Interactive Visualization Tool for brownfield redevelopment - A European experience

SiTI
Istituto Superiore sui
Sistemi Territoriali per l'Innovazione

QUADERNI DI SiTI

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Compagnia di San Paolo

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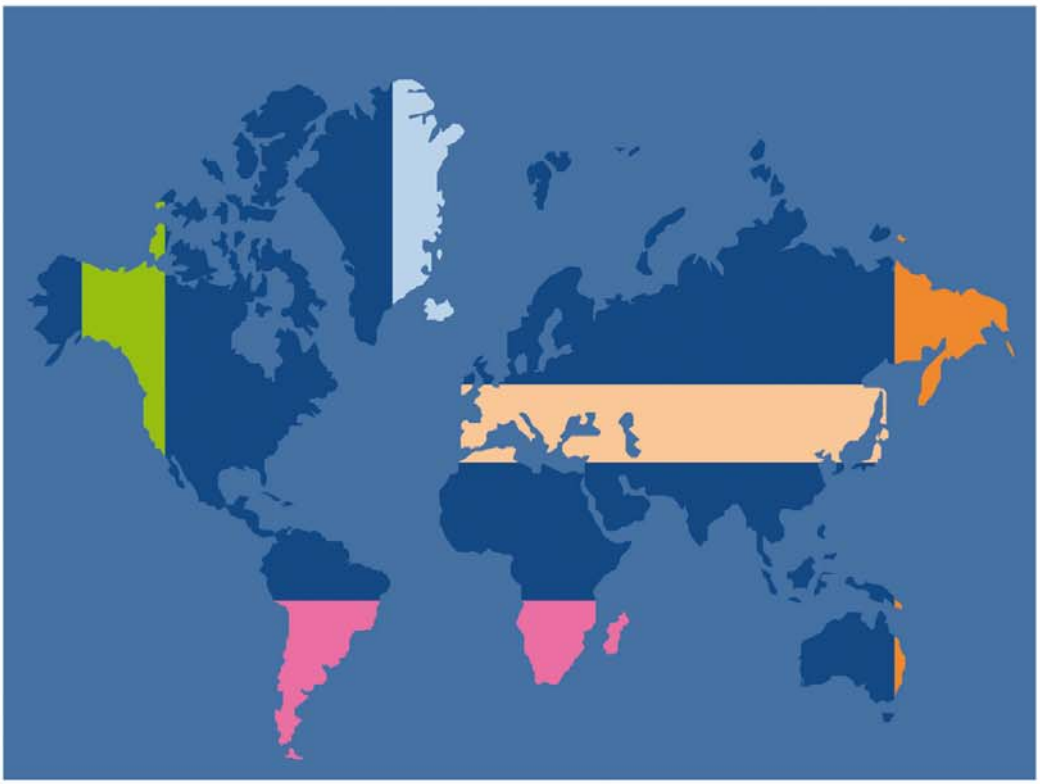
## A European experience



Editors: **Elena Masala, Giulia Melis**

Celid


Istituto Superiore sui
Sistemi Territoriali per l'Innovazione

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*diretti da* Riccardo Roscelli

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## A European experience

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# Foreword

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Massive urban sprawl, the current economic crisis and the effects of the demographic change in Europe lead to land use patterns neither competitive (e.g. in attracting viable economies, efficiently providing infrastructures) nor sustainable. Dispersed land use patterns, with their high demands of land and energy, accelerate the process of climate change. Furthermore, Central Europe's cities must face social (e.g. segregation and social tension), economic (e.g. unemployment) and environmental problems (e.g. pollution, noise, traffic congestion) related to urban development, and at the same time urban and planning policies have to cope with them. Another distinct consequence is the ongoing, unrestrained land-take and continued soil sealing all over Europe, often even in regions with shrinking populations.

These issues are transnational, with corporate developers either seeking opportunities to acquire sites in areas that pose least resistance to sustainable development principles, or wishing to champion its merits, requiring a standard process to benchmark, evaluate and reward sites across the EU.

Many Central European cities have been developed (or are quickly going to develop) into regional agglomerations, but planning methods, institutional structures and the associated management tools have not progressed fast enough to cope with the increasing scale, interconnectivity and complexity this growth has generated. It is claimed that the ''traditional'' planning visions still applied can no longer deliver integrated planning for modern cities facing the demographic development and the integration of the need to respond to climate change.

An integrated approach for land use management characterized by the inclusion of public and private stakeholders in Central European regions is still missing. Existing local, regional, national and European instruments did not succeed in solving this process in the past and have even had adverse impacts on the former accession states by the dislocation of public grants (ERDF) on non-viable greenfield sites. The problem is specifically relevant to regional and local authorities dealing with land management and the allocation of European and regional funding and investments.

The project 'Circular flow land use management' (from here on referred as CircUse) contributes to reduce the use of new green spaces for urban development. It is consistent with the Gothenburg Agenda (2001) priority objective: sustainable management of

natural and environmental resources. CircUse approach supports, in a sustainable way, the long-term objectives of the EU Sustainable Development Strategy (2006, reviewed 2009), namely the action to limit climate change and increase the use of clean energy. The pilot actions implemented support the reduction of greenhouse gas emissions through the limitation of transport due to a circular use of areas in city centres instead of letting urban sprawl develop. Biomass production solutions in pilot cases contribute to increase the use of clean energy. These sustainable initiatives are fully compliant with the Agenda's steps towards Sustainable Europe[1]: their consistency is assured by actions supporting sustainable development and contributing to environmental conservation.

The "Leipzig Territorial Agenda on Sustainable European Cities" initiative, which promotes integrated strategies for urban development, supports the Lisbon Strategy by high quality in the fields of urban design, architecture and environment. Integrated urban development policy was defined as a process where the spatial, sectorial and temporal aspects of key areas of urban policy are co-ordinated.

CircUse strongly supports the Urban Dimension in Community Policies recognizing the importance of land re-development for social and economic reasons, ensuring these do not compromise the natural environment. The CircUse system will provide member states with a transnationally-developed tool to improve sustainable land use. This aims at improving the governance of urban interventions, through the commitment of all the parties concerned, to ensure effective planning as the basis for the coherent financial interventions of ERDF mainstream funding.

This volume aims at presenting the results achieved by the CircUse project in proposing new tools for urban planning on brownfield sites. An overview on the CircUse philosophy, as developed in the 3 years of cooperation between 10 partners representing Central Europe regions, and a more in-depth introduction to InViTo, a spatial decision support system developed by the colleagues from SiTI, our scientific partner in the project, is given in the following pages.

An added value of interregional cooperation in the CircUse project can be recognized in efforts for making regions more competitive and regional policy more effective by creating an efficient model of land management, and here is a contribution to this objective, hoping to represent a small step forward in this direction.

[1] For further information see http://ec.europa.eu/environment/eussd/.

# Introduction

**Giulia Melis** - Istituto Superiore sui Sistemi Territoriali per l'Innovazione (SiTI), Torino, Italy

*A point has been reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences. Through ignorance or indifference we can do massive and irreversible harm to the earthly environment on which our life and wellbeing depend. Conversely, through fuller knowledge and wiser action, we can achieve for ourselves and our posterity a better life in an environment more in keeping with human needs and hopes. There are broad vistas for the enhancement of environmental quality and the creation of a good life. What is needed is an enthusiastic but calm state of mind and intense but orderly work. For the purpose of attaining freedom in the world of nature, man must use knowledge to build, in collaboration with nature, a better environment.* (Declaration of the United Nations Conference on the Human Environment, Stockholm 1972, Paragraph 6)

## 1. Preamble

As already expected in 1972 by the United Nations Conference on the Human Environment, "we see around us growing evidence of man-made harm in many regions of the earth: dangerous levels of pollution in water, air, earth and living beings; major and undesirable disturbances to the ecological balance of the biosphere; destruction and depletion of irreplaceable resources; and gross deficiencies, harmful to the physical, mental and social health of man, in the man-made environment, particularly in the living and working environment" (Paragraph 3). It is clear nowadays that the uncontrolled and booming industrial development which occurred in the last century, is today delivering a large amount of dismissed areas with contamination problems, mainly inside the urban area, thus exposing the resident population to dangerous substances.

We are now facing deindustrialization, a long-term process which since the 1980s has started driving us towards a new post-industrial management paradigm, characterized by globalization and the rapid increasing of the tertiary sector, and whose effects are made nowadays more visible due to the economic crisis.

The result is that in our cities – considering the European context – there are various brownfields and abandoned sites waiting for reconversion to new uses: many of them have been reclaimed and reused since the '90s, but a lot more, especially those presenting contamination problems and those located in economically disadvantaged areas, are

still waiting for revitalization. The first chapter of this book wants to offer an overview on the general and most common problems and challenges presented by the presence of brownfield areas in urbanized contexts.

## 2. The CircUse project

CircUse, acronym for Circular flow land use management, is a project developed within the Central Europe Program, co-financed with European Regional Development Funds (ERDF): it involved 12 project partners and 3 associated partners from 6 countries.

All the represented regions are confronted with similar problems, the most relevant of which can be summarized in massive urban sprawl, the current economic crisis, the effects of demographic change. These factors cause unfavourable land use patterns which are neither competitive nor sustainable. Dispersed land use patterns, with their high demands of land, soil and energy, accelerate the process and the impacts of climate change.

In the frame of the project the concept of "circular flow land use management", presented in Chapter II, and especially the pilot projects in the 6 involved regions, have tried to demonstrate how the above identified problems can be solved. The concept of CircUse represents an integrative policy and governance approach which presupposes a changed land use philosophy with regard to land utilization. CircUse has specifically contributed to the objective of integrated development strategies and investments by providing a viable framework, action plans and pilot projects on land use management as preconditions for private investments, which have been tested on the selected pilot projects.

The CircUse approach aims at overcoming several problems of spatial and urban development emerged in the transformation of Central European cities and regions, as the loss of a number of historical industries, military conversion, inner-areas segregation, migration and demographic change. The development of regular integrated action plans on sustainable land management and the realization of projects demonstrating practical solutions by local and regional stakeholders are important for Central European regions. Therefore partners of CircUse will work on this new circular flow land use management concept consistently with the implementation of instruments and pilot actions.

CircUse will also be strongly influenced by the goal of creating climate beneficial land use structures: this could be achieved either passively, decreasing energy consumption by traffic or natural soil protection, or actively, by incorporating energy production systems in temporal or final land use options for brownfield areas. Instruments to reach the goal are being provided by the concept of circular land use management as an integrative policy and governance approach, and are presented as a result of the project.

One of the most important benefits from the CircUse project is the platform for the mutual exchange of transferable knowledge based on authentic experiences in circular land use management in different contexts in the project partner countries. Although the European Union is characterized by different land-use management and planning cultures and systems, the approximation processes in the EU, globalisation of the market and environmental problems open the space for the mutual exchange of know-how and the joint development of efficient approaches to the problems connected with the safeguard of the social, economic and environmental sustainability in spatial development. This can be of special importance at the European level, as the EU enlargement increased their diversity, as well as the diversity of geographic and economic preconditions and of the urban structure development.

In comparison with other spheres of governance activities, land-use management includes a number of influencing factors differing from country to country, and from locality to locality: starting with nature preconditions, continuing by historical development, spatial and social aspects and ending by existing development strategies, human, financial and other available resources. These facts frame different approaches both to land management and land re-use, and offer an opportunity of transferring of innovative approaches, representing a best practice in each country, region and locality. Moreover, the overview of the land re-use management instruments in the frame of the CircUse project has already shown that the land-use management systems in different EU countries were influenced by the varying dominance of different dimensions of management approaches – architectural, spatial planning, urban design, townscape or building control –, with an overall lack of economic approaches, despite their growing importance in the context of the current global crisis. In this context the role of the EU programmes and of a proper definition of the framing preconditions for the eligibility on EU funding schemes seems to be one of the most important catalysing phenomena in land re-use.

This book presents, together with some theoretical insights, the contribution developed within the CircUse project by the Italian technical partner: an innovative tool supporting decision-making processes has been tested and refined thank to the application on the Asti case study, and it is now ready to be used in different contexts.

## 3. Structure of the book

The book is divided into three sections. The first one gives an overview on the concept of brownfields under different points of view, trying to frame the problem by progressively focussing from wide to local scale: Chapter 1 gives a look at the European level, Chapter 2 links it to the philosophy of reuse developed in the CircUse project, while Chapters 3 and 4 present Italian experiences in brownfield management, with some reflections and a case study.

After explaining the concept of brownfield, the second part of the book presents the conceptual instruments that could be used to help the process of brownfield redevelopment, having defined which are the major problems and challenges affecting the decision process. Thus Chapter 5 gives an overview on the state of the art for planning support systems, tracking their evolution and use in recent years. Chapter 6 guides the reader into their application to urban issues, explaining why they became fundamental for understanding the city in its complexity. Chapter 7 analyses the meaning and the power of visualisation tools in the communication process, by deepening the meaning of the image, and showing how it is produced, intended, and then received and reinterpreted by the end user, pointing out strengths and weaknesses we should pay attention to when dealing with this means. Chapter 8 presents the InViTo tool and its features, the steps behind its settings, the applications tested so far and the results achieved.

Eventually, the third part of the book relates about the process that SiTI has been developing in the framework of the CircUse project, by describing the calibration of the visualisation tool called InViTo, and the results of its application to a case study carried out in the Municipality of Asti. SiTI and Asti were both involved in the CircUse project, respectively as technical and institutional partner. Thus Chapter 9 presents the context of the pilot action, describing the Asti territory, the issues that have characterized its history in recent years, and the general situation of its brownfields, also giving information

on how the Municipality has faced the participation to a European project relying on its organizational structure. Chapter 10 is intended to introduce the consultation process carried out to set InViTo parameters, which involved several stakeholders representing different views and needs inside the urban context, who were interviewed in order to gather and synthetize the relative weights of the variables included in the application of the tool to the selected pilot area (a former industry with heavy ground contamination). The last chapter, then, shows the results of the application of InViTo to the Way Assauto pilot area: a series of maps at different scales – from the level of the city, undertaking some possible major-impact infrastructure realizations (such as the ring bypass or the improvement of local public transport), to the area level, displaying different impacts linked to the new use suggested for the brownfield – are commented. The tool aims at assessing the compatibility of a given use of the brownfield area with the needs of the city around it: how it would affect the present situation and interact with it, in order to suggest the most beneficial solution.

*Acknowledgements*

This book is the result of 3 years of work in the framework of the CircUse project. A special acknowledgement goes to every partner of the project, which actively contributed to these results, even if not directly participating in the book, and specially to Anna Starzewska-Sikorska, who successfully coordinated the project.

SECTION I

# Brownfields and reuse

1.

# Brownfields as a common problem in Europe

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## Abstract

This chapter handles the issue of the underused or vacant urbanized land, commonly known as brownfields. It introduces a shared definition of brownfield at European level and it deals with problems connected with brownfields emergence, recognition, monitoring and identification. It identifies the connection between sustainable use of soil and reuse of brownfields, and discusses which elements limit and which ones promote brownfield reuse chances. Lastly it looks into governance conditions that can support their reuse.

*Keywords*: brownfields; land use management; urban land recycling; urban sprawl; underused urbanized land.

## 1. Brownfields definition and recognition

The concept of brownfield may vary from one European country to another, and in most EU countries there is no exact definition of what it is. During the years 2005-2007 the EU project called CABERNET (2006) gave a definition now generally accepted within the European area. According to this definition, brownfields are sites that:

- are affected by the former uses of the site and of the surrounding areas;
- are derelict and underused;
- may have real or perceived contamination problems;
- are located mainly in developed urban areas;
- require an intervention to bring them back to fruitful use.

The European Environment Agency (EEA) has recently estimated that "there are as many as three million brownfield sites across Europe, often located and well connected within urban boundaries and as such offering a competitive alternative to greenfield investments". It also stated that "unfortunately, no common legislation at European level for the sustainable use of soil resources has been adopted. Thus, there is a lack of impetus for a coherent approach for remedial soil protection, for a harmonised inventory of potentially contaminated sites and how to regenerate them efficiently. Another distinct consequence

is the on-going, unrestrained land-take and continued soil sealing all over Europe, often even in regions with shrinking populations" (Bartke, 2013).

The decision of classifying a plot of land as brownfield is subjective and qualitative, usually made by experts. The perception of what a brownfield is, however, is also connected to the local urban and economic qualitative development standards.

Additionally, how to deal with brownfield sites is a question that involves various sectors – for example spatial and strategic planning, property development, industrial development or environmental remediation. These sectorial interests, together with a general absence of reliable and comparative data and the lack of know-how at national, regional and local levels compromise a full recognition of the brownfield issues and often that of the threats they pose to local communities, while their potential contribution to sustainable soil use of communities is also not considered.

Over the last 50 years the European area has been affected by globalization, with new economic trends and social transitions which have fast led to social, political and lifestyle changes. All these trends in our communities have also brought about changes in spatial development and land use patterns. Changes have caused the downsizing of local industries, a reduction of armies, amendments in our methods of farming. They have influenced our usage of railways, have dismantled a lot of our national institutions, and so on. On the other hand, the growth of road transport, the new services, information, knowledge-based and creative industries, in conjunction with the transformation of our urban lifestyle needs have created significant pressures for new developments. But all these changes have also brought about an ever increasing 'consumption' of previously un-built land (forestry, agricultural or natural land).

These and other factors relating to the use of soil have in some instances caused a vast new suburbanization, whereas elsewhere in existing built-up areas, they have created large volumes of vacant, underused or brownfield land. In urban quality terms, on the one side these dynamics of land use have resulted in dereliction, but, on the other side, in new developments with high quality standards. But overall, these changes have also left to many of our communities a significant legacy of brownfield sites, a loss of natural or agricultural land and a limited land use economy.

All countries and regions have a percentage of brownfield sites. This is a natural market-driven occurence, similar for example to unemployment levels. Low levels of unemployment are normal and good for the labour market, while high levels cause problems. Something similar is applicable to brownfields. Some regions have relatively few brownfields that markets can easily absorb and reuse, but other regions may be threatened by an unusually high number of brownfields, which may be superfluous to the real-estate market. Even a single brownfield site can have a detrimental effect on its surroundings, and if there are too many brownfields in a community, they can seriously compromise its development potential and its competitiveness.

For many EU communities brownfields emergence was, or still is, a new issue, the complexity of which has not been fully perceived, and the economic, social and environmental effects of which have not been fully understood. In some European countries brownfield reuse policies and redevelopment techniques have been successfully practiced for more than 40 years. In other countries, this is still an emerging subject. This is the reason why sharing knowledge and experience on brownfield reuse is so important in the European context.

For the same reason brownfields have been a concern of European policies since the late '80s. Initially brownfields were mainly located in regions of traditional industries and

mineral extraction locations where crisis, production losses and population changes created hundreds of hectares of sites previously urbanized, but now underused or vacant. These sites were often in areas of low market demand and most of them were perceived to have development risks, which deterred private investors.

BOX 1 – *Brownfields and the New EU member states*

The relevance of brownfield matters was accelerated by the integration of the new Central and Eastern European states into the EU. In these countries, the social and system changes of the 1990s installed democracy and market economy, but they also made necessary a fast adaptation of their governance formats, as well as changes to their legal systems, amendments to their production or security patterns and the remodelling of many of their social processes and relationships. Furthermore, prior to their EU membership, these countries also had to absorb a large amount of EU directives into their legal frameworks, which were already in rapid evolution. For a number of questions covering the accession agenda, the candidate states received ample technical assistance from their EU peers. But there was no EU technical assistance concerning soil use management, spatial planning or urban development skills, because these are all under direct national responsibility. And at that time, being busy with the accession process, these candidate states failed to address their national, regional and local urban development issues correctly. The changes in society and economy, combined with an absence of land use management and of planning and urban development skills, prevented these states, their regions and communities to be able to cope with the free market situation. One of the outcomes was also a vast amount of underused brownfield lands in the candidate states, emerged at the beginning of the third millennium. Meanwhile (especially in the fast growing regions), greenfield developments have sprung in ever increasing number.

Upon joining the EU, these countries have been forced to compete on the same footing with much more sophisticated planning, land use and urban management processes of the 'old' EU member states. After the year 2000, the EU candidate states had access to the EU Instrument for Structural Policies for Pre-Accession (ISPA). But the ISPA funding priorities had no urban dimension, and therefore sustainable urban land use – such as the reuse of brownfields – could not easily obtain EU funding support. Local support for brownfields reuse was then problematic as well. This was mainly because of the local knowledge gaps in the land use management skills and also due to the fact that brownfields as such were not a 'recognised' planning issue and so they were not presented as national/regional priorities in several national and EU development support programs.

In the new member states the lack of development know-how combined with governance principles of subsidiarity and uncoordinated local planning tasks rapidly worsened the sustainable use of soil in many local communities. Often, local governments considered increases in urbanized land (not necessarily matched by population increases) as signs of local growth. This caused a large loss of agricultural, natural and forest land in favour of new building sites, produced unsustainable practices of urbanized land use and increased costs of development externalities. Such trends also reduced the local, regional and national competitiveness when these mounting costs of externalities entered the production cost chain. Today the loss of soil environmental services due to such urbanization is still insufficiently valued or compensated, and land as public good is not being well protected at national and especially at regional level.

Within the European area, the issue of brownfield reuse was initially approached as a problem of contamination and industrial development. Only at the beginning of the millennium it has started to be perceived mainly as a question of project management, development and planning, which may influence entire communities. But around 2007, the brownfield issue was put into the soil use context, and since 2010 it has always been included in the scope of land-use management. It is gradually being realized that more complex and integrated solutions are needed to steer and encourage brownfield reuse. Today, brownfields are still a problem in most European countries and regions. As an indicator of the on-going regeneration of the European economy, the rate of brownfields

remains still on a high level and the current economic and financial crisis has led to important new questions, including the emergence of new brownfields from the commerce, housing and tourist sectors (Bartke, 2013). The financial crisis has fundamentally changed the environment for private and public strategies for redevelopment, and brownfield reuse is very sensitive to the real-estate market situation.

## 2. Sustainable land use and brownfields

Conversions for urbanization are often carried out in an unsustainable way. An expansion of urbanized areas often takes sprawling forms, which are not always based on population growth. There are losses of arable land and biodiversity. There are concerns for food security and rising costs of infrastructure due to urban sprawl[1]. For many years spatial planning has been considered by many as the main land-use management tool for local authorities. Then other factors, such as market influence, personal preferences, demographic changes, new investment formats, funding availability, etc. demonstrated that planning itself is not enough to guarantee sustainable soil uses. It is becoming obvious that it is necessary to employ more suitable and integrated techniques of land use management, focused on reusing already urbanized areas. Re-using urban brownfields is socially, economically, environmentally and culturally important for the development of our cities and regions – and it is also a valuable alternative to urban sprawl.

For various reasons, land use sustainability has been neglected for a long time by most national and EU policies and regulations. We have only recently seen the emerging of guide principles (inspired by the EEA dataset on soil sealing at EU level[2], for example), which are gradually making their way into the national legal frameworks, policies, strategies and, above all, into wider practices of land use management. Land use sustainability for a long time remained outside the EU regulation and policy focus and even when they started to develop environmental policies or strategies (soil thematic strategy for example), they could not quite reach it because this issue fully falls under national responsibility. But over the last 10 years the EEA informal data gathering and various EU projects, as Corine Land Cover just to mention one, focused on soil use have helped to promote the sustainability issue. Even the INSPIRE directive is now pushing the EU member states to produce different public and comparable data sets. This is not only expanding the IT and GIS skills across the EU, but it is also increasing countries and regions interest in land use monitoring techniques. A similar effect is seen by various EU urban development orientated projects, where one can see an increased interest in the use of urban audits, peer group evaluations and the emergence of several urban development indicators. All this could help promote urbanized land recycling and this would also have a direct impact on more sustainable practices of land use.

The new user-friendly IT technologies make sustainable land use management and monitoring easily accessible to larger municipalities and to regional levels. At these levels suitable tools, inducements and promoting measures (in support of brownfield reuse and sustainable land use management) could produce the best results. However, such tools

[1] On these issues, interesting articles can be found at ZEF (Zentrum für Entwicklungsforschung - Center for Development Research, University of Bonn) website: http://www.zef.de/zefhome.html. Accessed June 19, 2013.

[2] EEA – European Environmental Agency, http://www.eea.europa.eu/data-and-maps/data/eea-fast-track-service-precursor-on-land-monitoring-degree-of-soil-sealing-100m-1. Dataset created November 13, 2009, published January 26, 2010, last modified August 5, 2013.

need to be very simple and very user-friendly, so that they can be used directly by the local decision makers and land management administrators. Sustainable land use management principles have to be introduced down to regional and local levels, where key decisions are made.

BOX 2: *CABERNET findings on land use sustainability*

CABERNET was the 5th Research Framework Program project which has functioned as a European Expert Network on Brownfields; it was funded by the EC to examine land use problems from a multi-stakeholder perspective and as a result it has set out a number of key recommendations that relate to policy, good practice and research programs. Already in 2006 the CABERNET project report recognized that: "Land is a finite resource and Europe is not consistently managing its urban land in a sustainable way. Poor land use hinders sustainable urban regeneration. Not utilizing land to its full potential, in terms of its development options, is a lost opportunity". The CABERNET network also claimed that "brownfields are a land use problem caused by a failure of our historical land management strategies". CABERNET promoted sustainable land use and urban land recycling in preference to greenfield developments. Such goals can be achieved by concentrating and focusing on improvements in urbanized land use management that can lead to patterns of more sustainable use.

The importance of sustainable use (which already encourages urbanized land recycling and brownfield reuse) also needs to be understood by the public. Public in the EU has to be made aware of how expensive and damaging unsustainable practices are, and of what risks and social costs they represent. For an implementation of sustainable land use practices (such as urban land recycling and brownfield reuse) at local and regional levels, an honest, continuous and long lasting political support is needed. However, to achieve a full change in political and public perception for making more sustainable land use choices (to promote brownfield reuse and urbanized land recycling), a lot of advocacy and awareness would be required. Simultaneously, at many national levels, a final tuning of holes in individual member states legal frameworks and policies would be necessary. Such policies should also consider some land conversions compensation measures, which would help finance brownfield reuse in locations where their development is possible; or consider financing brownfield naturalization in locations where brownfields are superfluous to market needs. Soil use and urban land recycling are also critically important for creating sustainable and smarter cities where citizens enjoy shorter journeys to work, enjoy a high quality life and participate in cultural, leisure and retail activities. In Europe, polycentric urban patterns of high quality environment could quickly erode, if gaps between cities were simply filled in with sprawling developments. Reuse of brownfields and urbanized land recycling also offer some hope for containing the carbon footprint of our urbanized communities.

## 3. Visualising brownfields and advocating brownfield reuse

Though brownfields are a problem in most EU countries and despite the developing mapping and IT techniques, no consistent and comparable national data sets do exist[3] in many EU countries. Identification and recording of brownfields have to be carried out

[3] An exception is the UK, which has tracked and monitored its vacant and brownfield land for many years now and was therefore able, between the years 1990 and 2000, to reduce the greenfield uptake by $^{1}/_{4}$, when comparing to Germany (Schulze Baing, 2010).

by site surveys. This is an expensive process which, if it is going to be of any long term use, has to be regularly updated. At national level missing brownfields data can be in some cases supplemented by using available samples of regional brownfields data. But the detailed inventories of brownfields and other developable land (greenfield land for example) are of a prime importance for the land use management at local and regional levels.

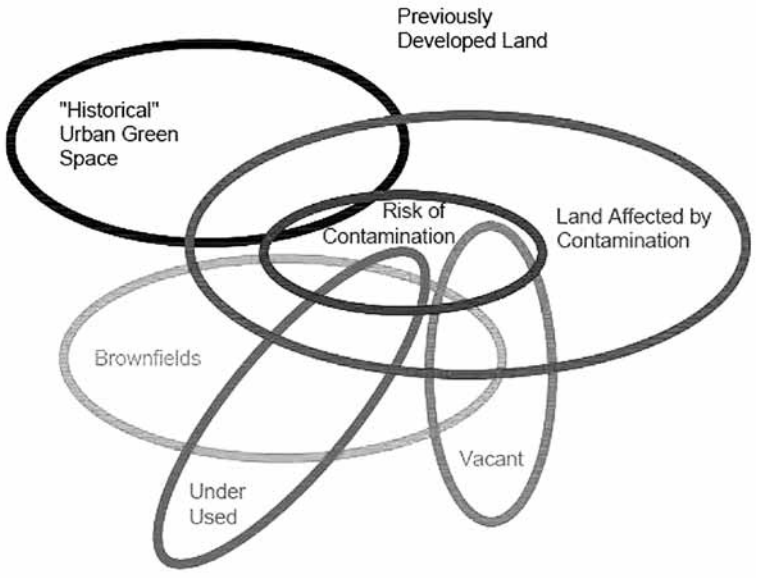


Figure 1.1. Model of Urbanized and Land use categories (Source: UK land use categories, elaborated for CABERNET, 2008).

Only with such data availability at regional and local levels it is possible to realize that large brownfield volumes and high levels of greenfield conversions cause serious sustainability problems. Only then sustainability measures (such as urbanized land recycling measures and brownfield reuse support) would penetrate into the regional and the local land use strategies, plans and decision making. Only then brownfield reuse priorities could be introduced and concrete measure identified (in some cases also necessitating some level of public intervention and support) and concrete coordinated actions could take place.

In the UK (fig. 1.1) and in Germany, data about national land use and brownfields have existed for many years. This is why in these countries also existed land use policies and targets. In many other EU countries, especially in the new member states, such data, policies or targets are still missing. But things are not that simple. Although at the beginning of the third millennium in Germany the aim was to reduce the land-take from 2030 to only 30 ha/day, the current German experience shows that data sets and national policies alone cannot lead to the desired land-take reductions and that more comprehensive efforts are necessary. German experience demonstrates that at local and regional levels, integrated and often creative non-formal approaches are needed in order to curb the local land-take.

On the other hand, the UK brownfield land reuse targets were set to build 65% of new housing on brownfield land. These targets were over-fulfilled, since finally up to 77% of new housing was constructed. This was achieved by imposing a strong policy, detailed land use monitoring and firm planning guidance. But recent reports indicate a swing in the UK soil use policy, from the brownfield reuse to more greenfield land deregulation.

This aims at increasing the housing land availability and, by doing so, at lowering prices for young first-time buyers. Hence it seems quite a difficult task to invoke successful, long lasting and effective land use sustainability measures, even in countries with a strong policy and governance tradition.

BOX 3: Czech brownfield data

Available data in the Czech Republic shows that 15 ha of farmland or natural land per day is becoming lost to urbanization, while large amounts of brownfields are still underused or have been totally unused for over a decade. The total volume of brownfield land in the Czech Republic is not actually known. The last national data evaluation was carried out about ten years ago and was based on a sample of a detailed regional brownfield data survey. In many Czech regions there are various incomparable data sets, also gathered by different agencies (for example the Ministry of industry or the Ministry of regional development etc.). Today a common methodology on how making brownfield data inventories does not yet exist. But since some national and regional data existed, the ERDF and other 2007-2013 sources of funding in the Czech Republic focused on brownfield reuse and urban regeneration. These programs recorded hectares of reused brownfields and a large number of regeneration projects. However, nobody in the Czech Republic actually knows the amount (in %) of the brownfield area reduction, or how many new brownfields occurred due to the recent financial crisis. This lack of data is critical especially at community level, where most planning decisions are taken. Most Czech communities do not have brownfield inventories (or they are not updated regularly) or they are following up the actual brownfield reuse dynamics. Communities which have updated brownfield inventories seldom analyse such data.

Usually Czech communities have plenty of data on transport, water, air pollution and so on, but they do not have any on their urbanized land use economy. They do not know how many brownfields they have, how much of their urbanized area is made up of brownfields, for how long their brownfields have been abandoned, or how much of their brownfield area was regenerated in a given year. They also do not evaluate what effect the plentiful and easily accessible greenfield land has on their brownfields, or what actual reuse potential (if any) their brownfields have.

The situation described in this BOX 3 however does not apply only to the Czech Republic, but is found in many other EU countries. But when comparing the Czech Republic to other Central and Eastern Europe member states, one can actually praise the Czech Republic for its brownfield know-how and support initiatives, which have flowered with the 2007-2013 various Structural funds priorities.

## 4. Brownfields and their many different chances for reuse

Not all brownfield sites have the same chances of reuse and so it is important, for the owners and the public administrators, to understand which category or type they are dealing with. During periods of economic crisis or in areas of low market demand and with problematic economic development, a reuse of brownfield sites may be nearly impossible because there are too many obstacles. On the other hand, when the economic situation improves, the brownfields in areas of high market and development pressures may have good chances of reuse. The 'brownfield reuse potential' gave origin to one of the most widely used categorization, promoted by the CABERNET project, where brownfields are classified according to their chance of being reused (fig. 1.2).

The key to brownfield sites regeneration is to identify new activities that can be located there. After that, the next question is: would this brownfield development be profitable? Which means – are the intended activities able to produce enough income to cover the costs of brownfield regeneration? And also – do they offer sufficient profit for redevelopment promoters and investors? If the answer is yes, then we are dealing with the 'A' site category. Otherwise, we are dealing with the 'B' site category. For a profitable

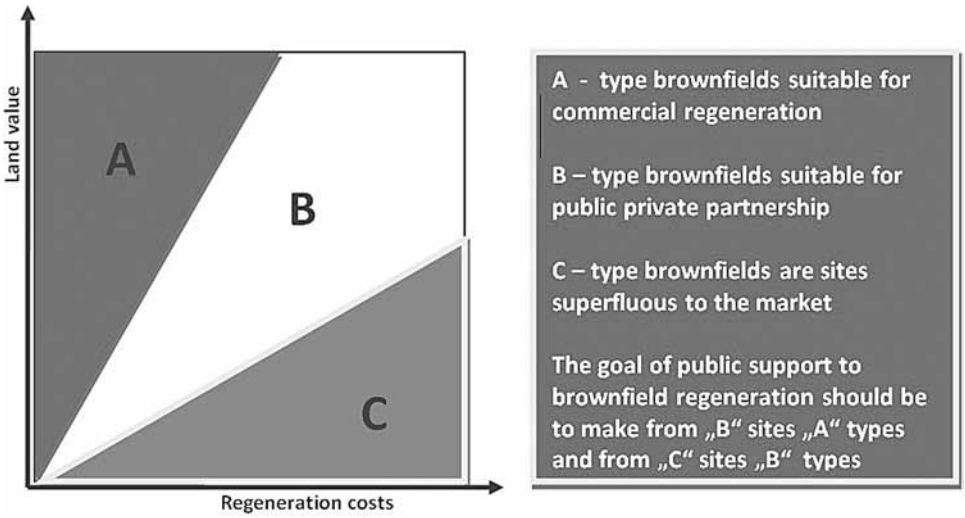


Figure 1.2. 'A', 'B', 'C' brownfield categorization (CABERNET, 2008).

reuse of any 'B' category site, some sort of intervention is needed, but it is necessary to balance carefully the benefits and costs that a reuse of such a site can have. If, however, it is not possible to foresee any actual activity for a site for a while (market has no interest and public-driven remediation is too expensive), we are dealing with the 'C' site category.

Brownfields usually start having a problem of reuse when there are obstacles to absorbing them back into new urban usage patterns. This may occur because there are too many brownfields on the market, or because of the competition of previously underdeveloped land, the greenfields. But it may also be due to the fact that the demand for development land is being affected by different economic performances of specific locations, or to a general market recession, which prevents any chances of reuse. During a protracted recession, the 'A', 'B' and 'C' categorization of brownfields may actually change for the worse. The following schemes (fig. 1.3) explain the influence of economic conditions upon brownfield sites.

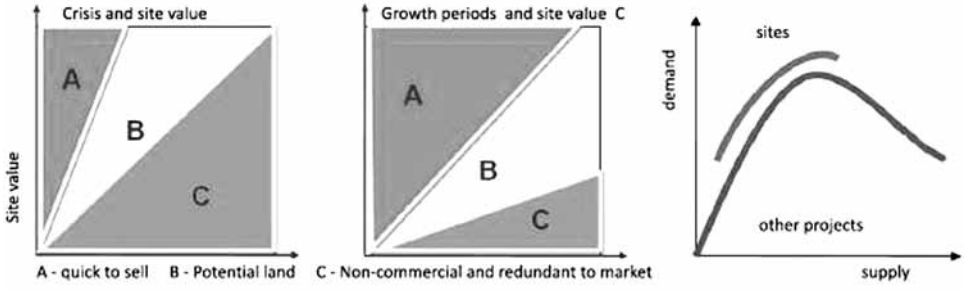


Figure 1.3. Effects of economic conditions on brownfield sites (CABERNET, 2008).

There are many other categorizations of brownfields depending on:

– their original use (industrial, institutional, military, agricultural, infrastructural, cultural, etc.);
– their size and their built up area (smaller, larger, the built up area index);

– reuse risks they represent (level of environmental pollution, etc.);
– their nuisance (e.g. brownfields located on access roads to communities reduce local development opportunities);
– other.

There are many barriers which may limit the reuse of brownfield sites; some of them are listed in the following table (tab. 1.1).

