of Part II, *Levine* introduces a Motor Vehicle Safety PSS which is able to address severe traffic safety problems. The PSS is developed and applied in the Houston area, Texas. The system provides tools for storing, analysing, and presenting crash data and produces information for safety reports, for identifying hazardous locations and for policy decision making on road improvements. The chapter explains the application of the well-known freeware programme, *CrimeStat,* to perform crime travel modelling and to calculate various statistics for measuring spatial distributions, hot-spot identification, risk analysis of incidents, and space-time interaction analysis. The studies show clearly that crash information and crash analysis should be combined with crash expert knowledge to provide valuable recommendations for arriving at safety improvement measures. In principle, the PSS is just a tool which, to become valuable, should be embedded in a more extensive analytical framework that goes beyond the data that has been collected and which addresses the behavioural issues involved in traffic safety. It shows that there are no simple engineering solutions, but that increased enforcement and public education is needed too.

In Chapter 6 by *Hahn, Kofalk, de Kok, Berlekamp* and *Evers*, a PSS for the Elbe river basin is introduced which consists of interactive tools for simulation, analysis and presentation and which is intended for use in exploring appropriate measures of effective and sustainable river basin management. To arrive at a functional PSS for strategic river basin planning, it is argued there is a need to understand the driving forces of the river basin and its dynamic behaviour, to simulate the combined effects of policy options and external effects, to assess the aggregated ecologic and socioeconomic impacts of potential measures and to communicate the goals and results to stakeholders. From these requirements, the chapter describes some methodological and practical lessons learnt during the development of the PSS, as well as some reflections on issues related to the application of the system.

In the next chapter, *Van Esch, Vos, Janssen* and *Engelen* present a PSS for reducing pollution emissions in the surface waters of Flanders, Belgium. In fact, the PSS helps the Flemish Environmental Agency to fulfill its day-to-day monitoring and reporting obligations regarding the pressures and impacts of point and diffuse emissions on surface waters *vis-à-vis* the Flemish, Belgian and European authorities. Essentially, the PSS is an accounting system, keeping track of the pollutants from a variety of sources towards their sinks in the surface waters. It enables the detailed representations of sectors responsible for the emission of harmful pollutants, their transport to treatment facilities and finally their discharge into the surface waters. In addition to this function of providing an up-to-date technical database, it enables the design and assessment of alternative policies and spatial – alongside technical – measures targeted at particular sectors, groups in society and/or regions and aimed at improving the quality of the surface waters in different river basins and administrative entities in Flanders. It supports 'what-if' analysis in an interactive context.

Van der Hoeven, Aerts, Van der Klis and *Koomen* introduce an integrated discussion support system with which policy makers can gain insights into the consequences of diverse flood risk management strategies for the Netherlands under the influence of climate change. Flood risk is determined by combining spatial land-use and hydrological information. Thus, use is made of a land-use model that operates under different future trends using socio-economic scenarios and climate information. Flood risk assessments are presented in both monetary and casualty terms. Both the construction of the system and its application to the Netherlands are discussed. The system aims to support the learning process of the users by facilitating discussion on the long-term adaptability of the Netherlands to flood risk. The system does not provide unambiguous answers on which management strategy is preferable but it does provide knowledge that adds to understanding of the impact of various flood risk management strategies, such as information about flood probabilities, potential damage, potential number of casualties, flood risk, as well as costs and benefits of the proposed safety strategies.

A spatial planning support system (SPSS) developed for the city of Bangalore in India is introduced in Chapter 9 by *Sudhira* and *Ramachandr*a. The core of the system consists of an integration of spatial dynamics and agent-based land-use models. The system is dedicated to simulate different urban extension scenarios in order to get to grips with the patterns, processes, causes and consequences of urban sprawl. In particular, the set-up of the system and its user requirements are addressed, emphasising its utility as an effective tool for policy, planning and decision making. Moreover, its present drawbacks and the future intentions for development in the direction of a more web-based and participatory PSS are discussed.

In the last chapter of Part II, the *GRA*S system is introduced by *Pelizaro, Arentze* and *Timmermans*. This system can be considered a prototype SDSS for the planning, design and maintenance of urban green spaces. In short, *GRAS* is a GIS scenario-based, micro simulation multi-criteria DSS that incorporates a range of domain-specific models. The system is able to predict every individual's spatial-temporal ‘green-space-choice’ behaviour. It is capable of assisting every stage of the decision-making process, i.e. from the identification of a problem and the definition of multiple objectives to allowing the users to generate alternatives, and to the evaluation/assessment of alternatives. Its architecture and design are described, its constituting components explained and its first experiences of application in practice are documented.

