

GIS for SUSTAINABLE DEVELOPMENT



edited by
**Michele
Campagna**



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Foreword

I was glad, but slightly puzzled, when Michele Campagna asked me to write the foreword for his book about GIS and sustainable development. In my planning experience I always welcomed and appreciated the arrival of the GIS cavalry, both in research and in the professional practice; I even found myself fostering its calling for in many occasions. Especially at the present time of spread diffusion and democratization of the computing power, and geographic data availability and access, planning professionals have the chance to experience new ways of exploiting geographic data management capabilities toward more creative analytical and design forms of planning. However, I am afraid that planning has perhaps more to take from GIScience than it has to give to it. Thus, I was puzzled — what should I have had to say about planning to introduce a book about GIS and sustainable development?

This happened before I read the table of contents first, and then the whole manuscript. Although it is not straightforward to accept a unique definition of planning — and perhaps of sustainable development either — nevertheless, reading this book I enjoyed discovering that it concerns sustainable development and planning as much as GIS. It concerns GIS but offers many useful insights for sustainable development planning practice. Definitely this is a book as much for the GISers as for the planners. I was quite relieved afterwards.

I think that there is not much more to say here about planning, but this book deals with crosscutting planning objectives and the way to tackle them. In the last century or so, planning evolution faced very different paradigms, spanning from the rational to the collaborative approach. In this evolution very different methods and techniques were proposed and applied, sometimes with consensus among practitioners and stakeholders, and success in the outcomes, other times not. It is perhaps now time for the planner to face the challenge to browse in this full box to find the right set of tools which best fit each individual local context, to design creative planning processes able to support democratic and informed decision-making, in this way aiding, as an expert, to foster the dialogue on the nature of the consistency of possible alternative courses of action with economic, social, and environmental concerns. Ample freedom is left to the reader to ethically interpret and address this challenge.

With this book the framework is set by the editor to discuss different calls for action proposed in Agenda 21. However, the focus on Agenda 21 is given instrumentally for the sake of clarity in the discussion, and most of the issues dealt with

in the book may be applied to the many national and local programs and actions which, in one way or another, are consistent with a broader sustainable development framework. On the one hand, progress in GIScience is proposed to address specific problems such as socioeconomic and demographic analysis, environmental degradation, health care, or natural risk management. On the other hand, research results and experiences from practice are presented, which can be considered best practices in (geographic) information production, maintenance, analysis, and sharing. Moreover, several case studies are proposed which concern the collaboration of major groups in sustainable development planning and decision-making, such as institutional stakeholders, indigenous people, local communities, and citizens, undertaken in real settings to promote subsidiarity, transparency of administration, and public participation for democratic decision-making. In fact, in addressing many of the Agenda 21 objectives, the work itself conversely provides a contribution, although partially and at a conceptual level, to another specific call, namely capacity-building by carrying knowledge and knowhow. This book puts many problems on the table, illustrating in a sort of undeclared and implicit SWOT analysis, through documented case studies, strengths, weakness, opportunities, and treats of GIS application in the domain of sustainable development. This framework supplies many useful hints for the practitioner approaching the design of informational planning working spaces.

While one might be tempted to pay attention to selected chapters, as they concern a number of different particular GIS methods and applications addressing specific problems, I would suggest the reader to span throughout the whole book, as most of the chapters deal with the same overarching sustainable development issues with regard to the support GIS may offer for their solution, although from very different perspectives. As a matter of fact, topics such as data, technology, and knowledge integration, data sharing, and public participation, to mention only few, are dealt with through the different chapters in a diverse mixture of perspectives, giving as an overall result a much deeper insight — especially for the planner — than what may be achieved by reading certain selected chapters clearly related to particular issues or concerns. This is the major twofold value of this work, in that although avoiding a point-by-point answer to the call for sustainable development actions, on the one hand it aims at driving the GIS community toward a deeper awareness of sustainable development issues in setting research programs and in application design, while on the other hand it offers a wide spectrum of tools that professionals and practitioners may draw on after they understand how GIS can assist them in spatial planning, management, and decision-making to achieve sustainable development objectives.

This is a book for a broad readership. While most of the chapters will flow easily for the average reader, a few of them require some technical GIS background to be fully appreciated. Nevertheless, once Michele Campagna sets the framework in the first chapter suggesting crosscutting paths for reading, the reader will enjoy discovering the further facets of GIS application for sustainable development thanks to the diverse perspectives offered by the contributors in each chapter.

Thus, I would like to conclude this foreword suggesting, as an added value, considering this book not so much a conclusive work, but rather as a starting point to trigger further discussion, which may eventually lead to defining a structured research agenda for GIS use in sustainable development processes.

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In the second half of the 1990s, the GIS academic community has grown considerably in Europe. Many research conferences, workshops, summer schools, or other GI-related meetings were held, contributing to the creation of a multidisciplinary network of researchers sharing the common interest for GIScience, with the active participation of young researchers collaborating and sharing their achievements. Thus I would like to acknowledge the work carried out by the following organizations: the European Science Foundation, for promoting the European Research Conferences on GIS; the Association of European Geographic Information Laboratories in Europe (AGILE), for organizing the annual conferences; the Centre for Spatially Integrated Social Sciences funded by the National Science Foundation, for the CSISS summer workshops; the Vespucci Initiative Founders, for the Vespucci summer schools; the eduGI.net, for the first summer school in GIScience; and the UNIGIS, for the international summer schools in GIS. All these initiatives contributed to stimulate not only scientific interest and research results exchanges, but also overall networking by early-career scientists. A special thank you goes to those individuals within or collaborating with these organizations for contributing to the success of these events.

It is within this framework that I was tempted by the challenge to have this established yet informal network of scientists, researchers, and GI practitioners discuss opportunities for GIS application in a cross-cutting field of utmost importance for our society such as sustainable development planning and decision-making by integrating our diverse perspectives in the present work. Most of the invited contributors gave immediate positive responses to the first call for expression of interest. They come mainly from European and North American academia, but also from the public and private sectors.

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Contents

Introduction

- Chapter 1** GIS for Sustainable Development3
Michele Campagna

PART I

General Issues for GI Use in Planning Sustainable Development

- Chapter 2** The Rise of Cyber Planning: Some Theoretical Insights23
Andrea De Montis
- Chapter 3** Theories of Digital Participation37
Robin S. Smith
- Chapter 4** Metadata and Data Distribution.....55
Bénédicte Bucher
- Chapter 5** GI-Based Applications on Public Authorities' Web Sites and
Their Nonprofessional Users71
Mette Arleth
- Chapter 6** Geographic Information as an Economic Good.....85
Alenka Krek

PART II

GIS Research Perspectives for Sustainable Development Planning

- Chapter 7** Advanced Remote Sensing Techniques
for Ecosystem Data Collection 107
Alexandr A. Napryushkin and Eugenia V. Vertinskaya

Chapter 8	Spatiotemporal Data Modeling for “4D” Databases.....	123
	<i>Alexander Zipf</i>	
Chapter 9	Spatial Multimedia for Environmental Planning and Management	143
	<i>Alexandra Fonseca and Cristina Gouveia</i>	
Chapter 10	Computer Support for Discussions in Spatial Planning.....	167
	<i>Claus Rinner</i>	
Chapter 11	Integration of GIS and Simulation Models	181
	<i>Andrea Giacomelli</i>	
Chapter 12	Microsimulation and GIS for Spatial Decision-Making	193
	<i>Dimitris Ballas</i>	
Chapter 13	Using Geodemographics and GIS for Sustainable Development ...	211
	<i>Linda See and Phil Gibson</i>	
Chapter 14	Multivariate Spatial Analysis in Epidemiology: An Integrated Approach to Human Health and the Environment.....	223
	<i>Stefania Bertazzon and Marina Gavrilova</i>	
Chapter 15	Zone Design in Public Health Policy	247
	<i>Konstantinos Daras and Seraphim Alvanides</i>	
Chapter 16	Tools in the Spatial Analysis of Offenses: Evidence from Scandinavian Cities	267
	<i>Vania A. Ceccato</i>	
Chapter 17	Sustainable Hazards Mitigation	287
	<i>Tarek Rashed</i>	

PART III-A

Learning from Practice: GIS as a Tool in Planning Sustainable Development Urban Dynamics

Chapter 18	Urban Multilevel Geographical Information Satellite Generation	313
	<i>Sébastien Gadal</i>	

Chapter 19	Urban Scenario Modeling and Forecast for Sustainable Urban and Regional Planning	329
	<i>José I. Barredo, Carlo Lavalle, and Marjo Kasanko</i>	

PART III-B

Learning from Practice: GIS as a Tool in Planning Sustainable Development Natural and Cultural Heritage

Chapter 20	The Development of the Cross-Border Region of Hungary and Austria Analyzed with Historical Cadastral and Land Register Data	349
	<i>Susanne Steiner</i>	
Chapter 21	Computer-Aided Reflexivity and Data Management in Archaeology	367
	<i>Anthony Beck and Assaad Seif</i>	

PART III-C

Learning from Practice: GIS as a Tool in Planning Sustainable Development Society and Environment

Chapter 22	A Geographical Approach to Community Safety: A U.K. Perspective	385
	<i>Jonathan Corcoran and Bernadette Bowen Thomson</i>	
Chapter 23	GIS Application to Support Water Infrastructures Facilities Localization in Particularly Valuable Environmental Areas: The Eolian Islands Case Study	403
	<i>Giuseppe Cremona and Luisella Ciancarella</i>	
Chapter 24	Influence of Data Quality on Solar Radiation Modeling	417
	<i>Tomaž Podobnikar, Krištof Oštir, and Klemen Zakšek</i>	