Table 1.1. Main barriers to brownfield reuse.

| Main barriers to brownfield reuse | Notes |
|---|---|
| Unfavourable economic and property market conditions | – The majority of brownfield regeneration is being carried out by private investors.<br>– Market perception (of the investors and also of potential users or tenants) of brownfield reuse is not very good.<br>– Global and local market conditions directly affect the rate at which brownfield projects are regenerated (on rising market periods regeneration is attractive, while during recession periods it is too risky). |
| Unsuitable legal framework and badly focused policies, strategies and plans | – General conditions for brownfield redevelopment are set up by the public sector on a national, regional or local level.<br>– If national legal framework or policies are not suitable, brownfield reuse barriers are higher, resulting in higher redevelopment risks.<br>– If the land use and planning regulation does not exist or is not suitable and flexible in changing land use typology when needed, activities and their investments are more easily addressed to greenfields. |
| Redevelopment barriers | – Not enough activities located on brownfield sites.<br>– Non-commercial and badly accessible location.<br>– Too large and complex sites.<br>– Lack of site ownership integrity.<br>– Serious contamination. |
| Owners´ and investors´ level of development experience | – Brownfield regeneration is a complex process requiring high levels of stakeholders´ cooperation and competency for creating multidisciplinary development teams.<br>– If investors, consultants or local authorities do not possess such skills, development risks and usually costs also may rise, resulting in project financing complications.<br>– Leadership, vision and advanced management techniques are necessary, especially when planning the redevelopment of large 'B' category sites. |
| Private interest and motivation | – Owners' position and their ability to act.<br>– Owners´ interest in brownfield regeneration is important and their interest can be either:<br>  – active: maximizing profits, reducing ownership risks, reducing liability or potential financial commitments, promoting brownfield reuse, forming partnerships with other owners supporting a common project, etc.<br>  – or passive: speculative purchase, attitude of no responsibility, limited know-how and finance availability, limited ability to act, etc. |

| Main barriers to brownfield reuse | Notes |
|---|---|
| Level of community interest and motivation | – Community interest in urbanized land use sustainability is crucial.<br>– Community needs to know how much brownfield land is there in their neighbourhood and what category of brownfield it is.<br>– In low market location and in recession periods, community administration needs to help owners both in marketing brownfield reuse opportunities and with brownfield project preparation (planning, informal advice, etc.) |
| When market conditions are suitable, brownfield projects are not readily available | – Brownfield project preparations are more expensive and take longer time.<br>– Brownfield project preparations are often affected by economic cycles. At first signs of recession brownfield projects cease and only when a development recovery period has been well established, investors´ interest in brownfield projects is renewed. |
| Availability and accessibility of funding sources | – Brownfield loan finance is more expensive to cover the increased development risks. This affects funding (costs and availability of loans).<br>– Grants or programme inducements, etc.<br>– Funding especially established for planning, project and design phases of brownfield redevelopment.<br>– Compensation measure funding (funding which allows, for example, naturalization of unwanted brownfield presenting public health risks). |
| Competition of greenfield sites | – Local authorities deregulate undeveloped land for development without considering the inner amount of development potential within their already urbanized land.<br>– Development on greenfield sites is easier and presents fewer risks for investors.<br>– Compensatory measures for greenfield land take are too weak or not in place at all: this makes greenfield land cheaper and readily available.<br>– Availability and easiness of development mean crucial competition to brownfield site reuse. |

The actual size of a brownfield may also determine its reuse potential. Generally, smaller 'A' and 'B' sites have much more chances of being reused or redeveloped than larger ones. This is because development risks and complexities on smaller, well located sites are usually much lower and this enables the private capital to invest in their re-development. On larger sites, even if well located, development risks may be too high and guarantees for a profitable regeneration too low – so private financing would decline to act. Larger size brownfields may have other problems:

– their ownership (too many owners, unclear ownership, unknown tenants, etc.);
– technical complexities (structural and ground conditions, demolition costs, contamination, etc.);
– wrong planning (unsuitable land uses);
– wrong image (the site is perceived in a negative way);
– communication problems with numerous stakeholders.

The reuse of any large brownfield site must be preceded by a clear redevelopment vision and it also needs a strong leadership and broad stakeholders´ participation. Such regenerations are usually very complex projects and as such they require a previous development experience and a large multi-professional team. This applies especially to

the regeneration of large 'B' category sites, where, in addition to the above, a strong presence and some kind of intervention by the public sector is required. Such a public intervention can be realized in different ways, but usually the most efficient is to establish a development partnership between private and public sectors, which helps to attract activities and create bankable projects (i.e. with sufficient and certain profit for banks to lend money to investors) – in order to transform 'B' type sites in 'A' type ones. Providing better information on brownfield sites lowers the obstacles to their development and adds to their value.

Brownfield reuse can be approached with several methods, depending on many circumstances. Some results of brownfield site regeneration (which may imply land use changes, partial or total demolition and new construction) are reconstruction, new properties, new look, and new uses. On the other hand the site revitalization outcome is a site where risks have been removed, existing properties revitalised and new uses found. Brownfield naturalization and temporary use techniques are usually applied in the areas of low market demand. The temporary reuse techniques can help to raise public awareness and investors' interest. They often help to remove sites' negative image and/or gain public acceptance for their reuse and they can also preserve these sites for development or remove them from the developable land market for a limited period. On the other hand the naturalization techniques bring brownfield sites back to their natural uses and the sites stop being developable land. Such a naturalization technique can be used as a compensation measure for the greenfield land take in areas of strong development pressures. This, however, requires reliable and updated data on land use, at local level or at least on the NUTS[4] scale. As indicated in the previous paragraphs, the actual potential for reuse of any brownfield site depends on its category ('A', 'B', 'C'), on its location, on the economic conditions and on the state of the real estate market.

## 5. Brownfields and their governance

The national levels usually provide legal frameworks and tools for regulating urban development processes. But the real implementation of urban development on the ground is in the hands of local authorities, and within the EU there are different national approaches and local examples of how to deal with urban regeneration and development. Levels of development powers of local authorities and their legal or budgetary independence may somewhat vary among the EU states, as well as the sophistication of each national or regional regulatory system and of the urban management and development skills that individual local authorities may possess. Even the level of understanding and the abilities of local development stakeholders (institutions, financing bodies, consultants, developers, etc.) could be different and, lastly, also the actual state of local markets and of local economic, demographic and social conditions that test the local government competencies in 'governance'. But despite all these differences, the principles of successful urban governance are usually the same.

The powers of jurisdiction of the local government, its responsibilities and duties in the field of local development are generally clear. But there are many areas where the development issues overlap with the jurisdiction boundaries, stakeholders´ interest varies or the solutions and the leadership of particular issues are being moved from the local

[4] Nomenclature of Territorial Units for Statistics, NUTS, for French *Nomenclature des unités territoriales statistiques*.

government level to a different one. Brownfields are very often an issue whose impacts or solutions are reaching above local jurisdiction. Where the 'jurisdiction *status quo*' and the current legal framework create barriers, more cooperative, informal or contractual ways of addressing those issues are required. That is where the 'governance principles' come in. Governance processes are generally more participatory and address solutions without depending on the departmental responsibilities or other jurisdiction boundaries. Competent urban governance can have a significant influence on handling communities' urban development and regeneration.

It can be documented that the quality of local governance and of local authorities' leadership (especially where difficult circumstances are present) are in most instances the main deciding forces that drive local urban regeneration. Governance success can be further enhanced by invoking a wide public interest in local regeneration processes and by a broad stakeholders´ participation and involvement in local redevelopment. Urban governance skills are usually reflected in the local ability to manage and steer local development processes, to attract and coordinate private and public interests and investments and to provide high quality public domain with ample benefits. The quality of local urban governance involvement in regeneration and development, however, depends on many factors:

– urban investments are carried out by various private or public bodies;
– financing is controlled by private institutions or public grant programs;
– technical and legal implementations are governed by the local legal framework.

But without an effective and committed local governance and a strong local leadership, the end result of brownfield reuse is usually insufficient.

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2.

# CircUse approach towards sustainable land use management

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## Abstract

Circular flow land use management is an innovative approach for the reduction of land consumption by a limitation of zoning of new greenfields and the mobilization of formerly used land potentials. This new management approach requires action on a cross-sectoral basis and the involvement of many stakeholders in the process. A wide variety of instruments must be used in combination with one another to reach a sustainable level of land use, including fiscal, economic, regulatory and planning tools. This chapter highlights targets, land types, fields of activity, instruments and the role of mobilization of brownfields.

*Keywords*: circular flow land use management; land types; brownfield redevelopment; planning.

## 1. Philosophy and principles of Circular flow land use management: an introduction

Circular flow land use management – the point of origin for the Central Europe project CircUse – embodies a different philosophy of land use, expressed by the motto: 'avoid-recycle-compensate'. This management approach accepts the use of greenfield sites under specific conditions, but primarily and systematically seeks to utilise the potential of all existing built sites (Federal Office for Building and Regional Planning, 2006).

Circular flow land use management also intends to provide an integrated political and governance approach which includes the entire spectrum of the policy areas and fields of activity relevant for land management.

a) Zoning new greenfields (to be minimized)
b) Rejection of land not suitable for subsequent use
c) Activating land potentials (to be strengthened)
   - brownfields (industrial, commercial, military)
   - gaps between buildings in internal areas
   - urban renewal sites
   - sites undergoing planning

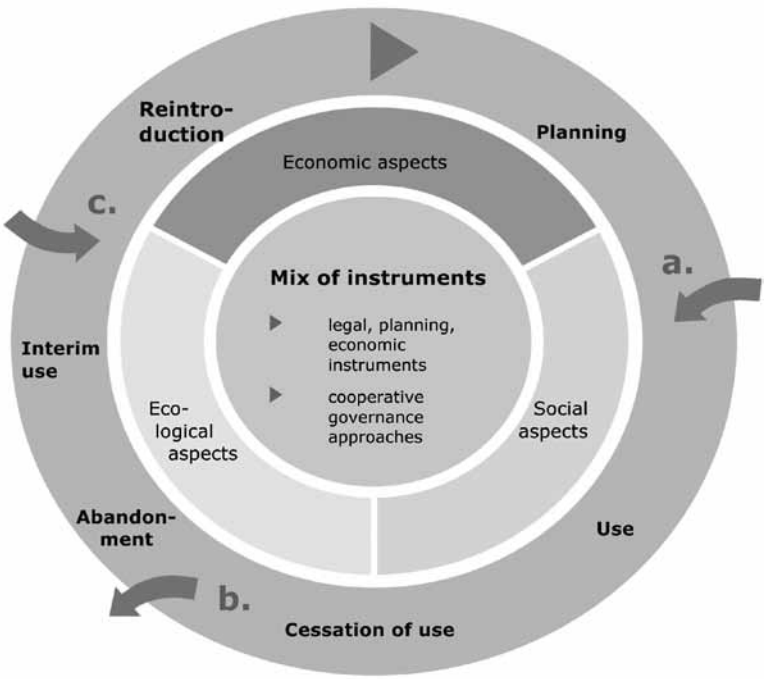


Figure 2.1. Circular flow land use management: phases, potentials and instruments (Federal Office for Building and Regional Planning, 2006).

This approach is implemented at both local and regional level and combines these in an integrated urban and regional land development policy. The cycle relies on the interplay between strategies in different fields of activity and on a suitably comprehensive deployment of tools (instrument mix) in these areas. These areas include planning, land information, cooperation, organisation and management, investment and support programmes, marketing and legislation (fig. 2.1).

Similar to the recycling-based principles which have become commonplace in recent years in areas such as waste and water management, 'circular flow land use management' should become an established policy for sustainable land utilization. Material cycles serve as a model for circular land use management: the constructed city is understood as a system with a structural makeup which is subject to various usage phases and where, in certain instances, entire districts and industrial areas are dismantled and made suitable for subsequent use. During this process, the total area of land used should remain the same. Structures no longer fit for reuse are demolished or re-naturalised. Infill measures are implemented in areas regardless of growing, stable or shrinking population conditions. The idea of a 'circular flow' of land use thus seizes upon the notion of a use cycle in the allocation of building land, development, use, abandonment and reuse.

A circular flow land use management requires action on a cross-sectorial basis and the involvement of various public and private stakeholders. This includes municipal policymakers, the various local administrative departments (e.g. urban planning, environment, business development, real estate), regional planning departments, businesses, business development associations, developers, estate agents, large property owners, banks, planning offices, environmental and nature conservancy associations, committees made up of members of civil society (fig. 2.2).

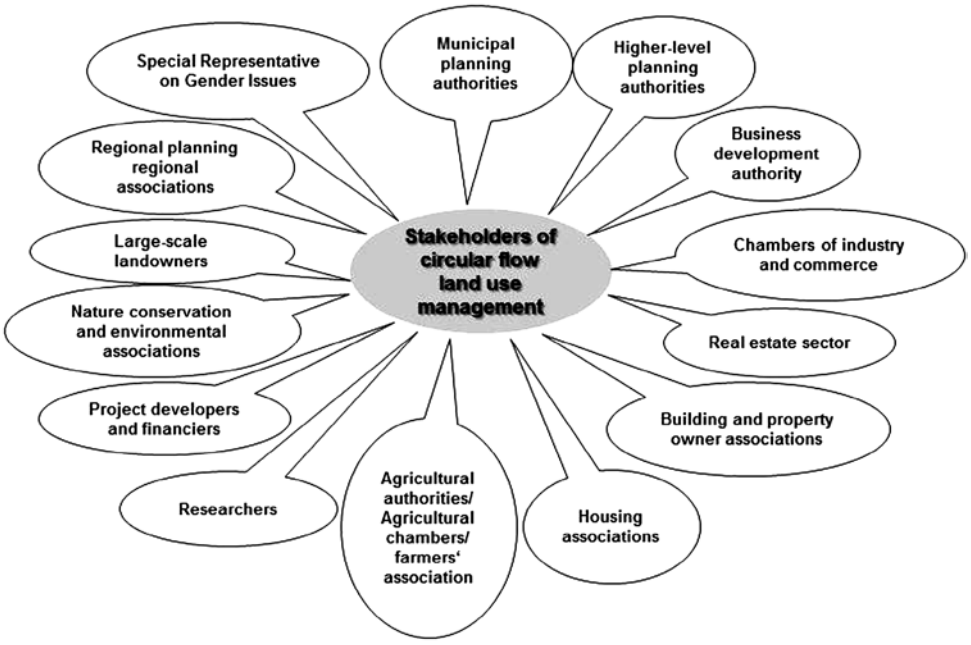


Figure 2.2. Stakeholders of a circular flow land use management, based on research findings in Germany (Preuß, Ferber, 2008).

The CircUse approach presents a holistic adaptation of land use management that aims at enhancing social, environmental and economic sustainability. To achieve it, work has to be done in various fields of activity, as described before. But the question remains, how can this best be carried out in the differing contexts of different nations, regions and municipalities?

## 2. Targets of Circular flow land use management

The CircUse approach pursues quantitative and qualitative management goals which take the ecological, economic and social aspects of land use into account. This means pursuing the minimization of land used for building and transportation purposes on one side, and, on the other, a densification of the urban structure through infill, land recycling and raising density allotments with the goal of increasing the efficiency of use and economic productivity of built land.

There is a need to define set aims, before establishing a circular flow land use management system on a regional or local scale according to the specific area in question, when dealing with the issues of infill development or land take.

The European Thematic Strategy for Soil Protection aims at preventing further soil degradation and preserving its functions by acting on soil use and management patterns and restoring degraded soils (European Commission, 2006). Furthermore, the Leipzig Charter on Sustainable European Cities since 2007 has promoted integrated strategies for urban development by promoting high quality standards in urban design, architecture and environment (Leipzig Charter, 2007). The nations of Austria and Germany have set goals within their national strategies for sustainable development aiming for a reduction of land take and soil sealing (Austrian Federal Government, 2002; German Federal Government, 2002).

The circular flow land use management approach supports these types of decisions and approaches taken by transnational and national organisations.

## *3.* Fields of activity for Circular flow land use management

Implementing the strategic approach of circular flow land use management is complex. It can only be realised through the integrated application of instruments, tools and specific strategies in several different fields of activity. This new management approach requires action on a cross-sectorial basis and the involvement of many stakeholders in the process. A wide variety of instruments must be used in combination with one another to reach a sustainable level of land use, including fiscal, economic, regulatory and planning tools. The following paragraphs specify such fields of activity.

### 3.1 *Information*

Information is an important starting point to engage in circular flow land use management. Not only is information the basis for sustainable planning decisions, but it is also the first stepping stone for raising awareness of the economic, social and ecological consequences of the real estate investment decisions by businesses and private households.

For example, planners at the local level need to know about the amount of brownfield sites, gaps and underused land in the area and their specific characteristics. Furthermore, planners need to know about the amount of land zoned for future development as well as the future demands on the real estate market. This knowledge helps to assess the opportunities for internal development or 're-greening'. To get this information, appropriate tools for data collection and management are required. CircUse partners have developed a tool for land use management linked with a geographical information system (GIS).

### 3.2 *Planning*

National planning legislation is an important instrument because it sets the framework under which a regional and local action on circular flow land use management can take place. Throughout Europe, regions and municipalities develop legally binding plans or informal plans that influence the scope, location or nature of land uses at different spatial scales, ranging from entire regions, to neighbourhoods, to individual development sites. The CircUse pilot-regions' activities have made clear that a certain type of plan, the land use plan, can be a key contributing element to circular flow land use management. With land use plans it is possible to regulate, for instance, the type and amount of land use in relation to the demand for development and demographic needs.

Other plans consider the aspects of building site coverage or the implementation of measures intended to compensate for interventions. Planning instruments for urban renewal and redevelopment concepts in Germany are oriented to be integrative, implementation oriented and open to participation. Redevelopment and urban renewal instruments assist in occupying vacant buildings and eliminating functional deficits in districts where such problems are particularly concentrated.

Municipal council resolutions on land management policy could serve as statements of commitment on the part of a municipality or a group of municipalities. Despite the limited

obligation inherent in such resolutions, they have considerable potential to influence land use management decisions and to spur activity on existing building sites.

One key element of circular flow land management is to formulate quantitative limits on land consumption coupled with qualitative standards, such as minimum density requirements for new residential or commercial developments within regional (such as regional schemes) or local plans for land development. Here a regional approach to the implementation of circular flow land use management is favourable through the adoption of a land use plan agreed upon by the various municipalities involved (this requires inter-municipal planning to take place).

Informal plans can add important momentum to achieve sustainable land use. Informal plans can include the knowledge and perspectives of important stakeholders, as well as those of the general public, to help formulate the plan. Furthermore, planning authorities are free to include in the planning regulation aspects such as brownfield redevelopment, thus adopting a more integrate perspective that takes economic, social or ecological aspects into consideration, as well as to combine spatial development with other sectorial policies, e.g. biomass or other renewable energy production.

When it comes to the level of planning for individual sites, local planning procedures in various CircUse countries provide the local authorities with legal instruments (ordinances) to promote the 'recycling' of land. Local building orders oblige land owners to invest on certain municipal plots to help avoid speculation. Conversely, demolition orders can remove obstacles for new uses or re-naturalisation efforts.

### 3.3 *Financing*

One of the major challenges presented to circular flow land use management is the securing of adequate financing. At first glance, activating brownfields generally seems more expensive than developing greenfield sites. Actually, the individual features of the sites considered for development (e.g. soil contamination) and the local real estate market (determining land value) will influence each situation. One way to overcome this problem is by allocating public funds for developing such sites. Such funds already exist in some municipalities where the city or an affiliated land development organisation purchases problematic sites and invests in the site clearing, soil remediation and/or marketing of these plots.

Public programmes to fund investment on internal development opportunities such as brownfields, unused or underdeveloped lots are important in guiding private investors towards more sustainable investment choices. As the experiences from CircUse show, cities or regions often do not have the adequate funds to set up such funding programmes. Therefore, European, national or sub-national funding play an important role.

A higher level of efficiency with limited available public funding can be achieved by developing financial engineering mechanisms, such as the Urban Development Funds (UDF) initiated within the JESSICA program by the European Commission[1]. EU countries can choose to invest some of their allocated EU structural funds into revolving fund mechanisms to accelerate investment in Europe's urban areas. The revolving nature of the instruments means that the returns gained from investments are then reinvested in new urban development projects. Thus, public funds are recycled to continue creating more sustainable cities, increasing the impact made by EU and national public money[2].

[1] JESSICA - Joint European Support for Sustainable Investment in City Areas.
[2] See http://ec.europa.eu/regional_policy/thefunds/instruments/jessica_en.cfm#7.

### 3.4 *Marketing*

A specific set of marketing instruments is needed to support the development of abandoned sites and for higher densities. Circular flow land use management requires information from relevant authorities, property owners and real estate companies to develop adequate marketing schemes. Such information includes site characteristics, lot size, existing connection to the traffic circulation system, the amount of building coverage allowed on the site, ownership of the property, current and potential future uses for the site, as well as the designation given by planning documents. Web 2.0 offers new opportunities for the compilation of relevant information. One example is internet-based databases. These platforms can inform those involved in planning land use and can also serve as a marketing tool.

The activities of the public and real estate industry can help brownfields and gaps between buildings become marketable. Such activities include clarifying property ownership issues, drafting building laws, preparing sites for construction and resolving environmental contamination issues. The success of real estate marketing for the purposes of circular flow land use management depends on the marketability of existing sites in urban areas. This makes inner development potentials more successful when exposed to the market competition from new land zoned for development and demand behaviour.

### 3.5 *Organisation, management and cooperation*

Many different stakeholders must be involved to make circular flow land use management a reality. This includes groups such as policy makers, public administrators, property owners, investors, and many more. For example, many different departments have to contribute just within local administrations: the departments concerned with planning land use, those issuing building permits, those responsible for the acquisition and management of municipal land, even economic developers who market locations. This calls for new organisational approaches within public administration itself.

In addition, individual institutional solutions for land management on the local and regional level can be effective. Planning and land management activities of neighbouring municipalities are closely interrelated: strategies to restrict land use in one city can easily fail to meet their intended outcome if there is excessive land development down the road. For this reason, circular flow land use requires inter-municipal cooperation. Land use strategies should be discussed in a regional context. CircUse has developed organizational models for such collaborations.

CircUse has shown that local governments need adequate funds and resources to carry out all the activities associated with land recycling. In some countries the competencies regarding planning and land management have formally increased on the city and regional level, but the central government has lagged behind in providing matching resources. For this reason the municipalities are required to attempt to find the proper financial and personnel resources needed through new organisation, management and cooperation structures to support land recycling.

Land management is a main component of local government action as well as regional government action when the responsible authorities are present. CircUse has shown that cities and regions already advanced in terms of policy development for circular flow land use management need a management structure for its implementation. This includes

a management structure with defined competencies, a business agenda and a mission statement that match the strategies defined in regional circular flow land use action plans.

These tasks can be either fulfilled by an already existing or a newly established organisation. Both approaches have their advantages and disadvantages and have been tested in the CircUse project. In the City of Piekary in Poland, circular flow land use management objectives will be implemented through the existing Ekopark organisation. In the Austrian pilot region in the County of Styria, a new land management agency has been established. The CircUse experience highlights the need of innovative institutional solutions of circular land management on the inter-municipal and regional levels. These are to go beyond purely marketing or project-oriented approaches.

Since land use is mostly determined by private investment decisions, the implementation of sustainable land use needs to involve private real estate owners and investors. These parties not only can offer important experience, but also capital. The co-operation of private businesses and public entities through public-private partnership offers the possibility for strengthening the position of sustainable land consumption in strategic decision making and real estate investments.

### 3.6 *Awareness raising and training*

The issue of sustainable land use management is usually not very high ranked on the political agenda. In the past, new industrial areas or growing residential areas were seen as an indicator for growth and prosperity. New ideas are needed to raise awareness for the necessity of more sustainable methods of regulating land use. Businesses planning expansion or prospective house owners normally do not include aspects of land consumption as a decision criterion. Instead the opposite can be expected, as lower land prices in the outskirts or peripheral regions fuel the process of urban sprawl. This must be addressed through proper discussion and training.

The issue of sustainable land use first has to become an established topic. Unlike other issues of sustainability, such as climate change or the ageing of society, the issue of land consumption is not a broadly discussed issue. With a long term vision in mind, CircUse partners have developed and tested training materials on the issue of circular flow land use. These materials are tailored to target groups representing the present and future users of land: planning practitioners, professionals in the public and private sectors, and students in secondary schools (Preuß, Verbücheln, 2011).

Educating about the costs and follow-up costs presented by expansive settlement in relation to their profit in an urban context is another aspect of awareness raising for sustainable land use management. The players involved in urban development, namely public administrators, policy makers, real estate companies and even private households, should all be made aware about the 'actual costs' of different planning strategies and site selections. For example, the redevelopment of an inner city brownfield into a new residential area might be more expensive, in the short run, than building houses on former agricultural land in the outskirts. This is because the redevelopment of a brownfield site requires the removal of existing structures and soil remediation measures to be paid for.

However, the long term cost of a development located in the outskirts of the city may prove to be greater. This is because of the cost of creating and maintaining new infrastructure, plus the incurred transportation cost (carried usually by the individual, though this is also a matter of concern for public transportation), and other factors which tend to

accumulate over the years. Various tools and models for cost-benefit analysis (or follow-up cost analysis) have been developed with the stated goal of creating cost transparency for residential and commercial development (Preuß, 2009). Appropriate tools that can be used by professionals and the interested public at large are available in Germany (LEANkom, fokosbw, was-kostet-mein-baugebiet.de) and Austria (NIKK).

### 3.7 *Communication and participation*

The municipalities are an important – though not the most important – contact and communication partner for sustainable land management. It is the municipalities that primarily make decisions concerning the short- and long-term use of land.

Communication is an important aspect of circular flow land use management for two reasons. On the one hand, communication between the stakeholders involved in the decision and plan making processes is important on the local and regional levels. This involves individuals from the administrative, political, and general public realms. Here communication is an important component in supporting a successful implementation while applying instrumental innovations, legislative amendments and new plans and planning processes. Through communication, the different parties involved in the process can better understand the needs and motives of each other. Successful communication means working under the idea that each individual will approach the dialogue process with his or her own subjective experience in mind, and that shared goals and possibilities will emerge from mutual discussions. The effectiveness of this aspect of communication is strongly associated with the participation of the relevant stakeholders.

On the other hand, communication can help expose relevant target groups to the concept of sustainable land management. Therefore, the communication strategy should not only aim at a broad public campaign. The responsible players must be identified, primarily on the local and regional level of land-related decision making processes to systematically reach all relevant target groups that affect and modify land use. Since both land and land utilization are organized and influenced by numerous players with very different interests, an effective communication strategy would therefore address these highly diverse groups in a targeted manner. Regardless of whether the groups involved are citizens of different backgrounds, owners of smaller properties, or building owners or companies with their 'land policies', all of them pursue highly specific interests and must therefore be addressed to and/or motivated in the respective manner.

Participation is fundamental to all planning processes in an urban context, also for integrated action plans for city or urban region circular land use management. In general there are several levels of participation and possibility to influence decisions:

- informative public participation involves gathering information of interested parties about a proposition and its effects, like information meetings, hotlines, public hearings or the publication of plans;
- consultative public participation enables citizens to deliver their opinion on the presented suggestions, plans or decisions, as well as to produce their ideas, which have to be considered during the decision making process, such as during the development of a urban intervention concept;
- codetermination allows the concerned and interested parties to take part in the decision making process during the development of a proposition, its execution and implementation.

The involvement of all the concerned interests and a discursive approach are important factors for sustainable land use (to be included through workshops, expert forums, etc.). In the stricter sense of urban development law, e.g. the building act in Germany, public participation means the involvement of general citizens in the administrative planning procedure, especially on the municipal level (activities such as land use plan formation, legally binding land use plans, etc.). The CircUse experience shows that there is a need to go further than the formal procedures stated by participation law, and engage in additional informal procedures.

The same path of activities cannot be followed throughout the European scale, given the varying contexts of the regions and localities. Instead, the precise arrangement of activities and measures in these fields should be pooled according to regional differences in framework conditions, land use demands, land use management targets and the regional or local development dynamics.

## 4. Space oriented potential of circular flow land use management

Circular flow land use management strategy primarily and systematically seeks to exploit the potential to develop existing building sites and reuse derelict land. It focuses solely on internal development (recycling abandoned sites, higher density development, infill development, multiple use, etc.).

Circular flow land use management, therefore, aims at minimizing the rezoning of 'green belt' land (for development) and at activating existing building land, including, among other options, derelict land, gaps between buildings and exploiting possibilities for infill development (tab. 2.1).

Table 2.1. Expansion and internal development opportunities of land, based on terms and categories in Germany (Preuß, Ferber, 2008).

| | |
|---|---|
| Expansion opportunities (outlying land which has yet to be developed) | Theoretical development reserves with no (specific) planning status |
| | Regional planning reserves (anticipated building land – only in North Rhine-Westphalia) |
| | Preparatory land use plan reserves (building land awaiting development) |
| | Legally binding land use plan reserves which are fundamentally reclaimable (raw building land) |
| Internal development opportunities | Gaps between buildings (land prepared for building / building land) within the ambit of settlement-expanding legally binding land use plans |
| | Gaps between buildings within the ambit of legally binding land use plans using pre-existing developments and unplanned interior areas |
| | Scarcely developed lots / opportunities for infill |
| | Brownfields |
| | Vacant buildings |
| | Land which will be abandoned in the foreseeable future |

A comprehensive definition of land types has been developed according to the cycle orientated land management approach of the CircUse project. Land should be differentiated into the following types. These land typologies help to develop a common technical

data management solution on a EU level by the use of common area categories/types in the registration and monitoring of space oriented potentials of circular flow land use management (Otparlik *et al*., 2010).

### 4.1 *Greenfields with development perspectives*

A greenfield is a 'green' site within the scope of the preparatory land use planning in a spatially planned area. The perspective uses of these sites include new building zones for industrial, residential or commercial development. These areas are unique, as they were not previously developed upon. This means they are not connected to the infrastructural system of the city and, also, that they have natural soils undisturbed by human activity.

### 4.2 *Vacant or underused land*

Vacant or underused sites exhibit previous urban use. Some of these sites were demolished after usage, but some have retained their construction and are now simply underutilized. They are different to greenfields because they have already had development located on them, for example water plants, waste management systems, infrastructure for electricity, gas or district heating, street access and connections for public transport facilities. These sites may be located either in the inner city or on the periphery.

### 4.3 *Gaps in built-up areas*

Gaps are mostly smaller sites, which are suitable for construction in the existing urban structure, but remain underused or unused. These sites are usually included in development plans of the inner city districts or residential areas where they are most often located. These sites differ from greenfields both in their size (individual site instead of numerous sites bundled together), and in that they are, as a rule, fully developed. Other gaps are often found in industrial parks with existing infrastructure.

### 4.4 *Brownfields*

Brownfield sites are sites that have been affected by the former uses on and in the area. They are derelict or underused, but cannot be described as a gap because of the real or potential contamination problems associated with these sites. Brownfields are mainly situated in developed urban areas and require intervention to remediate them back into a usable condition. The category of brownfields can be further defined, based on the previous type of use, according to the following seven types:

- industrial brownfields (e.g. former mining, textile, steel plants);
- military brownfields (e.g. military facilities, including barracks and training areas);
- commercial (real estate) brownfields/'greyfields' (e.g. economically obsolescent or underused real estates and so called 'investment ruins');
- brownfields from infrastructure and traffic systems (e.g. former railway tracks, closed airports or harbours);
- residential brownfields (e.g. old buildings or prefabricated housing areas);
- cultural and social brownfields (e.g. former schools or leisure areas);
- agricultural brownfields (e.g. abandoned farms).

Each of these categories has its own characteristics and opportunities for future use. In addition to the type of land parcel being considered, the amount of space-oriented potentials differs from region to region, from municipality to municipality, and, in the cities themselves, from district to district. Factors that influence these discrepancies are the amount of vacant land due to abandoned industrial and military areas, the structure of the urban fabric, the migration processes at work and the demographic trends. Along with these factors, the chance for the reuse of inner development potentials also depends on the specific demand for housing and commercial uses in the area.

## 5. Mobilisation of brownfields as a partial strategy of circular flow land use management

Circular flow land use management aims at minimizing the rezoning of 'green belt' land (for development purposes) and at strengthening the reuse of the existing built land. Therefore the CircUse approach is to utilize, first among other options, derelict land, gaps between buildings and to exploit potentials for inner development. This is carried out through coordinated actions on, e.g., gaps between buildings, scarcely developed lots, brownfields, vacant buildings, land which will be abandoned in the foreseeable future, and through the re-densification of existing housing and commercial facilities. Circular flow land use management should:

- reduce the time land is left vacant or underutilised, and
- develop solutions for land difficult to regenerate (Preuß, Ferber, 2006).

The regeneration of brownfields plays a key role in reducing greenfield use. Land recycling is an important part of any land use management strategy. It constitutes a cyclic process encompassing planning, utilisation, cessation of use, abandonment and finally reintroduction (Federal Office for Building and Regional Planning, 2004, p. 7). The reactivation of brownfields as a part of this process is welcome not only from an environmental viewpoint, but also because it satisfies economic requirements (e.g. by avoiding investment in new infrastructure and optimising the use of existing infrastructure) and social needs (e.g. by contributing to a functional and social inclusion).

Mobilising the potential of brownfields in towns and cities is crucially dependent upon the initiative and commitment of both public and private stakeholders, who influence the real estate market through their activities, utilization preferences and intervention. In order to be effective, new strategies must not primarily rely on structural policy instruments (which make massive and unbalanced demands on public spending), or on highly specialised management instruments of general construction planning, as they have previously done. The issues of ever-shorter utilisation cycles, continuing abandonment of land in all regions of Germany and shrinking public budgets must be tackled differently, if broad expanses of derelict land are to be mobilized in future.

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3.
# Brownfields in Italy: approach and methodology

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**Abstract**

An overlook of urban regeneration seasons across Europe and Italy specifically is given in this chapter, as a response to the urgent need of rethinking cities from the inside, recovering degraded and abandoned areas and favouring new locations and neighbourhoods outside the historic town. Italian cities went through different approaches in the last 40 years, and a critical appraisal of these experiences is outlined, proposing a reflection on limitations and prospects.

*Keywords*: historic centre; redevelopment; instruments; policies; regulation.

## 1. Introduction

As in many European countries, in Italy brownfield reuse is part of a wider phenomenon of overall redesign of the city in the second half of the twentieth century. This is something that, after several practical, disciplinary and legislative developments, today is commonly called Urban Regeneration.

Indeed in Italy there are three main lines of action in the city:

- the recovery of historic centres, started in the late '60s;
- brownfield reuse, started in the late '80s;
- the restoring of public and private residential districts built between the '50s and the '70s, started in the last ten years.

These three lines agree with the necessity of rethinking cities from the inside, recovering degraded and abandoned areas and favouring new locations and neighbourhoods outside the historic town. What differentiate each area are its own social and physical conditions, the difficulties of intervention, and the opportunities and expectations they create and have created in stakeholders: public administrations, private operators, citizens.

The historic centres have emphasized the value of the cultural heritage represented by the architecture, monuments and public spaces of the city.

Brownfields forced everyone to face the question of the large empty spaces inside the city and to imagine new tasks and opportunities for economic and social development

(fig. 3.1). They offered the opportunity to fill in some gaps of the city of the twentieth century (utilities, green area, public spaces, etc.) and to start actions against soil waste before reaching a real awareness of the importance of the issue.

Figure 3.1. An example of a successful brownfield reconversion with economic and social feedback in a small town in Italy - Ex Jutificio in Piazzola sul Brenta (Padova) (Dragotto, 2012).

The '50s-'70s residential areas have drawn attention to the need to consider the city as a social space. The pursuit of answers and solutions to the physical and social crisis of whole neighbourhoods has brought out the mistakes made in the urban development of the last fifty years and is focusing the debate on the housing theme, not just as 'the problem of the house' but as a space of relationship, personality development and environmental well-being.

Each of these sectors has thus revealed different aspects of urban regeneration and has enhanced experts' toolbox and skills useful to elaborate complex projects and to rethink the role of cities in the social and economic development of all European countries. This paper is going to analyse the issue of brownfield reuse, pointing out its specific contribution to the notion of urban regeneration, to the fields where more effort is needed to improve projects and their realization, and finally to the sectors that may represent a new frontier.

## 2. Urban context in Italy

All over the world, the brownfield reuse issue is linked to the city evolution demand that has always balanced the expansion in new lands with practices of reuse and replacement of areas considered no longer functional. In Europe, and in particular in Italy, the city history is very ancient and there are numerous examples of transformations that took place by building on lands already built or used for other purposes.

Therefore cities have always regenerated themselves adapting their building and urban fabric to the requirements imposed by the social, economic, cultural and environmental evolution of the territory.

However, in the last decades of the twentieth century urban regeneration emerged as a totally new discipline linked to the deep transformations that occurred with the post war economic boom.

Between the '50s and the '70s the Italian city, which had become nearly the exclusive place of production and work, opposed to the rural space, rapidly grew around the new factories.

Over one third of the buildings existing today in Italy were built between 1946 and 1971. Between 1955 and 1971, nine million Italians were involved in internal migration, moving from the countryside to the city. This large concentration of activities and population in urban areas in those years was associated to a deep change in the relationship with soil use. With mass motorisation it was no more necessary to build the city in a compact way in order to move around on foot or by efficient public transport, and the new organization of food industry allowed agricultural land to break free from the duty of supplying the inhabitants of closer cities.

Without giving a detailed description of what happened, it is interesting to note that this period led to an enormous expansion of cities[1] that followed a pattern of low density and progressive weakening of the central area, which suffered from a significant loss of inhabitants and functions. An expansion model that in most cases met the house demand (a roof over one's head), without dealing efficiently with the overall quality of life of the new settlements (that registered a shortage of services for people and families, low standards of environmental quality, etc.) nor with their connection to central areas (no location of new settlements in line with the main axes of mobility, no adaptation of infrastructure, insufficient strengthening of public lines, etc.). It was a long season that led to a progressive impoverishment of the planning and implementation quality of the city, also because of a total lack of suitable coordination policies and tools.

In Italy this process, which affected all industrialized countries during the twentieth century, was very wide-ranging and extremely fast between the post war economic boom and the beginning of the first industrial crisis. In few decades, production and demographic transformations deeply changed urban systems, producing development but also some damages to the land (brownfield sites or deteriorated areas) and to the quality of life. Today it has to be noted that, as in other industrialized countries[2], our urban systems are suffering from a demographic and functional crisis, while peripheral areas (municipalities of the first and second belt) have not been able to take up the 'noble' features of the city.

Such 'evolution' of urban systems did not produce an improvement of historic urban centres' quality (social cohesion, services, chance of moving around on foot or by public transport), neither a shift of the 'centre' towards new areas in the city. Unfortunately the model of building expansion did not lead to the so-called 'expanded city', but rather to the decentralisation of the whole territory, forcing a growing mass of population to very expensive daily journeys, wasting time in the traffic instead of enjoying leisure time, family, culture, sport, social relationships, etc.

This represented an alarming waste of territorial resources, as long complained, but also a serious impoverishment of our social capital, which has always found in the cities,

[1] We refer here mainly to the province capitals where these events, despite differences of dimension, followed similar trends across the country, regardless of their geographical location.

[2] About this, it is remarkable the modernity of the publication by Jane Jacobs (1993 [1961]).

rich in services and social, economic and intellectual exchanges, the perfect place to draw up new lines of development for the whole society.

And while on the one hand we build Science Parks – in order to create workplaces full of daily exchanges between workers to encourage their creativity –, on the other hand we are witnessing the gradual dispersion of population in wider land, where convergence between people, intelligence, experience and creativity is increasingly entrusted to scheduling and long and expensive movements: in this way we are losing the natural and traditional character of the city (public space) as an exchanging place, while we are trying to recreate it in an artificial way. It was a kind of general 'distraction' that did not allow to develop housing policies on a large scale. The consequence is that, starting from 1971, city centres are constantly losing population in favour of the peripheral cities of the first, second and now third belt[3]. This trend is governed only by the market and by the cities of the belt that have been continuing to provide low cost building areas, whereas the provincial capitals started to talk about stopping land use.