1.4.3 Part III: New Methods for Planning Support

In the first chapter of Part III, *Johnson* and *Sieber* present a prototype PSS for the tourist sector based on the principle of agent-based modelling (ABM). With the help of the so-called *TourSim* model, experiments can be performed to simulate and visualize tourism planning scenarios under diverse policy changes. Examples of experimentation include discovering the effects of developing new tourism infrastructure (e.g. a new music festival) on tourist distribution, ‘what if’ questions concerning global tourism trends (e.g. monetary changes), and changes to tourism demand as a result of geopolitical or economic reasons (e.g. more domestic travel). The chapter demonstrates how *TourSim* works by applying it to the Canadian province of Nova Scotia where it is used to shows the effects of port of entry on tourist dispersion. Moreover, *TourSim* is evaluated in the context of three potential areas of adoption constraint: awareness of and experience with ABM; technological considerations; and overall fit with planning tasks. In a comparison with GIS adoption, it shows that the use of ABM in PSS holds great potential, but also is accompanied by significant hurdles that still have to be overcome.

Chapter 12 by *Gibin, Mateos, Petersen* and *Atkinson* describes a geographic visualization tool, named the *London Profiler*, for supporting public health service planning. It is built by University College London in cooperation with Southwark and Camden Primary Care Trusts and is based on an implementation of *Google Maps* APIs as a framework for geographical visualization of changing population characteristics. The system provides a frequently updatable picture of the London population at postcode unit level. With the help of *London Profiler*, it becomes possible to target public health initiatives and services to tackle health inequalities to specific population groups at risk or in need. Due to its flexible and inexpensive features, *Google Maps* APIs are considered to be a perfect platform for the development of these kind of future PSS.

In the following chapter, *Schaller, Gehrke* and *Strout* describe a new method involving geodatabase design and GIS processing modelling to support regional environmental planning procedures in a more effective way. The existing large geodatabases of the planning region of Bavaria, Germany, have been updated and restructured to be able to perform environmental modelling, sensitivity testing and site analysis for both decision support and scenario applications. With the help of these analyses, the authors are able to evaluate actual developments in land-use monitoring and predict future developments and their possible impacts on natural resources. The working of the new concept is illustrated with the help of some actual planning projects such as the urban growth model of the Munich region. Future research will entail, *inter alia,* the incorporation of the internet in the development of the new method.

In the last chapter of Part III, *Besio* and *Quadrelli* discuss knowledge bases they have built to support three environment and landscape planning processes to assess where and how to locate environmental systems. The first planning process relates to the definition of EU programme in the Liguria Region of Italy, the second to the preparation of a Cinque Terre National Park plan, and the last to strategic transport projects (new railways and motorways) in the Greater Genoa metropolitan area. PSS were built according to a cognitive procedure which organized data, processed information and produced knowledge at subsequent synthetic and interpretative levels, using geo-information technologies. These systems have been used to organize data for investigating many phenomena, the analysis of their numerous relationships to identify meaningful information, and the elaboration of synthetic models representing the environmental systems subjected to the planning process. The data and their meaning have been structured by making use of conceptualization and categorization procedures, whilst information processing has been carried out through qualitative, morphological and topological procedures. The experiences with the three planning processes are shown to be significant, not only in terms of the technological instrument adopted, but above all for the way in which it was used.

1.4.4 Part IV: Participation and Collaboration in PSS

Part IV contains the largest number of chapters, reflecting perhaps the relative importance of using PSS for participation in planning. In the first of seven chapters, *Lieske, Mullen* and *Hamerlinck* describe a participatory planning methodology in which planning support methods play an important role in order to arrive at comprehensive plans with high levels of community support. Therein, a distinction is made between planning support instruments (e.g. key pad polling, gaming) that were used to gather public input on issues, attitudes and values; and planning support systems (e.g. *CommunityViz*) which were used behind the scenes to integrate public values with geographic data and to evaluate citizen-generated development alternatives. Application of the participatory planning methodology has taken place in Albany County in Wyoming, USA, resulting in high levels of community support for the resulting plan and enhanced probabilities for plan adoption and implementation. Other applications of the methodology in different settings show similarly positive outcomes.

Chapter 16 by *Miller, Vogt, Nijnik, Brondizio* and *Fiorini* discusses the integration of analytical and participatory techniques and tools for planning the sustainable use of land resources and landscapes. It recognizes a need to provide a way of assessing the balance between the quality of the visual, ecological, cultural and production functions of the countryside. Two examples illustrate its findings. The first example considers land-use change in the Amazon, whilst the second discusses the socio-economic, ecological and visual aspects of land-use changes in a European landscape. Each example has employed the active involvement of stakeholders like landscape professionals and the public in the process of decision making. Stakeholder and public perspectives of landscape and land-use change were generated with the help of participatory techniques to enable these values, objectives and preferences to be incorporated into an analysis of options for future land uses. In short, the chapter presents a comparison of lessons learnt from the development and implementation of tools and methods for the assessment of scenarios of change in land use and landscape, in European and Brazilian contexts, in order to develop good practice in planning.