PART III-D

Learning from Practice: GIS as a Tool in Planning Sustainable Development Public Participation

- Chapter 25** GIS Support for Empowering Marginalized Communities:
The Cherokee Nation Case Study433
Laura Harjo
- Chapter 26** GIS and Participatory Diagnosis in Urban Planning:
A Case Study in Geneva.....451
*Aurore Nembrini, Sandrine Billeau, Gilles Desthieux,
and Florent Joerin*
- Chapter 27** Visualizing Alternative Urban Futures: Using Spatial
Multimedia to Enhance Community Participation and
Policymaking.....467
Laxmi Ramasubramanian and Aimée C. Quinn

PART III-E

Learning from Practice: GIS as a Tool in Planning Sustainable Development SDI and Public Administration

- Chapter 28** SITAD: Building a Local Spatial Data Infrastructure in Italy.....489
Piergiorgio Cipriano
- Chapter 29** Local GIS: Implementing the Urban Spatial Enabled
Information System.....501
Walter Oostdam
- Index**.....519

Introduction

1 GIS for Sustainable Development

Michele Campagna

CONTENTS

1.1	Introduction	3
1.2	The Way toward Sustainable Development.....	4
1.3	Agenda 21: Putting Sustainable Development Principles into Practice	5
1.4	GIS for Sustainable Development	6
1.5	Requisites for GI-Based Collaborative Sustainable Development Planning Support.....	8
1.6	Solving Sustainable Development Problems with GIS.....	11
1.7	GIS for Sustainable Development in Practice.....	15
1.8	Conclusive Summary	19
	References.....	19

1.1 INTRODUCTION

Sustainable development is the term commonly and broadly used to describe a complex range of objectives, activities, and mankind behaviors with respect to the environment which should be consistent with the aims of meeting “the needs and aspirations of the present without compromising the ability of future generations to meet their own” [1]. This concept implies that both technological and social settings should be organized so that human activities would not overload the capacity of the biosphere to absorb their impacts [1]. This, which may be agreed upon as a general definition, is yet a rather vague concept to define sustainable development for operational purposes. To this end, this introductory chapter starts with a brief note on the history of sustainable development, outlining some milestones that eventually led to international consensus and a widely agreed-upon adoption of common principles and plans of action to pursue sustainable development. Along a half-a-century path, the role of the United Nations (UN) has been fundamental in promoting international awareness among nations and the wider public. As an outcome, in 1992 nearly 180 countries convened in Rio de Janeiro at the Earth Summit and agreed on the principles of the Rio Declaration and on the programs of its plan of action, Agenda 21 [2]. The success of the initiative was reaffirmed ten years later in Johannesburg, where successful results and proposals of new ways were presented. Indeed many other international organizations, governments, and individuals contributed much to

define, promote, and achieve sustainable development objectives; nevertheless the widespread consensus on a such comprehensive plan of action as Agenda 21, makes it a fertile reference framework deserving special attention here to discuss the application of GIS to sustainable development planning, decision making, and management.

1.2 THE WAY TOWARD SUSTAINABLE DEVELOPMENT

With the Industrial Revolution, human activities started to produce new impacts on natural resources. Factories were built, producing new sources of pollution on air, water, and soil; many towns and cities started to grow, generating social and human health problems. Progress in science and technology continued to grow until after the Second World War, when it reached unprecedented rates, raising enthusiastic optimism on development. In many industrialized countries, the achievement of better life conditions, economic growth, increased production and distribution of goods, infrastructures, and housing generated an ideal trust in development, eventually changing radically the relationships between man and the environment. The outcomes would become evident soon. The unlimited growth of most developed countries would compromise seriously the terrestrial ecosystem, destroying limited natural resources, causing dangerous conditions for human health, and augmenting poverty in less developed countries, which were unable to contrast the exploitation of resources carried on for the sake of development at their expenses. Soon the awareness arose of the need for new sustainable development models.

Rachel Carson's *Silent Spring*, first published in 1962 [3], reporting the negative impacts on human health and animal species caused by the use of pesticides in modern agricultural production processes, is widely acknowledged as an embryonic alarm call from which the debate on the environmental issues has arisen and evolved until the present day. In 1972, under the aegis of the Club of Rome — an organization of economists and scientists — the “Meadows” proposed their catastrophic vision with their *Limits to Growth* [4], a report of a model-based forecast according to which trends in demographic growth, increase in production and consumption, and widespread pollution diffusion would have led in a few decades to the collapse of the terrestrial ecosystem. These widely known early works in the history of the socio-cultural debate on environmental issues are only two examples of the enormous work promoted in the last fifty years or so by the establishment in many countries and carried on with the support of the international scientific community. The evolution of the environmental issues debate and of the initiatives of the many organizations spread internationally, which led to the definition of the principles of sustainable development and the way toward their practical implementation, is rich and is characterized by the important role played by the United Nations. In 1972 the UN promoted the Conference on Human Environment held in Stockholm, where those issues which would have later become the principles of sustainable development were discussed. The view of man as “creature and molder of its environment” is proposed in the Declaration of the UN Conference on Human Environment [5]. The document acknowledges the ability of man, enhanced to an unprecedented scale by the progress in science and technology, to transform his surroundings. This ability can be used wisely to bring improvements in the quality of life of the people all

around the world, or conversely, if used wrongly can produce incalculable harms to human beings and the environment. Seven proclamations are given in the document, and twenty-six statements are proposed as guiding principles for sustainable development [5]. The UN continued to build on the outcomes of the Stockholm conference, forming in 1983 the World Commission on Environment and Development, chaired by Gro Harlem Brundtland. The commission worked for three years, eventually producing a report on social, economic, and environmental issues [1], which brought the idea of sustainable development into the international view in 1987. The results presented in the report titled *Our Common Future*, also known as the *Brundtland Report*, were discussed at the UN General Assembly, and in 1989 the UN made the formal decision to convene the UN Conference on Environment and Development, which was held in Rio de Janeiro in 1992. The Summit agreed on the Rio Declaration establishing twenty-seven general principles. Moreover, the action plan, Agenda 21, was issued, and it was recommended that all countries adopt national strategies and promote local practices according to sustainable development principles and programs. After ten years, a second World Summit on Sustainable Development was held in Johannesburg (Rio +10), being one of the most important international meeting ever held on economic, environmental, and social decision-making, and focusing on promoting further actions to put Agenda 21 into practice.

This brief yet oversimplified discussion gives just an outline of the history of sustainable development. The reader is invited to consider reading the original documents mentioned above for a thorough definition of the principles of sustainable development — which are out of the scope of this discussion — whereas in the following section the contents of Agenda 21 are reviewed critically with the aim of discussing the implications for the GIS application as support to spatial planning practice according to sustainable development principles.

1.3 AGENDA 21: PUTTING SUSTAINABLE DEVELOPMENT PRINCIPLES INTO PRACTICE

Since its adoption in 1992, Agenda 21 plans of action have been implemented at different rates worldwide. Meanwhile, the UN promoted the monitoring of the initiatives at the national level, and after 10 years of implementation a thorough report was presented highlighting the monitoring results with respect to the Agenda 21 calls at the national, regional, and global level [6].

Agenda 21 is divided into 40 chapters. While some of the chapters are concerned with specific objectives — or objects — such as promoting sustainable human settlements development and sustainable agriculture and rural development, or protecting human health conditions, some others deal with the ways or processes, in both societal and operative terms, that should be adopted to pursue these objectives, such as integrating environment and development in decision-making, promoting collaborative decision-making processes, fostering participation, and promoting public awareness and training. Both *objects* and *processes* are derived from and consistent with the principles agreed to within the Rio declaration. These broad categories are proposed in Agenda 21 in the different chapters within four parts taking into

account, respectively, the social and economic dimensions, the conservation and management of resources for development, strengthening the role of major groups, and means of implementation.

While Agenda 21 is directed primarily to national governments, the role of local public administration is acknowledged by the action plan as fundamental, since the problems addressed have their roots at the local level (Agenda 21, Chapter 28). It is also often at the local level that national and regional environmental policies and planning processes are implemented. Locally, moreover, the level of governance is closest to people. Thus public administrations face the challenge to act locally to achieve the objectives of Agenda 21. In order to achieve sustainability, subsidiarity is seen as a means to integrate, both vertically and horizontally, global and local development frameworks. Besides, public participation is seen as a means to achieve democratic decision-making through transparency of public administration and citizens' involvement in sustainable development processes. According to the plan of action, a comprehensive group of actors is proposed to be involved with local authorities in sustainable development decision-making, such as local (indigenous) communities, nongovernmental organizations, workers and trade unions, business and industries, farmers, and the scientific and technological community. Moreover, the role of women, children, and youth should be fostered. The promotion of awareness and education with regard to sustainable development issues, and development of know-how and skills is a prerequisite for socially inclusive collaborative decision-making. To this end the scientific and technological community faces the challenge to develop methods and tools for supporting sustainable development practices.

Information (Agenda 21, Chapter 40) plays a major role in planning and decision-making for pursuing the objectives of sustainable development. This is a common prerequisite for all the Agenda 21 plans of action at all levels. Geographic Information Systems are proposed generically in Agenda 21, Chapter 40.9, as one of the tools to be used to produce, maintain, analyze, and disseminate environmental data. However, as it is discussed in the reminder of this chapter, GIS offers a wide range of reliable tools to support sustainable development-led activities, such as problem setting and solving, planning, decision-making, and management. Thus, further insights are required to fully understand opportunities for this application field and to promote geospatial technologies application as a valuable support to sustainable development processes.