In this context it is clear how today urban regeneration should be a priority in urban policies.

The 'failures' caused to the cities are now recognized as a social and economic problem that affects the stability of our nations. The urban regeneration operations (building on built areas) allow to use existing elements in order to promote the social capital reproduction of the urban centre and to rediscover its values:

- complexity of function and relationships within the area or its surroundings;
- internal or neighbouring infrastructures (roads, networks, utilities…);
- a community of reference to ask for support;
- an appropriate spatial scale.

## 3. Brownfields: a story in evolution

In Italy the issue of brownfields emerged strongly in the mid '80s, with the first great abandonment of industrial areas near to the city centre of the main Italian productive cities (fig. 3.2): some examples are Lingotto in Torino, Bicocca and Sesto San Giovanni Falck in Milano, Novoli in Firenze, Porto Marghera in Venezia and the Bagnoli steel plant in Napoli.

Figure 3.2. The former Arsenale, occupying a huge central area in Venezia, now converted to tertiary functions, preserving the historical value of the building (Giorgio Bombieri, Archivio della Comunicazione - Comune di Venezia, 2012).

[3] The data of the last decade indicate a demographic upturn of the provincial capitals, but it has to be noted that the new population is represented by immigrants, who offset the never stopped loss of local population, who find houses with greater quality and affordable costs in the belt areas.

Deindustrialization, together with the delocalisation of some services (slaughterhouses, wholesale markets, railway areas, hospitals, etc.), that had already started in the previous years, reinforced a process of public or collective function reorganization, which has not been completed yet.

From an administrative perspective, Municipalities – traditionally the main authorities for the territory management in Italy – were the first that had to respond to the brownfield issue as a structural problem. They collected the social and economic tensions of their population affected by the crisis, urban transformation demands by land owners and the expectations of inhabitants interested in a sustainable land reuse.

In the early '90s a number of positive elements acted in aid of local administrations:

- the launch of European projects dedicated to the the rebuilding of urban areas;
- the Italian Government's commitment in supporting complex programs of territorial transformation with their own funds;
- a vibrant administration period, following the introduction of the direct election of mayors.

The accession to European projects of several Italian cities (e.g. Urban programs) forced the Italian town planning culture to exchange views on some key concepts: the need to break with the practice of total public funding projects in order to enter into the rationale of planning and implementing the projects in partnership between public and private; the close link between EU financial contributions and the compliance of binding timelines for design, execution of works and cost reporting; the opportunity to elaborate projects based on the combination of social and economic functions able to reactivate entire urban sectors.

The action of the Italian Government, specifically through the so-called *CER – Comitato per l'Edilizia Residenziale del Ministero dei Lavori Pubblici* (a Ministerial committee for public housing) and the *Dicoter – Dipartimento per il Coordinamento dello Sviluppo del Territorio del Ministero delle Infrastrutture e dei Trasporti* (another Ministerial committee for coordinating territorial development under the infrastructural and transport domain) has moved in this direction. Through public tenders addressed directly to Municipalities, they funded the planning of complex programs, such as the *Programmi di Riqualificazione Urbana* (Urban Renewal Programs) or the *Contratti di Quartiere* (Neighbourhood Agreements), that characterized the 1990s and 2000s and encouraged the reorganization of the territory according to some main lines: the recovery of urban areas, the modernization of infrastructures, the renewal of residential neighbourhood, etc.

In the same years the introduction of the direct election of mayors in Italy brought new life into the local political and administrative class. Cities developed ambitious projects of social, economic and urban development, all focused on providing the population with more services, new residential areas and courageous visions of the role that each city should have in the territorial competition. Strategy Plans intervened in support of an integrated image of the strength of each city and their role in a local and national context and, in some cases, they helped to establish a long term, shared view of development.

Overall it was an extraordinary period that generated an important innovation in town planning and in the openness towards a codified relationship between the public and private sectors. A time in which brownfield reuse projects were a central comparison ground.

Even if not everything has proved 'efficient' and 'sufficient', this period encouraged:

– cities to go beyond the obstacles, by creating sophisticated projects whose importance is turning out as their long process is taking place;
– Regions[4] to undertake legislative and programming initiative to support urban regeneration;
– private promoters to organize their plans to meet the growing complexity of urban projects, often focused on brownfields;
– citizens to ask for participatory processes in redesigning the role and functions of brownfields, experienced as important urban areas to their daily lives.

In the same years both the population and the public administration expressed an increasing attention to environmental issues: the former by asking for green spaces, reduction of pollution sources and environmental protection; the latter by developing environmental regulations.

In particular, the entry into force of the first national standard for the regulation of land reclamation (DM 471/99)[5] had a strong impact on brownfield reuse programs started in the early '90s because it established a more structured practice for projects, forcing to a revision of both land reclamations started without a national regulation and the related urban and building projects (fig. 3.3).

Figure 3.3. A former industrial area in Turin, with heavy pollution problems, reclaimed and reconverted to public green space (Melis, 2012).

[4] In Italy legislative powers in urban planning are handled by Regions, whereas legislative powers in relation to environment protection are up to the National Government.

[5] Decreto Ministeriale 25 ottobre 1999, n. 471, *Regolamento recante criteri, procedure e modalità per la messa in sicurezza, la bonifica e il ripristino ambientale dei siti inquinati, ai sensi dell'articolo 17 del decreto legislativo 5 febbraio 1997, n. 22, e s.m.i.*

Many projects started in the '90s have gradually revealed a weighty limitation: they kept the urban and functional plans separated from the reclamation one.

Early projects of that time underestimated the technical difficulties (and therefore the costs) in the realization of urban functions (services, residences, parks, etc.) on brownfield lands because of the lack of awareness on the environmental problems accumulated under the soil of industrial, military or railway areas.

Today we cannot say we have overcome the problem yet, because many projects are still designed by separating the environmental issue from the urban one[6], but the experience is gradually leading to closer attention and better skills in problem management.

Still, thanks to a greater attention on environment, the local spatial plans of the provincial capitals developed during the 1990s and 2000s introduced rules limiting un-built land use, therefore promoting brownfield reuse. A further incentive to brownfield reuse came from the long positive period of the real estate market (1997-2007) that, at least on the more central (and better connected to the economic system and mobility network) areas, opened a season of great transformation projects mostly aimed at providing a function mix based on housing, commerce and the service sector.

From this point of view the consequences of the real estate market crisis started in 2008 have been extremely serious.

Among the elements of innovation arisen in these years of activity, there is also a considerable progress of private promoters, who are increasingly well organized in planning and management teams, and of financial instruments, that are more structured to support complex operations and to control business risks.

## 4. Limitations to be overcome and prospects

Brownfield reuse projects have overall had a positive development and, although slowly, they have been driven by a regulatory progression.

But there are still several problems to be solved.

Today we can say that on paper none of the operations on brownfields ignores urban regeneration issues, but we have to acknowledge that in some cases the transition to the implementation phase has revealed the fragility of the starting projects. Many of these in fact underestimated the difficulty in attracting and consolidating the programmed functions, and in solving structural problems of the area (from land reclamation to the lack of infrastructure). It is not enough to conceive commercial spaces, because, if they are not properly designed even in relation to the context, they will never be really full of activities. It is not enough to conceive spaces for services or public mobility connection if the number of users does not fit the forecasts. And it is not enough to think of placing production activities if local demand has not been carefully evaluated or if there is an excess of supply.

The successes and difficulties of brownfields reuse programs help us to understand the importance of starting projects' completeness. The failure to start several actions (or worse, the block of building sites already under construction) was often attributed to

[6] Here we refer to the special report n. 23/2013 *Le misure strutturali dell'UE hanno sostenuto con successo la riqualificazione dei siti industriali e militari dismessi?* This is the result of the analysis carried out by the Court of Auditors about the management of industrial and military sites rehabilitation by EU Member States, through a detailed study of the 27 sites that also benefited from funding from EU. The report considers the technical and environmental aspects, giving advice to Member States and EU Commission and bringing important innovations regarding the approach to environmental management.

external issues (new environmental regulations, market changes, delays of public administrations, etc.), but in many cases it would be fairer to admit the weakness of the initial projects, which failed with the early problems since they underestimated the complexity of the actual conditions, they did not carry out proper market research and/or they were managed by promoters not sufficiently professionalized.

To these assessments, begun about ten years ago, today we have to add the action of the crisis, which exposes real estate programs and spatial development to a very strict quality verification at different levels: the exact scheduling of the settled functions, the correspondence to the target of real demand, the balance of economic and financial plans.

A further interesting aspect pointed out by the crisis is the oversupply due to the boom in real estate, caused by a lack of management of territorial balances in relation to the real demand. Many cities today are simply overstocked with a supply without a demand (the tertiary sector is a typical example) and lacking in a number of things of real demand, first of all quality residential buildings at affordable prices.

The renewed focus on the city, its regeneration and the quality of targeted actions expressed in recent years by different actors (European Union, Government, Municipalities, Associations, entrepreneurs, etc.) suggest a consolidation of the above-mentioned virtuous processes. A good sign that now needs to be supported by verification tools for each project, by a greater attention to territorial scale programming and by a better organization of the administrative processes, which, because of their excessive bureaucratization and slowness, significantly penalize the implementation capacity.

A new era has started where public authorities and private stakeholders are asked to pay more attention to the overall quality of the brownfield reuse operations that should lead to the creation of new parts of city with a consistent and coherent mix of functions closely interwoven with the context. Such operations are probably more sophisticated, slower, less profitable and they require commitment of capable public administrations and skilled entrepreneurs, but they are also safer and more valid for the future of our cities[7].

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4.

# Redevelopment through temporary use: a successful experience in Torino

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## Abstract

Since the mid-late twentieth century, many European cities have had to manage deep economic and social transformations caused by the deindustrialization crisis. Over the past few decades the recovery of disused industrial sites has been the main driver of economic growth in urban areas. Today some successful experiences in other cities around the world lead us to consider the innovative potential of temporary use, in terms of environmental and social sustainability. This paper aims at fostering public discourse on strategies for temporary use as an emerging economic development and an urban design tool.

*Keywords*: temporary use; brownfield; creative city; urban practices.

## 1. Introduction

Temporary use strategies were born and developed in response to the decline of the industrial city. After the 1970s energy crisis, the removal and reduction of industrial capacity left behind an amazing amount of abandoned and decaying spaces. Discarded rail yards, former barracks and factories, unused slaughterhouses, schools, hangars and warehouses: the management of the abandoned industrial heritage represents today one of the most important challenges to the urban development of our cities (Pagliaro, 2010).

Waiting to find a new use, these spaces often remain vacant, and become places of degradation, discomfort and risk. The delay in redefining their destination has different causes, often related to environmental issues, the high costs of conversion projects and the inefficiency of the public administration.

Torino is the most industrious city in Italy and reflects this in a unique way. Its failing industry left a million square meters area vacant, with its associated urban decay. From the mid-'90s to 2006 Olympic Winter Games, major projects of urban transformation were developed thanks to national and transnational resources. In the current period of global economic crisis, traditional instruments of urban planning are increasingly unable to address the new demand. It is timely to explore new strategies, tools and models of actions.

Informal temporary use practices are starting to spread in Torino. This chapter presents the experience of *URBE Rigenerazione Urbana*, a non-profit cultural organization.

## 2. Aspira creative conversion factory: from experiment to experience

In the summer of 2011 a group of young architects, artists and cultural workers asked a private owner to use his abandoned factory for a couple of months, knowing that such a factory was bound to be demolished. Once settled there, the group created a so-called short-time 'pop-up' event (from the end of June to the 31st of July) and declared since the very beginning the date of expiration of the event itself. The former factory Aspira, in the heart of the Aurora neighborhood, was thus turned into the *WTC – War Trade Center*. The 1500 square-meter structure, waiting to be demolished and converted into modern lofts, became a place of artistic contamination, an independent collector of cultural events – photography, art, theater, architecture, design and music.

The characteristics of the space involved and the temporary duration of the initiative immediately matched the fleeting and intuitive character of street art, that soon became the cornerstone of the event through a festival/show called *SUB URB ART – Arte Urbana in Subbuglio* (Urban Art in Turmoil). More than 40 Italian and international artists took possession of the factory's walls and turned them into works of art.

Thanks to a spontaneous word of mouth, the initiative got at first a great audience success. Later it attracted the local web media, and some photographers and video makers started using the factory as a stage – or even the main subject – of their work. The festival eventually reached the major media: television and newspapers. Day by day the event grew and improved: the free access to the space, the new and unorthodox nature of the artistic experiment – which was taking place outside of the conventional path – and an easily accessible and low-cost bar service, all those elements caught the attention of several different targets. Youth, artists, and cultural workers, first; then families and neighbors (fig. 4.1).

Figure 4.1. A summer afternoon in the courtyard of the former factory Aspira (Goggio, 2011).

In a very short time the factory changed its face many times and developed different models of public use of the space. Its hybrid character – an art gallery as well as a workshop, a social network as well as a backyard – met two kinds of social needs: on the one hand, the need to experience togetherness and share a new cultural event, either as a performer or as part of the audience; on the other hand, the more personal and individual wish to restore a strong – even emotional – relationship with the physical space. In via Foggia 28 the audience has not only attended a summer festival, but has also actively participated in the creation of something new, a renovated sense of living the public space and taking care of it. As a matter of fact, the former factory Aspira, whose ownership was initially private, has gradually turned into a public 'square', an arena where confrontation and conflict took place, experiences were shared and social heterogeneity reigned.

The experience in via Foggia sent a clear message: a city can be transformed from grassroots, from spontaneous practices of participation. A new public dimension can be reinvented and the protagonists of such a change can really be the citizens.

The collective response to this first experiment of temporary use has pointed out the 'right to the city' as one of the most valuable human rights. In this case the right to the city has to be intended as the active right to create and recreate the existing city (Harvey, 2012), starting from the most basic levels, from those spaces left unattended for a long time. After all, the artistic scene of a city can be created and regenerated also in unconventional and non-institutional places.

The non-profit organisation *URBE Rigenerazione Urbana* was then founded at the end of the summer, to explore new temporary use strategies for vacant land. Since then *URBE* has drawn attention to the need to reactivate abandoned or underused spaces, instead of dismantling them or removing them from the urban environment. It has developed a model that sees reuse as an artistic experiment capable of transforming residual urban areas in breeding grounds of independent art and culture. Creativity can narrate the urban transformation, it can bring together new interested users for the disused building and foster interesting process of social and cultural integration.

*URBE* enhances the involvement of the private sector in the management and development process. It strongly believes that today private owners might be very interested in temporarily allocating their disused or underused spaces for cultural and social projects. In the absence of a real estate development, this could be a marketing promotional strategy. The Aspira former factory has been the key initiator of a series of temporary cultural projects of reuse in Torino: the character of such interventions is still temporary, flexible and low-cost, and the goal is to trigger a number of longer-lasting relationships and projects, including those already in action in the city at a higher level.

## 3. *Variante Bunker*: an alternative method of urban development

A year later, in June 2012, the cultural organization moved to the northern part of the city and found a new privately owned industrial site, partly abandoned and underused: the former SICMA spring factory (*Società Italiana Costruzione Molle e Affini*). The earliest records concerning this firm date back to 1919. In 1950 the ownership passed to the Hydroelectric Company of Piedmont (SIP) and from 1964 to 2007 to the ENEL group, the biggest energy and gas provider in Italy. Today it is an industrial complex, composed of a plurality of plants: an office building, three low warehouses and three factories, partially occupied by productive activities. Finally there is a large green area of about 5.000 square

meters (fig. 4.2). The site covers an area of 9.382 square meters and it is limited to the southern side by the former Scalo Vanchiglia, a 750.000 square meters rail yard, which had been closed and abandoned for decades.

The organization obtained the facility use permit from the present property owner, the Torino Quittengo Srl Company, and signed a contract of loan for temporary use for a period of three months (July-September 2012). The second temporary use project was titled *Bunker*, from the bomb shelter dating back to World War II, located in the area.

During those months, many artistic events took place there, confirming the new temporary function of the *Bunker*, from an underused factory to an important venue in the city's art and culture scene. Exhibitions, art installations, theatre and street performances, concerts, dj sets and an overwhelming public response have brought this portion of forgotten land to the attention of the city.

Figure 4.2. Plan of the Torino Quittengo industrial site (Google Maps, 2013).

But this was not all. The site is included in one of the major areas of transformation and urban renewal of the city of Torino. The *Variante 200*, a revision of Torino's urban plan crosses settlement, environment, urban and infrastructural aspects: the construction of the second subway line, rearranging the disused railway tracks, and the redevelopment of an area extending over more than one million square meters of abandoned industrial buildings. The former yard Scalo Vanchiglia and its vibrant urban context are undergoing a radical transformation. Barriera di Milano is a traditional working-class neighbourhood, whose original inhabitants, mostly immigrants from Southern Italy, today are aged over 60 and live together with new migrants experiencing a new, multicultural and conflictual mixed

community. Neighbourhood integration and social cohesion need time to get permanent. Such a big challenge needs a deeper reflection on the cultural and social change in this area.

In order to have a positive impact on the entire community, the transformation process should start from bottom-up strategies, implementing the urban vision by comparing different point of views and activating new social places to enable citizens to draw the city they want and to influence the decision-making process.

Starting from this, by invitation of and in collaboration with the property, who has been an active actor in the transformation process in these years, *URBE* started the *Variante Bunker* project. The implementation of the master plan will take several years to complete: the site will be partly demolished to accommodate new buildings and partly transferred to the City of Torino for the development of public services and roads. During this interval *Variante Bunker* will start a continuous but flexible process of reuse, capable of redefining and 'reinventing' itself in the long-term transformation.

*Variante Bunker* aims at speeding up the urban renewal process, introducing a sequence of *interim* programmes, in accordance with the purposes of *Variante 200*, as catalysts of urban development. By accompanying the transformation, *Bunker* becomes the testing ground for a number of different uses leading to a mixed-use development (retail, accommodation, service and artisan activities, offices and residences, hotels).

The temporary cultural use is the main field of action and research, further enhanced by the opening of a multi-functional space, used both as a temporary exhibition area and a performing art stage. *Bunker* presents and supports the production of talented young artists, providing the required workspaces, promoting the creation and medial distribution of cultural goods and services and activating educational programs, laboratories, workshops and festivals (figg. 4.3, 4.4).

Figure 4.3. Artist at work in the former factory SICMA, now *Bunker* (Goggio, 2012).

Figure 4.4. Artist at work in the former factory SICMA, now Bunker (Goggio, 2012).

Physycal activities and recreational sports (indoor and outdoor) will be implemented to meet the inadequate infrastructural facilities and the insufficiency of functional equipments of the neighbourhood.

Further activities will include the design and construction of non-conventional accommodation structures (mobile, flexible and temporary) within the project area, to offer hospitality to the artists involved in the cultural events and to activate an artist-in-residence programme. At the same time a temporary and versatile accomodation facility, open to the public, such as a hotel, a motel, a hostel or a guesthouse, could improve the tourist infrastructure in the area.

A role of primary importance is given to urban gardens (fig. 4.5), realized thanks to the support of ENEL company and divided into spaces designed for educational initiatives (in collaboration with schools and neighbourhood associations) and spaces designed for individuals and groups of citizens, with the possibility of direct sales at the local scale. A soil pollution survey assessed the environmental quality of the soil. Activating a project of urban farming (including both biodynamic agriculture and synergistic gardening) is an important opportunity to create a meeting place in a neighbourhood that suffers from a huge lack of green and public spaces.

*Bunker* aims at fostering socio-economic development of the neighbourhood by supporting the implementation of cultural programmes and by promoting local citizens' access to culture. The project encourages community interaction through collaborative activities that enhance cooperation and social cohesion (artistic and craft laboratories and workshops, exchange programs, urban gardens, informal trade, public lectures). An increased social capital and an encouraged civic engagement are essential ingredients to create spontaneous, bottom-up processes of redevelopment.

Figure 4.5. Citizens working in the urban gardens (Goggio, 2012).

## 4. Systematization of urban experiences: learning from practice

Informal social practices in urban settings (i.e. urban farming, street trading, guerrilla gardening, appropriation of public space and public infrastructure, gift economies, DIY techniques) show practical and innovative ways of inhabiting our cities. A new generation of young professionals, creative practitioners and activists, which is naturally open to inclusivity, horizontality, and networking, is already making clever use of urban conditions of life. It's time for decision makers and city professionals to consider alternative options to the established procedures of city planning.

Temporary re-use practices need to be systematized within a new approach of urban policies, aimed at limiting land consumption and supporting local communities in the self-organization of land and self-promotion of services.

In recent years some cities in Europe and around the world have begun to address the temporary re-use issue, by implementing public policies and promoting brownfield cleanup and revitalization.

In Italy the development of social and cultural projects in temporarily allocated lands is becoming part of the public agenda of some metropolitan areas.

Two years ago Regione Puglia in Southern Italy started an interesting public programme titled *Laboratori Urbani* (Urban laboratories), which aims at promoting a regional network of creative hubs, allocating with a loan-for-use formula several abandoned buildings owned by municipalities to local non-profit organizations working in the third sector.

In the North of Italy, Temporiuso is an association and a research project started in 2008, which is working with the Politecnico di Milano and the Department of Urban Planning of the City of Milano, in accordance with the Decentralization, Culture and State

Property Departments, to target empty, abandoned or under-utilized existing building stock and land, publicly and privately-owned, and re-activate them through cultural and associative projects, small businesses and handicraft start-ups, temporary dwelling for students and low cost tourism. All of this is regulated by temporary use price-controlled contracts.

Torino is trying to develop an 'institutional' model too. The city council is working on a project proposal called *Waiting for the future*, focused on unused spaces waiting for a new life, and aimed at filling the 'time gap' between the collapse of their former intended use and their new use. It is in this interval between old and new use, when there are no financial means for investment and when traditional, institutional procedures are too slow, that it is possible to experience temporary projects and activities (*ad interim* use), offering new scenarios of urban regeneration. The City will soon initiate a mapping process to spatially delineate available residual spaces and temporary users, in order to create a municipal database where supply and demand of temporary re-use can meet (Grimaldi, 2012). An open call will invite young professionals, designers, architects, artists, creative practitioners and activists to develop new ideas (infrastructures, services, actions and events) to recycle these spaces and offer temporary services to the community.

## 5. Conclusions

To animate and regenerate urban spaces that were lively before they became vacant spaces, abandoned or degraded areas where social conflicts can easily emerge, is a central theme in the definition of current urban and cultural policies. It is, as well, an interesting topic of experimentation for both social innovation and cultural enterprise. Thanks to their particular characteristics, such places – identified as low definition spaces – become informal, extensive and adaptable, a new resource for those who are in charge of determining policies, managing and promoting the wealth of a given area. These are unfinished, open, unresolved and non-defined spaces, which require minimal intervention to be occupied and used, even temporarily, and to originate hospitality and self-reproduction (Emanueli, 2007).

The transformation of these spaces in collective places that work from the social, the cultural, and the entertaining point of view enriches their fruition and helps to create a polycentric, open and inclusive city.

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All the pictures in this chapter taken by photographer Marcello Goggio are courtesy of *URBE Rigenerazione Urbana* non-profit cultural organization.

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SECTION II

# Decision Support Systems

5.

# Spatial decisional processes: evaluation tools and new challenges

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## Abstract

Sustainability assessments of territorial transformations refer to complex problems due to the presence of many interrelated factors, multiple and often conflicting objectives, high levels of uncertainty and a wealth of possible outcomes. In this context, growing interest has been raised by spatial multicriteria evaluation as a tool able to both generate and evaluate alternatives in a spatial domain. This chapter shows the contribution that this integrated approach could provide in the field of strategic decisions concerning territorial transformations, highlighting the potentialities of such tools as well as the challenges faced by this research field.

*Keywords:* Multicriteria Decision Aiding; Spatial Multicriteria Analysis; Geographic Information Systems; urban and territorial transformations; integrated assessment.

## 1. Introduction

In the last twenty years, no major European urban economy has remained untouched by voluntary or involuntary restructuring processes. Cities are systems in continuous transformation. Therefore, the novelty does not concern the fact that today they are subject to change, but rather the increased difficulty to prefigure future developments, as well as managing their effects.

Nowadays urban and territorial governance is characterized by the presence of actors who manage the city with often conflicting purposes, and by the presence of potentially disruptive factors (such as telematics innovation) able to lead to an urban reorganization hardly predictable. In addition to this, there is an increasing limitation of resources.

This increased complexity favours the adoption of new decision models able not only to assess, but also to design new transformation scenarios. The shift from a synoptic rationale to a rationale of the process inevitably has an impact on the assessment activity, changing the conditions and giving it an iterative and interactive role. To avoid the risk of non-governance, the integration of different stakeholders must be oriented to a learning perspective, exceeding the traditional practice of information and consultation (Pichat, 1995).

Moreover, contemporary decision-making requires a balance of environmental, societal, and economic factors in very complex combinations.

In this context, Multi Criteria Decision Aiding (MCDA) could be used to make a comparative assessment of alternative projects or heterogeneous measures (Roy, Bouyssou, 1993; Figueira *et al*., 2005). These methods allow several criteria to be simultaneously taken into account in a complex situation. They are designed to help Decision Makers (DMs) to integrate different options, which reflect the preferences of the involved actors, in a prospective or retrospective framework. Participation of the DMs in the process is a central part of the approach.

This chapter shows the contribution that MCDA, in combination with spatial analysis techniques, could provide in the field of strategic decisions concerning territorial transformation. Combining Multicriteria evaluation methods and spatial analysis allows to produce policy relevant information about spatial decision problems, and to achieve greater effectiveness and efficiency in the spatial decision-making process (Geneletti, Abdullah, 2009). The result of this integration is known in the literature as Spatial Multicriteria Analysis/ Evaluation or Multicriteria Spatial Decision Support System, and has created a powerful tool for spatial planning. This integrated approach consists of procedures that involve the utilization of geographical data, the decision maker's preferences and the manipulation of data and preferences according to specified decision rules.

The remainder of the chapter is organized as follows. Paragraph 2 explains the main reasons why there is a growing need to support decision-making processes in the urban and territorial transformation domain. Paragraph 3 introduces Multicriteria Decision Aiding methods, exploring the variety of tools that are available. Paragraph 4 provides the methodological background and the state of the art of the spatial Multicriteria Analysis integrated approach; finally, paragraph 5 summarizes the conclusions that can be drawn from the research.

## 2. Why assisting decision-making in urban and territorial transformations

Generally, in recent urban and territorial transformations we can observe a certain degree of determination by local administrations to carry on partial interventions as part of an overall strategic vision, often employing land development as an instrument for the funding of infrastructures and collective goods. In these cases, the administration does not only have a 'reactive' position towards the private offers, but it also acts as a promoter for the redevelopment of brownfields, so that the inherently delicate urban texture may find real reasons for its development, in contrast with the detrimental logics of pure exploitation of the land value (Lami, 2012).

But to develop a real overall strategic vision of the city, 'traditional instruments' to manage planning issues do not seem to be sufficient any more. The increasing need for assessment procedures integrated with visualisation tools has multiple reasons:

- the specific nature of the decision problem, covering the territory with all its peculiarities and its increasingly uncertain and increasingly wide boundaries;
- the transformation in the territorial governance, after the apparent failure of interventionist policies and, similarly, the replacement of the market by direct public intervention in order to restore the social *optimum* conditions which have had an uncertain outcome;
- the cities' status of public goods;
- the new requests of sustainability and urban quality in territorial transformations.

### 2.1 *Evanescent territorial boundaries*

The Napoleonic code had accustomed us to territorial divisions that were at the same time parsimonious, stable, uniform. But nowadays, in a situation of high institutional fragmentation in which government interventions are the result of inter-institutional agreements, the territory is continuously disassembled and reassembled according to the areas of intervention, the policies to manage or, simply, the convergences between institutions (Bobbio, 2004).

Today this is even truer, because, among the many consequences of European unification, there is one that takes on particular relevance for the management of territorial transformations: while national borders become increasingly blurred, interdependencies between cities grow enormously in importance. These interdependencies are developed in terms of both cooperation and competition: the process of European integration, while on the one hand encourages cities to cooperate in many fields of common interest, on the other hand causes them to compete for new development opportunities.

Such a dynamic scenario requires the territorial governance to be managed differently than in the past, in order to capture all the possible forms of cooperation, and gain the competitive advantage needed to participate with a prominent position in the construction of the Community area.

### 2.2 *New governance*

Land policies articulate themselves upon spatial divisions that almost never coincide with classic distributions. Paradoxically, while territorial boundaries are getting more evanescent and variable, the chances to represent and visualise the territory are becoming increasingly common. These instruments are now widely studied mainly because the government of the territory itself has changed, with the processes of governance tending (albeit in a non-linear way) towards increasing inclusiveness.

Recent experiences of territorial planning have clearly demonstrated the ineffectiveness of authoritative policies in achieving a social *optimum*. The three 'traditional' phases for developing territorial transformations (i.e., land acquisition, construction works and management operations) faced enormous difficulties in recent years and the result is an asymmetrical urban development. Procedural, organizing and financial troubles have systematically slowed down the realization process for the public city. The old conception of *dirigisme* that assumed the adaptation of various economic entities' behaviours, and, in the end, the adaptation of market itself to the plan have often proved unsuccessful.

A huge change is taking place in the role of Public Administration and, as a consequence, in the role played by the law. According to Micelli (2011), negotiation takes the place of coercion and imposition becomes agreement.

In Italy, any decision to draft a plan, to define a path of transport infrastructure or to choose the location of an 'undesirable service' requires an impressive amount of discussions, negotiations and arrangements. As soon as a problem arises, the first reaction from the Administration is to open a discussion table: public decisions are the result of a continuous process of negotiation and conclusion of agreements. But such negotiating tables can be of many types: technical or political, quick or interminable, efficient or purely formal. Transaction costs are growing out of proportion and they represent the main obstacle to the government of the territory. In a situation of high institutional and social fragmentation,

the veto powers are in fact multiplied. They do not refer only to the traditionally strong interests, but also to the traditionally weak ones (as long as concentrated). And the groups that are not involved in the decision-making process have the actual possibility to block the choices made by others, or at least to delay them. If governance processes are not sufficiently open and transparent, they run the serious risk of failing. For these reasons, the current coordination system of policies also requires "architects of process" (Bobbio, 2004).

### 2.3 *Cities as collective goods*

Cities can be seen as collective goods that are created and defined through both public and private investments and decisions. As a consequence, the economic value of the single parts of a city is not provided by individual activities, but by a collective action. In other words, synergies and externalities are possible in the physical surrounding areas where individual decisions used to take place (Camagni, 2008).

Urban quality is a public good and, under the pressure for territorial competitiveness, cities can develop specific urban policies oriented towards the production of urban quality. Nevertheless, due to the fact that urban quality is a complex public good, urban requalification projects are complex problems and *a priori* there is no certainty that all the cities will have the financial and cognitive resources for designing and affording urban requalification processes in an efficient way. Over the last few years, an approach to the regulation of spatial development based on trading punctual (and authorized) interventions of urban transformation has prevailed: the city is built up by projects. From the point of view of urban quality this approach is important for at least two reasons. First, because the formal quality of any single intervention directly affects the quality of urban life, generating effects on all the characters that define it. Secondarily, because urban development operations generate an increment in the value of the transformed capital, and this is often overlooked. A surplus value is thus created, which, through taxation, can represent a great source of revenue for the public administration. Most importantly, it constitutes a fundamental instrument for the regulation of the market economy. The urban-architectural and the socio-economic dimensions of urban redevelopment interventions have to be regulated (Calafati, 2010).

Some of the public choices made by administrations may feel like impositions to the citizenship and are often irreversible; this evaluation mechanism may then be helpful in stressing their importance and utility for the collective good.

### 2.4 *Urban quality and sustainable development*

Any urban and territorial transformation has to address a double perspective: the potentialities of the region development, and the satisfaction of the users' needs. Moreover, when speaking about urban and territorial transformations, it is necessary to face the problem under the 'sustainable development' point of view: this means to consider the full range of consequences (economic, social, physical) that could affect the territorial system and the local communities involved in the transformation. In this context, the decision-making process implies a selection among alternatives, which is made on the basis of the understanding of the possible choices and the criteria through which it is necessary to judge such choices. It is therefore important to detect some tools in order to be able to describe and to measure those aspects that constitute the framework within which the

decision-making process is progressively defined in a complex context. The difficulties in the process increase when the objectives are diverse and conflicting, when uncertainty subsists respect to the alternatives of intervention and to the criteria of evaluation, and, finally, when the decisional arenas include a large amount of stakeholders (Abastante *et al*., 2013).

Facing the presence of several subjects involved in the territorial transformations, there are two main requisites that the decision support tools should possess: being simple from a cognitive point of view and structuring the decision-making process in a transparent way.

## 3. Multicriteria Decision Aiding

Due to the fact that "decision is not an act but a process" (Zeleny, 1982), characterized by continuous learning, the decision process has to be seen as the result of a set of consecutive and interactive actions occurring at different times in order to distinguish what is a priority of what may be negligible.

Multiple Criteria Decision Aiding (MCDA) allows a learning process for the DM to be structured and makes her/him able to evaluate the full range of elements that constitutes the urban and territorial quality. In this context, a fundamental role is played by Public-Private Partnerships (PPP), which allow the transformations to be implemented and require appropriate evaluation tools and methods.

MCDA is particularly useful as a tool for sustainability assessment and urban and territorial planning, where a complex and inter-connected range of environmental, social and economic issues must be taken into consideration, and where objectives are often competing, making trade-offs unavoidable.

MCDA not only gives a toolbox, but also, a well-developed, overall methodology to support decision-making processes.

It has been generally agreed that when dealing with sustainability issues neither an economic reductionism nor an ecological one is possible. Since, in general, economic sustainability has an ecological cost and ecological sustainability has an economic cost, an integrative framework based on MCDA is needed for tackling sustainability issues properly (Munda, 2005).

From a methodological point of view, multicriteria problems are commonly categorized as continuous or discrete, depending on the domain of alternatives (Zanakis *et al*., 1998). Hwang and Yoon (1981) classify them as: (i) Multiple Attribute Decision Making (MADM) and (ii) Multiple Objective Decision Making (MODM). According to Zanakis *et al.* (1998), the former deals with a discrete, usually limited, number of pre-specified alternatives. The latter deals with variable decision values to be determined in a continuous or integer domain of infinite or large number of choices.

In the more general domain of decision aiding, a very recent classification of methods has been proposed by Tsoukiàs (2011), considering: 1) the comparison among the various alternatives (preferences or similarities); 2) the elaboration of preferential statements; 3) the possibility of considering negative preferential statements: according to the author, the three above mentioned classes cover the whole area of methods.

There are thus numerous approaches that all fall under the umbrella of MCDA, each involving different protocols for eliciting inputs, structures to represent them, algorithms to combine them, and processes to interpret and use formal results in actual advising or decision-making contexts (Huang *et al.,* 2011).

The method most frequently used for spatial decisional processes is the Analytical Hierarchy Process (AHP; Saaty, 1980). As a matter of fact, since the incorporation of the AHP calculation block in the IDRISI 3.2 software package, it has become much easier to apply this technique to solve spatial problems. Mention can also be made of some recent experimentation based on the integration between Geographic Information Systems (GIS) and the evolution of the AHP known as Analytic Network Process (ANP; Saaty, 2005), which is particularly suitable for dealing with complex decision problems characterized by interrelationships among the elements at stake (Ferretti, 2011; Ferretti, Pomarico, 2012; Lami *et al.,* 2011; Levy, 2005; Levy *et al*., 2007; Nekhay *et al*., 2009; Neaupane, Piantanakulchai, 2006; Pensa *et al.,* 2013).

Both methodologies facilitate the communication between public and private actors, through the participatory way of expressing evaluations by means of specific focus groups. Moreover, ANP has been applied in numerous applications concerning real word problems in the domain of territorial planning; the authors themselves tested the appropriateness of the technique when facing decisions in the context of infrastructural development and sustainability assessments of projects and plans at both the national and European level. In fact, the network structure of the ANP allows to take into account the interrelationships among the different elements of the decision problem. This is very important in spatial planning, where the urban and territorial quality is seen as a union of different 'landscapes' that represent parts of the city/territory as they are perceived by the people, who think about the city/territory as a whole and not as a sum of different physical elements (Abastante *et al.,* 2013).

As anticipated before, different MCDA methods are available for integration with GIS; the interested reader is referred to Malczewski (2006) and Ferretti (2012) for a detailed classification of the literature highlighting which techniques are more often combined with GIS.

### 3.1 *Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP)*

The AHP (Saaty, 1980) represents a theory of relative measurement on absolute scales of both tangible and intangible criteria, based both on the judgement of experts and on existing measurements and statistics needed to make a decision. The AHP provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions. From the methodological point of view, the development of an AHP model consists of the following phases:

– Structuring complexity. The first step consists in the hierarchical structuring of complexity into homogeneous clusters of factors.
– Measuring on a ratio scale. Priorities are first derived for the criteria in terms of their importance to achieve the goal, then for the performance of the alternatives on each criterion. In particular, priorities are derived through pairwise comparisons using a ratio scale of 1-9 to compare any two elements, translating qualitative variables in numerical values and vice-versa (tab. 5.1; Saaty, 1990). The choice of using a pairwise comparison method is due to the fact that the human mind is more confident in discerning when it can compares two elements respect to another. In complex decision problems, decision makers, even if experts, are often in trouble with the large amount

of data they have to manage. The process of decomposition of the problem in 2 by 2 elements helps DMs to make an informed choice (Saaty, 2005).

– Synthesizing. Finally, a weighting and adding process is used to obtain overall priorities for the alternatives as to how they contribute to the goal.

Table 5.1. Saaty's fundamental scale: numerical ratings associated with pairwise comparison (Saaty, 1990).

| Value | Definition | Explanation |
|---|---|---|
| 1 | Equally important | Two decision elements equally influence the parent decision element. |
| 3 | Moderately more important | One decision element is moderately more influential than the other. |
| 5 | Much more important | One decision element has more influence than the other. |
| 7 | Very much more important | One decision element has significantly more influence over the other. |
| 9 | Extremely more important | Difference between influences of the two decision elements is extremely significant. |
| 2, 4, 6, 8 | Intermediate judgment value | Judgment values between equally, moderately, much, very much and extremely. |

Thanks to the intuitiveness of the method, the AHP is widely applied. Nevertheless, it does have some critics, who underline mainly its rank reversal effect and some areas of operational difficulty (Dyer, 1990).