In the next chapter, by *Van Delden* and *Hagen-Zanker,* a methodology is presented for the linking of qualitative storylines to quantitative modelling in a participatory approach. In this integrative framework, a two-sided methodology is envisioned in which storylines and scenarios steer the model development, but also vice versa, with modelling outputs providing information and arguments to adjust the storylines and scenarios. The methodology is illustrated by using a case involving, on the one hand, a range of qualitative storylines about possible futures of Europe and, on the other, the application of a quantitative land-use model for three regions within Europe: the Netherlands, Estonia and northern Italy. As an important outcome, it is concluded that the integration in a participatory approach of qualitative scenario development and quantitative modelling seems to be a very promising direction, in which one method contributes substantially to the other and vice versa. Nevertheless, it is recognized that future work is needed to link both approaches in a more advanced way.

A new implementation of information and communication technologies is presented by *Soutter* and *Repetti* in Chapter 18 to support public participation. A system called *SMURF* (*System for Monitoring URban Functionalities*) was created for supporting participatory planning and management. The system consists of a geographic database and spatial indicators for viewing and sharing information, for editing information and for evaluating city development. After a review of the content and set-up of the system, the chapter describes two implementation examples, one in Thies, Senegal, and one in the Seychelles. From these and other applications of *SMURF*, a range of experiences was gained from which various conclusions and initiatives for further research have been derived. One important conclusion is that the process results in better knowledge for all participants and in a strong consensus about the diagnosis of the actual situation as well as clearer strategic objectives for local development.

In the chapter by *Kahila* and *Kyttä,* the so-called *SoftGIS* method is introduced and presented as a bridge between residents and urban planners. The *SoftGIS* method entails a range of methods, and their underlying theories, concepts and ideas that are dedicated to expose the knowledge that residents have of their own living environment, which can be included thereafter in formal urban planning procedures. *SoftGIS* methods reveal how the everyday lives of residents are organised, the kind of place-based positive and negative experiences residents have and how they behave in their physical environment. They therefore contribute to participation and collaboration of citizens in planning processes. Besides introducing different variations of the *SoftGIS* method like *softGISquality* and the *softGISchildren*, the approach is also evaluated in the context of current critical GIS discourse. Moreover, its theoretical basis is elaborated upon extensively and future plans for extension are considered.

In the penultimate chapter, *Chin* introduces the so-called *Mainport Planning Suite* (*MPS*) with which studio-based planning can be facilitated. The *MPS* has been designed and prototyped in close cooperation with practitioners in the Port of Rotterdam in the Netherlands. In short, the suite consists of software for the user-friendly presentation of geographic information in maps, also linked to a timeframe. Moreover, it consists of a sketchbook for the drawing up of ideas and the storage and presentation of these ideas. In addition, with the help of a so-called ‘matchbox’, an overview is presented of scores of alternatives on both quantitative and qualitative criteria, and finally, the outcomes of the matchbox can be graphically displayed. It is foreseen this toolbox can be applied too in quite different contexts and will support more and more upcoming needs.

Finally, in Chapter 21, the last in the sequence and in the book, *Carver, Watson, Waters, Matt, Gunderson* and *Davis* explain the participatory approaches developed to map landscape values for landscape and resource management, in particular in order to implement wildland fire-use plans in wilderness areas. In that framework, a tool and a methodology are developed with which fuzzy qualitative information can be gathered, stored and geographically presented. This qualitative information concerns the meanings that are ascribed by Flathead Indian Reservation residents to certain places within the Mission Mountains Tribal Wilderness in Montana, USA. This information is used in focus group discussions with forest managers about fuel treatments. The qualitative information is subsequently confronted with more crisp quantitative information, concerning land-use categories and planning activities. It is envisioned as being crucial that fire planners must understand how proposed actions interact with human meanings ascribed to the land and describe a prioritization process that addresses publicly perceived threats. The case study demonstrates that the approach is well suited to developing a better understanding of indigenous peoples’ relationships with the land, and appears to be particularly useful for contrasting meanings attached to different classifications of land, articulating what is worth protecting and what it should be protected from, and showing how it is viewed by people from different cultures and/or stakeholder groupings. It is expected that the need for simultaneous handling of both qualitative and quantitative information will growth substantially (e.g. NIMBY effects, mental mapping).

1.5 Conclusion

The collection of chapters that we have introduced and which follow in the remainder of the book represents a cross-section of PSS development and experience around a decade after the concept of PSS originated and the first examples were formally identified. It is of course for you, the reader, to assess how the state-of-the-art has evolved during the last ten years but we hope that the contributions in this volume, by providing explanation of system components together with exemplification of applications and user experiences, will help you to structure your evaluation. We also hope to persuade you that PSS are innovative and exciting new tools whose wider application and adoption are likely to emerge with increasing regularity over the next ten years in different planning contexts across the world. Satisfactory progress will only take place if the obstacles that have been discussed in this chapter are confronted and overcome and if the planners are prepared to take advantage of some of the new technologies that this chapter has also reviewed.

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