1.4 GIS FOR SUSTAINABLE DEVELOPMENT

Economic, social, and environmental processes are inherently spatial. They can hardly be fully understood without taking into account their spatial dimensions. The relationship between man and the environment cannot be represented without a reference to a special location, because the environment is described by the topological relationships among physical objects (e.g., the soil or the air composition in a given space-time location, the solar radiation on a given piece of land), and human activities produce impacts on the environment spatially.

As introduced in the previous section, Agenda 21 focuses both on special objectives — the objects — and on the ways to be followed to pursue these objectives — the processes. The object is related to solving spatial problems, while the process implies sharing knowledge for collaborative, transparent, and participatory decision-making. Both serve to achieve the higher objectives set by the principles of sustainable development.

GIScience has been proven to offer theories, methods, and applications to effectively support the following categories of tasks, which together find wide space for application in the implementation of Agenda 21 to fulfill the principle of sustainable development:

- Producing and maintaining geographic information (by definition)
- Supporting distributed access to (environmental) information (i.e., spatial data infrastructures)
- Solving spatial problems (i.e., spatial analysis and environmental modeling)
- Supporting collaborative decision-making (i.e., group spatial decision-making)
- Supporting public participation (i.e., public participation GIS)

In planning, decision-making, and management GIS may be considered just one among the most advanced tools available to deal with complex problems — the spatial problems — in a balanced mediation of economic, environmental, and social objectives. It is an essential tool though, which, when properly used, may offer effective support to spatial planning and decision-making, because the geographical component of the problem at hand is determinant when dealing with sustainable development. Thus, geospatial technologies should be a driving engine in the technical, but also socio-organizational, implementation of knowledge-based open and integrated platforms for informed analysis, collaborative problem solving, planning, and decision-making.

According to this general premise, this book presents recent research results and case studies which offer a diverse perspective of the problem at hand, taking into account methodological and technical — but also organizational and societal — issues related to the use of GIS to solve complex problems faced by practitioners in planning and implementing sustainable development objectives.

The aim is to deal with a wide range of topics related to how GIS application may contribute to improve vertical and horizontal collaboration in decision-making among all the actors involved in sustainable development processes at all institutional levels (national, regional, and local). The growth in spatial data availability and the developments in GIScience allow us to carry on “informational planning” processes (analysis, design, evaluation, decision, management, and communication). In fact, whatever the planning paradigm adopted, a knowledge-based approach is required to carry on sustainable development processes.

The book is structured in three parts.

The first part sets the framework for GI-based collaborative spatial e-planning processes. Cyber planning is defined in Chapter 2, while societal, technical, and

organizational issues are proposed in the following chapters, giving particular attention to digital public participation, interfaces, data accessibility, and economic value of geographic information.

The second part of the book presents GIScience methods and techniques, which can be used to solve particular problems — objects — commonly addressed in sustainable development planning and decision-making. A number of topics are proposed, such as the GIS integration with simulation and microsimulation models, spatial multimedia, online computer-based collaborative tools, spatiotemporal databases, remote sensing (RS) data collection, geodemographics, (multivariate) spatial analysis, and zone design techniques and tools to solve problems such as environmental modeling, socioeconomic system analysis and planning, health care planning and management, urban settlement monitoring, community safety, risk prevention, and hazard mitigation. Practitioners in sustainable development processes commonly address all these problems, and the methods proposed here offer techniques and tools which can be used in integrated sustainable planning support systems.

In the third part, the book presents GIS applications and case studies from research and real practice projects. The chapters are grouped by topic according to the following categories:

- Urban dynamics
- Natural and cultural heritage
- Society, health, and environment
- Public participation
- SDI and public administration

For each category, several examples are given of application methodologies and case studies.

In the remainder of this chapter, the overall perspective is described in detail, discussing the opportunities GIScience theories, methods, techniques, and tools offer to support the work of practitioners and of all the actors involved in sustainable development planning, decision-making, and management processes.

1.5 REQUISITES FOR GI-BASED COLLABORATIVE SUSTAINABLE DEVELOPMENT PLANNING SUPPORT

Sustainable development is a multi-actor process that involves all levels of society globally and locally. The process is inherently collaborative and participatory in its own nature. Senior government decision makers at the international to the local level, organizations, entrepreneurs, interest groups, social minority advocates, and citizens are involved; individuals, groups, and organizations should have equal access to information for decision making.

The first part of this book pays attention to these characteristics of sustainable development decision making, spatial planning, and management processes, dealing with the issues of public participation, in terms of theoretical and methodological premises, and of accessibility to (GI) data, in cognitive, technical, and economic terms.

Information Communication Technology (ICT) has granted freedom from distance and from the cost of digital data reproduction, virtually giving ubiquitous access to information at no (or low) cost. Nevertheless, developments in information communication infrastructures do not warrant *per se* the absorption by society of the newly available ICT. Societal, cultural, cognitive, organizational, and economic issues, among others, have to be seriously taken into account when implementing new processes on innovative technology platforms. While one may acknowledge that the Internet affects people's everyday activities, the research is still ongoing about how members of a community adopt technology and telecommunications and use them to enhance their capabilities to perform a given task. On these premises Chapters 2 to 6 set a framework of basic assumptions for the implementation of e-platforms to support governance, spatial planning, decision-making, and management.

In Chapter 2, Andrea De Montis introduces the concepts of cyber planning. The pervasive diffusion of ICT is deeply affecting all sectors of society, generating cultural mutations. In many sectors the Internet has become an everyday tool to access information and communicate, fostering changes in the traditional way of working, and offering new possibilities of economic development. New professions were born, and other professions have substantially changed, while some others are changing with less radical differences. In spatial planning, technology adoption has been partially exploited, with differences depending on the planning processes and on the different local contexts in the different countries. While the planning professionals have enjoyed the support of ICT and GIS in many way [7–10], nevertheless we are perhaps still far from a sound mutation of the planning theories and paradigms, and thus from the core professional practice. Andrea De Montis argues, in line with an ongoing theoretical debate and on the bases of recent planning research results, that ICT can favorably support the implementation of collaborative information-hungry planning processes, such as those proposed by Agenda 21, to achieve sustainable development objectives. He envisages, moreover, that cyber planning instances are emerging in practice as a sort of digital evolution of planning in the Information Era, which might eventually lead to more substantial changes in the way of making plans. Chapters 9, 10, 26, and 27 propose methodologies and present case studies of digital planning experiences.

The inspiring principles of sustainable development require planning and decision-making processes to be participatory. The collaboration at the global and the local levels, and between major groups, such as institutional stakeholders, interest groups, local communities, and citizens, demands complex forms of participation. The implementation of e-government and e-governance processes, triggered by the availability of ICT, has fostered a new interest rising about democracy, transparency of administration, and public participation. To the latter, particular attention has been paid by the GIS and planning community in the last decade as many scholars, denying the idea of GIS as an elitist tool in the hand of power, on the stream of Pickles' *Ground Truth* [11], demonstrated that ICT and GIS together may help to support public participation, empowering marginalized communities and citizens [for an example, see 12]. Along with this debate, the renowned Arnstein's ladder of participation [13] has been reinterpreted to adapt the current digital e-government practices [14–16].

In Chapter 3, Robin S. Smith, on the basis of representative examples taken from U.K. local authorities' practices, discusses present achievements and opportunities for public participation processes and settings in Internet-based environments. The analysis of practical experience developed so far opens the way to theoretical argumentation dealing with the definition of public participation, the way actors are chosen to get involved, and the methods that can be implemented. He advises, "participation is not a unique or shared construct, and failure to recognize different views can lead to unsatisfactory outcomes for all." Attention is paid in this chapter to the differences participation implies in actual and virtual environments, and how traditional and digital participatory methods should be integrated. Participation processes are complex, and special care should be devoted to their design as well as to the analysis of current practices to elicit critical success factors. Finally, as he explains, the use of GI in digital participatory settings inherits the same characteristics from generic participation processes, yet presents new issues to which GIScience research should dedicate further analysis in the long run.

The theoretical issues dealt with by Smith in Chapter 3 are considered with different perspectives in Chapters 4, 5, 9, and 10, which discuss, in turn, information perception and access problems, and propose methods and tools which can support public participation; case studies are proposed in the third part of this book in the section on public participation.

Prerequisite to build collaborative (spatial) decision-making processes is information being available to all the actors involved. Thus, it must exist, it must be accessible, but also it must be comprehensible to those who use it. Information production, sharing, and integration involve high cost. Thus, the information cycle of life, from production to exploitation has to be cost effective. As the costs are sensible, new business models should be developed. The last three chapters of Part 1 address these problems in turn.

In Chapter 4, Bénédicté Bucher discusses the problem of data accessibility. Complete information for decision-making is often gathered from multiple sources; hence the role of metadata in its retrieval and exploitation is outlined, and reference to current interoperability standards is given. She illustrates then the problems data producers such as national mapping agencies face in implementing reliable data catalogs and tools to assist the users in discovering data sources to find suitable data to solve spatial problems they face. Current results and further research questions are proposed, aiming at improving the user interface for data discovering and retrieval and geolibraries exploitation.

When data are available, the new challenge is to use them to produce suitable information for decision making. Geographic information is characterized by representation models, which are not always intuitive or easily readable for the lay user. Sustainable development decision-making involves a variety of actors with different backgrounds and sometimes even different cultural underpinnings, and it may be sometimes difficult for them to agree even on basic geographic constructs such as boundaries [17]. Thus, when building GI-based web applications for spatial planning and decision-making, or territorial governance, special attention should be paid to geographic information modeling and representation and to interfaces design.