The Analytic Network Process (ANP), introduced by Saaty (2001, 2005, 2006) consists in a generalization of the Analytic Hierarchy Process and is now considered one of the most comprehensive multicriteria frameworks that can be used by decision makers (Tuzkaya, Onut, 2008). The ANP has recently gained wide popularity because it allows both interactions and feedback between elements (inner dependence) and clusters (outer dependence), in order to capture the complexity of reality.

Operatively, the ANP is structured as a network to represent the problem, as well as a pairwise comparisons to establish the relationship within the structure. The applications involving ANP are now quite common in many fields: strategic policy planning (Ulutas, 2005), market and logistics (Agarwal *et al.,* 2006), economics and finance (Niemura, Saaty, 2004), civil engineering (Piantanakulchai, 2005; Neaupane, Piantanakulchai, 2006), transportation (Abastante *et al.,* 2012; Abastante, Lami, 2012; Bottero, Lami, 2010; Tuzkaya, Onut, 2008) and territorial and environmental assessment (Abastante *et al.,* 2013; Bottero, Ferretti, 2011; Bottero *et al.,* 2008; Promentilla *et al.,* 2006).

From the methodological point of view the development of an ANP model consists in the following five main phases.

Step 1: *structuring of the decision problem and construction of the model*

There are two types of models that can be developed within the ANP technique: the complex network model and the simple structured model (Saaty, 2006). The 'simple' network is a free-modelling approach, which is not supported by any guide or pre-determined structure. It consists of a network which has cycles connecting its components and eventually loops connecting a component to itself. The 'complex' network, or BOCR

(Benefits, Opportunities, Costs, Risks) network, allows to simplify the problem structuring and classifying issues in traditional categories of positive and negative aspects.

Step 2: *pairwise comparison*

In this step, a series of pairwise comparisons is made to establish the relative importance of the different elements with respect to a specific component of the network.

It is important to highlight that there are two levels of pairwise comparisons in the ANP: the cluster level, which is more strategic, and the node level, which is more specialized. During this step, the use of the focus group methodology is fundamental. In fact, the focus group is structured as a series of group interviews, guided by a moderator with the aim of analyzing and discussing some crucial points (Morgan, 1993; Acocella, 2008).

Step 3: *formation of super-matrices*

During the development of the ANP technique, three different super-matrices are extracted:

- the un-weighed super-matrix (initial);
- the weighted super-matrix, which is stochastic and is obtained by multiplying the values of the un-weighed super-matrix by the weight of each cluster; in this way it is possible to consider the priority level assigned to each cluster;
- the limit super-matrix, which is the final matrix of the analysis, obtained by raising the weighted super-matrix to a limiting power (see equation 1); the limit super-matrix considers the indirect influences and represents the priority vector of all the elements considered in the analysis.

$$\lim_{k} W^{k} \qquad (1)$$

Step 4: *final priorities*

The fourth step concerns the elicitation of the final priorities obtained in the limit super-matrix.

In the case of a complex network structure, it is necessary to synthesize the outcome of the alternative priorities for each BOCR subnetwork in order to obtain their overall synthesis through the application of different aggregation formulas (Saaty, Vargas, 2006).

Step 5: *sensitivity analysis*

The sensitivity analysis concerns a 'what if' question to see if the final answer is stable when the inputs, whether judgments or priorities, are changed.

## 4. Integrating MCDA with Geographic Information Systems

### 4.1 *Methodological background*

Many types of decision-making problems have a geographical (spatial) component. Geographic Information Systems (GIS) facilitate the organization and display of spatial data and provide those data with a variety of distinctive spatial operations. These functions allow decision makers to explore the spatial aspects of their decisions. Consequently, GIS can be seen as an increasingly important technology for decision makers (Keenan, 2008).

Multicriteria Spatial Decision Support Systems (Malczewski, 1999) combine Geographic Information Systems and Multicriteria Decision Aiding in order to provide a col-

lection of methods and tools for transforming and integrating geographic data (map criteria) and decision makers' preferences and uncertainties (value judgments), to obtain information for decision-making and an overall assessment of the decision alternatives.

From a methodological point of view, a spatial decision support tool can be defined as an interactive computer system designed to assist the user, or group of users, to achieve high levels of effectiveness in the decision-making process, while solving the challenge represented by semi-structured spatial decision problems (Malczewski, 1999).

According to the decision-making process model proposed by Simon (1960, 1991), and considering the work of Steinitz (1993), Sharifi and Rodriguez (2002) have developed a framework for planning and decision-making processes, which is shown in figure 5.1

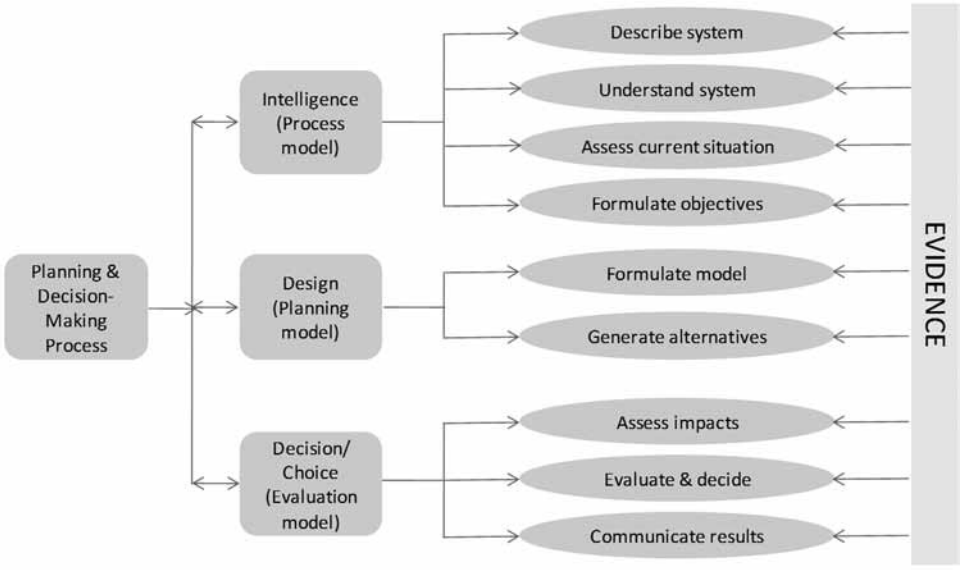


Figure 5.1. Framework for a planning and decision-making process (adapted from Sharifi, Rodriguez, 2002).

In this model, there is a flow of activities (from intelligence, to design, to the choice phase) as well as steps in each phase (Sharifi, 2007). Particularly, the intelligence phase refers to the examination of the environment in order to identify problems or opportunities and includes the structuring of the problem, the step during which the system under consideration is defined and the objectives to pursue are explored. One or more criteria, or attributes, are then selected to describe the degree of achievement of each objective (Keeney, 1992).

The design phase involves the development and analysis of several possible courses of action. This phase constitutes the innovative part of the process and refers to data collection and processing, as well as to the development of multicriteria analysis through the definition of the relationships between objectives, attributes and preferences of the decision makers (Malczewski, 1999). In this phase the alternatives are generated by performing a Spatial Multicriteria Evaluation and using the criteria structure and the set of constraints identified in the intelligence phase in order to generate a suitability map (Zucca *et al.,* 2007).

During the choice phase, alternatives are evaluated and a selection of specific courses of action is performed; furthermore, detailed analyses, such as a sensitivity analysis, are deemed appropriate in order to obtain useful recommendations.

Finally, evidence is defined as the total set of data, information, and knowledge at the disposal of the planners, decision makers and analysts.

A Spatial Multicriteria Evaluation is thus a procedure to identify and compare solutions concerning a spatial decision problem, based on the combination of multiple factors that can be, at least partially, represented by maps (Malczewski, 2006).

Two key steps in such a procedure refer to the standardization of the spatial criteria and to the weighing of the evaluation elements during the design stage. Both these steps underpin the final overlay of the spatial criteria being considered, since standardization allows to make all the factor maps comparable with each other, and weighing allows to determine the relative importance of each factor. Due to the large subjectivity which characterizes both steps, it is highly recommended to develop them through the technique of the focus group, paying particular attention to the panel composition and interaction mode, and making use of collaborative Decision Support Systems (Ferretti, 2012).

## 4.2 *State of the art*

One of the first experiences concerning the use of maps in decision-making processes refers to the work of McHarg (1969), where the basic concepts that would be later developed in Geographic Information Systems (Charlton, Ellis, 1991) are set forth.

Whereas Decision Support Systems and GIS can work independently to solve some simple problems, many complex situations require the two systems to be integrated in order to provide better solutions (Li *et al.,* 2004).

Arnott and Pervan (2005) trace and describe the development of the DSS field by identifying several sub-groupings of research and practice, comprising DSS landscape, as depicted in figure 5.2.

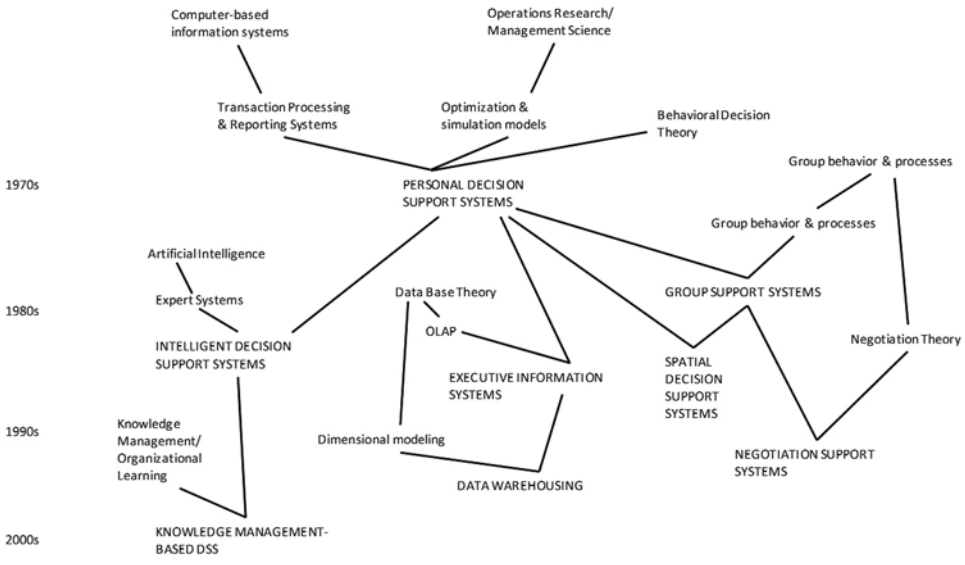


Figure 5.2. Evolution of the DSS field (adapted from Arnott, Pervan, 2005, p. 69).

In this context, it can be stated that the development of Spatial Decision Support Systems (SDSS) has been associated with the need to expand the GIS system capabilities for tackling complex, not well-defined, spatial decision problems (Densham, Goodchild, 1989). The concept of SDSS evolved in the mid 1980s (Armstrong *et al.,* 1986), and by the end of the decade many works concerning SDSS were available (Densham, 1991; Goodchild, 1993; Densham, Armstrong, 1987; Armstrong, 1993). Over the course of the 1990s there has been a considerable growth in the research, development and applications of SDSS, and in recent years these common decision support functions have been expanded to include optimization (Aerts *et al.,* 2003; Church *et al.,* 2004), simulation (Wu, 1998), expert systems (Leung, 1997), multicriteria evaluation methods (Feick, Hall, 2004; Malczewski, 1999; Thill, 1999; Janssen, Rietveld, 1990; Carver, 1991; Eastman *et al.,* 1993; Pereira, Duckstein, 1993) on-line analysis of geographical data (Bedord *et al.,* 2001) and visual-analytical data exploration (Andrienko *et al.,* 2003), with the aim of generating, evaluating, and quantifying trade-offs among decision alternatives (Spatial Decision Support Systems Knowledge Portal, 2013). The field has now grown to the point that it is made up of many threads with different, but related names, such as collaborative SDSS, group SDSS, environmental DSS and SDSS based on spatial knowledge and on expert systems (Malczewski, 2006).

With specific reference to GIS-based MCDA, the full range of techniques and applications has been recently discussed in the aforementioned study developed by Malczewski (2006).

The amount of papers on Multicriteria Spatial Decision Support Systems (MC-SDSS) was small for many years, but in the past decade studies presenting and solving spatial multicriteria problems have had a substantial growth, and have opened windows to research in different fields.

From figure 5.3 (Ferretti, 2012) it is possible to notice that there is a growing trend of this topic during recent years. As a matter of fact, since 2000 the number of studies has been increasing and several applications can be found in different fields (Malczewski, 2006).

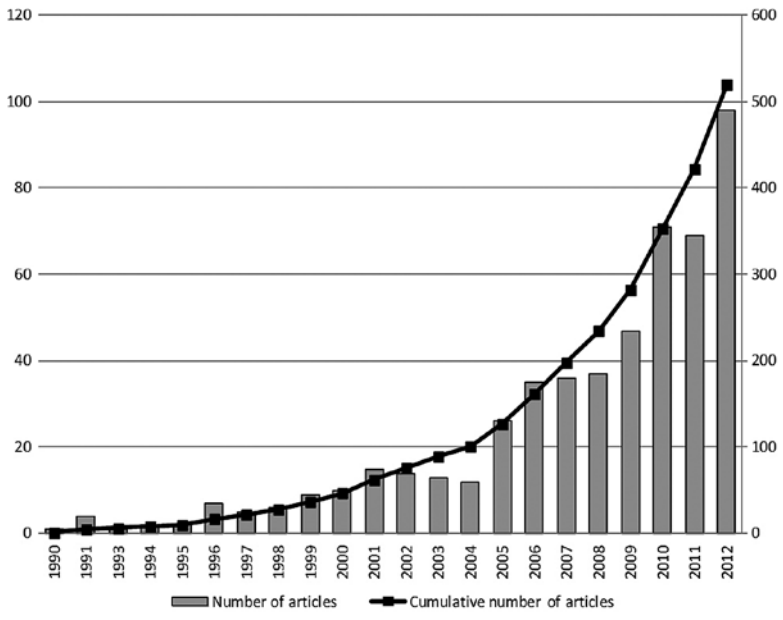


Figure 5.3. Development of MC-SDSS in terms of the number of refereed articles published in the period 1990-2012 and the accumulation of those articles (Ferretti, 2012).

A detailed analysis of the state of the art of these tools is beyond the scope of the present chapter; the interested reader is referred to Ferretti (2012) for a classification of the scientific international literature highlighting the most recent global trends of research in the MC-SDSS field.

In particular, MC-SDSS are most commonly applied to land suitability analysis in urban/regional planning, hydrology and water management and environment/ecology fields (Ferretti, 2012; Malczewski, 2006), and are usually based on a loose coupling approach and on a value focused thinking framework (Ferretti, 2012).

The rapid increase in the amount of MC-SDSS research can be attributed to different factors, ranging from the recognition of decision analysis and support as an essential element of GIS science, to the availability of low-cost and easy-to-use MCDA software and modules in spatial analysis software (Malczewski, 2006).

## 5. Conclusions

This chapter has highlighted the contribution of Spatial Multicriteria Evaluation to support sustainability assessments in a variety of decision domains.

One of the main strengths of this approach consists in its ability to support both planning and evaluation procedures thanks to the possibility of both generating and evaluating alternatives (Ferretti, 2012).

Emerging trends in this field refer to the possibility of supporting collaborative processes and developing models making use of the world wide web and global internet.

The future challenges this research domain will have to face refer mainly to the need to provide open access software, to the integration of the temporal dimension with 3D visualisations and to the development of distributed Internet-based models.

Future research should also explore the possibility of integrating the different MCDA methods with GIS in order to explore synergies across the different tools.

Although the importance of these tools is recognized by experts in many fields, the transition to the operation phase still remains critical.

In particular, two open areas of research related to the use of these tools deserve specific attention: (i) what tools to use, depending on the participants in the decision-making process, and (ii) at what time to use them. If properly used, these tools can indeed accelerate and facilitate the decision-making process, allowing to generate new alternatives; on the contrary, if not fully understood by the end-users, they can result in a real 'boomerang effect'.

In this sense, it could be particularly useful to analyze a number of real-life experiences in which assessment tools and visualisation have been combined in order to explore their effectiveness.

In conclusion, this chapter has highlighted that Spatial Multicriteria Evaluation represents a very promising field of research in the context of urban and territorial transformation assessments.

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# 6.
# New forms of spatial knowledge in cities

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## Abstract

Cities are complex spatial phenomenon marking the development of human society. Their nature is complex and they are becoming bigger and smarter. Hence, we need comprehensive systems and tools to visualise and to model the urban phenomenon. Urban modeling is not only a tool to grasp the knowledge about the form of the cities, but it is also a form of knowledge about the spatial and social nature of the cities.

*Keywords*: urban; models; cities; spatial; knowledge.

## 1. Introduction

Cities are complex systems constituted of physical elements interrelated in elaborated spatial relations. Their complexity is further increased by their constantly changing and evolving shape and structure. Therefore, the management of such complex systems requires theories, models and tools that will be able to cope with the challenge of managing data and the complexity of the phenomenon of urban environments. Urban and regional models are representation of our understanding of cities and regions (Wilson, 2012a).

Urban modeling has increasingly been used as a tool for the spatial simulations of a variety of urban phenomena, including urban growth (Torrens, 2006), housing development (Benenson *et al.*, 2002), traffic simulation (Barret *et al.*, 2002), gentrification (Jackson *et al.*, 2008), social and market dynamics (Wilson, 2012b). There is evidence of a growing interest in linking such models with actual places and geographic data. This will enable us to observe and understand how objects or elements of the modelled system interact and change in time and space. By moving into the spatial domain, urban models are becoming more related to the phenomenon they are representing.

By acknowledging the existence of a systematic relation between the spatial nature of cities and the modeling tools meticulously working on representing the complexity of the urban phenomenon, we can clearly see that comprehensive models of cities could be an excellent system for the production of knowledge that could be organised and used in a more profound way for feeding the systems for supporting planning policies, management and development of cities. This has been established as one of the key challenges:

to explore, visualise and communicate such models to those who are involved in the development of our cities and in the decision making process.

So the problem today is not the availability of systems and tools for modeling, but rather the production of models and networks of knowledge that will have an appropriate and useful level of detail, depicting not just the form of the cities but also the structure of spatial relations and spatial properties, organised in a systematic way and updated in timely manner. This situation urges to establish a systematic organisation and a more important integration of city data into the comprehensive system that will be coherent with the nature of the city as a relevant system for the process.

## 2. Cities as spatial and social structures

Cities in general can be best recognised through their distinctive shape, complex organisation and density of the build environment they create. This environment is created through a construction of architectural objects with different morphology, functions, materiality and density. Its complexity and vastness of typology comes from a process of continuous creation of architectural and urban forms, not only as physical objects but also as a network of spatial, social and cultural relations. Through these spatial configurations, urban form becomes the spatio-temporal manifestation of the order of the city realised through physical elements and urban morphology (Hillier, Hanson, 1996).

Urban form, as a dominant physical structure in the urban environment, determines many aspects of our everyday activities. It is part of everyday experience for a significant part of the human kind and it is the way humanity expresses its culture and society in a spatial manner. This spatial emanation of social order of the cities appears on all scales, with urban form and activities forming clusters of different sizes (Penn *et al*., 1997). It is believed that distinctive characteristics of societies exist within the spatial systems of the city and their knowledge is conveyed through space itself and the organisation of spaces.

The process of urban space production has often been attributed to the existence and influence of internal forces of the society and the dominant system. Following the thesis that space is a product of society (Lefebvre, 1991), many theorists have claimed that the role of the process of production of urban space within a distinctive social order is to facilitate and further enhance the product of the dominant order. The theories that see the dominant social order as a basic driving force of urban change, besides their positive contribution in establishing the productive notion of relation between society and urban space, more often limit our understanding of the processes that are shaping our cities. The emphasis on the regularities of the social order, with its usual focus on economic parameters of urban change, reduces or overlooks the multiplicity of actors, institutions, networks, structures, cultures, ethnicities, religions, trades and people as generators of urban change (Orum, Chen, 2003). As an opposition to this deterministic notion of the relation of society with the production of urban space, there is the idea that cities are the places of various densities of activity of individuals and institutions that evolve and emerge through a complex interaction of codes, customs, laws, agreements and cooperation between individuals and groups gathered around a common interest and goal (North, 1990). The fact that people use the locality as a site and resource for social activity realised in a spatial manner in different ways reinforces the notion of the existence of a socio-sphere (Albrow, 1997) as a complex social arena with overlapping networks and a fragile balance between different models of spatial behaviour.

In attempt to overcome the deterministic notion of production of urban space as a result of pre-defined conditions and forces within the society and social order, we should draw attention to the ways actors and institutions emerge and behave in a spatial manner through time under specific conditions, an action that influences the production and change in urban space. Each activity is not exclusive, but rather a simultaneous process of interaction. In Lynch's words (1960), "nothing is experienced by itself, but always in relation to its surrounding": such is the reality of the city. Therefore, the process of urban change and the resulting shapes cannot be determined as a static condition of the urban form fixed in time, but rather as a spatial and morphological result of dynamic phenomena of the city, developed in a process of coexistence and transformation. It is a bottom-up approach – starting from the specific in the urban space, whether it is a building, its shape, a program or a person – that goes through a process of negotiation, toward the cooperation and cohesion in bigger entities, blocks, groups, neighbourhoods, trades, parts of the city and institutions. Urban structure is generated through an emerging bottom-up process of interaction between its own constituents and is recognised as a topological, irregular spatial configuration. This structure is specific of the urban environments that have developed through a spontaneous process of morphogenesis of urban form.

## 3. Modeling the world

The idea that a scientific theory could be translated into a mediated form of representation of the corresponding system enabled the research of the reality to be performed not on the actual system but on the abstraction of that system. It introduced the creation of such intermediated forms called Models into scientific research as representations and abstractions of the system on which the exploration was taking place. It was a momentous step forward in scientific theory that was based on formal systems and systematic theories that were restricted to controlled experiments in the laboratory or thought experiments in order to reproduce the system of interest in such a way that would be closest to the real phenomenon.

Models are not theories, nor are equivalent to the realities they seek to represent, but they enable scientists and designers to explore, predict and design the real world before they act on it in an irrevocable way. Therefore, models have an autonomous role in science and design (Morrison, 1999), acting as a mediator between reality and theory. They have been classified almost half a century ago (Lowry, 1965) according to the media they use to simulate reality, the formalisation or type of abstraction used, and their description or prediction of the forms of reality they refer to. The first key distinction between models concerns the nature of the media through which models are represented; that is, a distinction between material and digital models. The physical material built models are referred to as iconic, with a clear intention of manifesting a superficial similarity to the reality or the phenomenon they represent. In contrast to these, there are symbolic models that embody logical functionality as the key element of their way of representing reality as a set of symbolic relations between reality and the phenomenon. There are, also, models built as an analogy to the systems and especially processes and flows (river or road networks). Symbolic, analogue and iconic models are closely related to the ways architectural production has been regarded within human society and through the development of human civilisation (Broadbent, 1977). It confirms the profound relation between the construction of models acting as instruments of representation and mediation between theory

and reality, and the human cognition and perception of the real world and especially the construction of the built environment.

## 4. Modeling the cities

Providing a comprehensive overview of the models focused on depicting the complex nature of cities is exceptionally hard, due to the background from which various models have come to exist, but also due to the overlapping of features in many model types. Different modeling concepts and theoretical background merge into one another, creating the contemporary myriad of models and modeling tools that refer to spatial aspects of the built environment and human society.

The first models following the big introduction of the computation breakthrough that emerged in the middle of the 20th century were specifically tailored to the problems and systems they were representing and the way the problems were perceived. These models were mainly in quest for equilibrium reaching systems, aggregated at the level of populations involving spatial activities and built on conceptions of the city articulated using ideas from urban economics and social physics. Many variants of models based on land use location and traffic flow had been developed (Harris, 1965), with a sweeping effect on the practice of urban planning. They simulated how activities such as employment, population and the trips that connected them with the travel to work, located at different areas represented small zones in the city. However, the main downfall of these models was the fact that, although they simulated locational activities, they were not linked to the built environment. Thus in terms of their representation and use, they were often too abstract, reducing the spatial heterogeneity of urban form and layout to a conceptual diagram of the general distribution of activities, and appeared irrelevant to the problems at stake, insisting on cities being simulated as systems in equilibrium represented in a section of time.

The idea that a complex system such as a city can be translated into a simplified form with high level of abstraction was used in order to obtain a tool for a controlled exploration of the systems associated with cities. Early models were condemned as 'too simple' or 'too complex' to successfully deal with the complex task of providing useful tools for a better understanding of cities. Nevertheless, their use was justified by the idea that the complexity of the studied system could be matched only through models similarly complex, so as to provide enough details, as required by decision-makers (Masala *et al.,* 2012). As an opposition to this trend is a tendency and urge to develop city models that are simpler than the former but that are inherently open toward producing more complex results, based on simple spatial rules and interactions. The spatial aspect of the urban models has been widely neglected in academic models (Thorp *et al.,* 2006), mainly due to the fact that the focus is on theory, and the growing number of digital tools that provides a variety of possibilities for spatial modeling usually does not provide a sufficient level of flexibility or integration with previous and other models.

In contrast, ideas about modeling transformation in cities from the bottom up led to the creation of models of cities that should lead to an emergent pattern formed by the myriad of spatial decisions and activities. The new modeling approach moved away from data associated with administrative units to those associated with morphological and spatial building blocks of cities. Hence, in bottom up models the city should be perceived as a structure of spatial relations and properties of cells and units, and the rules that drive the development of such structures are based on the notion of the intrinsic relations between

the distinctive units that are realised spatially. This enables us to simulate cities with models as a bottom up phenomenon, where urban spatiality and morphologies will emerge physically and the dynamics of urban development will be captured.

The model of urban development in general will depend and should be based on the way we understand cities and we explore the city structure and its relational nature within the complexity of the city. This approach to urban modeling resembles the anthropological view: a network perspective of a city as an interconnection of people, urban elements and their dynamic relationships and processes. The complexity of urban environment is understood through generalised cognitive human agencies and their experience. This model should serve as a spatial integration of distinctive urban knowledge, spatiality and formality of the city. It should explore and represent forces and processes that are beyond the materiality of urban forms and reveal hidden aspects of the processes that are shaping our cities. It should contain tools for the representation and analysis of the present city form, but at the same time it should be able to predict future conditions with the same stability as the ones observed in the past. Only through the comprehension of its inherent structure and generative nature will we be able to understand the consequences of our ideas of the city and our interaction with the world we live in.

## 5. Interactive city models for creative participation

Urban models are envisioned as tools that can help designers, decision makers and all the stakeholders to anticipate, plan and design cities that promote well-being, prosperity and sustainability. Designing liveable and sustainable cities with effective capabilities for avoiding and managing conflicts and potentially disruptive scenarios is a shared vision of both decision makers and people who live in cities. In order to improve the process of urban modeling, and to represent urban dynamics by using a more natural metaphor, an important focus has been given to the identification of the social-related knowledge categories that can help us explain the ways people behave and make use of the urban space. The premise is that the more is known about the factors affecting behaviour, trends and processes before we start modeling, the better design choices for urban modeling can be expected. It is an approach based on the spatial context of the observed reality through the generation of knowledge related to and created through the spatial activities of people.

In particular, the research on 3D city models should aim at providing some innovations in specific aspects, described hereafter. In particular, innovation should be brought towards modeling systems which can be usable both to manage and visualise data, created to promote awareness and discussion. Real time interaction and high customisability are key elements for the usability and efficiency of the instrument. The resolution of the issues of spatiality, semantics, interactivity, flexibility and avoidance of black-box situations in urban modeling are at the forefront of development of new and interactive urban models with enhanced usability that should fulfil the desired task of comprehension of the complex urban phenomenon through accessible and useful models.

– *Modeling cities as a network of spatial relations and properties.* In the context of urban models, spatial relations and spatial properties play a crucial role. This is true for common users, for professionals and for researchers (Bucher *et al.*, 2012). The issues of the ontology of the elements of the system could be resolved through the recognition of

the spatial relations and properties of discrete entities within the system. It will provide new opportunities for the management of urban complexity with tools that are coherent with the nature of cities, which are inherently spatial, and could go beyond a mere visualisation and analysis and toward envisioning and reasoning possible futures.
– *Enhance the semantics of urban models*. Whilst the visualisation capabilities of many urban models can be highly developed, they can act as 'empty shells', without any semantics or socio-economic data associated with the spatial entities or urban forms; or the capability to analyse the role of the built environment in urban processes (Batty, Hudson-Smith, 2002). Future advances should explore how such models can be enriched with socio-economic data connected to spatial entities integrated in elaborated networks, moving from representing to applying analysis and policy.
– *Interactivity.* Interactive features are essential to introduce a number of advantages: for the users, who can increase their awareness on spatial topics and project tasks; for the trustability of the model, which is no more a black box, but it appears more transparent, and, finally, for the whole decision process, because it enhances discussions on themes and support debates.
– *Flexibility.* Spatial models commonly used in the planning practice are based on general models that do not respect the particularity of places and purposes of each project (Pensa *et al.,* 2011). Therefore, planners require more flexible models, which could fit the purposes of specific projects. Flexibility is one of the main features to provide each specific case with a new model, which can vary in scale, purposes and themes such as economic and environmental assessments (Pensa *et al.,* 2013), accessibility evaluations, land use configurations and allocations. Furthermore, flexibility should also involve the compatibility with many software extensions, so as to allow the use of different input data, such as database, GIS data, raster and vector files.

Experience demonstrates that the creation of a urban model providing visualisation and analysis that are closest to the nature of the urban phenomenon increases the assessment capability and the comprehension of urban dynamics during the decision process.

## 6. Interactive visualisation tool

Urban morphology, spatial relations and properties can be investigated in different ways. Traditional methodologies provide studies mostly based on professionals' experience, but the use of computer analysis presents a wide range of opportunities in defining approaches, methods and tasks. Interactive urban modeling appears as an effective tool in approaching urban planning, for several reasons. First of all, parametrically determined city models can provide a comprehensive tool for analysing development scenarios and design solutions with a very large number of elements to consider. Secondly, they can quickly provide localisation and spatial emergence of different urban aspects, helping practitioners in their reasoning and enabling policy makers to promote real time debates with the local communities securing citizens' participation during the planning process.

The complexity of the result comes from a locally driven set of simple rules that induces continuous adaptations and changes at the local level, but with an impact on the overall condition of the system. It provides us with the tool that can generate complex and novel shapes and configurations as a result of a dynamic, nonlinear and locally driven process. These new structures are more than a sum of their parts and are not predeter-

mined or preconceived by any means. In particular, the use of an interactive tool such as InViTo allows users to combine different solutions and to receive in real time a feedback on the localisation of the effects of their specific choices.

It enables us to fulfil the imperative of the research project to become the milieu of a confrontation among the economic, social and spatial aspects involved in the city's transformation processes, and to provide the public administration, institutions or private sector companies with a tool for morphologic consultancy service on operations of greater complexity and relevance concerning the city. It will provide insight into the process of morphogenesis, a better understanding of the phenomenon of cities, and an opportunity for a better understanding of the potential for sustainable future development, but above all a better understanding of the results and consequences of our actions in the world we live in.

## 7. Conclusion

According to the way we comprehend and use our cities, the way-forward is to embed this variety of information into a city model that will simultaneously serve as a resource of integrated information, and a tool for analysis, evaluation and creation of new urban knowledge (Carrera, Ferreira, 2007). This shift in the practice of urban information management could enable a substantial change in the process of decision making and planning practices, and in the way cities will be developed in the future.

The future of cities based on the idea of the creation of a society of knowledge lies in the creation of semantically enriched 3D city models as a powerful tool for gathering, storing, evaluating and using urban information through a comprehensive open and accessible system, coherent with cities' nature and the way we see and understand them. Interactive Urban Information Models can emerge from the horizontal and vertical integration of different information sources, with an active contribution of institutions, companies and individuals creating a complex network of urban knowledge. This in return will enable municipalities to act as the facilitators of the exchange of urban information with a high level of detail and usability, and to become more effective and efficient in providing policies of city management and urban planning in the best interest of their citizens, building a new society based on new form of urban knowledge.

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7.

# Visualisation as a support to spatial decision processes: some considerations on the concepts behind the construction of a strategy image

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## Abstract

The knowledge of a territory is the first step for its management and strategic planning. The drawing of space is historically the method for achieving its knowledge, so that the visualisation of a territory becomes essential to its planning. Information Technologies (IT) provide nowadays new opportunities to enhance the process of knowledge building and sharing by means of spatial data visualisation. In this context, this chapter introduces the historical concept behind the production and perception of spatial data visualisation and proposes it as a support to decision making related to spatial issues.

*Keywords*: visualisation; geography; spatial decision processes.

## 1. Introduction

Since ancient times, the measurement and drawing of geographical space has traced the history of peoples. The visual representation of space provided not only an essential tool for describing the shape of a territory, but also the method to define, manage and plan the development of the peoples themselves.

Each military or commercial operation has always been guided by a deep knowledge of the geographical space, which has become the vehicle for all territorial expansions, but also for the growth of political and economic power that marked the course of our macro-history. The knowledge of a territory has always been the way to manage it, control it, invade it, lead it and plan it, and drawing the territory is the instrument to know it (Dematteis, 1985). For this reason, a task far more important than mere geographical description has been assigned to cartography: it assumes the role of a political, economic and social construction of the territory.

As well as in the past centuries, also today the visual representation of space is the means for informing people about the past, present and planned future of a region, as the way for defining strategies and actions. Moreover, it is a framework in which activities and projects are created and organised. However, with respect to the past times, new forms of representation are nowadays possible. Information Technologies (IT) provide new methodologies and techniques for building and displaying images, which can largely

contribute to the drawing of a territory, so that the representation of space becomes the superstructure within which planners and decision makers can place their activities, projects and strategies. In this context, new opportunities in approaching the representation, communication, analysis, planning and assessment of territories are offered. Mapping instruments such as Geographical Information Systems (GIS), CAD drawings, parametric models or virtual globes are just a few examples of the new technologies related to cartography which are widely available to both expert and non-expert users. In particular, many chances for next future developments come from the recent progress in the real time processing of large databases, which can be visualised in interactive environments as well as on web platforms, allowing a wide accessibility to spatial data analysis and therefore the involvement and collaboration of large numbers of people. As a consequence, scientific literature commonly agrees in recognising the possibilities given by IT as a new frontier for increasing knowledge-sharing within spatial planning processes.

Furthermore, the production of spatial images is a common practice in different disciplines and activities, especially in scientific research fields, whose aim includes objectivity and transparency as a fundamental principle for conveying knowledge and information. Nevertheless, images include a projective element due to the fact that they concisely represent an object filtered by a subject, on the basis of his/her own vision or intention (De Rossi and Durbiano, 2006), which is a peculiarity contrasting with the scientific aim of neutral communication. Thus, how the subject influences both the building and the reading of images is constantly an open question, in which new Information Technologies have a deep influence on the changing of paradigms.

This chapter will discuss the relationships between objects and subjects, assuming that images are a vehicle for subjects to know objects described by other subjects (fig. 7.1).

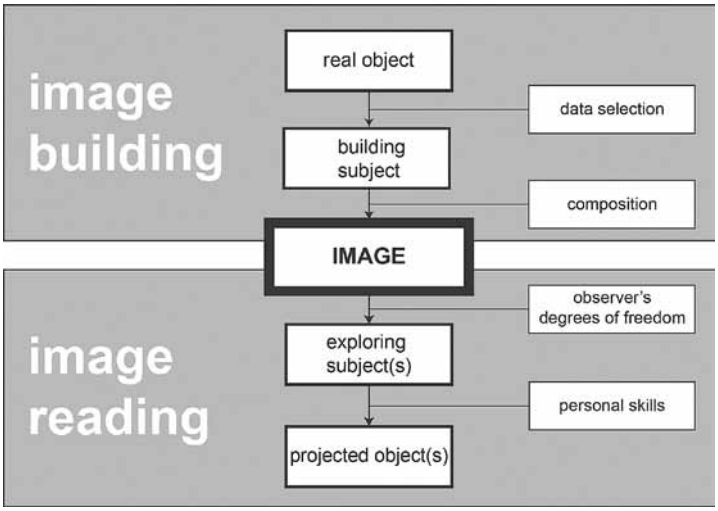


Figure 7.1. Building and reading images: a relationship between subjects and objects.

Therefore, images cannot be considered as the natural outcome of an aesthetic act, but it is necessary to assume that the production of a spatial image is the result of a communication project. The image of a territory is not just the translation of spatial data into a visual platform, but a structured project which must be designed and oriented to a specific task to be achieved, and addressed to a specific target of public. The process for build-

ing spatial images follows two main steps. Firstly, it is necessary to consider the way real objects are translated into images, that is, how images are built. This element is discussed in paragraph 2 and it includes the concepts behind the selection of data, and those related to the composition of such data within the image. The second element to be considered in designing a spatial image concerns how observers can translate this image into a comprehensible and plausible projection of reality. This means that an effective image should be designed, also, depending on the subjects who will read it, on their task and their interpretation (Tufte, 1983). Thus, paragraph 3 will discuss the theoretical issues concerning the reading of images, focusing on the methods used in showing the image and on the role of the observer. Finally, paragraph 4 will conclude on the conceptual elements to be followed in the organisation of an image focused on the description of a spatial strategy or project.

## 2. Building spatial images

Spatial images are means for analysing, planning and evaluating a territory. Building such images implies a conceptual dichotomy between territory and image. In fact, on the one side, a territory is by definition a complex system (Jacobs, 1961; Alexander, 1964; Batty, 2005; Batty and Marshall, 2009; Portugali *et al.,* 2012), which includes different realities, often opposing each other. On the other side, the concept of image leads to a synthetic visual reproduction of just a few selected realities. This twofold identity historically constitutes the main strength of the planning power of spatial images, because its balance determines the ability of the image to be useful and efficient at informing the observer. In fact, there is a huge conceptual border line between the images which represent data and those which visualise data. In representations, data are displayed as they are, thus generating simple data-maps, in which the semantic value of data is not showed. On the contrary, visualisations are knowledge-oriented representations, in which data are aggregated or interrelated in order to provide a level of information higher than the simple data. Visualisations should be built on the basis of a task and should keep in mind the expertise of the public they address. In fact, visualisations are a form of communication used by different disciplines to create a specific language for improving the process of information, also about complex systems (Brewer, 1994; Bertin, 1981; Tufte, 1983, 1990, 1997, 2006).