Mette Arleth discusses in Chapter 5 the issue of laypeople understanding geographic information. With the widespread diffusion of GI-based web applications by public administration and citizens, even in countries such as Denmark where public administration services on the web have reached a high level of development and diffusion among citizens, GI-based applications for spatial planning and governance are not accepted by different categories of users at the same pace. She argues that these difficulties are related to the fact that some geographic information representation models are not equally well understood by different categories of users. Hence, more research should be devoted to investigate user understanding of GI and GI-based web applications usability. Several methods relevant for such investigation are proposed, with reference to selected case studies.

Finally, *conditio sine qua non* for GI production, sharing, and exploitation in spatial decision-making, as required by sustainable development processes, is its economic feasibility. Information production, maintenance, and even its distribution, although digital technology helps a lot especially with reference to the latter, are high-cost activities. Thus, appropriate business models should be developed and implemented to make the information life cycle cost effective. The definition of a suitable economic value for geographic information is fundamental to design reliable GI products pricing policies. Alenka Krek in Chapter 6 argues classical economic principles may cause difficulties, giving an economic value to geoinformation, and proposes value-based pricing as a means to develop sustainable pricing policies.

To summarize, the digital media offer favorable opportunities to improve efficiency and efficacy in (spatial) decision-making processes. Nevertheless, the implementation of ICT and GIS settings to support collaborative spatial planning and decision-making processes presents several challenges. To view it with Latour [18], from a general perspective the black box (technology) is ready; hence the current challenge is to build on it effective collaborative processes. New hypotheses should be tested, and analysis of current practices should be carried on, in order to draw general guidelines for implementation. To this end, the first part of this book deals with several fundamental issues to which further attention should be paid in the planning and GIScience research agenda, so that practitioners may adopt more effective tools to fully exploit the opportunities GIS offers in implementing sustainable development planning and decision-making processes.

1.6 SOLVING SUSTAINABLE DEVELOPMENT PROBLEMS WITH GIS

Sustainable development planning, decision-making, and management are comprehensive processes which deal with multiple-dimension problems aiming at achieving balanced economic development, environmental protection, and social equity and welfare. The use of (geographic) information to support (spatial) decision-making requires availability of data, and tools to analyze data to be integrated in complex information systems.

In the second part of this book eleven chapters are presented which are concerned with the application of GIScience core methods and tools to support specific tasks

commonly found in spatial planning and decision-making. Methods and techniques for data production, data modeling, system integration, and advanced spatial analysis are proposed in this part of the book aiming at presenting recent research results in hot topics within this general theme. Methods and tools presented here should be liable for being integrated in broader information systems to support spatial planning processes.

Data production is often by far the most costly part of information system development. Within GIS, besides traditional expensive field surveying techniques, remote-sensing data have been proven to supply, at a relatively lower cost for the end users, the possibility to collect and maintain large datasets in terms of spatial footprints and time series. Environment can thus be monitored constantly, and changes detected promptly. Last-generation satellite sensors have improved significantly and offer very high-quality data in terms of spatial and spectral resolutions. Geographic information a few years ago collected once every so many years can now be recorded with daily temporal resolution. Once raw data are collected, techniques should be available for data processing in order to supply useful information for decision-making. This is still an open broad research field, and improved techniques for semiautomatic data processing and thematic information production are proposed unceasingly by scientific research.

In Chapter 7, Alexandr Napryushkin and Eugenia Vertinskaya present an advanced method for thematic mapping based on remote sensing data processing. A number of complex stages including an adaptive classification procedure allow classifying raw data in an efficient way. This technique is illustrated with reference to multispectral imagery from RESURS-01 satellite for mapping ecosystem themes, and tested in the Tomsk area in Siberia.

Improved availability of spatial data allows recording geographies in close time intervals. To analyze changes in physical environment, data models and analysis tools able to take into account the time dimension of data are required. Conventional GIS by now have shown difficulties in managing efficiently the dynamics of geography. More sophisticated data models and analysis tools are required to integrate the time dimension together with geographic objects' geometry and attributes.

In Chapter 8 Alexander Zipf presents an object-oriented model developed to manage temporal dimension of 3D geographic objects. The framework proposed by Zipf offers a sophisticated way to model time, hence contributing to extend database models for dynamic information systems. A case study is described, showing the application of the framework to a 3D historic city model for an urban information system, yet the model can be adapted to other domains. Finally, opportunities are proposed for further research developments in this field.

Besides geometry and thematic attributes of objects, environment can be effectively described and analyzed with the support of multimedia data. Multimedia data such as text, images, videos and sounds, have the advantage that they are immediately communicative even for the lay user. Multimedia data are usually handled with different technologies than spatial data. However, as thoroughly explained by Alexandra Fonseca and Cristina Gouveia in Chapter 9, multimedia information systems can be integrated with geographic databases. As a result, spatial multimedia information systems are successfully implemented to support spatial planning and

decision-making. The communicative capability of such systems makes them particularly effective in supporting collaborative and participatory planning processes. As a matter of fact, multimedia formats are particularly efficient in integrating the expert knowledge of the professionals with the common experiential knowledge of the laypeople that may be involved in collaborative planning, particularly in participatory processes. Different examples are proposed by Fonseca and Gouveia, showing different online implementation settings for spatial multimedia information systems, respectively, to disseminate environmental data, to support public involvement in environmental impact assessment, and for concerned citizens to collect environmental data. This discussion is integrated by the examples on the use of spatial multimedia in participatory planning given in the case study presented in Chapter 27, which address the same issues from a different angle.

The possibility for the actors involved in the planning process to supply their own information to enrich the dialogue with their local knowledge and advocate their interests is another interesting aspect to which research in computer support for collaborative planning has paid attention. Groupware is broadly used as an umbrella term to indicate computer tools to support collaborative work distributed in time and space. This characteristic is particularly useful when stakeholders have difficulties in arranging real-time face-to-face meetings. In Chapter 10 Claus Rinner argues how the integration of groupware with GIS would effectively support spatial planning and decision making. He discusses opportunities for the spatial extension of argumentation theory and proposes a conceptual model for implementing what he calls *argumentation maps*. Existing applications are analyzed in the chapter, and further developments for computer support to collaborative planning are outlined.

Another possible GIS capabilities extension is the integration with operational models to simulate and forecast environmental and social processes, with the aim of evaluating possible consequences of given courses of action. In the following Chapters 11 and 12, Andrea Giacomelli and Dimitris Ballas discuss, respectively, the GIS model integration from a general perspective and the implementation of spatial microsimulation models within GIS environments.

Giacomelli opens Chapter 11 with a general discussion of the capabilities GIS offer to support spatial planning and decision-making, particularly when the integration of environmental, economic, and social issues should be implemented in a common analytic framework. Then he outlines further advantages given by the integration of GIS with simulation models, which extend GIS capabilities for dealing with dynamic processes. The discussion addresses both technical and societal issues with regard to the GIS-models integration and gives general yet enlightening insights into the use of decision support systems in sustainable development planning and management, with reference to their main components — data, tools, people, models — and their integration.

After Giacomelli's framework discussion, in Chapter 12 Ballas goes straight to the core of the topic, proposing the integration of GIS with microsimulation models for the evaluation of socioeconomic and spatial effects of major developments. According to a system approach which considers a socioeconomic system as composed of a number of interacting subsystems, spatial microsimulation modeling offers a potentially powerful framework for the analysis of urban and regional

systems, as the integration of microsimulation models based on individual's behaviors within GIS allows investigation of the relationships between socioeconomic processes, spatial planning policies, and environmental settings.

Another class of GIS applications based on the analysis of small area statistics is geodemographics. Initially developed for research and planning support, these applications spread in the business and retailing field as analytical tools to supply operational, tactical, and strategic functions of an organization in locating business and services in the short, medium, and long term. Although geodemographics may give enlightening insights in understanding rich patterns of urban social structures, they can be fruitfully applied also in sustainable development processes to effectively tailor public services planning and policy design according to the local societal needs.

In Chapter 13 Linda See and Phil Gibson give a thorough overview of geodemographic underlying methods and application tools. Then they analyze recent experiences of geodemographics application to sustainable development processes and discuss further potential opportunities. They conclude the chapter not only arguing geodemographics may supply effective support to policy making and planning, but also suggesting its use to set up sustainable development sensitization and participation programs. Once again, it is shown how a creative application of a single GIS tool may address sustainable development planning issues in a multiplicity of ways.

Chapters 7 to 13 present several GIS methods, which may help to solve information production, management, and analysis for sustainable development planning and decision-making. The remaining chapters of the second part, in turn, address specific sustainable development objectives with regard to health, safety, and risk mitigation. Human health deserved a special chapter in Agenda 21, which proposes several program areas to meet primary health care needs, control the spread of diseases, and reduce health risks from pollution and hazards.

In Chapter 14 Stefania Bertazzon and Marina Gavrilova discuss the application of advanced multivariate spatial analysis to address the need for efficient models in health care management. They argue that spatial regression analysis based on alternative distance functions of non-Euclidean metrics constitutes an efficient tool for human health research and its integration with environmental processes.

Spatial aggregation of area units is a common problem in several policy fields and may be an efficient tool to help solve different sustainable development planning and management problems. In Chapter 15 Kostantinos Daras and Seraphim Albanides discuss the application of zone design methods to support public health management policies which better fit patients' needs. The new tool for zone design proposed by the authors takes into account objective functions as well as constraints of the zones' shape, offering reliable tools for effective health care management.