For this reason, in this chapter the concept of image will refer to the term visualisation, which considers the selection, intersection and exploration of data as the basis for building awareness in spatial planning processes. Then, each spatial image should be projected in order to be clear and avoid any possible misunderstanding, and it should be studied according to its purpose and the expected observers. It should also be broadly understood in an easy way even by non-experts, revealing its interdisciplinary nature.

During the last decades, the increase of the graphic power of personal computers has generated a wide progress of representation techniques, also providing new languages. Nevertheless, the literature developed within the field of geovisualisation is still deeply connected to the cartographic tradition. In particular, it retains and develops the fundamental concepts of selection, localisation and order of data.

### 2.1 *The selection of data to be represented*

The production of an image inevitably starts from a subject who reads an object. This first step requires a filtering of reality made by the subject, who will use his/her own point of view

in determining which elements are worth considering for building the image of the chosen object. This passage is essential to the resulting image and can be identified in the process of selection of data. Therefore, the selection of data is the first essential step to the conversion of the real object into an image. If the image aims at describing a territory, it will be identified as a spatial image, whose object, i.e. the territory, presents different levels of complexity, such as political, environmental, social, geographical, economical, infrastructural aspects. The resulting image might be a map or whatever form of spatial visual representation. In this, the number, quality and, in particular, the accuracy of the selected data determine how much the resulting image will be satisfying, coherent and consistent with the reality it wants to represent.

Today's technologies allow extremely detailed representations of our globe to be built in an easy and collaborative way. Despite virtual globes such as Google Earth or Virtual Earth provide a narrative potential never experienced before, some considerations are necessary to understand the usability of these new opportunities. In fact, as a realistic representation of reality, virtual globes are an interesting evolution of mapping, which aims at providing and gathering geographic information in a format accessible to the broad public, who can now participate and collaborate to the big game of 'constructing' the World. Therefore, virtual globes can be considered an important technological progress in geo-referenced information, but their use cannot be misunderstood. The construction of a Earth map to 1:1 scale seems an attempt to realise the paradox of Borges (1960) in which cartographers gradually improved their skills so as to draw an ever larger map of the empire, and when the map reached the size of the empire itself, they understood its complete worthlessness. So, even though challenging spatial visualisation tools, such as Google Earth, can be considered full-potential geovisualisation platforms and very useful instruments in supporting spatial data representation, like the 1:1 map of Borges, they cannot be considered as planning tools. The amount of data they provide is too wide and incoherent to have a meaning, so that they result into information tools providing only random information. At the same time, their excessive realism leaves no room for abstraction, whereas the high amount of information makes the classification and selection of data difficult. Spatial planning needs to simplify reality and abstracting all the key features necessary to solve specific topics. These requirements cannot be satisfied by simply switching in/off the data layers in the menu bar: only a conscious intersection and overlapping of such layers can offer a higher level of reading.

Moreover, in order to build an image, the selection of data requires a purpose, which can be intended as the first filter that the subject who builds the image operates on reading the object to be represented. The purpose has a strong influence on the subject building the image. In fact, depending on the chosen task and observing subject, the image building requires different methods. Thus, data should be selected depending on the final intention, adding in this way a further level of partiality in the building process. According to Batty, Steadman and Xie (2004), the purpose depends on the case study and can generally be classified in four categories:

- *education*: to enable forms of understanding that would not be possible to obtain without the use of images;
- *exploration*: to teach how inputs are converted into outputs by means of cause-effect relationships;
- *explanation*: to confirm or refute a theory through the use of comparisons.
- *engagement*: to communicate data to an audience of non-experts. This is a non-scientific purpose.

This classification of purposes identifies the areas of application for the images describing a territory as well. However, in spatial planning and decision processes, maps and spatial images are generally used to explore data. In fact, their purpose can be generally resumed in a search for information sharing and knowledge building to be achieved among both experts and non-experts by expressing the relationships between the possible decisions to be taken and the expected outcomes related to each choice. This ability to relate causes and effects is classified as the purpose of exploration, which is also commonly considered by thematic literature as the method for reaching a higher level of knowledge that an observing subject can have of an object.

Since the '70s of the last century, exploration has been introduced as a method to detect abnormalities within visual data analysis (Tukey, 1977; Di Biase, 1990). In this context, the visual exploration becomes a methodology to see and identify the relationships and connections between data through the use of the intuitive skills of the human mind. John Tasko, professor at the Georgia Institute of Technology, refers to exploration as one of the main purposes of information visualisation (Stasko, 2008; Fekete *et al.*, 2008). Also Maneesh Agrawala, professor at the Visualisation Lab of the University of California, Berkeley, argues that visualisation strengthens "the human visual system to support the analysis of large amounts of information" (Heer, Agrawala, 2008), and that this visual communication is fundamental to the process of exploring concepts and disseminating information (Agrawala, Li, Berthouzoz, 2011). Exploration is commonly intended as a support to intuitively browse and forage through the information space, thus becoming the essential step before the knowledge building (Dodge, 2005). In particular, within the geovisualisation field, four functions are depicted: the lowest level is represented by the presentation, followed by synthesis and analysis, while, at the highest level of knowledge, the function is the exploration, intended as a way to reveal the unknown (MacEachren, Taylor, 1994; MacEachren *et al.*, 2003; MacEachren *et al.*, 2004). It is based on the interaction between the user and the displayed data, so as to become the core for the construction of a knowledge which is firstly collective and, then, individual. In fact, the exploration of data originates a knowledge that is formed through self-teaching, during a continuous dialogue between the subject and the represented object.

### 2.2 *The composition of image: organising the data*

Once data are selected, the subject who builds the image should structure these data in a visual project and convert them into an image. To be effective, images should be able to organise information in a precise and ordered framework. With respect to spatial images, literature on geography refers to "localisation" and "ordering" as the primary elements for structuring the elements on Earth, where localisation comes before ordering (Farinelli, 2007). The same notions of localisation and ordering were identified by the philosopher Carl Schmitt (1950) as the elements founding the basis of Western thinking, assigning them the role for knowing the world. Therefore, the position and organisation of data within spatial images is essential to provide a specific priority and importance to the different elements which compose a territory.

Historically, cities and territories have been represented by means of different methods. This is due, on the one side, to the knowledge achieved on the representation techniques and, on the other side, to the evolution in the vision and conceptualisation of the world, which determine the order and importance of spatial data within the composi-

tion. In fact, a short overview on spatial representation during the last thousand years in Europe can show how spatial images and world vision are strictly connected.

On medieval maps, mountains, hills, cities and buildings were represented by elevations on flat landscapes, whose size depended not only on their dimensions but also on their importance. In the same way, the most impacting objects were placed in the foreground, while the others succeeded on the basis of their relevance, so that their location indicated the importance of the elements depicted. This characteristic overlapping of plans proved to be extremely important in organising and drawing a hierarchy among different objects and providing them with a ranking.

With respect to the medieval quasi-axonometric view, the introduction of linear perspective in the Renaissance "was not only a shift in representation, but a profound philosophical change in how people perceived themselves in the world" (Kwartler, Longo 2008). In fact, the use of a vanishing point within the representation implies the presence of an observer, by whom reality is filtered (Belting, 2008). Therefore, the point of view becomes the first way to select reality. Man is no longer crushed by the *timor Dei* that characterised the medieval age, but he rises above nature and governs it. He limits an infinite space into a finite one, and he assumes its full control. Images become three-dimensional, while the position of objects in the space fully depends on the eye of the observer.

With the passage of time, three-dimensional views evolved into *vol-d'oiseau* views. This representation did not alter the hierarchical structure that characterised the location of objects within the paper-space of perspective views, but it implemented the power of the observer, who became the centre of the world, i.e. the point of view the territory should be designed through. In fact the *vol-d'oiseau* views are a representation technique used as a guideline to determine the localisation and order of functions all over urban and suburban areas. In particular, such territorial images evolved in an important methodology for planning the territories that was able to provide information not only on the use of land, but also on the morphology of buildings and cities. This technique of representation has so marked the conceptualisation of space, but also of the world, that it has brought many changes in the design of space. Buildings, cities and territories started to be designed as parts of a whole system based on visual axes and cones, which deeply influenced European architecture and urban planning for the following centuries.

While the Renaissance changed the position of man in his relation with the world, the fall of Constantinople and the succeeding Age of Discovery introduced a quick development in mapping techniques. Human history has been deeply marked by cartographic production. The translation of spatial data into a visual form is a typology of communication which has allowed the growth of the collective cognitive process. Thus, the production of maps representing the geographical features of a territory, or shipping routes, and military maps became the professional application of a specific technique of spatial representation. In fact, cartography presents two main characteristics. Firstly, the selection of data to be represented is oriented to provide information on a very specific target. Secondly, it is based on a zenithal point of view, that is, the same viewpoint of God towards the Earth. The horizon line, here intended as the line through which we join and distinguish the sky and the Earth and, therefore, the first sign by which we build our world (Farinelli, 2007), loses its meaning and is replaced by an absolute look from the top of the sky, in which the observer can just learn what other subjects have decided. Despite the basic principle of mapping is selection, this concept provided a deterministic value to the elements showed in cartographies and caused an objectification of the represented data. This false objectiv-

ity has been, and still is, commonly used to describe cities and territories, to analyse them and plan their future. However, localisation and order of objects are not under discussion, the zenithal drawing imposes its viewpoint on the free will of the observer, who can just accept the univocality of the map.

After few centuries, a new conceptual leap was made by the introduction of photography, with an important consequence on the role of the observer and his/her point of view on the selection of the reality to frame. Nevertheless, another key point is going to be reached with today's information technologies. In fact, within the image composition, technological developments have already allowed the accomplishment of new steps.

First of all, the infinite space has no longer the need to be confined within the paper limits, because the space of the representation is nowadays a mathematical domain which is conceptually unlimited.

Secondly, the felling of paper space as the limit of spatial representation has changed the concept of the scale of drawing. The scale is no more connected to the quantity of land included in a paper sheet, but to the level of detail used in the representation and in the level of aggregation of the displayed data. In fact, it is now a dynamic and continuous element which defines the distance of the observer from the Earth, which can change on the basis of the observer's will.

Thirdly, a large amount of software, often freely accessible, is available for creating or generating spatial images. GIS instruments, generative 3D modeling tools, virtual globes, web applications are nowadays commonly available for the production of maps and spatial visualisations. These new tools are essential to improve the role of the exploring subject, who can partially assume a building role by selecting some data and choosing his/her own position in the space. Furthermore, they can also implement the steps relating to the image building, previously identified in localisation and order. In fact, such tools can improve the representation techniques of traditional cartography, such as the communication of "a sense of the whole" (Dodge, 2005), intended as "the ability to summarise and meaningfully convey a large amount of information in a limited space". The relationship among the "parts and the whole" (Tufte, 1983; Bell, 1993; Naveh, 1995; Nassauer, 1997; MacFarlane *et al*., 2005) is essential to highlight the relationships between objects, but also between the objects and their context, so as to structure a hierarchy between the parts and with respect to the ensemble they belong to. Sets and subsets, micro and macro, global and local are thus included in an ordered whole, whose meaningfulness reveals to be greater than the sum of the parts. The creation of such a framework is the basis for activating a cognitive process, because it brings the subject to have an overview of the problems which are addressed by the planning process.

Furthermore, the construction of effective images is affected by another concept, which can be defined as the ability of the image to reveal the "hidden connections" among data (Dodge, 2005), so as to provide new information about the spatial dynamics of a territory. In fact, efficient images are not just a collection of data represented in a visual form, but the outcome of a visual project that defines the hierarchy and the order of data passing by a structured selection. To show an example, a simple representation of the localisation of roads and buildings is not enough to understand how the two typologies of data can collaborate and integrate to plan an efficient infrastructure for accessibility and mobility. On the contrary, their intersection can generate different values of connection and can be mapped to provide useful information to develop strategies and projects. Visualisation is commonly defined as the science that allows users to "see the unseen"

(McCormick *et al*., 1987), because it is able to visually correlate geometries with attributes. It can communicate not only the quantities, but also the qualities of the represented objects by means of explicit connections (Tufte, 1983), which define the way objects can be known. Therefore, on the basis of these connections, data can be organised within the image, so as to highlight the elements with a priority in an explicit context.

## 3. Image reading

Once a spatial image has been built, it should be read. Thus, the observing subject captures from the image the information he/she needs, producing a further personal selection of the elements to consider. The observing subject will transform such information into a personal construction of an object, which will be no more reality, but a partial vision of it. In fact, the real object is filtered three times: firstly, by the choices of the building subject; secondly, by the personal skills and mental models of the observing subject, and, finally, its explorability is necessarily limited by the device through which its image is shown. As a consequence, the final object will be just a projection of the primary real object. Therefore, the amount of differences between the projected object and the real one depends not only on the accuracy, objectivity and transparency used to build the images, but it is largely influenced by the way images are proposed to and understood by the observing subjects.

New information technologies have brought new opportunities to the discovering of spatial data. Nowadays, a number of freely accessible tools are available to manage spatial data, browsing and exploring large amounts of information, as well as choosing the parameters for selecting and analysing it. Nevertheless, this technological development has also caused an increasing divergence among expert users. The individual ability in using information technologies has generated a new kind of gap, which separates simple observers from expert explorers. The ability to investigate the contents of data sets by means of tools with a high level of interaction is, nowadays, a skill which allows the observing subject to easily know objects by intuition, thus raising his/her own awareness.

Since the individual components of the observing subjects can limit the understanding of information, but it cannot be controlled by the process of image building, the development of technological devices is essential to improve their usability and decrease the difficulties in approaching new instruments. Consequently, the process of image reading can be supported by the image building process, by means of a knowing application of the devices used to communicate the visual information.

At the same time, the image can be intended as an universal language, independent from the political boundaries in which it is produced, simply because it provides a physical aspect to elements which compose reality. Thus, if the reality to be represented is composed by a tree on a field, even if with unlimited different techniques of representation, the resulting image will still reproduce the original concept of a tree on a field. However, many components of reality are abstract and generally expressed by numerical values, so that their translation in a visual form of communication generally follows an indirect mental path. In this context, it is possible that the message generated by the image is open to interpretation, causing misunderstanding among observers, dependently on their personal reading. Once again, the way the image has been built is essential to determine the quality of the image reading process.

Therefore, the easiness by which images can be read strictly depends on the methodology used for their construction, and on the way observers are involved in their reading.

### 3.1 *Information Technologies and the evolution of the role of observers*

Territorial images have always been tools used to communicate and learn about space. Over the course of the centuries, illustrations and maps have constantly been used as instruments for spatial planning, but there is something else that has profoundly changed, and this is the viewer's eye. Today, technologies have remodified the forms of representation, thus causing a change not only in the organisation of space, but also, in particular, in the traditional role of the observer and his/her relationship to the image.

During the Renaissance, in the perspective view man became the new centre of the world, who filters reality through a hierarchical construction, while during the Age of Discovery the zenithal mapping of geographical features generated a deterministic objectification of the elements represented, in which cartography is conceived as univocal, total, exact and self-referential. Nowadays, "cartography is increasingly *indeterminate* (open, versatile, abstract) and therefore, also more evolutionary in its trajectories" (Gausa *et al.,* 2003). The passage from a static to a dynamic image opens a new way of conceiving the representation of territo bry, in which observers can decide their movement within the space of representation so as to build their spatial knowledge by means of their personal skills and actions. Observers are no longer passive elements as contrasted with the subject who builds the spatial image, but they can now use their own abilities and become explorers, or exploring subjects. If in the past cartography was intended to be objective, even though it was only a representation of a necessarily partial view, today spatial representation has an informative task, in which the educational role is assigned to the single observer, who can gradually refine his/her inquiry by means of exploration (Spence, 2001).

The horizon line has been upset again. Traditionally, it is the line that, at the same time, separates and joins sky and earth, defining their difference and providing an indisputable sign by which constructing the world (Farinelli, 2007). The horizon line is the reference axis along which human beings situate objects in the space. Today, the technological development has changed its conceptualisation. In digital representations, the horizon line is no longer fixed and determined, but dynamic and arbitrary. The order of things now depends on the observer's eye, who can also have a range of choices among the data to be represented. The transition from the two-dimensional projections of cartography to this new dynamic and indeterminate perspective brings the representation of territory to a new humanism, where the observer becomes the new centre of the world. In fact, nowadays, everyone can move the horizon line thus changing the order of objects on Earth. The exploring subjects can now freely direct their gaze towards the elements they prefer, without the need to accept the viewpoint chosen by the subjects who built the image. This possibility for the users to change their point of view within the representation is a goal that has finally been reached. Therefore, the building subjects and the exploring ones are getting closer. The building subject will be substituted by a data provider, while the observer becomes an explorer who will participate in the building process. Thus, a constant dialogue between the image and the explorer will generate a new projection of reality, which will result less filtered and more fitting the subject's requests (fig. 7.2).

Nevertheless, some important tasks have not been completely achieved yet. Interaction with data is one of the most significant ones, which still requires further implementations. In fact, if nowadays the observer can select the data to be visualised, and move

within the virtual space with control commands as Zoom and Pan, some technological difficulties still persist in providing a wider freedom of choice in editing and changing data, as well as in deciding their mutual relationships.

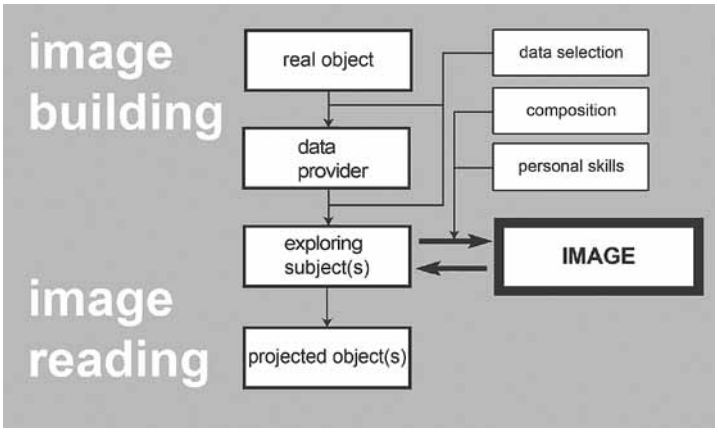


Figure 7.2. The exploring subject uses the image as a tool for building his/her personal knowledge of reality.

As the ultimate goal of spatial images is just the knowledge building, imaging techniques should focus on interactive communication. In fact, interaction can facilitate the creation of knowledge and awareness in experts and decision-makers, and it can make the exchange of information easier, not only among different users, but also between users and data (Andrienko, Dykes, 2012; Andrienko *et al.,* 2011; Andrienko *et al.,* 2007; MacEachren *et al.,* 2004; MacEachren *et al.,* 2003). Therefore, the tools used should allow individual users, as well as groups of users, to share information through a common platform able to feed the debate between the parties and to support the reasoning.

On the one hand, GIS technologies and parametric modeling tools already allow the formulation of queries, some degree of customisation in data displaying, and also the building of dynamic maps that change on the basis of the values entered by users. On the other hand, a number of hardware technologies provide new opportunities, especially in the entertainment field. In fact, new development opportunities come from the devices for human-computer interaction (HCI) in real-time. Remote controls, touch screens or camera systems are a few examples of devices which can improve manual skills in information management as in data location or order. However, these technologies have so far been used just for leisure or eye-catching presentations, with no real applications within spatial planning practice. Therefore, the building of spatial images can have new developments in both selection and composition of data, with important changes in the way subjects can handle and know spatial objects.

### 3.2 *Projecting the object of knowledge: mental models and personal skills*

In a spatial planning process, the exploring subjects are composed by several actors who embody different intentions and knowledge (Van Den Brink *et al.,* 2007; MacEachren *et al*., 2004). The heterogeneity of interests, as well as the different viewpoints of many stakeholders, converge in several final objects, one for each actor, which reflect just small

parts of reality. This fragmentation in knowing reality generates a lot of misunderstandings and conflicts among the parties. Thus, spatial planning processes have to manage these differences.

Historically, maps and territorial representations were used to support decision-making processes in spatial planning. In fact, images can be easily shared among people with different skills and expertise, so as to create common mental models, intended as the archaeology of our knowledge (Foucault, 1969). Nowadays, it is commonly shared the idea that images work as mental representations and, then, they play an important role in the processes of memory and thinking (Barsalou, 1999; Prinz, 2002). For MacEachren (1995) the role of a map is to provide an external, tangible representation that helps people to form and structure an inner mental model.

By observing an image, a subject receives a visual input which activates some specific thinking and reasoning, thus creating a personal knowledge of the object. In this sense, the exploration of images works as the Socratic maieutic, helping the subject learning by himself. In fact, the image is able to show several elements to the observing subject who has to answer himself, through queries and by refining queries. Then, the need to build mental models through the use of visualisations is due to the necessity of building one's knowledge. Since the use of senses is the main, pre-scientific system for knowing the real world (Bettelli, 2007), spatial memory and movements will be the main support for human mind to the structuring of space. Without a mental model, objects cannot be localised nor ordered, thus hindering their knowledge. Moreover, without a shared mental model, processes involving many subjects cannot obtain a common basis for pursuing a goal.

Therefore, the creation of mental models is a useful tool not only to make people agree, but, in particular, to create a common understanding of planning issues. Thus, to have effective spatial planning processes, it is essential the sharing of common mental models, which could improve communication among different actors, also in multi-disciplinary sessions (Zhou *et al.,* 2002; Khoo *et al.,* 2008).

Since the production of an image also implies the creation of connections to some underlying mental models, once again, image reading can benefit from the process of image building. This means that the construction of images has a deep influence on how images can be read and perceived, so that its design goes far beyond what was initially assumed.

## 4. Concluding remarks on the use of visual communication within spatial planning and decision processes

Theoretical and practical literature recognises the effectiveness of visualisation in sharing information among people with different skills and in activating the cognitive process so as to improve the understanding of spatial dynamics and the assessment of territorial issues (Tufte, 1983; Globus, Raible, 1994; MacEachren, Taylor, 1994; MacEachren *et al.,* 2004; Card *et al.,* 1999; Batty, 2000; Spence, 2001; Batty *et al.,* 2004; Thomas, Cook, 2005; Andrienko *et al.,* 2007; Simao, 2009; McCormick *et al.,* 1987; Kwartler, Longo, 2008; Van Den Brink *et al.,* 2007). Nevertheless, the use of visualisation within spatial planning and decision processes implies a set of issues which requires some further consideration.

First of all, the images used to plan a territory cannot simply be a rendering of spatial data, but they have to reveal the hidden connections among data, so as to provide a methodology for increasing their level of information and, consequently, the analytical reasoning

of exploring subjects. Therefore, to be strategic and effective, spatial images should be built as the means for achieving the end of knowledge and action (Bertin, 1981).

This issue is strictly connected to the second one, which concerns the methodology through which knowledge can be achieved by the use of spatial images. Literature on geovisualisation recognises this method in the exploration of spatial data by means of highly interactive devices. In fact, the interaction between image and observer is identified as essential to the growing of a personal awareness and knowledge of the represented object. Interactive tools can provide new opportunities to the observing subject, as the possibility to decide his/her position in the space or to access to specific functions for the construction of the image. In this case, the interactive features can enhance the role of the observer, who, even if partially, can act as a building subject and select and organise data within the image. However, changing the role of subjects involves some changes also in the meaning of the visual outcome. In fact, the real object is directly elaborated by a subject who investigates reality, selects and organises the chosen components, builds his/her own projection of reality and translates it into an image which can be shared with others subjects. The result of such a change in the subject's role is evident in two main outcomes. On the one hand, the image is no more a filter between the real object and the observer's knowledge, but the means for the subject to build his/her own definition of the object. This can be very useful in creating awareness among the actors involved in spatial planning processes, because they can use data exploration as the means for understanding the cause-effect relationships within spatial dynamics. On the other hand, the subjectivity of images increases, because it reveals the personal projection of the subject. Thus, the introduction of a degree of freedom in the choices of the observing subjects generates a decrease of objectivity in the visual output.

Furthermore, objectivity is another issue that the steps of analysis, planning, evaluation and presentation included in spatial processes have to deal with. In fact, the selection and composition of data produce an image of the object which cannot be objective, firstly because it is based on a choice, and, secondly, because the localisation and ordering of data provide them with a specific importance and priority. Furthermore, the personal skills of the subjects involved in spatial processes increase this level of subjectivity within visual communication, because the knowledge of the object is different for each person. Therefore, both the building and the reading of images are subjective processes which scarcely deal with the multiple subjects involved in spatial planning and decision-making. This means that the resulting image is necessarily a subjective and partial vision of reality. A fact that leads to the formulation of a primary question: is the objectivity of images an essential requirement for decision making in spatial processes?

To provide an answer, it is necessary to consider the meaning of objectivity in building images. In fact, objectivity implies that the final object should be the precise reproduction of reality, without any subjective projections. On the contrary, one of the first assumptions of the use of images in spatial planning is their ability in conveying information, which means that the real object is translated into a projected object through a series of intermediate steps, previously identified as a selection and composition of data. As a result of this assumption, spatial processes do not need objectivity, but transparency. In fact, it is not important if the represented object accurately reproduces the real one, but it is necessary to know which process the subjects followed to select data and choose the technique of composition to project a real object into an image. The process of image building translates selected data into an image: therefore, it is the language used to convey

a message and it is the first step to build an opinion which can be shared among a number of subjects. It is the essential step which should be shared in a transparent way among the actors involved in spatial processes.

However, even if the goal of objectivity in the images used during spatial processes can be discussed, the accuracy of the data used in building such images persists as a key issue. The more precise and complete those data are, the more appropriate the understanding of the current status of a territory will be. Nevertheless, this issue does not affect the relationship between objects and subjects in spatial processes, whose effectiveness is generally based on individual skills and abilities in interpreting territories.

In fact, spatial processes need projections. Since the represented object is just a filtered vision of the real one, it becomes the starting point for reading the past and present time of a reality and for projecting it into the future, a concept which is essential in spatial planning (Couclelis, 2005). Only through this partiality it is possible to convey planning actions towards a specific target. In addition, the images used in spatial processes are not unique, but multiple, so that they can be used to show various point of views, and the subjectivity of an image can be balanced by the multitude of views. In this sense, the comparison and overlapping of different subjective images can provide an useful and effective methodology to support spatial planning and decision processes. The plurality of interests can thus be respected, and differences in the spatial impacts of the actors' choices can be highlighted. Finally, since images can create common mental models among different subjects, the multiple subjective projections can be a starting point for feeding discussions on future spatial developments.

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8.

# The Interactive Visualisation Tool (InViTo): concepts and usability

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## Abstract

Spatial planning and decision processes have to deal with the complexity of territory and the multitude of actors involved. Communication among experts with different backgrounds, as well as among non-experts, is often limited by difficulties in understanding technical languages. Visualisation can overcome such barriers and offer a common basis for sharing information and enhancing discussions. Moreover, interaction provides a lot of advantages for users, who can now receive feedbacks to their queries. Therefore, this chapter will describe the realisation of a supporting system for spatial planning and decision-making, named Interactive Visualisation Tool (InViTo).

*Keywords*: geovisualisation; interaction; parametric modelling; sDSS; PSS.

## 1. Introduction

An overview on the state of the art of spatial Decision Support Systems (sDSS) highlights how, on an international level, scientific disciplines are being applied to the studying of new methods and instruments to improve communication among people with different personal skills and cultural backgrounds, and to increase compatibility among tools. Meanwhile, this investigation outlines the new trends on this field of research and, in particular, it defines the more challenging issues related to the usability of existing tools and their ability to respond to the needs of practitioners in urban planning and design.

Decision Support Systems are generally conceived so as to offer quantitative answers to questions which are generally qualitative in nature. Their aim is, in fact, to provide an organised framework for planning processes, in which the different issues are tackled by means of a scientific approach, that is, in an ideally objective, transparent and rational way.

With regard to the technological point of view, a number of innovations are now available, so that the requirements of practitioners can easily be met by suitable and satisfactory instruments. Unfortunately, this technological availability cannot always be converted into tools which can have a methodological usability. In fact, thematic literature highlights the difficulties in communication between instrumental developers and professionals of spatial planning and design. The former aim at technological progress, while the latter

need to apply these tools in a perspective of territorial transformation. The debate on this topic is very rich (Klosterman, Landis, 1988; Couclelis, 1989, 2005; Scholten, Stillwell, 1990; Harris, Batty, 1993; Bishop, 1998; Sheppard *et al*., 1999; Stillwell *et al.,* 1999; Uran, Janssen, 2003; Batty, 2003; Geertman, Stillwell, 2003; Vonk *et al*., 2005; Andrienko *et al*., 2007; Pinto, Antunes, 2007; Klosterman, 2008, 2012; Geertman, Stillwell, 2009; te Brömmelstroet, 2010). In particular, scientific literature agrees on considering the products of information technology as they are, namely instruments, that means they should improve and support the abilities of professionals rather than offering complex models, which may be difficult to understand, manage, use and apply.

Meanwhile, the analysis of the current state of research highlights two main types of difficulties in carrying out spatial decision processes:

– inner structural difficulties;
– external relations, communication difficulties.

The first type can be defined as an issue which is structural to the planning process. It is caused by all the information that cannot be known, such as uncertainty about the future, or that can hardly be quantified, such as abstract factors on the perception of urban quality. In this case, scientific research can contribute with tools that support the systematisation and definition of spatial problems and that, without producing real solutions, allow professionals to build their reasoning.

The second type of difficulty in spatial decision processes is related to the way tools are used by the actors involved. It is a question of communicative nature, at different levels. Although information tools are now able to support the interaction between user and model, and they have overcome many of the problems of incompatibility among different types of data, file formats and extensions, there are still hard difficulties in facilitating interaction and collaboration between people.

Therefore, from a technological point of view, the available tools and devices appear more than sufficient to meet the needs of local decision-making processes. The variety of tools offered is larger than the requests made by planning and design professionals, who look for much simpler tool than those conceived by developers. In addition, these requests are more concerned with practical problems of communication, between people and data, but also between the actors.

Information, intended as the essential step before knowledge and awareness, should be the main target to achieve in spatial planning and decision processes. Scientific literature highlights how many of the problems related to information can be at least partially solved by the use of visual and interactive communication systems. In fact, visual language has a vocabulary and grammar of its own, so that it can be considered particularly suitable for overcoming both disciplinary and geographical barriers. Through perception and intuition, visual communication allows actors to quickly implement their skills in reasoning. In addition, if accompanied by an interactive system, visualisation can be a very effective method for the construction of knowledge (MacEachren *et al*., 2004), which can be both individual and collective, and that would make actors aware of their choices as well as of the effects of such choices.

As a consequence, in order to support the spatial decision processes it is not necessary the development of new software neither the creation of new technologies, but rather it would be preferable to use the existing ones in a way more focused on the communication issue. In this perspective, the research here described has been carried

out following two main streams. The first has generated a constant attention to the latest information technologies and their availability, especially to the open-source ones, as the most suitable for the development of new applications and those with the highest potential spread. The second deals with the effectiveness of available tools, leading to the analysis and evaluation of the existing spatial decision support tools.

In this context, this chapter describes the steps followed for the realisation of a new methodology to support planning and design practitioners in the communication with people with different skills and expertise, in the creation of reasoning, and in building territorial knowledge and awareness. Based on the processing and simultaneous visualisation of data, this methodology aims at providing a simple, highly flexible tool which should be able to give decision makers a visual form for their reasoning during the various steps of the planning process, such as the analysis, the production, the assessment and communication of the plan.

The outcome of this research is InViTo (acronym for Interactive Visualisation Tool), a method for the elaboration, management and visualisation of spatial data which can be used as a support to the processes of territorial decision.

## 2. InViTo: a visual methodology for the management and visualisation of spatial data

The Interactive Visualisation Tool is a methodology of spatial data processing, able to work both as a Planning Support System (PSS) and a spatial Decision Support System (sDSS). InViTo aims at helping decision-makers to formulate their own choices by providing them with an intuitive and easy-to-use support. It is based on data visualisation and interactive communication as a medium for sharing data and arguments between the different actors. Its potential comes from its working on a visual structure, which allows to explain the relationships between the data and, thus, to activate the cognitive processes of individual actors. Therefore, the main purpose of InViTo is not to provide solutions through deterministic mathematical calculations, which may be difficult to understand, but to guide decision makers to build their arguments by themselves.

### 2.1 *Requirements for the choice of instruments*

Due to the large amount of existing tools and applications, the starting point for structuring InViTo has been the choice of not creating an additional program but to use the existing ones more effectively. Therefore, the first task was to find a tool which could satisfy the requirements of planners and designers, without imposing any disciplinary constraint.

Such a tool should be able to manage, process and visualise large amounts of data, variables and results. It should allow the customisation of the entire process of analysis, production, evaluation and representation of plans and projects in order to support their development. In particular, the list of requirements included two key elements. The first related to the interaction between user and data, deemed necessary for knowledge construction (MacEachren *et al*., 2004), and it was expressed as the need to have a tool capable of working in real time, generating visual results that users could explore. The second concerned the overcoming of disciplinary approaches to the study of territory and the search for a highly flexible tool able to adapt its structure to specific case studies. As a consequence, this instrument should be able to be set and calibrated on the specificities of each case, so as to include the local dynamics and the different expertise of the actors involved in the planning process.

The analysis of several existing PSS and sDSS showed a general lack of tools for visualising and interacting with spatial data. While developers build models as complex as the urban system they want to reproduce, the improvement of a system of communication and of the inter-relations among the actors appears limited to a mere representation of results. The human mind needs a simple and linear connection to explain the relationship between causes and effects. On the contrary, spatial models include indexes and indicators that are mathematically expressed by formulas, often very complex. This has strong consequences on the usability of tools going against the needs of professionals for models more communicative and transparent. Users should be able to enter the structure of the model, to understand its working functions and the method by which results are calculated.

### 2.2 *InViTo: the working framework*

The research went on, based on three key elements. First of all, the new approach in supporting spatial planning and decision processes should be based on the visualisation of data in an interactive environment. Secondly, the support system should be able to handle large amounts of data and databases. Thirdly, it should be as simple as possible, to reproduce the linearity of human reasoning process.

Therefore, the analysis of the state of the art in spatial studies brought to the definition of the methodology named InViTo, as the combination and customisation of some software commonly used worldwide, as Microsoft Excel and Google Earth, with well-known tools for the three-dimensional modelling: McNeel Rhinoceros and Grasshopper.

The first tool, Microsoft Excel, has been chosen to handle and process the database of spatial data from different sources, including GIS data. Unlike other tools for managing data, Excel can be easily customised through programming in Visual Basic, which also allows the creation of specific interfaces for each case study. The second tool, Google Earth, is used as an interface for displaying data. It is a web application whose well-known interface facilitates end-users in handling spatial data.

To explore the field of spatial data visualisation, this research investigated the possibilities given by parametric three-dimensional modelling. The best opportunities were found in Grasshopper, a plug-in for McNeel Rhinoceros, a software application commonly used in architectural or industrial design and jewellery production. Although Grasshopper is generally used for small or medium scale objects, it showed a huge potential of application to larger scales. In fact, it is a tool which offers interesting perspectives in three-dimensional modelling by means of the management, processing and visualisation of geo-databases. In particular, it creates geometric shapes and volumes through generative algorithms which are set by the user, thus allowing full control of the visual outcome.

Therefore, Grasshopper appeared as the ideal tool to change the approach to spatial modelling, currently intended as a visual support to the understanding of cities and territories.

First of all, Grasshopper allows the use of different types of input data, such as numeric, textual, audio-visual (raster files) or vector data. This is a very important feature, because it allows high compatibility with other tools used in spatial studies.

Grasshopper is free of charge, so that no licence costs are needed for it, but it works within Rhinoceros that is a licensed tool commonly used in architectural studies. Nevertheless, the use of Grasshopper can be facilitated by a fertile web-community (Davidson,

2009), where many users offer a wide range of free *add-ons* that can constantly implement the utility of the tool. Therefore, also the customisation of Grasshopper, as well as its relations with Excel and Google Earth, is possible, through scripting using computer languages like Visual Basic, C# or Python.

In addition, Grasshopper is structured on a linear workflow which allows a visual coding of data (fig. 8.1). This framework provides the possibility to intuitively manage and correlate spatial data, also by means of mathematical formulas with different level of complexity. This structure also corresponds to a strong ability to create visual cause-effect relationships between the input data and the shape of geometries, which has immediately proved to be a key element in making the urban model a support to the creation of knowledge and awareness in spatial decision processes.

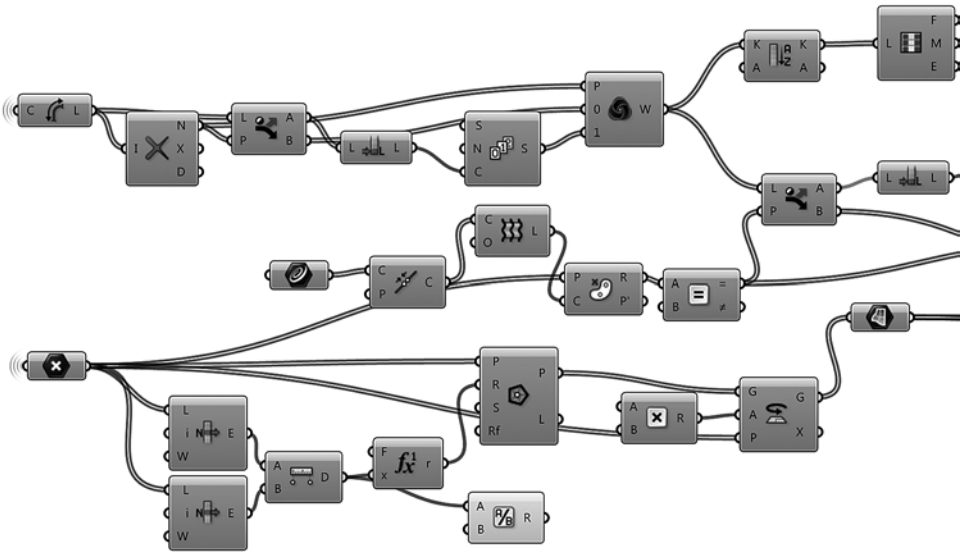

Figure 8.1. The structure of Grasshopper: a linear workflow which includes the functions assigned to a curve (top left) and to a point (bottom left) (Pensa, 2013).

The combination of Grasshopper and Excel also allows the interaction with data coming in real time from the web using specific API to get information from social networking platforms. Moreover, it is still possible to use the same approach with maps or virtual globes, such as Google Earth, for visualising the outcomes of data processing and analysis.

Finally, by means of sliding cursors, users can set the values of different parameters for generating new morphologies (fig. 8.2) and visualising the effects of these changes in real time.

To summarise, the working of InViTo can be defined in five fundamental steps (fig. 8.3):

- data import;
- description of behaviour;
- user-interaction data;
- calculation of results;
- display of output.

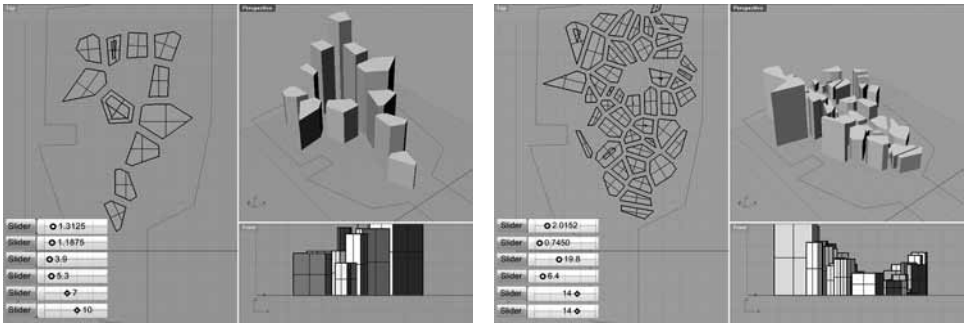

Figure 8.2. Experiments with Grasshopper in generating parametric 3D models (Pensa, 2013).

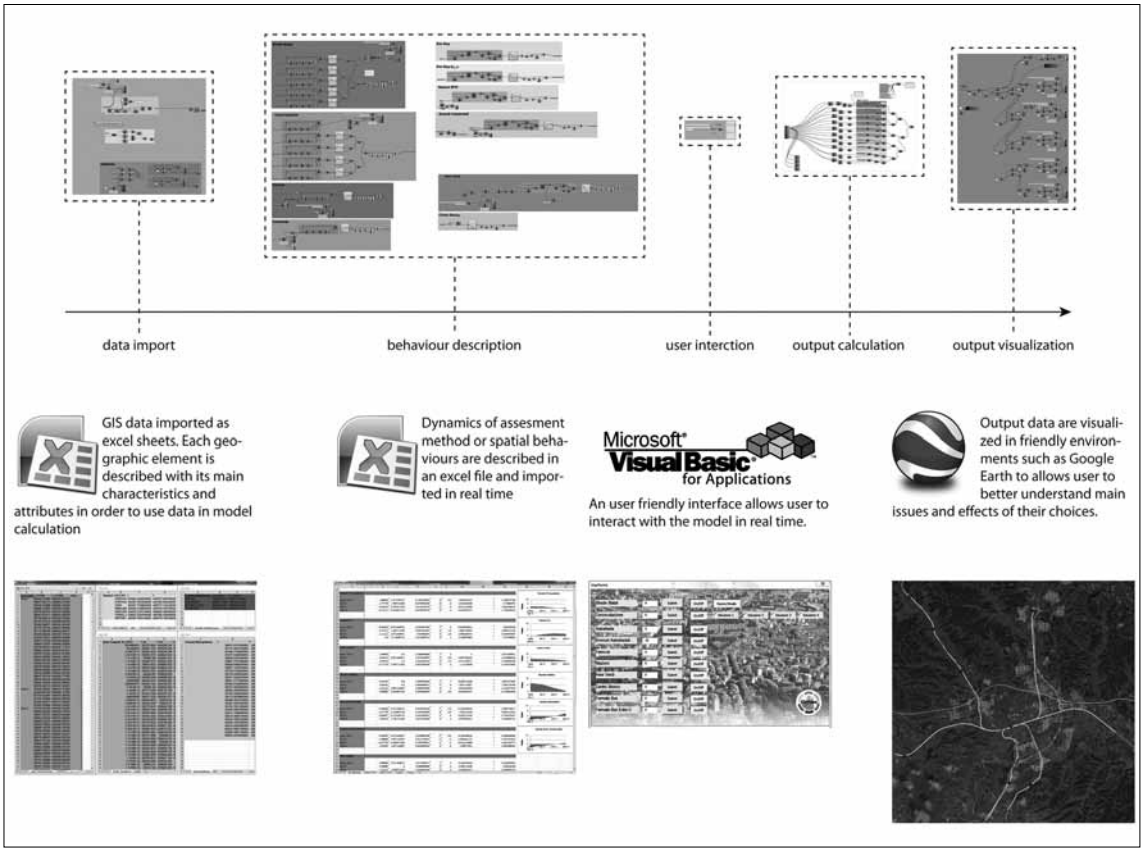


Figure 8.3. Working framework of InViTo (Pensa, 2013).

Each of these steps is made and customised according to the main tasks of the specific case, the scale of the study, and the type of audience to which it is addressed, so that InViTo can be considered as a highly customisable tool. Thus, step by step, an overview of its main characteristics is presented in the following paragraphs, to allow a better understanding of its overall working framework.

*Data import*

The first step for the construction of a case study in InViTo is the import of data (fig. 8.4). Since InViTo aims at using Grasshopper on very large scales, spatial data are first elaborated in Microsoft Excel and then imported in Grasshopper. As already noted, nowadays Grasshopper accepts the most part of spatial data, either raster files, such as images or videos, or vector files, such as CAD drawings, but also different kinds of database as geo-data. This high compatibility has been achieved through the contribution of many users, who have constantly implemented the tool. Initially, Grasshopper did not provide the possibility to import GIS or spreadsheets, so it became necessary to create a specific script in Visual Basic. This first customisation allowed geo-referenced data to be read and used within a parametric and generative environment.

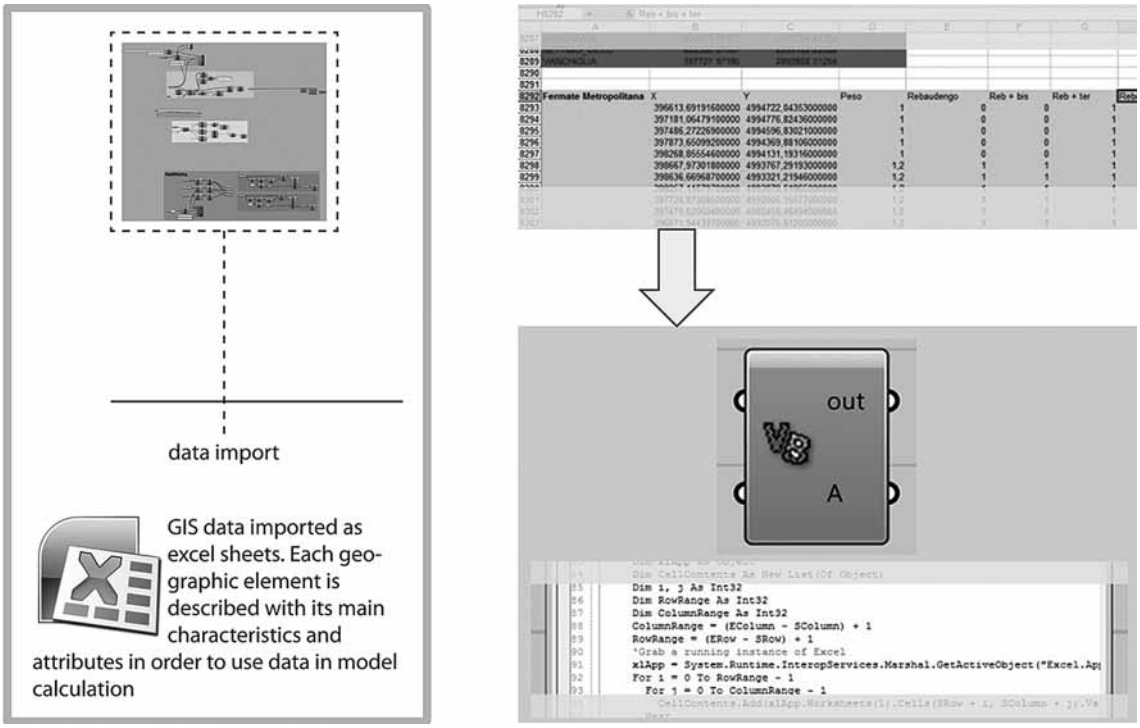


Figure 8.4. Data import: from Microsoft Excel to Grasshopper (Pensa, 2013).

This script was used in InViTo until October 2010, when Luis Fraguada (Fraguada, 2009) published *gHowl*, a new add-on of Grasshopper for implementing the exchange of information over different applications and devices. The replacement of the previous script in VB with the more recent one facilitated and speeded up all the importing process.

*Behaviour description*

Once data are imported in Grasshopper, it is necessary to build a three-dimensional model for the visualisation of data.

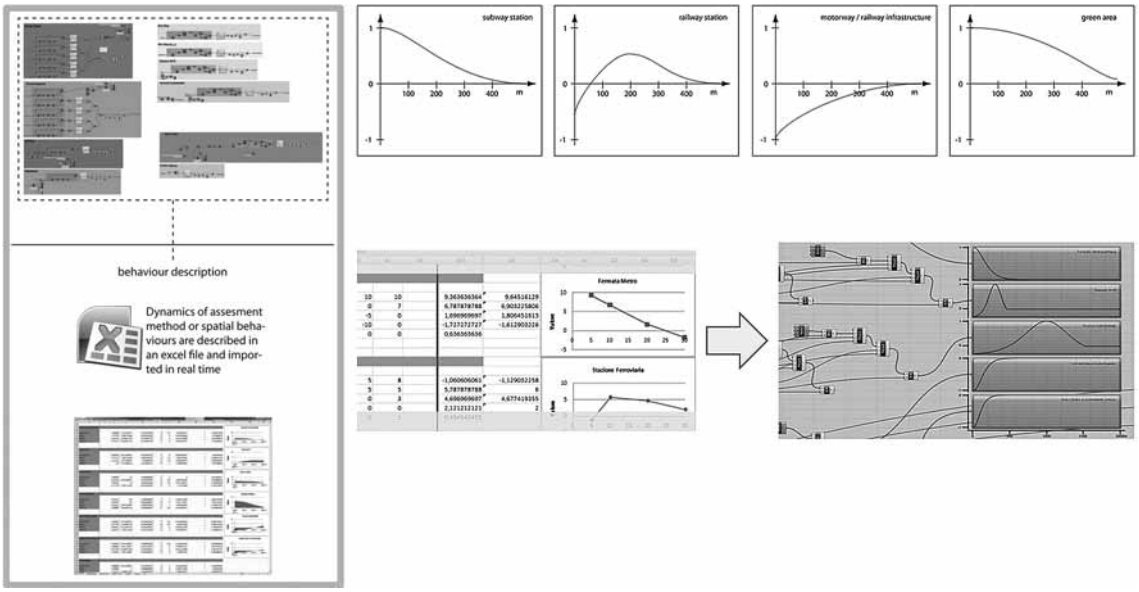


Figure 8.5. Model construction in InViTo: examples of mathematical functions based on spatial distance (Pensa, 2013).

Grasshopper allows parametric modelling, meaning that each geometric element can be controlled by one or more values (parameters), so as to change its form on the basis of a number of variables. At the same time, Grasshopper produces a generative system, whose consequence is that geometries are not drawn as in traditional CAD models, but automatically created from a sequence of predefined commands.

This means that data are related to a geometric shape through a series of actions to complete (fig. 8.5). Grasshopper allows to compose these complex structures of relationships between data, which InViTo uses to build a specific model for each case study. To achieve this task, data have to be:

– associated to a function;
– related to each other;
– associated to a form.

First of all, data must be associated with a territorial function. Information included in databases is grouped on the basis of attributes and typologies. Then, data are related to each other in order to define their priorities and mutual influences, considering that these influences strictly depend on the territorial functions to be studied in the specific case study. Finally, data are associated with a physical or abstract form, which is essential to provide a visual aspect to data.

To obtain these connections among data, forms, functions and relationships, each datum is associated to a spatial behaviour that is described by geometric rules, algorithms or mathematical formulas.

In some cases, data are associated to geometric rules, which attribute dimensional values, such as the height or the footprint area, depending on the values of other variables, such as the distance from a node or the density of use of a space. In other situations, data can be associated to more complex elements, such as the curves of influence. For example, data collected by means of surveys may be used to construct the curves that describe

the behaviour of an element with respect to the spatial distance from another element. These curves can be included within Grasshopper to relate two or more elements and can also be dynamically changed on the basis of new requirements. Nevertheless, it is also possible to increase the complexity of relationships among elements, while, in other cases, data can be related according to algorithms or mathematical formulas, depending on the objective to be achieved.

The building of such models necessarily requires a good knowledge of Grasshopper, as well as some familiarity with GIS data. Therefore, specific technical skills are required. However, unlike traditional models, the structure of a model built in Grasshopper can be very easily understood. In fact, the structure of the model consists of a sequence of functions and relations between all the objects included in it. Each connection between the various elements is filtered by a mathematical operation that defines how the single component acts in the geometric space and influences its surroundings. The complexity of relationships is included in the mathematical formulas, and not in the model structure. In fact, the model is based on the linear organisation of data; more specifically, it is conceived as a flowchart, which defines the hierarchy and relationships among data.

The result of this sequence of actions is simultaneously displayed either in Rhinoceros or Google Earth, depending on the case. This means that each action is transformed into a geometric, visible shape, which is dynamic and changes in real time according to input data.

*User-data interaction*

Once the model has been built, it can be interfaced with the user (fig. 8.6).

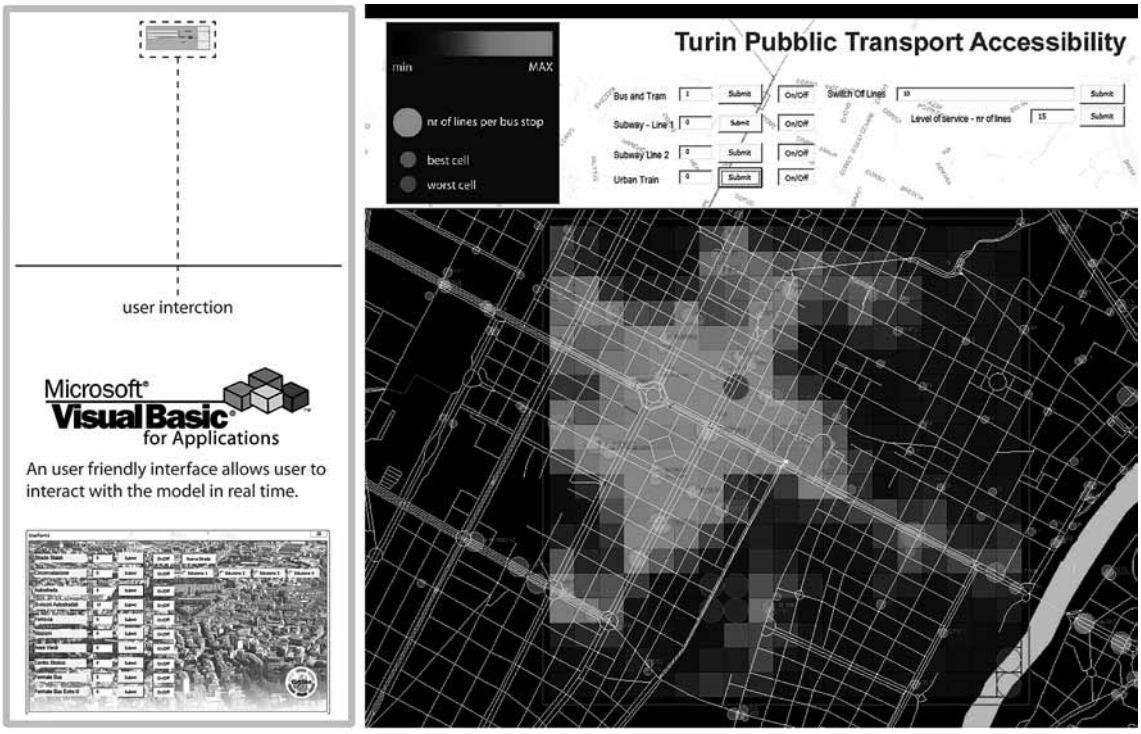


Figure 8.6. User interface of a model built in InViTo (Pensa, 2013).

The building of a user interface is not necessary, but it is recommended, to ensure participation and cooperation among the actors involved in the spatial planning and decision processes. The interface implements the perceived transparency of the model and, furthermore, it helps the *dialogue* between the settings of the model and its users.

The interface can be built by means of a Visual Basic programming, to connect the database in Microsoft Excel and the values given by users. Two levels of setting can be done in a model built with InViTo. The first concerns the setting of the model, its calibration and validation, where users can change elements such as:

- mathematical formulas, as well as the values or curves resulting from the behaviour of elements included within the model;
- the structure of connections between the different elements;
- the values of the indicators;
- the weights assigned to establish priorities among the different elements.

The second level of use of a model built with InViTo employs the settings made in the first level to support the discussions in the planning or design sessions, in which the topic is not the working structure of InViTo but the reasoning on territorial issues. Here users, notably stakeholders, are asked to interact with some parameters in order to decide the weights among different elements which constitute the key components of a spatial area, such as infrastructure, services and functions. However, depending on the case study, the model can be set in different ways, allowing users different levels and possibilities of interaction.

Some attempts have been made to investigate the use of particular devices, such as laptops, smart phones and tablet PCs, distributed among the participants in the spatial planning and decision processes. Even if very interesting for enhancing participation, this test increased the number of questions about the importance and the degree of freedom allowed to each user. It also opened new issues, as the modality of editing the model in sessions with multiple individual devices working at the same time; besides, it generated some doubt on the value of the weights given by participants with specific knowledge. These issues proved essential to the transparency of the process and, therefore, to its effectiveness in real working sessions.

*Outcome processing*

Now the model has been set with curves, parameters and weights, so that results are immediately calculated and instantly rendered in a visual form.

The output is a *what if?* response which indicates the localisation and intensity of a spatial effect following a specific planning choice. It is a spatial outcome, which relates decisions to their consequences on land, without providing information on time dimension. Unlike simulation tools, InViTo does not make temporal projections, considering time as a variable linked to political choices and economic contingencies, which cannot be spatially mapped. However, InViTo can work on different scenarios at the same time, providing different visualisations depending on various temporal phases as well.

InViTo does not intend to predict future land use neither to provide solutions, but it aims at supporting the discussion between the actors of spatial planning processes by analysing problems and helping the reasoning. It avoids models built on complex calculations, since their usability is very difficult also for experts and professionals. It provides priorities to communication between the actors rather than providing accurate simulation of uncertain future scenarios, so that it prefers a simpler, but more comprehensible model.

*Visualisation of the outcomes*

The outcome of each model built using InViTo is a parametric three-dimensional model generated by a sequence of mathematical and/or geometrical rules. The spatial behaviour of data is represented by shapes and volumes that change their geometry according to the actors' choices. The visualisation of these geometries can be set in a two-dimensional space, but also in a three-dimensional environment (fig. 8.7).

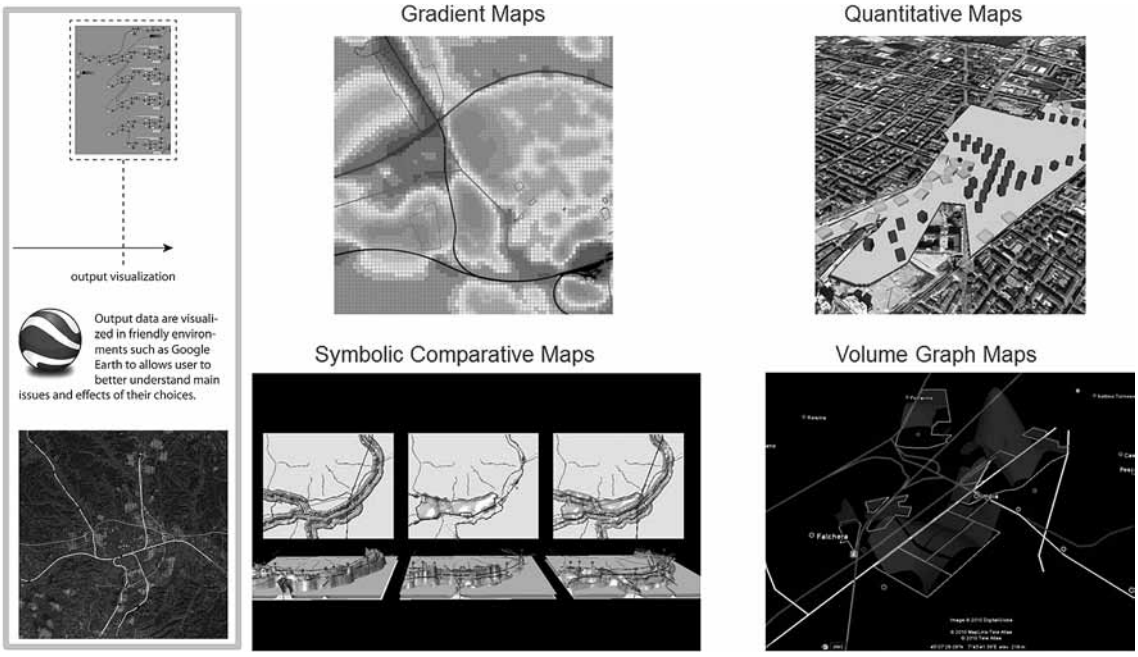


Figure 8.7. The generation of visualisations: different typologies which can vary depending on the task and target of the case study (Pens, 2013).

Each shape, colour and size is chosen through Grasshopper and set as a sequence of actions to be associated with geometric data. This means that the visualisation of data is fully customisable and adaptable to the specificity of the case study. As InViTo is based on a three-dimensional modelling software, it can provide three-dimensional models directly from the processing of databases, thereby maintaining all the features of original data. This also allows a choice among different methodologies and techniques to visualise data. It is possible to generate dynamic maps, as well as three-dimensional models, three-dimensional diagrams, gradient maps, and, in general, InViTo can work on thematic views that describe various parameters, such as the desirability, the density or the property values. These views can be freely explored, allowing navigation to take place at any scale.

The outputs can be displayed within the windows of Rhinoceros, but since the data to be displayed are geo-referenced, there are also other opportunities. One of these is the virtual globe of Google Earth, where an interactive interface can be added directly from Grasshopper. While the interface of Google Earth can only handle a selection of

colours and levels, the interface built by Grasshopper provides users with an instrument for exploring spatial data, allowing the change of the values of parameters, indices and weights included in the model. The use of Google Earth provides some advantages, in particular due to its widespread notoriety. In fact, it is one of the most popular virtual globes, so that many users will already know how to explore the data included in the model. Moreover, it simplifies some parts of the modelling process because it makes freely accessible databases available, generally updated or easily adaptable. However, Google Earth cannot always be used, due to the particularity of some requirements. For example, it is not possible to work in parallel windows to simultaneously visualise two or more planning scenarios. In this case, it is necessary to use the views of Rhinoceros.

Data visualisations produced by InViTo can be frozen in raster images, transformed into three-dimensional models or converted in geo-referenced database. This wide compatibility provides a wide range of possibilities for applying the output in other studies.

Finally, thanks to its quick response, InViTo provides actors with a tool for working with information in real-time, which makes it particularly suitable in collaborative sessions such as focus groups, workshops, meetings and public debates.

### 2.3 *Some innovations provided by InViTo*

Scientific literature on Planning Support Systems (PSS) and spatial Decision Support Systems (sDSS) highlights several factors that hamper the use of these tools in daily professional practice. InViTo aims at overcoming some of these barriers, focusing more on facilitating the process of knowledge construction rather than on implementing the calculation power of the tool. Thus, InViTo focuses on:

- visual communication of data;
- interactive framework;
- flexible structure;
- transparent system;
- management of large amounts of data;
- easily adapting to the different parts of a territorial decision process;
- a structure able to enhance the individual abilities of the users.

First of all, InViTo is based on the visual communication of data. It aims at sharing a common platform among the actors involved in the decision making process, in order to facilitate their cognitive process by means of intuition and perception.

Secondly, InViTo offers an interactive structure so as to strengthen the dialogue between user and model. It provides answers to the user's inquiries in real-time, thus feeding discussion between the actors and supporting the cognitive process of users. This feature makes the tool really interesting to stimulate participation in workshops and working groups.

Third, InViTo offers a flexible structure. Unlike many models used to calculate spatial data, such as cellular automata (CA) or agent-based (ABM) models, which hardly cope with the particularities of new case studies, InViTo is easily adaptable to different applications in its scale, purpose and project.

Fourth, InViTo works in a transparent system, so that users can easily read a model and use their personal experience to inform it. This is essential to make the users understand

and trust the model, avoiding the black box approach (Latour, 1987) which has so far dominated the history of urban modelling. InViTo focuses on implementing communication towards and between actors, dismissing the notion of urban modelling as a conversion of reality into automatic processing. It uses its structure to be informed directly by users on the basis of a discussed and shared consensus, so that the process of calibration and validation of the model can, in specific situations, be obtained automatically from the use of experts.

Fifth, InViTo can handle large amounts of data, allowing for application on very large scales. Currently, only ESRI products (ESRI, 2012) provide technologies to manage geodatabases within three-dimensional parametric systems, but they have high licence costs and require high technical abilities to be used.

Sixth, InViTo can offer support throughout the whole process of spatial decision. Unlike other PSS or sDSS, which can be applied only in specific stages of the process, it can be used during all the different steps of analysis, design, evaluation of the plan, as well as for the presentation and communication of final outcomes.

Finally, InViTo has a linear structure, which is consistent with the linearity of human reasoning. It aims at implementing the individual abilities of users, helping experts to keep in mind the effect of several variables and providing sums, differences, overlaps and intersections between the different maps.

## 3. Usability of InViTo

The application of InViTo to different case studies (Pensa, Masala, Lami, 2013; Pensa, Masala, Marina, 2013; Lami, Masala, Pensa, 2011; Pensa, Masala, Marietta, 2011 ) showed its flexibility to be adapted at different purposes and to be used on various spatial scales. Its use during workshops and focus groups has been judged by partecipants as useful in sharing data and information, in promoting discussion among the actors involved in planning processes, and, in general, in supporting participative and collaborative processes.

Its three-dimensional visualisations have been rated by participants as eye-catching, but less useful and easy to understand than colour scaled maps. In fact, bi-dimensional maps resulted more intuitive and no communication problems have been observed in relation to their use.

Furthermore, many users have found very important the effectiveness of dynamic maps in expressing spatial localisation and the distribution of effects due to the actors' choices.

In general, the participants in the workshops and focus groups in which InViTo has been used as main supporting tool have positively evaluated its usability in collaborative processes, focusing on its effectiveness in enhancing information sharing, knowledge building and supporting discussions.

*Acknowledgements*

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SECTION III

# The application of InViTo in the Asti case study

9.

# Asti: urban context and its brownfields

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## Abstract

The problem of abandoned areas is crucial for local economy and sustainability. Since many abandoned and under-utilized properties lie within economically distressed communities, land recycling offers benefits and stimulates re-development in these areas. This problem is diffused in European countries that are living a critical situation for social and economic problems. A complex approach is necessary: in this way the support of a trans-national work team and approach could be helpful. The case study of Asti is explained and contextualized with an overview of the approach to brownfield redevelopment in a medium-size Italian city.

*Keywords*: European project; brownfield; remediation solutions; medium-size Municipality.

## 1. Introduction

The Municipality of Asti has taken part in the CircUse project, dealing with its themes and goals, in cooperation with SiTI – Higher Institute on Territorial Systems for Innovation, a non-profit private research centre based in Turin.

While land recycling has great economic and environmental benefits, without the right tools, skills, and knowledge re-using land can produce certain challenges. When a brownfield redevelopment project comes to fruition, local communities experience benefits such as neighbourhood revitalization, or a reclamation of land for public use.

By forming partnerships with various actors, maximizing available financing, and implementing smart growth principles, Asti could demonstrate an advanced and integrated approach to manage brownfield redevelopment projects, thanks also to the testing of a decision support tool as InViTo, which helped the Administration to cope with complex and tangled data about the Way Assauto pilot area.

## 2. Asti territory: local context for a revitalization project

The Province of Asti, in the heart of the Piedmont Region, is famed for its rolling hills with a wealth of vineyards and age-old farms, as well as for the area's food and wine heritage. It is the leading wine producing province in the Region, with over 5.000 vineyards

and wine making companies, alongside important industrial operations and production co-operatives. The Province counts around 220.000 inhabitants, less than 5% of the total inhabitants of the Region.

The vocation and main activity of this territory is therefore agricultural, and it is characterized by a unique landscape, developed along smooth hills covered by vineyards as far as the eye can see, interspersed with small villages and valuable medieval castles, where wine-growing activities have been the focus of economic and social life for centuries. Recently, a vast part of the province, counting as its core zones five production sites of different wines, has been proposed for the inscription on the UNESCO World Heritage List as "The Vineyard landscape of Piedmont: Langhe-Roero and Monferrato", which is now under process of nomination.

Asti town is then surrounded by this valuable landscape, which is facing the challenge of preserving its historical heritage while evolving according to the needs of modernity, of new infrastructure, and adapting to up-to-date production techniques.

Asti, the capital of the Province, hosts today around 70.000 inhabitants. It was funded by the Romans, and had an important role in the Roman Empire for commercial and strategic reasons, even if it reached the peak of its economic and cultural splendour in the 13$^{th}$ century, when Asti was the most powerful city in Piedmont. Consequently, the town has a rich and outstanding historical heritage dating back to this period, nowadays recognizable in the city centre, with its streets, palaces, towers and churches.

Asti has a high potential connected with the 'Slow Food movement', with a touristic ambition due to its landscape preservation, agricultural products and the offering of a huge amount of opportunities for food and wine. However, its tourism vocation is partially discouraged by rather poor accessibility, as the city is not efficiently connected to the main international and national hubs.

Furthermore, the city has a strong manufacturing history, developed especially during the golden age of Italian automotive sector. It developed on several industrial plots, some of which are particularly huge, when compared with the size of the town. Since 1980, the industrial activity started to decline, so that many areas have been abandoned.

Craft companies, though, have an important weight in the economy of the province, with over 7.000 firms[1] distributed in various sectors: building counts for 47%, followed by manufacturing, business and personal services. Asti also hosts one of the main Italian industries in the food-production sector, the well-known Saclà.

Crafts represent 27% of the local enterprise fabric and produce about 20% of the GDP, a position above the regional and national average.

## 3. Asti in European projects: an eye to organizational structure

European projects are increasingly gaining the interest of public administrations in Italy, as they offer the opportunity to develop programs, knowledge, and to learn from partner cities facing similar problems; this is particularly important due to the period of deep crisis we are crossing, as funding for local authorities has been almost completely cut at the national level, and in Italy municipalities have to respect the so called *Patto di stabilità*, an agreement which has paralyzed municipalities' investments in the last years.

[1] Data provided by Piemonte Agency for Investments, Export and Tourism, in the working report "Asti, Piemonte, North-Western Italy".

EU funded projects are therefore considered as one of the few breath-taking solutions for working on action plans and strategic programs for the territory. What has to be noticed, nonetheless, is that not always the organization inside a public administration is suitable to this short term task, which require a slenderer and more responding structure, not usually encountered in the complex bureaucracy of Italian public offices.

Thanks to contributions from the EU Community, public and private institutions of the EU countries have the opportunity to build international projects in various fields of action, as the culture and education sector, environmental policies, health issues, social policies and urban planning, to cite just some of them.

Participation in European projects allows to enrich experience and technical knowledge, scientific and cultural education, and to fully develop as Europe's most advanced, most dynamic and competitive cities. And also, participating in a Community project means working in an international dimension, dealing with foreign partners, getting to know innovative experiences at the European level, testing good practices already realized in other countries, inventing new and innovative solutions to give a broader perspective to local policies and initiatives.

The European Commission, in fact, runs a huge number of funding programs aimed at the local, regional and national level in different fields of action; but, while some European countries have assiduously worked in the formation of skills and professional competencies in order to get project proposals funded through EU tenders, and to manage European projects within public administrations, taking advantage of it, Italy has often lagged behind and has not been able to fully exploit the opportunities offered. This delay is mostly due to the fact that in the public administration offices there is often a lack of appropriate facilities and skilled professionals able to find timely information on financing opportunities, to draw up projects, to keep relations with the European Commission and to properly handle the financed proposals. The Administration often has to temporarily employ external experts, in order to face the added work amount, and the expertise gained at the end of the EU project is not kept inside the public offices.

Besides, modern cities are experiencing more and more pronounced levels of competitiveness (Thornley, Newman, 2011). In Europe this has become particularly evident since the early 1990s, when cities had to assert themselves in the new global economy, going beyond the limits of national economy (Borja *et al*., 1997). Today, competition between cities has become more and more selective and this requires the ability to internationalize and to rethink and reinvent their role. New paradigms are taking place, clusters represent a new way of thinking about national, state, and local economies, and they call for new roles for companies, government, and other institutions in enhancing competitiveness (Porter, 2000), to play an even larger role.

Even smaller cities of the industrialized world must update and adapt their tools, policies and planning schemes, building networks in order both to learn good practices developed in other contexts, and to export their know-how as well as their innovation, gaining a leading role.

In Italy this problem is now spreading not only through academics and experts, who started debating it some time ago, but also in the public administrations that are concretely facing it. Participating to EU funded projects, exchanging knowledge, building networks and confronting with cities facing similar problems, are all ways to try to overcome this stagnation period.

The town of Asti equipped itself with a European Projects Office dealing with the European territorial cooperation issues, and monitoring calls and funding opportuni-

ties, and is trying to tackle this innate deficiency of public offices' organization, which has become a real and acute problem with the economic crisis.

Some characteristics of the city have turned into qualities that make Asti particularly suitable for participating in innovative cooperation programs.

First of all, its size: realizing innovative projects that have an impact on the environment, on population, on local economy, requires a not excessively wide area of experimentation, to contain the necessary investments, and to quickly monitor and assess the results of the action.

Secondly, the presence on the territory of systems, infrastructures and organizations which can support the projects incrementally, acting as an existing important set to be enhanced.

In 2010 the Municipality of Asti has joined the project partnership of CircUse. The project offered an excellent opportunity to deal with sustainability issues, and to undertake one of the main problems of the city, i.e. a huge presence of brownfields to be reclaimed and reused.

## 4. Brownfields and dismissed areas in Asti: the Land Use Management Database

Despite its medium size, Asti has many abandoned sites located both in the city centre and in the periphery outside the urban agglomeration. The first step of the CircUse project was to survey and map each one of them, collecting information on their state, through an on-field survey.

A first survey, made in partnership with Asti administration, allowed the identification and mapping of 23 dismissed areas (fig. 9.1), 7 of which being former industrial areas and 8 being buildings currently used for social functions. In fact, the changes of needs and procedures, as well as the cuts to social services, caused the abandonment of a lot of historical buildings located within the city, such as former hospitals, clinics and military buildings.

The industrial brownfields, mostly located in the eastern part of the city, cover areas which are more than 20.000 $m^2$ wide, while the former social buildings in the inner part of the city have smaller dimensions (less than 4.000 $m^2$).

For both situations, the Public Administration of Asti has to define new uses, not only because of the importance of avoiding decay in the consolidated city, but also because of the urgent need of solving the contamination problems of huge brownfields in its peripheral urban areas.

A map was then produced, showing abandoned areas and buildings inside the municipal boundaries in order to compare useful information to decide which pilot area would be chosen for the CircUse Action Plan. The map was based on GIS traditional instruments, connected with a Microsoft Access database. This tool, one of the main outputs of the CircUse project, was produced in English and successively in each one of the partners' languages, and was successfully applied in the different European contexts.

The Land Use Management Database (LUMD) was designed to support local decision makers on land use options and to monitor the impacts of reuse projects. With the development of the LUMD, local authorities got the tool for flexible, strategic and operational land use management based on the availability of relevant selected and classified data about the current state of land use, with specific focus on available underused, abandoned or unused areas and their potential for re-use. By using hyperlinks, various digital documents (e.g. photos) can be saved directly in the database.

Collecting info and photos about underused areas, checking their actual condition, looking for data on contamination and previous uses, is a new work for the Municipality. Until now abandoned areas have been discussed only during internal meetings with paper maps when some event occurred, or on proposal of private investors interested in the area, and the Administration was seldom in possess of up-to-date data.

The CircUse project gave the opportunity to update the tools and instruments for urban planning used by the Municipality; it succeeded also in promoting dialogue between various technical sectors inside the Municipality that were formerly used to work independently, as the Urban planning, Territorial planning, Historic heritage and Environmental planning sectors.

The LUMD is an helpful tool when looking for private partners' involvement on land reuse: in fact a potential investor can quickly and easily visualise the opportunities in Asti Municipality, the characteristics of each area (size, previous use, building, degree of soil sealing, etc.), the rules in force for urban planning, and – when it is known – the degree of contamination, holding then many useful elements for a pre-feasibility assessment.

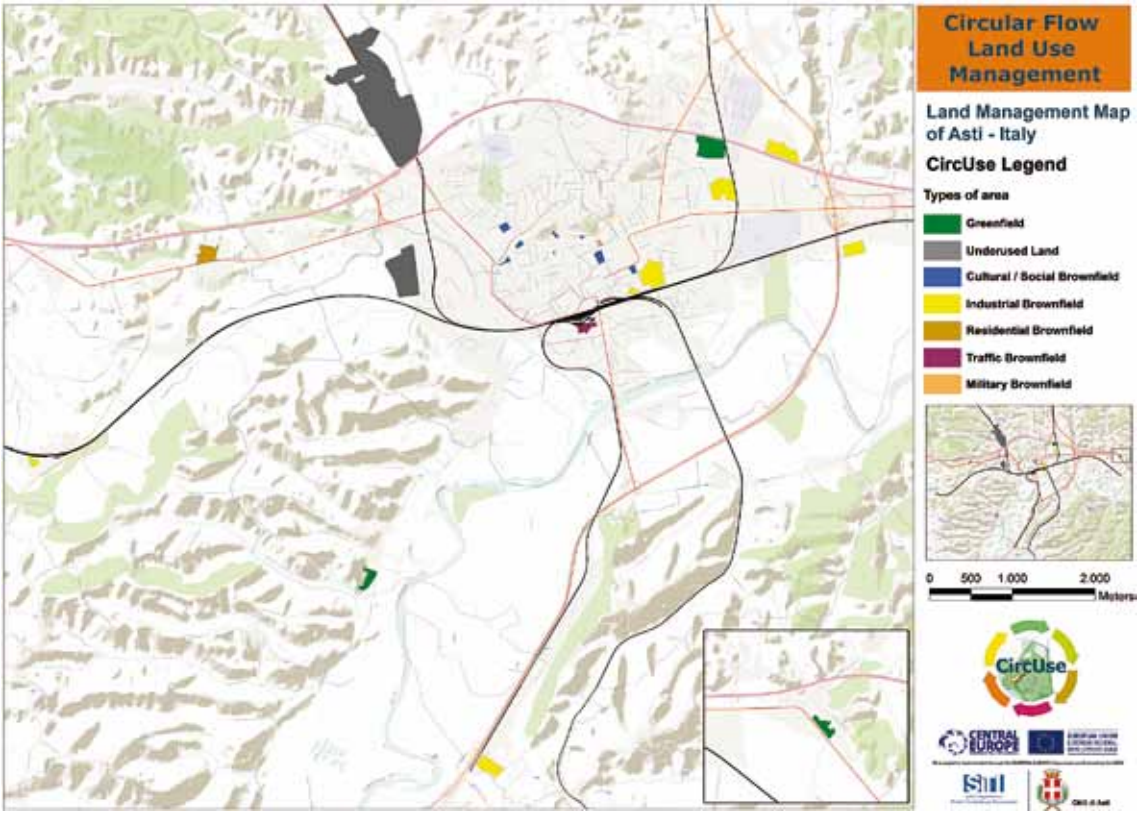


Figure 9.1. Land use management map (elaborated by SiTI for the CircUse project, 2011).