Besides human health, according to sustainable development principles, the well-being of all urban dwellers must be improved so that they can contribute to economic and social development. Urban areas often face high rates of violence and crime occurrences, which underline symptoms of social disorder. Vania A. Ceccato discusses this important issue for social welfare in Chapter 16. On the basis of the recent literature, she argues crime events tend to be related to particular socioeconomic conditions and functional and physical settings within the urban environment.

To fight crime events and promote community safety and social well-being, GIS and spatial statistics, she argues, should be used in planning and policy design in defining measures to reduce crime events and risk. Ceccato illustrates in detail several techniques for crime analysis and outlines advantages and limitations of the different methods. Then she suggests potential applications of spatial pattern detection and explanation techniques to strategically support safety planning. Later, in Chapter 22, Corcoran and Bowen Thomson present a real-world case study of community safety policy making.

Human health protection also involves risk prevention and mitigation. Hazards originated by natural and human causes can create serious dangers to populations especially when people live in concentrated areas. Vulnerability assessment and hazard mitigation is of utmost importance in settlement planning and management.

Tarek Rashed sensibly addresses this important issue in Chapter 17 with a thorough explanation about the concept of vulnerability and hazard, and about possible approaches for its mitigation, before turning to a detailed discussion about the GIS and remote sensing methods in vulnerability analysis, which may be helpful in sustainable development planning. Rashed outlines the opportunities GIS and RS offer for vulnerability assessment for planning hazard mitigation and proposes a GIS/RS-based methodology for understanding spatial and temporal vulnerability patterns in urban areas.

In line with a common perspective in this book, once again attention is paid to the opportunities geospatial technology offers in supporting an integrated knowledge-based holistic approach to sustainable development planning.

1.7 GIS FOR SUSTAINABLE DEVELOPMENT IN PRACTICE

The history of scientific and technological innovation is studied by adaptive evolutionary processes of putting scientific research findings into practice. Discovering a new theory, method, or technology is not always a warranty of its recognition and acceptance by users. When this is the case, it often requires a lot of effort by the end user to put *science into action* [18] by an adaptive process through which the user might modify the initial product into a new one. Differences among the two might be significant. Economic, cultural, societal, and institutional factors influence the innovation adoption in given contexts at different rates.

The GIScience and geoinformation industry in the last decades produced a plethora of theories, methods, and tools to solve spatial problems. However their diffusion and adoption in professional practice varies in the many application fields. Data availability, funding supply for implementation, and training facilities determined a wide range of GIS diffusion patterns in a variety of contexts. It is interesting to note how general patterns of GIS innovation and diffusion have recently been subject to a general turn toward giving broad access and diffusion to small pieces of (geo-) information, to use Frank and Raubal's words [19], rather than continuing to search for advanced spatial analysis tools. That is to say that putting GIS into practice is not just a matter of quality data and efficient tools availability. The application user requirements often drive technology adoption toward unexpected trails in an adaptive process, which sometimes may offer as many interesting hints

as research findings. This is particularly true in planning, which is an application field strongly related to economic, institutional, and sociocultural settings, where disciplinary theories, methods, and tools vary sometimes substantially in different local contexts. To this end, the third part of this book presents a series of application research and real practice case studies aiming at showing GIS theories and methods application to different tasks of spatial planning and decision-making with reference to sustainable development objectives and processes.

Chapters 18 to 29 are grouped in thematic sections regarding different sustainable development issues, namely concerning urban settlement dynamics analysis and forecasting, natural and cultural heritage preservation, wise use of energy, water resource and community safety management, public participation, and information system management to support governance and decision-making.

Sébastien Gadai opens the first section with Chapter 18. As introduced in Chapter 7 by Napryushkin and Vertinskaya, remote sensing data processing is a reliable source of information for detecting by thematic mapping anthropic impacts on the environment. Gadai analyzes the case study of the urban dynamics in Maghreb, Morocco. The Morocco Atlantic Metropolitan Area is subject to considerable growth forces. The lack of quality data availability to monitor ongoing urban sprawl causes serious problems with regard to settlement expansion control. To address this problem, which is especially common in developing countries where there is a lack of quality socioeconomic and geographic data, Gadai presents a methodology for multiscale geographic dataset generation by integrating different satellite data sources and processing techniques. The result is the availability of updated datasets, at different time steps, at a cost relatively lower than those required by traditional surveying campaigns, to monitor the urban dynamics and support settlement development control.

When quality geographic datasets are available on top of that, it is possible to implement, as discussed earlier in Chapters 11 and 12, sophisticated simulation and forecasting models to assist decision-makers in planning processes.

José Barredo, Carlo Lavallo, and Marjo Kasanko present the successful results of the MOLAND research project. Barredo et al. discuss the application of the MOLAND methodology to the case study of Udine, Italy. The methodology, based on a multiscale modeling framework that integrates several submodel components representing environmental, social, and economic subsystems, allowed them to implement long-term development forecasts for settlement development in an area characterized by residential discontinuous urban fabric and industrial land uses.

The second section deals with the preservation of natural and cultural heritage.

In Chapter 20, Susanne Steiner presents a case study of rural landscape analysis in the transnational border between Austria and Hungary. Different historic vicissitudes of the region in the last century deeply affected the agricultural landscape differently on the two sides of the border. Thus, current development pressure requires seriously taking into account such differences while planning national policies on the two parts of the same region. To this end, a detailed explanation is given on data acquisition and database modeling to implement an information system able to support an understanding of rural landscape evolution in time as a basis for

further development planning, sustainably exploiting local resources, and safeguarding the regional historical identity.

On the basis of research and practice experiences in archaeology, in Chapter 21 Anthony Beck and Assaad Seif discuss the role of geoinformation technology in the discipline. As argued by the authors, the latest theoretical developments in archaeological data collection and interpretation require computerization with high potential for improving analytical frameworks. Geospatial technologies offer reliable tools to integrate diverse data in a coherent whole, which, according to the authors, is the current challenge in archaeology.

Three examples are given in the third section that address specific societal and environmental issues.

In Chapter 22 Jonathan Corcoran and Bernie Bowen Thomson present a case study of community safety policy-making in the United Kingdom. They explain a GIS-based methodology to support crime analysis, giving particular attention to institutional problems of collaboration among the different actors involved in the process. This is an interesting real-practice example for the discussion of data sharing and integration process with its institutional, organizational, and technical problems. The efforts to achieve a balance between the application of advanced spatial analysis tools and data integration requirements in a collaborative process guided the application of the methodological approach, and they outline the satisfactory compromise solution implemented and the reliability of results.

Giuseppe Cremona and Luisella Ciancarella present a strategic plan for water resource management. The authors illustrate the methodology implemented according to an environmental suitability approach in water facilities planning, aiming at achieving a balance between the demand for the water supply and natural protection in such environmentally sensitive context as the Mediterranean Eolian Islands.

In Chapter 24 Tomaž Podobnikar, Krištof Oštir, and Klemen Zakšek present a case study of solar radiation modeling for the evaluation of solar energy resources in Slovenia, whose exploitation can reduce the need for other energy sources, which generally produce much higher negative impacts on human health and the environment.

A crosscutting theme found in Chapters 22 to 24 is the data availability, which deeply influences the application of methodological approach and the reliability of the analysis results.

The theme of geospatial technologies as empowering tools for communities and citizens, discussed from the theoretical and methodological points of view, respectively, in Chapter 3 and in Chapters 9 and 10, is further investigated in its practical implementation by Chapters 25 to 27.

The case studies presented offer three different perspectives, which together give a multifaceted and thorough insight into the application of GIS and spatial multimedia in collaborative and participatory sustainable development planning processes.

In Chapter 25 Laura Harjo discusses how GIS is used to empower the local community in a sensible context such as a tribal nation in the United States. Thanks to the implementation of a dedicated information data center, decision-making processes are supported in a number of application fields such as health care, cultural

heritage, land and property use, negotiations, and others. Of special interest in the experience presented by Harjo is the integrated approach, according to which geographic information is analyzed to support multiple decision-making processes within the community. This is an excellent example of how the tools can be used in an integrated manner to pursue sustainable development strategies. Moreover it is interesting to note how the experiences presented by Harjo show the opportunities for GIS to represent local identity and the citizens' common knowledge.

A different perspective is offered by Aurore Nembrini, Sandrine Bileau, Gilles Desthieux, and Florent Joerin, who in turn pay attention to the use of geoinformation technologies in participatory urban planning. Nembrini et al. focus on a traditional planning process in which citizens — and this is the original experience of the case study of Geneva — are called for involvement in the plan-diagnosis phase. The authors describe a methodology to elicit citizens' views and aspirations about future urban development. The methodology proposed in this chapter is used to perform analysis on spatial indicators, which represent citizens' concerns. Furthermore GIS representations are used instead of traditional means to support the dialogue among professionals and citizens. Nembrini et al. conclude the chapter by discussing the role GIS played in the process, and to what extent citizens accepted the use of geoinformation technology support.

As a third example of participatory planning practices, Laxmi Ramasubramanian and Aimée C. Quinn in Chapter 27 present a successful experience of GIS and geovisualization tools integration in a web system to support a broader participatory planning experience in Chicago. A spatial multimedia web application was used, together with traditional face-to-face methods, to promote concerned citizens' involvement and help them to discuss future scenarios for their neighborhood development. This paradigmatic example thoroughly shows both societal and technical aspects of digital support to participatory planning in the detailed description of this best practice.

The last section presents two experiences, in Italy and The Netherlands, respectively, concerning organizational and technical underpinnings in developing geographic information systems.

In the last decade, growing attention has been given to the development of spatial data infrastructure at the global, national, and local levels in order to integrate geographic information sources produced by the public sector (i.e., government bodies, national mapping agencies, local administrations) according to interoperability standards for its exploitation in decision-making, and to promote its reuse by the private sector as an opportunity for economic development.

Piergiorgio Cipriano presents the latest developments of the spatial data infrastructure implemented in the Piemonte Region in Italy. A joint consortium of regional and local administrations undertook its development according to European and international standards for data, metadata, and technology platforms. The results achieved so far represent a best practice in this field.

The last section is concluded by Walter Oostdam with Chapter 29, which gives a detailed description of an urban geographic information system developed by the municipality of the City of 's-Hertogenbosch in The Netherlands. This case study offers several interesting insights into both the organizational and technical problems

afforded in information system development. Unlike major national organizations and research centers, smaller organizations such as local administrations often barely meet the demand for funding, infrastructure, and skills required for enterprise GIS implementation. Oostdam explains in detail how technological implementation has been accompanied by multisteppe adaptive processes of organizational changes. He explains also how pilot projects were implemented to promote the awareness of the advantages offered by GIS at a managerial and operational level.

1.8 CONCLUSIVE SUMMARY

Sustainable development is a primary objective and an urgent problem to be addressed by our society. Geospatial technologies offer reliable tools to support analysis, problem solving, planning, decision-making, and management of the processes required to pursue this common objective. GIScience theories, methods, techniques, and tools are presented and discussed here in the role they play in setting up sustainable processes to achieve sustainable development objectives.

The GIScience community has a role to play in further investigating opportunities to solve sustainable development problems by means of sustainable development processes and in promoting awareness of all the actors involved about the potential of geospatial technologies.

This book aims at addressing this challenge by presenting a diverse set of contributions, which together propose a comprehensive perspective of the issues and possible solutions for implementing knowledge-based sustainable development support systems. To this end data production, maintenance, and access issues are discussed together with their economic, technical, and organizational feasibility. Moreover, tools for inclusive collaborative planning are presented, which may constitute reliable platforms for participatory analysis and problem solving and decision-making. These tools, although promising from a technical perspective, need to be implemented carefully, taking into account the impact new technologies may have on diverse groups of users.

The overall discussion aims at dealing in an integrated way with the many issues outlined in this chapter; nevertheless, further efforts are required to develop a more focused research agenda for GIS application for sustainable development. To this end, it is the hope of the editor that this work, by paying attention to a broad range of problems and suggesting possible solutions, may contribute in raising the awareness of researchers, developers, and end users of the opportunities for the application of GIS for sustainable development.

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Part I

General Issues for GI Use in Planning Sustainable Development

2 The Rise of Cyber Planning: Some Theoretical Insights

Andrea De Montis

CONTENTS

2.1	Introduction	23
2.2	Cyberspace, Virtualization, Ubiquity: A General Theory and Some Applications to Practice.....	24
2.2.1	Cyberspace: Starting from Information and Telecommunications Technology (ICT)	25
2.2.2	Virtual Versus Actual	26
2.2.3	Cyberspace and Economy: Disintermediation and Destructuralization	27
2.2.4	Cyberspace and New Job Descriptions	28
2.2.5	The Virtualization of the Government: Toward a Digital Agora?	29
2.2.6	Cyberspace, Architecture, and Planning.....	30
2.3	Cyberspace and Planning: Could It Be the End of Geographical Location?.....	30
2.4	Conclusion: Confronting Cyberspace and Cyber Planning to Sustainability	32
	References.....	33

2.1 INTRODUCTION

According to recent estimates [1], the number of personal computers in the world currently amounts to around 600 millions units and, by 2010, is expected to reach 1 billion. This means that on average, almost one out of six persons on the planet is forecasted to have a personal computer and, most likely, to be able to connect to worldwide networks. Studies on real complex networks [2, p. 10] reveal that in 2003 the number of World Wide Web pages linked by the sole search engine AltaVista equaled 203,549,046, while the number of connections among them was 2,130,000,000. With respect to regional distribution of information technology, according to a recent UN report [3, p. 4], the so-called digital divide is shrinking: the number of personal computers per 100 inhabitants in 1992 in the developed countries was 27 times more than in the developing countries, while in 2002 it was

only 11 times more. Moreover, the number of Internet users per 100 inhabitants in 1992 in the developed countries was 41 times more than in the developing countries, while in 2002 only 8 times more.

Even though twenty years have passed since Gibson's *Neuromancer* was published in 1984 [4], by looking at the reported figures it is possible to acknowledge the power of the previsions envisioned in that famous novel, which introduced the term "cyberspace" into our current ways of speaking and thinking. What perhaps Gibson was not able to foresee was the exact size of this particular space and its immediate reflections onto societies, economies, and cultures: the rise of the information and network-based society will keep on producing even sharper changes in lifestyle, and thus in the patterns citizens think, work, organize, communicate, speak, buy, invest and plan their own future.

While the spread of the digital culture involves mutations and may display its effects in more visible and touchable ways in other sectors of our societies, in planning it is possible to detect the rise of a new kind of player, the cyber planner, who has developed his or her skills, apart from traditional issues, in new branches of knowledge, such as information technology, geo-informatics, communications technology, software engineering, and network and distributed computing. This professional is confronted with the need to communicate, involve, and stimulate groups of other practitioners and citizens in order to sustain a social-consensus-based and collaborative style of planning. One of the milestone principles of sustainable development can be found in the empowerment and auto-determination of local societies, which should be made able to master their own plans and programs for future development. According to this perspective, this new figure of practitioner, the digital info-planner, may be believed to be the suitable professional, as far as he is able to bring the required endowment of transparency, trustworthiness, and responsibility into the procedures of analysis and production of structured information supporting the activities of planning.

In this chapter, the author aims at providing insights on the rise of cyber planning by examining the diffusion of digital informative culture across all the sectors of our society and by suggesting relevant relations among the strategies toward sustainability, distributed computing, and digital planning. The arguments are presented as follows. In the next section, the concept of cyberspace is first presented from a theoretical point of view and then applied to the mutations of some leading sectors of society. In the third section, cyber planning is introduced and described as a new style of practice. In the fourth section, concluding remarks of the chapter are drawn, by viewing the concepts of cyberspace and cyber planning with sustainability-driven processes and emphasizing the key role informational endowments may play for decision-making, planning, and management in a perspective of sustainability.

2.2 CYBERSPACE, VIRTUALIZATION, UBIQUITY: A GENERAL THEORY AND SOME APPLICATIONS TO PRACTICE

In a thought-provoking article, Batty [5, p. 1] stated that "by 2050, everything around us will be some form of computer," referring in the end to the evidence that

everything, and the city as well, may soon become computable. According to Batty [5, p. 3], the main point, which induces a very real revolution and leads to a novel kind of space and metric, relies on the convergence between those computers and telecommunications. Starting from this statement, a possible definition in complex terms of cyberspace should apply not only to the ways information, models, geographical displacement are stored in their digital format into an electronic domain but also, and especially, to the patterns in which they are transmitted along clusters of networked hard disks. Other scholars refer to cyberspace, invoking “any types of virtual space generated from a collection of electronic data that exist within the Internet” [6, p. 2]. Thus, a precise definition of cyberspace has to be given in connection with the discourse on remote exchanges of data in the network of the networks.

2.2.1 CYBERSPACE: STARTING FROM INFORMATION AND TELECOMMUNICATIONS TECHNOLOGY (ICT)

Information and communication technology (ICT) can be interpreted as the current system of thought and associated tools that make an individual able to manage information, meant as data structured into an informative framework. This system allows one to construct, gather, edit, and transfer information from a transmitter to a receiver device. A particular ICT has been the hallmark of every historical era. Thus, information and communication technology can be considered not only as the cultural product of a certain community, but also as a crucial factor in the behavior and thoughts of that society.

McLuhan [7] believes that an affinity can often be found between the content of the information and the medium used to transfer it from a transmitting to a receiving system. The sentence “the medium is the message” is the starting point of the McLuhan hypothesis and provides an instrument for the interpretation of the relationship between media and society. According to McLuhan, the medium can be considered as an extension of human possibilities, a tool for widening the field of action, either in material or in cultural terms. The innovative process of technological advance is principally responsible for the changes in the medium throughout the last millennium and, above all, in the last century.

McLuhan’s thoughts seem to be relevant, as they focus on the relationships between the medium and the cultural infrastructure of a society. Every time there is a change of the nature of the extent of the medium, it is associated with a disturbance in the categories of perceived reality and in the individual’s relationship with space.

In the contemporary era, telecommunications represents the current innovation. Definable as a medium in the McLuhanian sense, this instrument is believed to finally remove the obstacle of the physical distance. Telecommunications allows the contemporaneous transmission of information to a theoretically unlimited number of destinations. Thus the crucial cultural repercussions of telecommunications are that it eliminates space or, more simply, eliminates the category space in Euclidean terms. In this sense, the “message” embodied in telecommunications can be interpreted as the system of social, cultural, and productive opportunities stemming from

the enlargement of the number of users and from its “real-time” aspect. The sensorial sphere of the individual widens and, theoretically, can become ubiquitous. Virtual reality technology is an example of the artificial extension of human capacities. Through this instrument an individual becomes able to perceive sensation, such as the sense of touch or smell, about realities located in remote places or, sometimes, in unreal environments.