## 5. The pilot area selection process

The general survey on dismissed areas performed through LUMD brought attention to three sites that seemed to be the most interesting ones for the Administration.

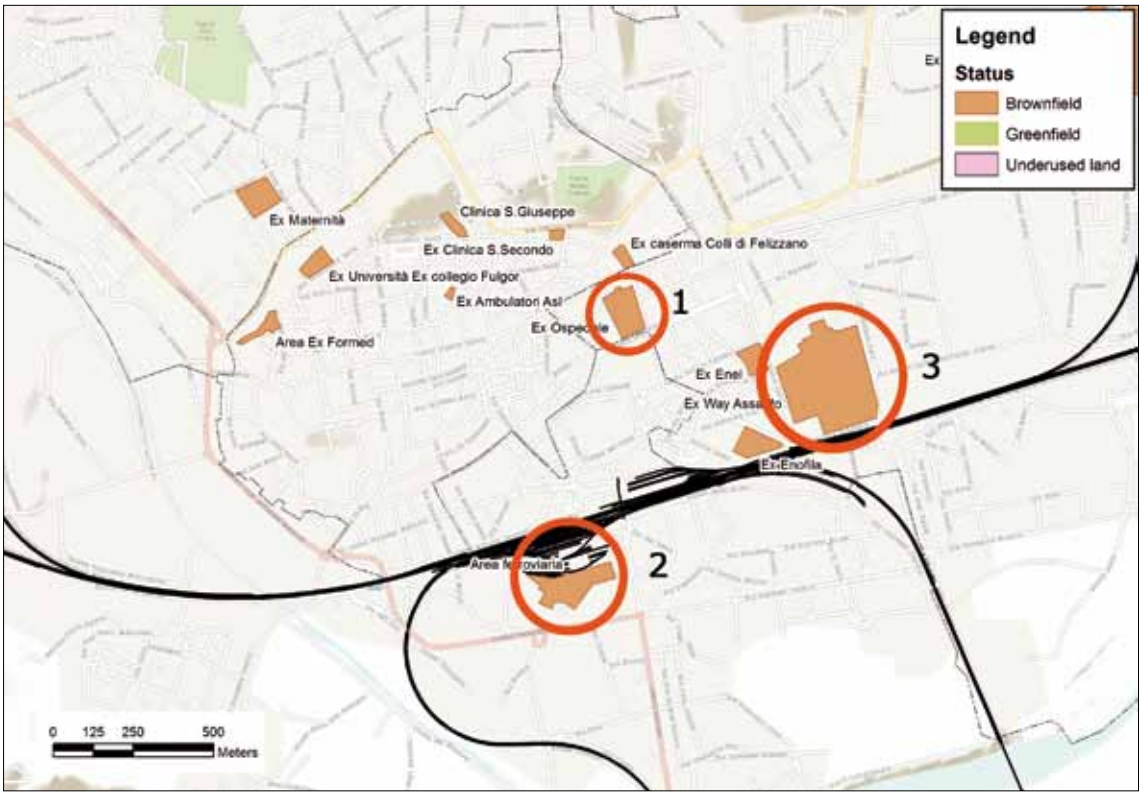


Figure 9.2 The pilot area selection process (elaborated by SiTI for the CircUse project, 2011).

1. Former hospital. Located in a very central position, the building has historical and architectural value (Grattapaglia, Campia, 2010). It functioned as a hospital since the XVI century; it was then restored and a new building was added to better fit the community needs. It was abandoned in 2004, when it became too small; today it is still empty and unused. Its most ancient part is under law protection for its characteristic old style structure, with arcades and a green courtyard.
2. Railway maintenance area. Very close to a new residential neighbourhood, it is a low quality area, adjacent to the railway. The Administration has recently decided to refurbish part of the area: the so called Ferrotel building, a former hotel for the accommodation of railway workers, was to be renewed to realize temporary housing for people in trouble.
3. Former industry Way Assauto. The big factory, founded in 1907, used to have more than 2.500 workers in the '70s: after a lot of vicissitudes, it failed in 2010 when it had about 250 workers. The industrial area, today almost totally dismissed, measuring approximately 95.000 $m^2$, is close to the city centre. The site is heavily polluted by the chemical agents used during chromium plating processes.

A deeper analysis of the sites was led while the database construction went on. The area to be chosen had to be of top interest for the Administration, since the resources and efforts granted for the CircUse project had to be usefully conveyed, with a challenging problem to solve. In addition, it seemed more suitable, when applying a sDSS tool, to take as case study a brownfield that had no re-use proposal.

The former hospital could attract investors because of its high-quality buildings and its privileged position in town. The reuse would probably follow the ordinary logic of market and functional substitution, preserving the historical values, according to the urban context around it, and a discussion table had already been launched at the time the CircUse project was started.

In the same way, the railway maintenance area didn't seem the best choice, as the time horizon for its total abandonment was not really defined yet. A large part of the area was still used for railway services; at the opposite site, on the Ferrotel area, Municipality was already starting works for reconversion. The risk was that, for a long time, re-use would be limited to on-going intervention part, and could not be extended to the whole area.

Figure 9.3. The Way Assauto historical building stock (Melis, 2011).

Figure 9.4. A view of the inner area of Way Assauto former industrial site (Melis, 2011).

The former Way Assauto area, on the other hand, had a great deal of interesting points.

First of all, a wide surface, extremely close to the city centre; to get an idea, the size of the area is approximately three times the big square in which every year the famous Palio of Asti (historical horserace) takes place. That would open to a large number of possible reuses and mix of destinations.

The second challenging point is its underutilization for a long time, with no solid perspective of industrial reuse.

A big issue is then represented by the environmental limitation connected to the pollution in the area, which requires huge investments for reclamation.

Finally, when mentioning this area, Asti citizens recall a negative event, and social tension is still alive, due to the environmental disaster suffered by the inhabitants of the neighbourhood, caused by the Way Assauto chrome spilling.

All those factors suggested that it could be more useful and interesting to apply the sDSS InViTo model to the former Way Assauto then in the other sites. Choosing a new use is in fact very complex and here, more than in other brownfields, it was important to provide a tool to stimulate a participated process to find a re-use that could spur the development of Asti, as well as make people re-approach this area.

Some highlights and data on the chosen area: of the total area of 90.000 $m^2$, about 80.000 are affected by production activities (55.000 are occupied by buildings, 3.000 are destined to car park and the remaining areas are internal roads and logistic spaces).

The plant started its activities in 1908. Its buildings were constructed at different times, from the first activities until the '90s. Initially, the main processes were the casting, pressing and cutting of metal and the production of screws, nuts, bolts. During the 1st World War detonators were produced, as well as fuses and projectiles, but not explosives. After the war, the plant resumed its original asset and started making products for the automotive and cycling sector. From the '50s on, Way Assauto started the production of shock absorbers that would become its main activity in the following years, making it the main industry in Asti until the '80s: it employed in the best years around 2.500 workers. During this period it was included in the IAO group, an American corporate company[2].

In 1999 a serious accident took place, and from the chrome plating department polluting substances started spilling out, with a contamination of the soil and ground waters by Chrome VI. It spread around and water serving the inhabitants of San Fedele neighbourhood was no longer safe.

A hydraulic barrier was implanted, after the incident, by the responsible directors of the plant: it is composed of eight wells and collects the ground waters flowing beneath the plant, treating them both for chromium and solvents. Semi-annual monitoring shows that the operation of the hydraulic barrier is efficient. Monitoring is carried out on 11 wells inside the plant, 22 outdoor and three private wells in a residential area close to the factory. A lawsuit is still open, and further action has to be taken to reuse the area.

Nonetheless, the property of the industry passed in the hand of Chinese investors in 2011: production and research still went on for a short time, but lately (May 2013) employees have been dismissed, machinery has been removed and the production transferred to China, thus leaving the site completely empty and abandoned.

## 6. The remediation proposals

The former Way-Assauto area is an interesting pilot case, as mentioned before, because in the past years it has been contaminated by a chemical shedding that reached the underground water level, and therefore it has a chemical reclamation plan, on which the Municipal Administration and the Regional Environmental Protection Agency (ARPA Piemonte) have been working for years.

[2] The research was conducted by Franca Inno for the Historical Archive of the Municipality of Asti (not published).

The CircUse project offered the opportunity to update the previous assessment and the estimated investment according to the new remediation techniques available on the market. Remediation of a brownfield site implies the removal of all known contaminants to levels considered safe for human health. Redevelopment can take place only once all the environmental health risks have been assessed and removed. It can be an expensive and complex process, and it needs to be seriously considered before making decisions on brownfield land.

The biggest problem is represented by the balance between costs and real estate's value. This is one of the main obstacles to the regeneration of brownfields. Market trends establish the value of land on the base of position, accessibility, landscape, urban standard, distance from the city centre, and of course, costs of remediation. The public administration should first of all find solutions to protect the citizens' health, to give back to the community public spaces, to eliminate potential sources of degradation inside the city.

Waste problems, past chemical hazard and contamination: environmental requirements pose the biggest obstacles to a timely brownfield redevelopment when Public Administration is in charge of it, as costs are often exceeding the real value of the land and buildings. A purely economic approach has therefore to be abandoned, in order to consider benefits for the society in terms of health and usability of the area.

Beside this, financial and legal problems play an important role too: public ownership and financial assistance are critical, as well as the possibilities of attracting new investors. This is exactly the case of the Way Assauto area.

In this case, the reluctance to redevelop the brownfield site was associated with the uncertainty regarding risks: wrong location, redundant infrastructure, decontamination costs, high rehabilitation costs and low real estate value. With the help of the InViTo tool on one side, and of a study on remediation costs and techniques on the other side, some of the unknown risks came into light and became a real object on which the Administration could make appropriate decisions.

The study on contamination was carried out by the Chemical Department of the University of Torino. The results proved that reclamation with innovative techniques would be relatively low-cost compared to traditional processes, with the benefit of protecting and preserving the environment.

Despite its high degree of contamination, a significant portion of the site (33.570 $m^2$) seems to be immediately available for re-use for both commercial and residential redevelopment, with the sole constraint of planning only above-ground structures (no basements or underground parking). A capping of non-contaminated soil of about 50 cm has to be placed over the existing ground to avoid dermal contact and ingestion of original soil by the future users of the area.

A second portion of the site (12.710 $m^2$) seems to be immediately available for re-use for commercial/industrial redevelopment only, with very light remediation intervention to be carried out.

A third portion of the site (48.560 $m^2$), which is the largest and heaviest polluted one, still requires strong interventions of remediation before the risk related to the contaminants present in the soil and in the groundwater allows redevelopment for industrial, commercial or residential use.

A draft revision of remediation costs ends up to about 11 million €. It has to be pointed out, however, that the costs for interventions to be carried out for the first area only (33.570 $m^2$) are about 250.000 €, which allows the Municipality to consider a real and quick possible redevelopment.

## 7. Local urban planning and re-use proposals

The current General Urban Plan (the so called *Piano Regolatore Generale del Comune di Asti*, approved with D.G.R. n. 30-71 on May 24, 2000) is based on the concept of urban growth and enlargement of the city. From a careful analysis of the present situation, it is evident that the goal is not consistent with any principle of sustainable development. The city appears to have a large housing stock in good condition, though not fully exploited. Many residential buildings and apartments are not inhabited, neither by the owner nor by tenants.

Nowadays, it is necessary to re-consider and re-calibrate the future development of the city. In the past years, when the building sector was a driving force in the city's economy, it seemed that the city was going to grow unremittingly, acquiring new dwellers, and an exponential increasing of the capacity of residential areas has therefore been included in the city master plan, by zoning new greenfield for residential settlements.

Even when data on the population growth inside the city started showing a decreasing trend, a positive trusting attitude continued: data on immigration flows and new residents, however, do not support this approach. Consequently, it is necessary nowadays to review the zoning plan, starting by the evidence of the data on new dwellers, building market trends, and taking into account theories of sustainable urban development.

The City of Asti, aware of the need to update and adapt its general plan, is working on a new plan of the city consistent with its real situation, the needs of the population and territory, with regards to the current trends, economic crisis and real-estate market current situation.

In addition, the CircUse project appeared as one of the most engaging challenges: it gave the chance for many abandoned areas inside the urban borders, with different locations and characteristics, to be turned into opportunities. The aim is the integration of multi-disciplinary actions in order to regenerate derelict areas in the city with the participation of various stakeholders. Re-using is an opportunity for re-making a place. It could be a new chance to improve the territory of Asti and to find innovative solutions to its emerging problems. In this context, the CircUse project is an essential step towards a new planning process: regeneration has to become the driving philosophy of political and administrative actions on the territory, reorienting, in this way, urban planning.

The CircUse project represented an excellent opportunity for a reflection on the future of the city: InViTo has shown that brownfield areas have strong potentialities for redevelopment, with different vocations for different uses. With reference to the current need to provide decision-making support for the problems concerning the development, transformation and management of the urban and territorial system by means of a sustainable approach, SiTI elaborated the sDSS called InViTo, and implemented it successfully in Asti. SDSS are tools for the analysis of complex systems in the field of spatial semi-structured decision problems. Implementation of the sDSS allows to find optimal solutions for area revitalisation problems – achieving a balance between costs and real estate's value as the precondition for entering the real estate market –, to reduce the contamination and chemical hazards in the area as the precondition for redevelopment without health or environmental risks, attracting new investors in the critical situation of public finances with strong limits in financial assistance and public ownership.

The objective of recovering abandoned and derelict areas, as the CircUse philosophy fosters, and the mix of functions suggested by the InViTo application, are consistent with the objectives of sustainable development in the guidelines of EU and Smart City programs.

That's what has pushed the Municipality of Asti to work on the proposal of a Technological Park linked to university research services, and incubator activities for new start-ups.

The former Way Assauto was chosen as the most suitable area for creating a Technological Park with such services, and was proposed in the National Plan of Smart Cities[3]. This is a step by step selection, and at the present moment the Municipality has passed the first and second steps, concerning the technical and economic evaluation. In this way the Municipality has capitalized the CircUse experience for the future use of the area.

## 8. Innovation and participation: driving themes on the pilot area

The Municipality of Asti has chosen microcredit for social business as the main solution for realizing the CircUse Action Plan on Asti's territory. In this particular period of economic depression, this method seems to be the most appropriate to help people start up business-plans. "Social Business City" means a city that is sensible, at various levels (local administrators, civil society, students) to the topics of social business, and adopts social business as a practice of intervention to solve social and environmental problems on its territory. Social business means solving social problems and not the maximization of profit. On March 5th 2012 a Memorandum of Understanding was signed between the Municipality of Asti and Yunus Social Business Centre University of Florence (YSBCUF) about the development of social business supported by microcredit. Microcredit has proved its effectiveness not only for the 'South of the World'. In the face of global economic and social crisis, microfinance is an essential tool also in Western countries. This action aims at improving access to credit for small businesses and individuals who are in a situation of social exclusion: workers in vulnerable employment and younger freelancers, especially women with children, the elderly and immigrants. The Municipality will try to pursue this objectives and to involve people in the social management, rather than trying to attract external investments in the city. The latter may have a rapid impact and repayment, but it would denature local economy: that's why the Administration has always opposed the opening of new shopping malls within the city centre, which from the beginning looked as the most rapid and successful solution for reusing the Way Assauto area. It would have meant, among other things, losing an opportunity for giving back a public space to the residents and the death of several small shops in the city centre.

The territory of the Municipality of Asti has seen, in recent years, a reduction in the number of (especially younger) employees and in general a lack of human capital and innovation. The third sector organizations are in increasing difficulty to support their activities, for the lower propensity of citizens to make donations. Therefore, it was considered appropriate to activate agreements between institutional bodies, enterprises, cooperatives, and third sector organizations to define integrated interventions and activities to improve research on social problems in Asti. Furthermore, it is considered appropriate to promote the knowledge of the theory of social business and help in the creation of social enterprises to prevent and combat social unrest. Social business is a method of intervention to solve social and environmental issues on our territory.

In the meantime, as mentioned above, a proposal was advanced to the national tender for "Smart cities and communities and social innovation". It is based on the project of a recycling plant inside the Way Assauto area, focused on an integrated system based on:

[3] Decreto Direttoriale 5 luglio 2012, n. 391/Ric., "Avviso per la presentazione di idee progettuali per Smart Cities and communities and social innovation".

– enhancing separate waste collection through pneumatic collecting technologies (less exhalations, noise, transport pollution);
– solid urban wastes transformed into thermic and electric energy;
– district heating system with innovative (more efficient) heath pumps;
– an overall planning and monitoring through software innovative systems, also developed for opening participation to each stakeholder in the decision process.

The proposed approach is multidisciplinary, based on economic, social and environmental aspects: such collaborations are moving towards a more strategic collaborative approach, ensuring more intense relationships able to jointly create added value to the project. This shift represents an opportunity to maximize benefits for partners and citizens. This kind of approach is used for collaborative activities, including the development of interoperability, cross-sectorial participation and new opportunities offered by innovative solutions.

Multidisciplinary approach assumes integration of approaches and synergic targets; in multidisciplinary planning cohesion is holistic, vision-driven and horizontal.

The Municipality of Asti commits itself to:

– having knowledge of the social and environmental problems of Asti;
– mapping local organizations;
– organizing workshops, seminars and meetings with university and high school students, cooperatives, local agencies and civil society in general;
– promoting start-ups and spin offs for third sector organizations, organizations interested in developing social business;
– organizing promotional local events about communication and dissemination of social themes;
– monitoring and publication of results.

When a brownfield redevelopment project comes to fruition, local communities experience benefits such as neighbourhood revitalization or reclamation of land for public use. By forming partnerships with various actors, maximizing available financing, and implementing smart growth principles, Asti could demonstrate an advanced and integrated approach to manage brownfield redevelopment projects.

Brownfields success is for people. The most successful local authorities in brownfield revitalization have set up brownfield teams including local leaders, a cross-sector team of public and private supporters, and an advisory group composed of local citizens. That is the aim Asti is trying to pursue.

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10.

# CircUse Italian case study: developing a sDSS for Asti

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## Abstract

The CircUse Project includes the realisation of an information tool aimed at facilitating the decisional process on the best re-use of brownfields. For the Asti case study, the Italian Research Group developed an application of the Interactive Visualisation Tool (InViTo), an instrument able to combine multi-criteria evaluations with interactive maps. A number of stakeholders and privileged observers of the local reality has been involved to fit the rules and elements of the spatial model. The implemented sDSS is a tool usable by other CircUse partners, in different contexts, thanks to its graphic versatility and general flexibility.

*Keywords*: Interactive Visualisation Tool; InViTo; Asti case study; urban regeneration.

## 1. Introduction

According to European directives, the renewal of urban areas has to be developed within a participatory process. No brownfield could be transformed without a large involvement of public and stakeholders. This is due to the fact that territories are complex realities and no effective assessment is possible without considering a large number of criteria. At the same time, one of the characteristics of a spatial decision-making process is the lack of a common knowledge shared by the decision makers. Each of them, in fact, moves from his/her own personal territorial knowledge, which is once again strongly influenced by his/her personal cultural background, causing possible misunderstanding or disinterest towards many important variables.

For these reasons, SiTI, Higher Institute on Territorial Systems for Innovation, proposed the creation of a tool to expressly translate the hard issue of land re-use into a more friendly language, that could open the debate over a larger group of technicians and politicians. Thus, SiTI proposed and started to develop a spatial Decision Support System (sDSS), namely Interactive Visualisation Tool (InViTo). This tool is conceived as a support for spatial decision processes and it has been used in the CircUse project to implement the cognitive process through an interactive framework which organises data in a complex structure of relations and connections. It is able to gather a large amount of very diversified data and it translates them into dynamic visualisations, intended to foster

a conscious discussion among stakeholders. In fact, visualisation helps to define a common starting point to share technical information, so it has been chosen as a way for disseminating information and creating awareness among the actors involved in spatial planning and decision processes (Pensa, 2013a; Pensa *et al*., 2012).

## 2. The re-use of the brownfields of Asti by means of InViTo

InViTo uses data of different nature to build dynamic visualisations on specific purposes which depend on the case study. In order to deal with the specificities of the CircUse project and the requirements of the city of Asti, InViTo has been set to evaluate and visualise the level of suitability of new possible land uses for dismissed industrial areas within the city (Melis, Pensa, Tabasso, 2012).

The tool generated in the framework of the European Project should fit the Asti case study, but the sDSS has also to be flexible and to adapt its framework to other partners' case studies. Therefore, the sDSS designed for the CircUse project has to meet specific requirements:

– it has to be able to collect multicriteria analysis results;
– it must support the decisional and participative processes oriented to define the best new land use for the dismissed areas;
– it has to be flexible, in order to grant a visualisation of the spatial effects resulting from different problems in different contexts.

The suitability of urban areas was calculated with respect to different uses, on the basis of reclamation costs, accessibility, localisation of services, green areas, transport and commercial structures. The outcomes of InViTo are bi-dimensional or three-dimensional maps which provide information on how much every point could be fit for a specific land use depending on its relative position. In this way, InViTo visualises how the distance from certain territorial features could increase or decrease the successfulness of changing land use. In particular, the model realised for the city of Asti allows to operate on different elements in real time:

– *Mathematical functions*: that is, the formulas which determine the relationship between every single element and different land uses. Mathematical functions provide a value of suitability as a function of distance, thereby defining the spatial behaviour of the analysed elements.
– *Weights of spatial elements*: the combination of multiple spatial aspects requires the weighting of the contribution of each element to the choice of location.
– *The design choices*, or the projects that affect the studied area.

The application of InViTo has thus been organised in a sequence of different steps, which should bring to the realisation of maps for enhancing the discussion among decision-makers in Asti to assess the possible future land uses that would better fit urban needs and characteristics.

### 2.1 *Step 1: data gathering*

To build an sDSS for the city of Asti, the first step has been the realisation of a georeferenced database. The collection of data has been possible by means of a collaboration

between the partners of the project, who also contributed to defining the main features of selected areas, to gathering the necessary normative and cadastral data and to finding multimedia contents such as photos and videos.

In Asti, 23 dismissed areas have been identified and ranked as spaces to be re-qualified. For these areas, spatial data have been integrated with information about existing, or planned, infrastructures, public facilities, green spaces and other useful documentation to the analysis and re-use of these areas. In fact, InViTo can include within the model all those data which can be quantified and associated to geographic coordinates, so that a large number of opportunities is possible for combining information coming from various disciplines and fields. Therefore, data with different nature – demographic, environmental or social – can become a part of the model framework.

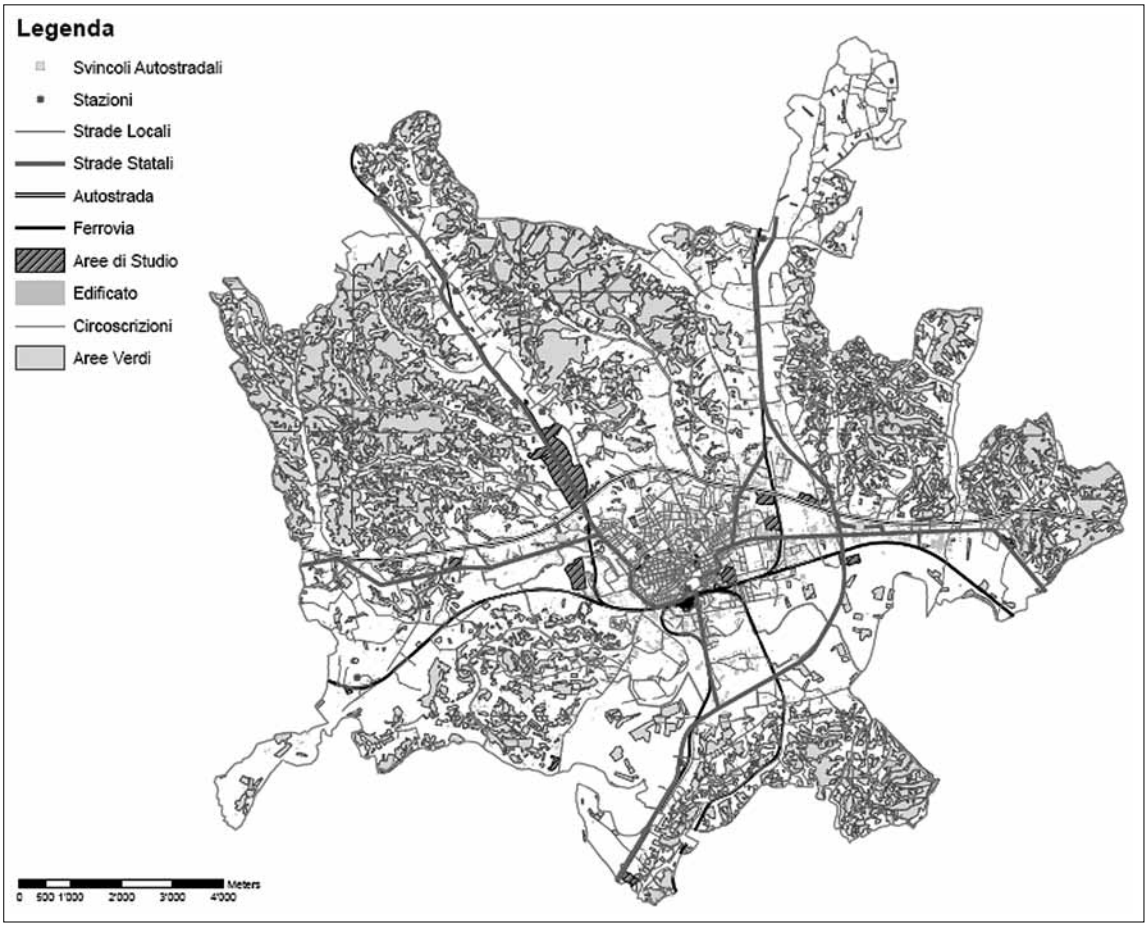



Figure 10.1. City of Asti: dismissed areas and green spaces (SiTI, 2013).

As a consequence, the gathering and organisation of such data provide the possibility to build a model which, firstly, describes the current state of the whole Asti area (fig. 10.1), and, secondly, allows an evaluation of the future spatial transformations resulting from projects and plans that still have to be discussed.

### 2.2 *Step 2: consulting local uses*

The second step concerned the gathering of opinions and needs among local citizens by means of a survey. The principal purpose was to understand the perceived vocation of the city and the most popular needs through direct interviews to privileged observers, so as to obtain information about the specific lifestyle of the population of Asti. In fact, intended as a whole complex of individual habits to manage daily life, such as use and availability of public transport services, sensibility on pollution themes, habit to commuting, relationship and use of public spaces, lifestyle changes on the basis of city size and the services offered, and, at the same time, deeply affects the success of urban policies.

No statistic value has been sought, but just a trend on the use of services, although there was the risk to gather just personal opinions instead of a representative overview on collective uses. The desired goal was to obtain additional information about the ongoing dynamics and the potential development of territory.

A list of selected local actors, representatives of 26 different bodies, was proposed by the City of Asti and included: the Mayor and Commissioners of the City of Asti, the council of the Asti Province, various urban district institutions, the local agency for housing, the public service companies of Asti, landscape observatory and environmental protection associations and agencies for the areas of Monferrato and Asti, the tourism public agency, the local craft confederation, the Chamber of Commerce of Asti, the National Craft Trades Confederation, the confederation of cooperative companies, the shopkeeper association, the association of industrial stakeholders and labour unions, a bank foundation, the Way-Assauto (pilot case area) owners, the professional associations of surveyors, architects and engineers, a neighbourhood committee, a citizen committee, local and national newspapers, the library, and local cultural associations.

The interviews were structured in two different moments. In a first set of interviews, experts were asked to improve and help to redefine a draft questionnaire, just to make it better fit for the reality of Asti. Thus, they were asked to describe the local situation concerning housing, industry and commerce. This first set of questions showed that large shopping malls were not perceived by the interviewees as an interesting or necessary function for reusing dismissed areas. On the contrary, the answers pointed out the lack of hotels and accommodation facilities within the city.

Therefore, the questionnaire was redesigned in order to assess the suitability of three different re-uses of the dismissed areas:

- residential use;
- industrial use;
- hotel/accommodation use.

This second questionnaire was conceived so as to relate these three re-uses with specific spatial elements, in order to understand the positive or negative effect of each element in determining the effectiveness of any of the re-use choices. The survey asked the experts to indicate the influence of spatial elements, such as public transport, industrial areas or public gardens, on the localisation of different urban functions (residential, accommodation and industrial; tab. 10.1).

Table 10.1. Spatial elements considered for each re-use (Pensa, 2013b).

| Spatial Elements | Residential | Accommodation | Industrial |
|---|---|---|---|
| Urban public transport bus stop | × | × | × |
| Regional public transport bus stop | × | × | × |
| Railway station | × | × | |
| Historical centre (restricted area) | × | × | |
| Public garden | × | × | |
| Highway access | × | × | × |
| Commercial mall | × | | |
| Bicycle path | × | | |
| Railway axes/ Highway axes | × | × | |
| Industrial plant | × | × | |
| Goods yard | | | × |

*Suitability functions*

The main task of the second questionnaire is to define the effect of spatial elements on the three specific urban functions through mathematical functions describing the positive or negative influence (suitability), on the basis of the distance from the area proposed for a specific land use.

In order to find the curves describing such degree of suitability, the survey is structured to provide questions for each function. Experts are asked to score each answer on a 7-based scale (from +7 to -7), which resulted more appropriate to obtain a wider variety of responses than using a decimal scale, that generally causes a flattening of results on the values 0, 5 and 10 (and reciprocal negative). As a consequence, also the curves of suitability result more reliable. Thus, assigning scores on a scale of 7 (maximum positive effect) to -7 (maximum negative effect) determined for each fixed distance (100m, 250m, 500m and 1000m), respondents to the questionnaire are able to provide useful information to simulate local dynamics. In case of zero score, the meaning is that the spatial element does not have any influence on the specific function, so it not attracts neither rejects it.

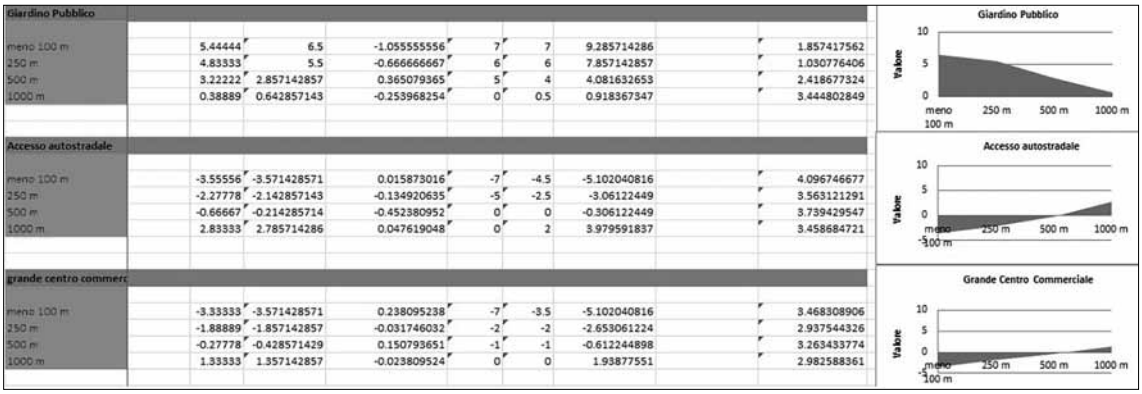
To show an example on the scoring of the distance of a bus stop from a residential plot, the survey proposes a table like the one shown hereafter (tab. 10.2). Experts have to graduate their perception of service on the basis of distance of bus stop from a residential plot.

Table 10.2. Example of question: evaluation of the suitability of public transport (bus stop) for residential use. Users have to choose among a value on table to indicate their opinion (Pensa, 2013b).

| If the bus stop is … | … the suitability for residential use is: | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Less than 100 m away | -7 | -6 | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 250 m away | -7 | -6 | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 500 m away | -7 | -6 | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 km away | -7 | -6 | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

+ 7: optimal distance
0: at this distance, the presence of the bus stop is unimportant
-7: maximum inefficiency distance

The elaboration of the data gathered by this survey provides a table of values and a graph for each spatial element in relation to each urban function (fig. 10.2).



| Giardino Pubblico | | | | | | | |
|---|---|---|---|---|---|---|---|
| meno 100 m | 5.44444 | 6.5 | -1.055555556 | 7 | 7 | 9.285714286 | 1.857417562 |
| 250 m | 4.83333 | 5.5 | -0.666666667 | 6 | 6 | 7.857142857 | 1.030776406 |
| 500 m | 3.22222 | 2.857142857 | 0.365079365 | 5 | 4 | 4.081632653 | 2.418677324 |
| 1000 m | 0.38889 | 0.642857143 | -0.253968254 | 0 | 0.5 | 0.918367347 | 3.444802849 |
| **Accesso autostradale** | | | | | | | |
| meno 100 m | -3.55556 | -3.571428571 | 0.015873016 | -7 | -4.5 | -5.102040816 | 4.096746677 |
| 250 m | -2.27778 | -2.142857143 | -0.134920635 | -5 | -2.5 | -3.06122449 | 3.563121291 |
| 500 m | -0.66667 | -0.214285714 | -0.452380952 | 0 | 0 | -0.306122449 | 3.739429547 |
| 1000 m | 2.83333 | 2.785714286 | 0.047619048 | 0 | 2 | 3.979591837 | 3.458684721 |
| **grande centro commerc** | | | | | | | |
| meno 100 m | -3.33333 | -3.571428571 | 0.238095238 | -7 | -3.5 | -5.102040816 | 3.468308906 |
| 250 m | -1.88889 | -1.857142857 | -0.031746032 | -2 | -2 | -2.653061224 | 2.937544326 |
| 500 m | -0.27778 | -0.428571429 | 0.150793651 | -1 | -1 | -0.612244898 | 3.263433774 |
| 1000 m | 1.33333 | 1.357142857 | -0.023809524 | 0 | 0 | 1.93877551 | 2.982588361 |



Figure 10.2. Survey outcomes. Example related to three different spatial elements.

These results provide the mathematical curves that describe how services influence the suitability of a specific land use (fig. 10.3).

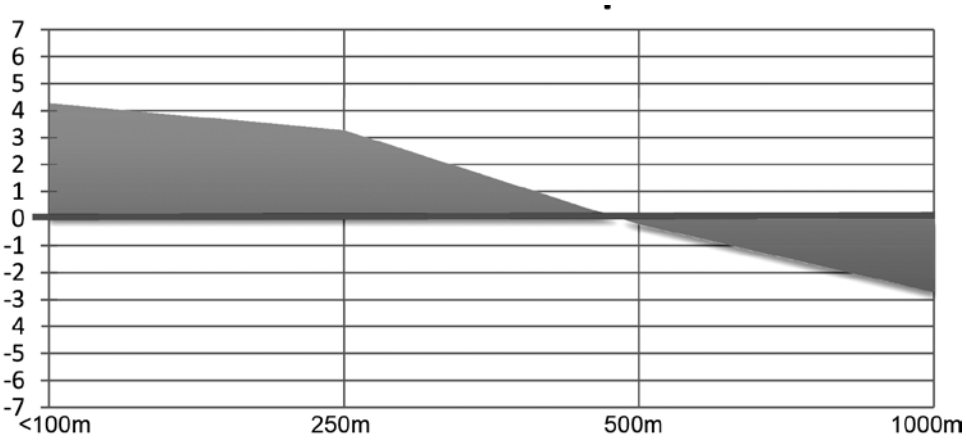




Figure 10.3. Examples of curves derived from the question on urban bus stops as related to residential use (Pensa, 2013b).

*Weighting the curves*

The survey proposed to local actors had a second part, which asked the participants to sort by relevance the spatial elements considered for each urban function, giving them a specific weight useful to relate such elements to one another. Thus, in order to define the localisation of a new hotel, or a residential or industrial area, respondents had to rank the importance of the spatial elements to be considered in evaluating the different spatial effects.

This second set of values has been used to provide a weight among the curves, so as to have a priority in influencing the localisation choice.

### 2.3 *Step 3: the outcomes of interviews*

The outcomes of the interviews allowed to define a general description of the behaviour of Asti citizens according to the three different land uses proposed for the former industrial areas. The relation between each spatial element and land functions has been translated into a curve, which can also be used to outline the lifestyle of Asti citizens. Hereafter are listed the considerations resulting from the reading of the curves.

*Housing*

Concerning the residential use, the survey provided the following results.