Currently societies are being affected by a huge diffusion of information technology, whose products are becoming accessible to everybody and are likely to become necessary components of daily life. These strategic innovations can be seen in digitalization and miniaturization. The bit and the microprocessor are nowadays really the masters of current culture and design. These objects, when linked to the development of distributed computing, yield what is known as the Internet work environment. One common hypothesis is that the Internet can be considered as the medium, which allows the digital revolution to explode, following the same pattern as the Industrial Revolution in the eighteenth century. The latter caused the exponential increase of industrial production and, above all, of goods. The former permits a similar increase in information transmission. According to studies about the social mutations caused by technological change [8], the contemporary era is going through a painful transition to a new interpretative paradigm of reality, a “techno-communicative transition” from a sociocultural system dominated by communicative technology to a sociocultural system dominated by another communicative technology. Currently, humankind is experimenting with a techno-communicative transition from a system dominated by the analog and spatial communication technology of the Industrial Era to the digital and cyber spatial technology of the Informatics Era.

2.2.2 VIRTUAL VERSUS ACTUAL

Two phenomena can be considered the immediate consequences of the aforementioned current changes being related to a process of undermining the status of reality and, hence, becoming crucial keys to understand the revolutionary concept of cyberspace: deterritorialization and virtualization.

With respect to the deterritorialization, telecommunications allows reaching through the Net places located even quite far away in a very short period of time; even if the time of the so-called death of distance has not come so far, nevertheless a deep mutation affecting the concept of geographical space might result in the beginning of social uprooting and the progressive waning of the sense of belonging to a certain place. Hence, telecommunications can result in the absence of identity.

On the other hand, the virtualization can be interpreted as an activity connected to an enlargement of human actions and their perception of remote objects. As Steven Spielberg has foreseen, soon it will be possible to have neuronal and psychic contact with anyone on the planet. In this sense, the tele-transmission of sensorial experiences is the final objective, which has not yet been achieved by virtualization. According to Lévy, the cultural impact of new information technologies can be studied under the umbrella concepts of virtualization and of collective intelligence [9–11]. Lévy defines virtualization as a change of identity, a displacement of the ontological center of gravity of the case-study object. In his view, the virtualization

of any entity whatsoever consists of discovering the general idea beyond it and of the redefinition of the starting reality as an answer to a precise question. In this way, virtualization makes the established differences fluid, increases the degrees of freedom, and turns the empty creative space into dynamic moving power [9].

Digital advances allow a virtualization of the concept of geographical displacement, until the sense of “*hic et nunc*” is dissolved, as is a feeling of cultural identity with a precise place. In the case of the transmission of information through the Internet, a text, an image, or a form are virtually present because they are available in whatever personal computer is connected to the Net; no location or address need be indicated. Telecommunications leads to situations where digital communities can meet and express their opinions together. Deterritorialization, in the sense of the contemporaneous presence in many places, can be seen as one of the characteristics of virtualization. Without the sense of geographical location, collective intelligence is able to evolve. It can be defined as a ubiquitously distributed, ever-present, real-time coordinated intelligence that leads to an effective mobilization of abilities [10]. It is now accepted among sociologists and communication philosophers that current telecommunications technology is able to generate a true digital culture. Interconnection seems to be the principal task of cyberculture, a new paradigm for the digital communities. The culture of cyberspace aims at a civilization of the generalized tele-presence [11].

In the remainder of this section, cyberspace is described with respect to the changes it determines on a variety of social and economic domains.

2.2.3 CYBERSPACE AND ECONOMY: DISINTERMEDIATION AND DESTRUCTURALIZATION

The rise of cyber spatial patterns into entrepreneurship, finance, and commerce keeps on producing structural mutations that often bring benefits to clients by means of the progressive abolition of the intermediaries.

A study on the virtual enterprise in Italy detects a positive movement of large northwestern firms toward the introduction of ICTs into their management systems [12]. According to this research, Italian medium and small northeastern firms, while considered the engine of development for the entire country, risk being trapped in their current scarcity of digital infrastructures. The most relevant changes affect the relations within the production and delivery systems, while a collaborative attitude involves the firm and its external partners, which are considered not only as simple deliverers of services but also as contributors to the efficiency of the system in its whole. ICTs may be introduced along different patterns; they can support activities such as research of alternative delivery channels, customer relationship management, supply chain management, and enterprise management. The highest level of penetration of the ICTs corresponds to a reengineering process toward a new map of production and service/goods delivery processes. Nevertheless, it is worth considering the mutations that ICTs, and the embedded concept of cyberspace, provoke in the strategies of customer relationship management. One of the key concepts of digital commerce, the abolition of the intermediaries, is led by the possibilities opened by the use of the Internet as a common marketplace. Nowadays its users,

the customers, have the opportunity to directly access digital catalogs and archives of goods and services, compare them, and judge the convenience of each purchase.

According to many scholars [13], the spread of cyberspace into commerce will bring extreme consequences to the already studied gap between economics of ideas and of objects [14–16]. Economics of ideas, information economics, are going to separate from the economics of goods, since the vector is fading into a less physical and tangible support. It is also possible to recognize the influence of cyberspace-inspired concepts on the calibration of novel econometric models related to the link between economies “located” in digital spaces and in physical places for urban domains [17]. The introduction of web-based patterns for presentation of the information about commercial products is predicted to abate in a few years the current system of consolidated comparative advantages due to imperfect information throughout the markets. With respect to selling strategies, soon it will be possible to solve the dilemma between depth and wideness. By means of strategies aiming at the digital affiliation of the customers, they are now becoming digital navigators and self-instructed miners of commodities. In this way, the traditional compensatory relationship between depth and wideness will be overcome. There soon will be a deconstruction process of the traditional roles and professions linked to commerce; somehow commercial information delivery services are likely to become more profitable than selling activities themselves.

On the side of finance, the development of computerized trading has led to an often-anonymous market environment. Deterritorialization acts as a potential cause of elimination of any difficulties connected to physical distance. These aspects parallel the rise of what we know as globalization of financial markets. Wider possibilities to directly access financial markets can open unimagined options for investors to browse into the catalog of products and choose the most suitable one for their own needs. Also in this case, the intermediaries, formerly the financial promoters, are going to be replaced by personal consultants, who will be in charge of guiding and suggesting appropriate paths to the investors. Deterritorialization also fosters the birth of parallel systems, such as Island, an electronic communication network (ECN) that hosts a number of electronic terminals connected to online unofficial, although actual, marketplaces. The ECNs display a series of advantages: they grant low transaction costs, and they allow buying and selling for a longer period of time each day, since the open time period is longer than in the official markets. Recently an ECN, like Island, applied to be recognized as an official stock exchange. In addition, other ECNs are willing to list themselves at the stock exchange [18].

2.2.4 CYBERSPACE AND NEW JOB DESCRIPTIONS

The first immediate, and perhaps also most quoted, consequence of telecommunications can be considered teleworking: every place, even home, when connected to a central organizing body, may become a workplace. Deterritorialization might result in the beneficial creation of an unexpected number of new jobs. Despite the hopes for this generalized 24-hour-work world, after more than two decades it is possible to state that, especially at a directive level, strategies should be set during face-to-face meetings when physical space, emotions, touch, and smell still do matter. What is

recognized as a radicalization of teleworking, meant as the link between telecommunication and job strategies, is the widespread rebound effects of electronic remote control on almost every production process over the shape and role of traditional professionals. According to Rifkin [19], workers currently live in a post-market era ruled by digital technologies. The introduction of the ICTs implies a sharp reduction of the employees, since higher levels of productivity may be reached, encouraging, however, a deep transformation of the skills and education required of the incoming labor force. Knowledge workers represent the actors of the Third Industrial Revolution, since they are required to master the high-tech information. Among these professionals, web architects occupy a particular niche, which will widen its embrace. They are expected to acquire a high credit for the design of large-scale web sites, their maintenance and future development [20].

2.2.5 THE VIRTUALIZATION OF THE GOVERNMENT: TOWARD A DIGITAL AGORA?

How does cyberspace reflect upon the strategies of government reform? According to Lévy, the invention of new forms of political and social systems seems to be one of the main duties of contemporary humanity [11]. He stresses the opportunities offered by communication technology in the fields of political participation and representation. While in the past, one of the main obstacles to direct democracy was that it was impossible for a large number of people to collect in a single place, nowadays, a number of personal computer terminals could be used as diffuse interfaces between citizens and political bodies. There could be a revolution in political style, because of the innovative utopia created by dispersed decision-making. Cyberspace, according to Lévy, is to become the place where problems are explored and pluralistic discussion will focus on complex questions, where collective decisions and evaluations will be adjusted to the needs of interested communities [11].

Political institutions, however, seem to react slowly to these suggestions, since the changes in the ways of receiving and processing information imply a painful abandonment of the old political procedures and the start of a new era. The environment of this democratic decision-making would “take place” in a digital arena dispersed among many terminals participating in the political debate. In this way the problem of finding the meeting place for a great number of people can be overcome. Some signs of this mutation are already visible in many digital civic activities, such as social networks and online forums. But the way ahead is directed to scenarios where the simultaneous digital expression of the political ideas of each citizen will acquire an importance, which will be impossible to ignore. Real-time democracy needs new forums, new agoras, new places for socializing and government that help people and groups to recognize each other, meet each other, negotiate, and draw up contracts [11].

Through the Internet, each citizen could virtually participate in government processes. The current form of digital dialogue between governmental bodies and citizens takes place inside the civic networks. In these cases, the virtual agora means speeding up administrative processes and simplifying control procedures, since data can be transmitted to a virtually infinite number of users.

2.2.6 CYBERSPACE, ARCHITECTURE, AND PLANNING

Among the scholars who have conceptualized the influence of cyberspace on architecture, Maldonado refers to dematerialization [21] as a parallel counterpart of virtualization. According to his thought, just as, in “microphysics,” the studies on subatomic processes have revealed the existence of antimatter, in “macrophysics,” theorists try to suggest the development of similar paths toward the dematerialization. While he is skeptical about the rise of worlds populated by ectoplasms, Maldonado stresses the new role of virtual modeling. According to him and to Eco [22], semeiotics should receipt the changes of the nature of the vectors that bring the iconic meanings. Cyberspace seems to be acting either on the introduction of even less material digital models, as a means of design and support to knowledge and control, or on the use of lighter materials for building. During the Renaissance age, architects had a relative advantage over the other artisans, since they were able to previsualize the future products of their craft. The development of computing performances has enhanced their role of previewers, opening novel opportunities to redirect cyberspace in terms of the aid to design both a single building and a group of buildings within an urban fabric. A sort of obsession for space representation has characterized architectural curricula, while it has been considered a potential source of physical determinism by planning theorists. The contamination of planning with other disciplines, such as sociology, anthropology, economics, and statistics, brought as an immediate consequence a part of the evident beneficial effects for the foundation of a multilayered complex field, a clear, although transient, indifference of planners for physical space [23]. Langendorf recognized an appreciable development of the visualization methods, due to the higher performances allowed by current network-based information technologies. Three ages can be individuated [24]: during the 1980s, the birth of computer graphics and 2D digital representation with analogical use of movies, pictures, and audio documents; during the 1990s, the research of integration among different information systems to link spatial with other related multimedia information; and during the current age, the 2000s, the experimentation of further integration of systems, such as multisensorial systems, multimedia data sets, hypertexts, and geographic information systems, that enable the design of informational landscape, digital libraries, and electronic laboratories. In the information landscape, visualization of cyberspace can be interpreted as the creation of informational domains where knowledge is linked in a continuous virtual context, which opens new and unexpected scenarios for aiding the design. The evolution of the visualization techniques, inspired to cyber spatial modes, has followed a path along with representation and interpretation of information in a heuristic pattern able to support actions for planning and design [25–29].

2.3 CYBERSPACE AND PLANNING: COULD IT BE THE END OF GEOGRAPHICAL LOCATION?

How does cyberspace relate with planning?

It could be advanced that digital technologies contribute to a sort of attempt to change the nature of geographical space by mining its own physical distance-based

properties. Deterritorialization might cause a transition from a cities-based to cyber cities-based world and society. Again, the absence of the sense of belonging to a specific location might imply also that cultural identity, based on geographical location, may be in danger of extinction. Thus, the focus of planning has changed; planners are now confronted with the task of managing cyberspaces. On the other side of the coin, planning itself has deeply changed: traditional blueprint professionals, used to drawing by means of pencils and afterwards to discussing their master plans with citizens and stakeholders, are currently engaged in a transition to soon become cyber planners, always connected to their digital draft plans, which most of the time will be considered in progress and will be distributed and accessible by 24-hour-living communities.

The disciplinary paradigms of urban and regional planning do not seem to be adequate to provide correct analysis and to deal with complex changes affected cyberspace, in its wider sense. Graham and Marvin confirm this crisis in the interpretative framework [30–31]. They complain that urban planning researchers and scholars are not very interested in the relationship between the digital field of telecommunications and the stony hardware of the city: “Urban analysts and policy makers still see cities through analytical lenses which actually have less and less to do with the real dynamics of telecommunication-based urban development” [30, p. 48].

Batty agrees with them: “Understanding of the impacts of information technology on cities is still woefully inadequate” [32, p. 250]. The specialist literature itself shows the signs of a sort of scientific inertia, since the attempts to classify do not go beyond the metaphorical transposition between the dual virtual/actual fields and avoid describing the real changes induced by digital telecommunication into the city. Graham and Marvin [30] and Couclelis [33] after them quote more than twenty different terms coined ad hoc for illustrating the revolutionary nature of cyber cities.

However, the dichotomy of urban places/electronic spaces seems to leave the directions of future research open. The key to the problem is the correct interpretation of the related material and immaterial flows between city and hyper city. These are characterized by synergy and not only by simple duplication of social fields of study.

The unspoken background of the above problem is the need to establish new paradigms for urban and regional planning. In this transition process, planners have to adapt to the demands of new spatial settlements and infrastructure, listening to both the displaced and the digital communities. Digitalization encourages changes in the types of planning tools through the introduction of digital formats and the need to negotiate digital draft procedures. The imperative seems really to be to discover the new sense of location displayed by the “collective intelligence.”

Nevertheless, planning still seems to be connected with geographic systems of real displacements, even if telecommunications allows people to work without moving, to vote without going to the ballot box, or to watch movies without entering a cinema. This global interconnection, through virtual presence, means an expansion of opportunities and also of the need to move, act, travel and picture.

The rise of the Internet mode of exchanging information truly opens aspatial ways of relating with others. Even without the indication of addresses and locations, the Internet is configured as a “place” where it is possible to meet people, to work, and to live an associative life. In this respect, William Mitchell describes the place Internet,

[Internet] subverts, displaces, and radically redefines our perceived conceptions of gathering place, community, and urban life.... The Net negates geometry.... The Net is ambient — nowhere in particular but everywhere at once. You do not go to it; you log in from wherever you physically happen to be [34, p. 8].

Simultaneous contact admits the existence of a third dimension, the “real time,” beyond space and time. It is easy to understand how the system of geographic spaces implies different relationships among its points, with respect to the relationships linking the points of the virtual spaces. These fields have different topologies.

Planners are engaged in interpreting the evolution affecting the topology of urban environments, while bearing in mind that there are important interactions, sometimes invisible, from electronic spaces. Telecommunications modify the sense of living and the related architectural design. They modify regional relationships and the planning processes connected to them. Virtual locations dominate real situations, as in the case of telecommanded houses or of telesecured offices.

In this “digital era” [35], professionals have to think about their working instruments and disciplinary paradigms. Their subjects are going to change and be complemented with elements coming from different subjects, such as geomatics, geographic information science, remote sensing, and fractal and cellular modeling. This era seems to be characterized by the use of network cooperation between remote professionals and scientists. According to Howkins [36], who describes the transition to a new style for planning, the old style planner talked about physical zoning, the balance of employment, housing, and open space and traffic flows. In contrast, Howkins stresses how the new style planner, which might be termed the cyber planner, has to consider the configuration of electronic systems and local area networks (LAN) and the provision of bandwidth to each urban area. The town planner dealt with the stock and flows of vehicles. Today’s public authorities have to face the stock and flows of information [36, p. 427]. Furthermore, according to Machart, “Telecommunication is becoming a new component in urban and regional development planning. [The] desire is to use telecommunication as a structuring element in cities and regions and to incorporate telecommunications in economic and social development” [37].

The actual challenge is to interpret how the suggestions of high-tech solutions for communications can be used to design new relationships and cultural geographic spaces. According to Mitchell, the physical integration of electronic devices will characterize future planning and design practice: “... architects and urban designers must gracefully integrate the emerging activity patterns created by pervasive digital telecommunication into the urban forms and textures inherited from the past” [38, p. 35].

2.4 CONCLUSION: CONFRONTING CYBERSPACE AND CYBER PLANNING TO SUSTAINABILITY

The variety of declinations of cyberspace introduced above can be thought to constitute an ideal basis to translate into current practice some of the most important and often-abused concepts inspired to sustainable development.

The solemn declarations formulated at the end of the well-known conferences held in Rio de Janeiro in 1992 and in Johannesburg ten years later (Rio +10) seem

to agree on this topic: achieving full access to information in order to strengthen the deliberative capacity embedded in groups of as many citizens as possible [39, p. 102]. This is believed to be the basis for increasing the level of empowerment of local societies and stimulating self-driven patterns of decision-making and planning. Furthermore, according to Agenda 21, the subsequent operative document, one of the most important tasks in a process toward sustainability should be “improving the use of data and information at all stages of planning and management” [40].

Information can be made entirely open and accessible either by disseminating it to remote communities and groups or by bringing those societies to it. In the last hypothesis, cyberspace might play a leading role, by inducing innovative channels for digital information distribution and exchange, by individuating and constructing common, sharable, and thus transparent datasets, and by opening an era of collective and interactive processes developed by local societies on self-built scenarios. The institution of a common and always-accessible informational endowment can be considered a fertile humus for encouraging the diffusion of behaviors inspired to Local Agenda 21 protocols, with respect to trustful, transparent, consensus-built, and self-reliant planning. In this perspective, tools for managing, enhancing, and distributing (spatial) information are particularly welcome: web-based maps, GIS, images, movies, other multimedia, checklists, networks, forums, and newsgroups are the necessary bricks to conceive innovative digital planning environments. The supply of these tools is already well grounded on a wealth of software and GI-based applications available online; on the other side, though, the social demand might not meet this level of diffusion. A widespread and acceptable level of social trustfulness for digital processes and tools is still lacking; this constitutes one of the most difficult barriers to a current practice of cyber planning. After creating a common ground for the culture of bottom-up self-planning, and sustainability, society should produce its efforts for reducing the large digital gap that still divides information-rich domains in cyberspace from the corresponding information-poor excluded communities in the geographical space.

While the broadness of this mission cannot be deferred only to a single kind of institution, public sector bodies seem to be directly charged with the commitment of introducing local communities to the potentials of cyberspace and planning, by displaying, and often also explaining, the revolutionary meanings of activities, such as online retrieval, manipulation, editing, and interactive upload of each one's own informative experience to a common spatial database [33]. In many cases, municipal web sites show an important effort for the diffusion of the culture of digital geography and information and thus of cyber and shared planning [41].

These can be considered the necessary steps toward the construction of what might now be termed “informational digital heritage,” the personal endowment communities actually leave to their future generations.

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