- The urban public transport service in Asti is considered helpful if the nearest bus stops are placed no further than 250 m from any of the residential buildings. On the contrary, bus stops farther than 500 m from home are perceived as a disservice (negative impact).
- Asti citizens do not generally consider public transport as a viable alternative to private cars, when they need to move out of urban boundaries. The bus stops of regional public transport are not considered very important for defining the level of service within residential areas: until 700 m the level of suitability is low (between 2 and 0.4 points), while farther than 700 m the disservice perceived is minimum (0.6 pts).
- The best localisation for the railway station resulted to be about 500 m far from home (2 pts). If it is too close, the score tends to be negative (-0.6 pts), while at 1000 m it is still considered a good distance (1.7 pts).
- According to all the participants, the city centre is an attractive element for housing. Its maximum score is reached for a distance shorter than 100 m (3.5 pts) and remains on positive values also for distances higher than 1000 m (0.8 pts). But the high reputation of the city centre is not opposed to a low suitability of suburbs: unlike what generally happens in big cities, Asti has not a strong opposition between the suburbs and the city centre. In the common opinion, suburban housing can offer a better exposition, cheaper parking availability and a quieter environment.
- In the perception of Asti citizens, urban quality strictly depends on the closeness to parks and public gardens. Parks are a desired service. Green facilities get the highest score for short distances (6.5 pts at 100 m, 5.5 at 250 m), while, farther than 250 m, the suitability function decreases. However, their influence on residential use is always perceived as positive, even though they are situated 1000 m (0.65 pts) away.
- Cycle paths are positively considered for residential areas, even if they are very far. According to the respondents, however, cycle paths should be close or very close (3.5 pts at 100 m, 3 pts at 250 m) to home. The influence remains positive also at a 1000 m distance, with a score of 0.28 points.
- Industrial plants, railway paths and highways have a similar behaviour as regards their influence on residential choice. They are all considered de-qualifying elements for housing. Their negative effect of visual, air and acoustic pollution vanishes between 500 and 700 m. On higher distances (1000 m from home), some positive effects can be observed: industrial plants reach a score of 2.4 points, meaning that job places are preferred to be not so far from home, while highways have a score of 1.8 points, providing information about the necessity to be quite connected with main transport axes.
- Motorway exits and big commercial malls are perceived both as a service and a displeasure factor, so they show a similar curve. In both cases, they have a negative trend in proximity of residential areas (until 500 m, values are lower than -0.2 pts), while their

suitability increases with distance, reaching a maximum level at 1000 m (shopping mall: 1.35 pts; highway access point: 2.78 pts).

*Industrial areas*

With respect to the industrial use of land, the outcomes of the survey are the following.

- Accessibility appears as the key factor for attracting industries. The closeness to an highway access point seems to be strongly determinant (6.1 pts at 100 m and 3.7 pts at 1000 m). In fact, in Italy, freight transport is strictly connected to the movement of trucks, highlighting a general weakness of the Italian railway network in moving goods by trains.
- The average score for a hypothetical goods yard shows an interest which linearly decreases with the increase of its distance from the industrial area (3.5 pts at 100 m and -3 pts at 1000 m).
- Moreover, all respondents agreed about the positive effect of an industrial district equipped with broadband connection, since the offering of technology and a synergic organisation represent an effective way to attract new businesses.
- With respect to the public transport system, industrial settlements are positively affected by proximity to the regional public transport lines, which is described by a linear curve passing from 4.1 pts at 100 m to -0.2 pts at 1000 m. On the contrary, the presence of urban public transport is quite irrelevant: the maximum score is reached with 2.1 pts at 100 m, showing a trend opposite to the residential function.

*Hotel facilities*

When considering touristic accommodation as a possible land-use, the respondents to the survey provided the following outcomes.

- The choice of a localisation for touristic structures is strongly affected by proximity of the historical city centre. The maximum score of suitability is reached on distances shorter than 100 m (5.75 pts). If a tourist has to walk more than 250 m from the hotel to the city centre, the suitability linearly falls. Farther than 1000 m, the localisation appears not suitable for touristic accommodation (-1.5 pts).
- The quality of the urban context is also important: the presence of an urban park near the hotel makes the place more suitable. Green areas closer than 100 m are scored 5.25 pts. Then, the curve linearly decreases and vanishes at a distance of about 900 m, meaning that, also for the accommodation use, green areas are positively considered even if they lie far from the area.
- A hotel should be about 250 m away from a railway station (4.5 pts), so as to have a good accessibility without suffering the negative effects characterising railway stations. Anyway, the proximity of a railway station is still scored positively (1.75 pts for distances shorter than 100 m), while farther than 700-800 m, the plot loses accessibility, providing negative scores (-2 pts at 1000 m).
- The regional public transport is chosen mainly by one-day tourists: this is the reason why, for hotel facilities, closeness to regional bus stops is not very important. Furthermore, operators prefer not to be too close to regional public transport routes, but a little aside. In fact, 250 m results to be the best distance, with a score of 1.75 pts, while after 500 m scores become negative.
- Most tourists arrive in Asti by private car or bus. Therefore, the closeness to highway exits is perceived as positive because it improves accessibility. The disturbing elements

are considered only at very short distances, as showed by the negative score registered at a distance of 100 m (-2 pts), while for limited distances the scores are lightly positive (0.25 at 500 m).
– Urban bus service is considered as an important support to the tourism proposal. A plot with a bus stop within a 100 m radius gets more than 4 points, but it loses its suitability if the bus stop is farther than 500 m (-3 pts at 1000 m).
– Finally, the survey underlined the negative effect of railway lines, highways and industrial plants within a distance of 1000 m from hotel facilities.

### 2.4 *Step 4: the creation of a model*

Once all data have been gathered, these are used to build a model which could describe the relationship between the different spatial elements and land uses. This was made through the Interactive Visualisation Tool (InViTo), using as input shape files, vector files and the curves deriving from the analysis of the above mentioned surveys.

InViTo was used to associate the spatial elements with some components of the drawing, such as points, lines or polygons, so that each spatial element was given a geometric form. To each spatial element was then assigned its corresponding spatial behaviour, as defined by the curves resulting from the surveys. This means that each geometry has an influence on the others, depending on the spatial elements they represent. The whole ensemble of influences is associated to a mesh, which changes its form and colour on the basis of the value of influences. Through this step, InViTo can generate both bi-dimensional and three-dimensional models (fig. 10.4), according to specific choices linked to the case study.

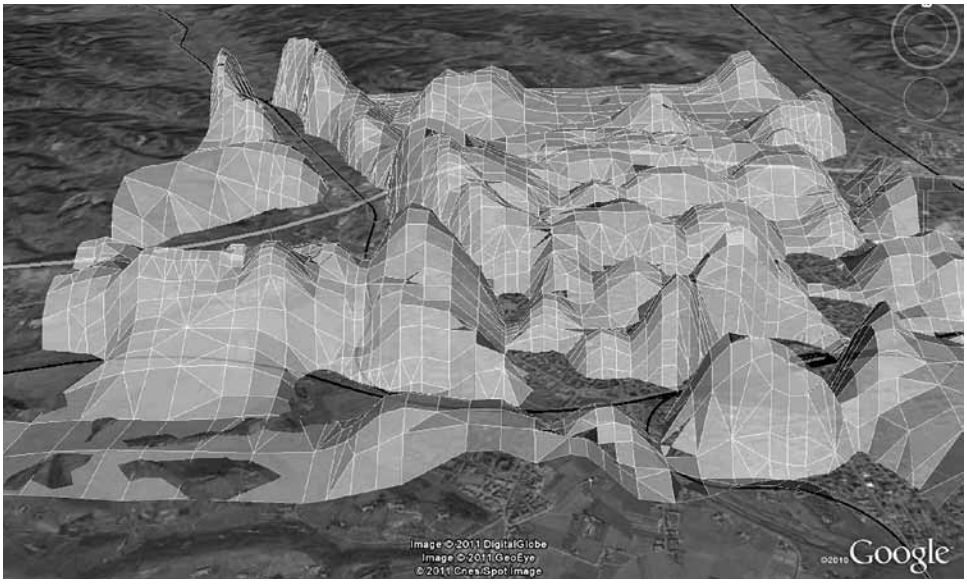



Figure 10.4. Example of a three-dimensional model generated on the Asti case study by the use of InViTo in the Google Maps viewer.

However, a number of different visualisation are possible by the use of InViTo (Pensa, 2013a, 2013b; Pensa *et al.,* 2012; Pensa, Masala, Marietta, 2011). A more accurate descrip-

tion of the chosen representation techniques is available in Chapter 11, which focuses on the output maps resulting from the application of the tool.

### 2.5 *Step 5: drawing scenarios*

A discussion with the selected stakeholders provided the key points for structuring the urban questions. The city of Asti is discussing a number of future projects (fig. 10.5) and most of the proposals for urban transformation concern infrastructural interventions, which could be either alternative or complementary:

- *a metropolitan railway service*: the use of a railway network to improve public transport serving the city's suburbs and outer belt;
- *a ring road and a new motorway exit*: the ring road would complete the motorway system around the city, providing new access points to the motorway network;
- *a car bypass*: a new road on the south-eastern area of Asti could reduce traffic congestion on other roads.

These infrastructural projects have been used to intersect the values of suitability for each land use, and produce new maps so as to understand how the suitability of brownfield areas changes by switching on/off the infrastructures considered. Therefore, the maps change, in real time, depending on both the spatial elements and the projects affecting the city which are being considered by the users.

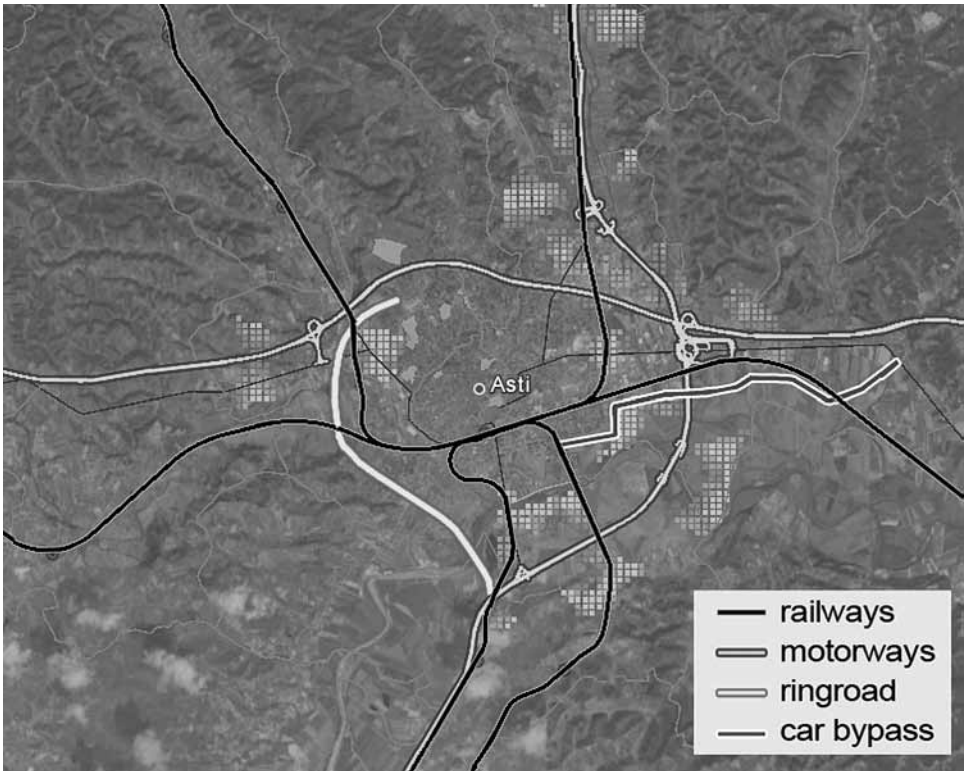



Figure 10.5. Projects concerning the infrastructural system of Asti.

These projects have been used to produce multiple scenarios. Different maps have been generated to investigate the changes in suitability depending on various alternative options. The realisation and non-realisation of the ring road connecting the current motorways have been separately intersected with the two other hypotheses: the improvement of suburban public transport by means of a railway network and the construction of the car bypass on the eastern side of the city. A further option has been studied, considering the ring road as compared with the realisation of both a metropolitan railway service and a car bypass.

## 3. An overview of the Asti experience

As a first application of InViTo to a real case study, the Asti experience offers a number of indications to improve spatial analysis within urban contexts.

With respect to the methodology for data gathering, the direct contact with the territory and local people turned out to be an effective way to obtain information on local reality and build an overall knowledge of the lifestyle of citizens. This also allows the collection of their perceived needs and the building of scenarios which can best fit the specific requirements of the case study.

Nevertheless, the interview system was still probably not accurate enough and some difficulties emerged in the evaluation of some elements by a number of respondents. In particular, when local actors were asked to evaluate distances, their answers did not always correspond to their actual opinion, because sometimes distances are not clearly perceived. Sometimes the answers were too optimistic or represented reality not as it actually was but as it should have been. As a consequence, the presence of some spatial elements resulted emphasised with respect to other urban components. In cases like this, respondents can be supported in their choice by offering them one or more maps which show some real and well-known distances, so that the level of realism of their perception can be increased and the outcomes of the survey can be more reliable.

Furthermore, the time available for interviews is often very short, so that the ranking and weighting of spatial elements can be somewhat inaccurate, while reflections on the score are left to a later stage of data elaboration, managed by technicians.

Therefore, surveys proved to be a possible way for defining the human preferences that influence the spatial use of land, depending also on its localisation and possible future development. In fact, surveys provided:

- a mathematical function, described by a curve, which defines the behaviour of different spatial elements on the basis of their distance from a series of plots intended for different land uses (residential, industrial and accommodation);
- a list of weighted priorities of the different spatial elements on the basis of a specific land use.

The outcomes of the survey have been used to set InViTo as a tool for spatial analysis and obtain interactive visualisations able to support discussion within the decision process.

InViTo proved particularly flexible in using survey data for providing visual outputs. The data entry process caused no problems, allowing more time to be spent in implementing the visual interface and the map representation.

The model built for the Asti case study can be defined as a simple model because it works as a weighted sum of maps, in which users are asked to change the weights of each

single map, on the basis of their personal experience and knowledge, and to explore the changes of values of suitability in dismissed areas resulting from the realisation, or non-realisation, of three different urban infrastructural projects.

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11.

# The version of InViTo designed for Asti: maps and results

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## Abstract

Once the Asti case study was set up, InViTo could produce different typologies of interactive visualisations according to the expertise level of viewers. The use of dynamic outcomes enhances the participation and collaboration of the actors involved, who can modify a number of parameters and see the consequent effects in real time. At the same time, maps and visual outputs provide useful information for generating the guidelines of new projects in the studied areas, also by means of scenario comparison.

*Keywords*: geovisualisation; dynamic maps; scenario comparison.

## 1. Introduction

The Interactive Visualisation Tool (InViTo) has been conceived as an instrument for supporting the discussions and evaluation procedures within spatial planning and decision processes. To perform this task, InViTo has been based on the use of visual and interactive communication, as a scientific methodology to enhance the intuitive perception of the actors involved.

Focusing on the generation of dynamic maps, InViTo offers an instrument for creating images which contribute to the production of common mental models. This is fundamental to allow people with different expertise and background to share information. In particular, for the case study of Asti, InViTo has been used to generate a number of maps containing different projects, so as to allow its users to compare the results and create their own reasoning.

## 2. The visualisation of scenarios

Since InViTo is based on a parametric 3D-modelling system, its visualisation process is simultaneous with the data input. In fact, InViTo readily generated the maps of suitability for the city of Asti (see Chapter 10, par. 2.4) on the basis of the data and mathematical curves which are entered into the system. In particular, InViTo is set to calculate the influence of each spatial element on the other ones. This calculation provides a map which

visualises how much each function (residential, industrial or tertiary) is suitable for renewing the Asti abandoned industrial areas.

All the maps refer, point by point, to the level of suitability and can express it in different ways. One of those techniques uses a colour gradient (fig. 11.1 – left), which can be effective in both 2D and 3D visualisations. In addition, other types of mapping can be realised: three-dimensional charts (fig. 11.1 – middle), which express the difference in the values of a variable by the heights of columns, or three-dimensional meshes which cover the whole area with a new 'semantic-terrain' (fig. 11.1 – right).

When associating the values of influences with a three-dimensional chart or mesh, InViTo provides the visualisation of higher values by means of peaks, which localise on the map the areas affected by a higher impact on suitability. At the same time, depending on the chosen indicator, lower areas can also have a particular meaning and indicate where the lightest consequences are expected. Moreover, in mapping, colour can be used as a visual indicator as a further dimension. In figure 11.1, colour has been used to provide information on the kind of urban function assigned to the area, but it can be associated with any other value, as preferred.

The flexibility of InViTo includes the possibility for its users to modify the model parameters as well. In fact, InViTo can be set to provide its users with a series of cursors through which they can interact with the data model, by selecting the data to be analysed and changing the weight values of each curve (fig. 11.2).

For the Asti case study, the weights of the different spatial elements have been defined by means of a specific set of questions within a survey distributed among a group of selected stakeholders. Nevertheless, the data model built in InViTo allows both volume and colour to be changed by users on the basis of their preferences.

The resulting maps can be displayed in different ways, depending on the audience and their level of expertise. In the CircUse project, the suitability outcomes were addressed to a group of expert users, which included people having both technical and non-technical knowledge.

Thus, the easiest technique of representation was a bi-dimensional map, where the changes in colour identified different values of suitability. For each of the analysed land use, suitability has been illustrated on a gradient map, in which the colour green indicates the most suitable areas, while red localises the less suitable ones (fig. 11.3).

However, a minimum level of suitability has been fixed. Areas under this threshold are those where the considered urban function is not recommended. Thus, areas with the lowest values of suitability are not considered within the visualisation and are not coloured, making the representation simpler and more readable (fig. 11.4).

The maps built for analysing Asti's suitability required to highlight the location of a number of elements. First of all, maps indicate the areas covered by the brownfields considered in the CircUse project (the black-outlined polygons in fig. 11.3 and the white ones in fig. 11.4), so as to facilitate their identification and the raising of considerations about the opportunity of their reuse. Secondly, new projects concerning the urban and suburban areas have been included in the visualisation so as to indicate where future developments are expected. These new projects change the levels of suitability of each function and, with it, modify the land use map. InViTo shows how some areas may become either more attractive and suitable, or more repulsive and inappropriate for a certain use, as a consequence of its having been selected for a specific development strategy or project.

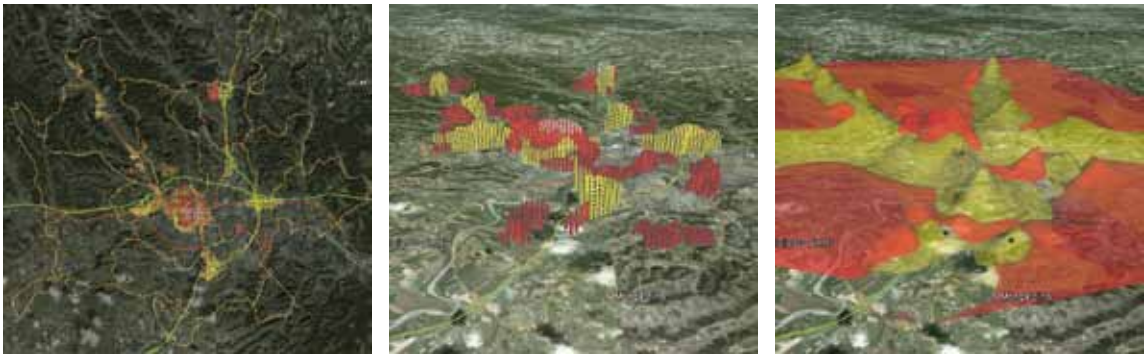


Figure 11.1. Possible types of visualisation showing the compatibility between residential function and commercial function: a gradient map (left), a 3D histogram (middle) and a volume graph (right) (Pensa, 2013).

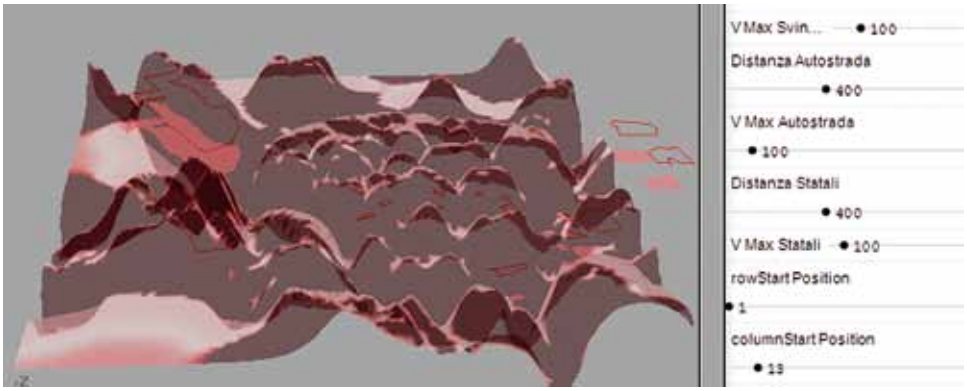



Figure 11.2. Example of a three-dimensional mesh associated to a series of cursors (on the right), whose setting changes the form of the mesh itself.

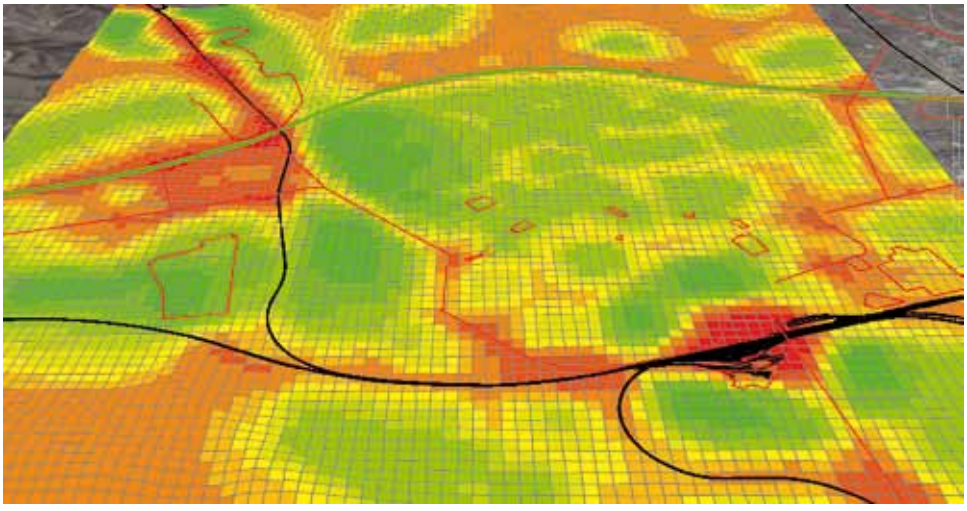


Figure 11.3. Example of a colour map based on a bi-dimensional mesh. Red patches identify unsuitable areas, while the green ones show the most suitable lots for a certain land use (Pensa, Masala, 2014).

Thirdly, maps show the main transport networks, including highways and railways. Finally, some geographical features, such as rivers and administrative boundaries, complete the information given by the maps.

Figure 11.4. Typology of visualisation chosen to represent the suitability for the different land uses in the city of Asti: the most suitable areas are highlighted in green, and the less suitable in red; areas under the minimum threshold are not coloured (Pensa, 2013).

In order to allow comparison between the maps illustrating different project options, InViTo has been set to allow a simultaneous view of six scenarios. Therefore, a matrix of projects has been built to visualise the differences in suitability at the same time (fig. 11.5).

The matrix considers a few specific urban projects concerning the transport system which connects Asti to its province. The matrix separately analyses the realisation and non-realisation of the Asti ring road, and it intersects those two possibilities with the projects concerning the urban railway system and the road bypass, providing also a visualisation for the case that both the urban railway system and the road bypass could be realised.

The choice of displaying six scenarios at one time is due to the fact that visual comparison is considered as an effective way to facilitate the evaluation of different maps. In fact, map comparison highlights the city changes due to the introduction of the strategies and projects which the city of Asti is discussing.

All six maps are dynamic, so that participants in the decision processes can operate in the spatial model and simultaneously visualise the effects on the six alternative options. Users can obtain different results by changing the values associated with specific parameters while maps change their contents. In this way, users can explore new spatial configurations and be helped to understand the effects of specific choices.

In order to facilitate the users' access to the setting of the spatial model, InViTo has been provided with a graphic user interface (fig. 11.6). A simple interface has been created with a Visual Basic script. By this form, actors can assign a weight to each spatial element and, at the same time, decide, among four alternative options, which urban infrastructural projects should be considered.

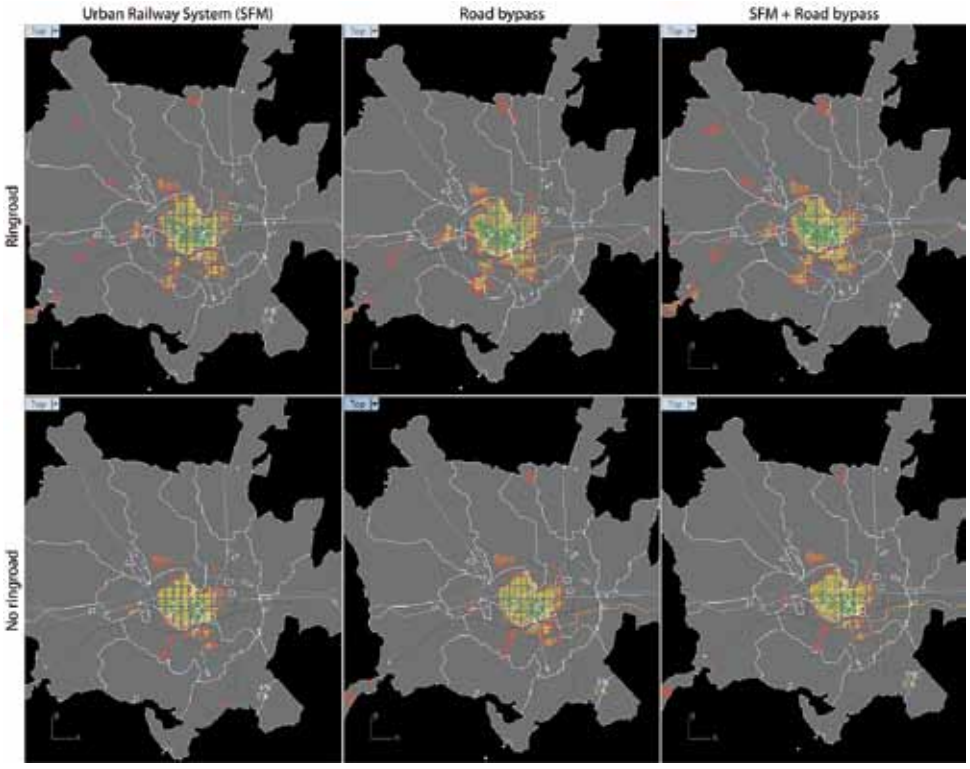



Figure 11.5. Matrix of projects concerning Asti and its surroundings: six dynamic maps (Pensa, 2013).


Figure 11.6. Graphic user interface for the spatial model of Asti: a new resource for enhancing the collaborative sessions (Pensa, 2013).

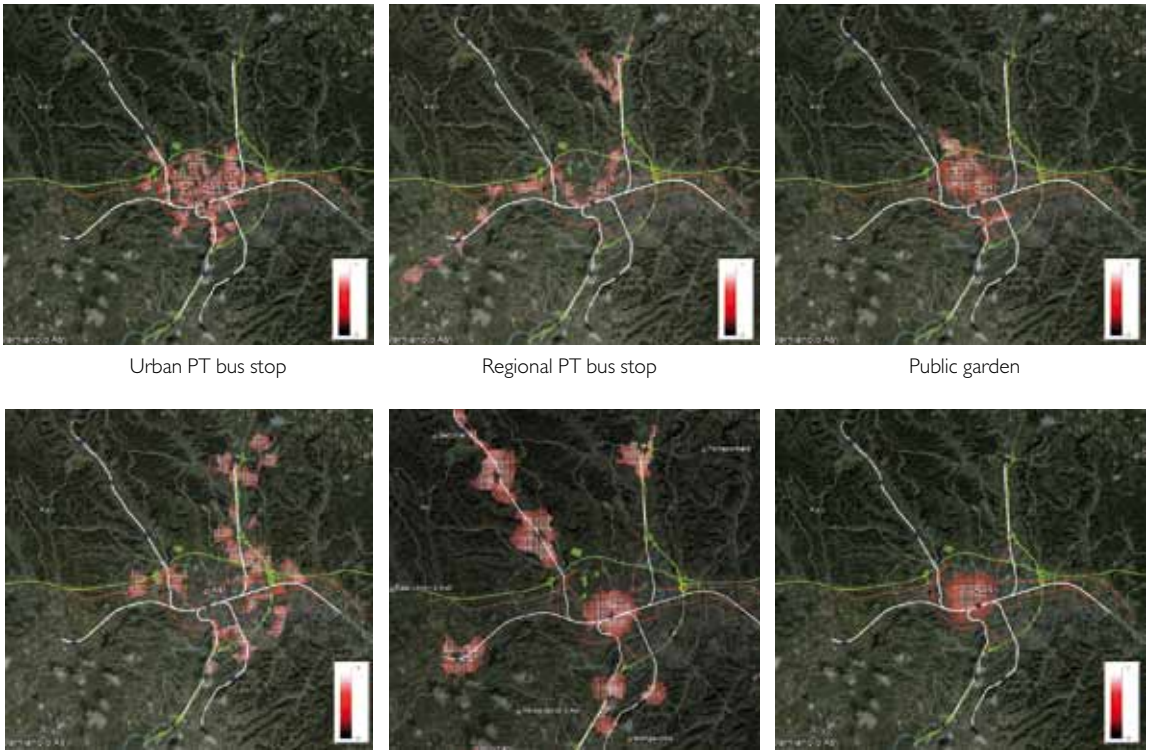
Therefore, users can constantly control which priorities have been decided to generate the maps they are looking at, and they can change these values to explore new combinations until they find the most suitable one. In addition, users should consider that their favourite solution provides further useful information. In fact, it indicates the priorities they have to respect to achieve it, as well as the planning scenario which better fits their purpose.

The interface also provides users with the possibility to control the data displayed on the screen. Users can switch on or off the layers which are resumed in the map. This enables lighter and simpler visualisations to be built, by which only the key elements are showed. In this way, the particularities of the Asti case study can be analysed and evaluated both as single parts and as a whole system.

## 3. Map building

The questionnaire distributed among the selected stakeholders of Asti provided two fundamental elements:

– the curves which describe the suitability of different urban elements which fulfil three different urban functions, i.e. residential, accommodation and industrial (fig. 11.7);
– the weights to be associated with each urban element to obtain the general priorities for city planning (tab. 11.1).



Urban PT bus stop | Regional PT bus stop | Public garden

Highway access | Railway station | Historic centre (restricted area)

Figure 11.7. Maps built by means of InViTo using the values gathered by the survey. Urban elements are here considered separately according to the residential function curves.

Table 11.1. Average weights assigned by Asti's stakeholders.

| Spatial elements | Residential | Accommodation | Industrial |
|---|---|---|---|
| Urban public transport bus stop | 3 | 3 | 4 |
| Regional public transport bus stop | 5 | 3 | 4 |
| Railway station | 5 | 2 | |
| Historical centre (restricted area) | 2 | 1 | |
| Public garden | 1 | 3 | |
| Highway access | 6 | 5 | 1 |
| Commercial mall | 7 | | |
| Bicycle path | 5 | | |
| Railway axes / Highway axes | 6 | 5 | |
| Industrial plant | 8 | 7 | |
| Goods yard | | | 2 |

The priorities emerged from the survey highlight how suitability for a specific urban function changes with respect to the urban land use. Depending on the desired use, some urban elements will result more important than others, so that the successfulness of a project is strongly affected by its context. Therefore, according to new project proposals, development strategies or administration choices, some areas may become more attractive and suitable for a certain use. In the same way, other areas within the consolidated city can become less suitable, and even repulsive, for specific urban functions.


Figure 11.8. Map representing the weighted sum of the maps referring to the residential function in Asti.

Urban elements can be combined with each other so as to obtain a single map. Nevertheless, it is a common notion that urban elements do not have all the same importance. For this reason, a weight is assigned to every map relative to an urban element, so as to obtain a weighted sum of all maps. The result is a general map which displays the more suitable areas for a particular urban function (fig. 11.8).

The weight is initially provided by the average values obtained by the survey results (table 11.1), which is a way to provide users with a shared point of view. However, during meetings and workshops, all the weights can be modified by users to obtain a more knowledgeable and focused analysis of the planning issue.

## 4. Comments on the resulting scenarios

The maps built by means of the survey weights have been used for comparing the six planning scenarios referring to the residential use, while the accommodation and industrial uses have not been considered in the evaluation phase because of a lack of interest in those aspects. Zooming on a more detailed scale, the scenario matrix highlights the effects on suitability within the urban boundaries (fig. 11.9).

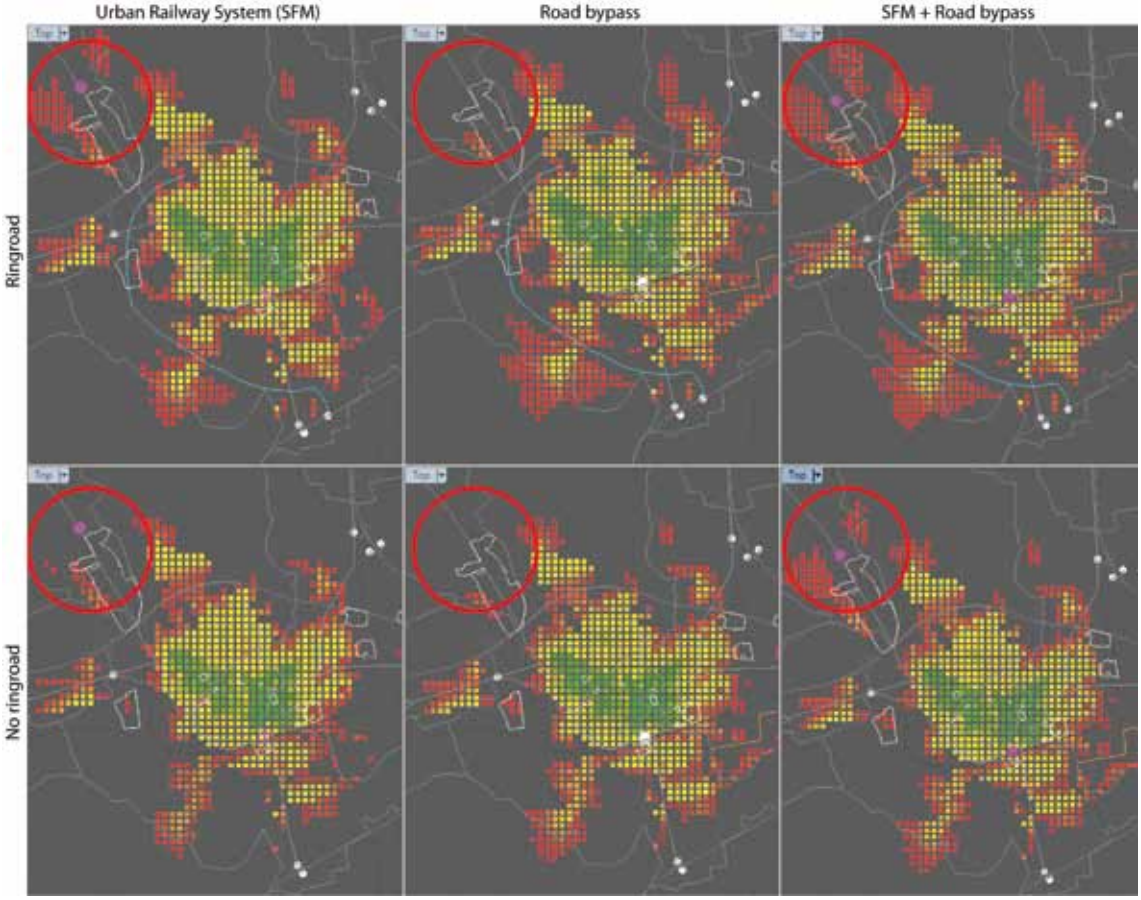



Figure 11.9. Matrix of projects insisting on Asti: detail of the urban area. The white polygons represent the brownfield areas. The six maps show their suitability for residential use (Pensa, 2013).

The outcomes of InViTo highlight how the planning choices on the city transport system have strong consequences on the brownfield sites considered by the CircUse project. In fact, in the case proposing the realisation of ring road around Asti, the brownfield areas

on the western and central part of the urban system would become more attractive for new residential purposes, while the abandoned eastern areas would remain cut off from new urban projects. The brownfields in central Asti proved to be very suitable for housing, whatever project could be realised. Thus, in any case, these central vacant areas are suitable to be re-used. The large brownfield on the north-eastern area, on the other hand, will have no benefits from the new infrastructural projects. Its suitability value for residential use remains unchanged.

In general, the comparison between six potential development scenarios for the city of Asti showed that, according to the model assumptions, the most effective policies would be those closely linked to the development of road infrastructure and to the decongestion of city traffic. The widespread use of private cars and a disinclination to resort to public transport would not reward the choice to strengthen the supply of public transport services, for example with the activation of an urban rail system (SFM), which would not produce significant changes on the suitability of a certain area for residential use. The general low weight of the public transport system cannot generate any noticeable changes in the residential demand. The completion of the ring road and the improvement of private mobility through the construction of new roads, on the other hand, would have a positive impact on the existing road network, which would become less congested. These design choices show to have a high impact on the perception of suitability for both residential and commercial areas. Therefore, location choices should consider these urban elements as a priority for urban development.

## 5. Comments on the case study

Within the CircUse project, SiTI proposed to develop a spatial Decision Support System (sDSS), namely Interactive Visualisation Tool (InViTo), to explain the complex issues related to the re-use of brownfield areas in a simple and easy language which can be understood by a large audience. Therefore, InViTo is conceived as a support for decision-making in spatial processes, which could enhance the debate in large groups composed of technical and non-technical experts.

InViTo has been used in the CircUse project to deal with the urban issues such as brownfield re-use. The application of InViTo showed to be a useful instrument to sum up and share the different opinions of multiple stakeholders. It organises information within a complex structure of relations and connections, highlighting the links between design choices and their effects on land. Moreover, it can increase the chances of success of decision-making processes and the agreement upon shared solutions in public debates, as it offers a urban vision that effectively acts as a common mental model among the various participants. Thus, the future of brownfield sites can be discussed within a data framework capable to show both opportunities and critical elements.

The outcomes of InViTo have been presented to the partnership of the CircUse project, showing how its interactive visualisation enhances the possibilities for stakeholders to explore the effects of different solutions, while its simultaneous visualisation of six different scenarios enables its users to make comparisons among the possible choices.

In addition, the suitability study for different urban functions highlights how the presence and perception of urban elements deeply affects urban value and, indeed, the successfulness of a project. The projection on maps of suitability value highlights the areas which are perceived as more or less interesting for a specific function. This provides

important elements to the Public Administration for identifying areas with low life-quality levels, as well as areas that can be at risk for social distress. Suitability maps can be used in different ways. For example, suitability maps for residential use can be superimposed on the map of existing residential building and show where new projects are needed.

From this point of view, small cities like Asti can benefit from such kind of analysis. Firstly, because suitability analysis can help avoid expensive urban projects, that would not offer sufficient advantages to justify their high costs. Secondly, in the case of vacant areas, such an analysis can provide useful guidelines for finding new uses that could satisfy the needs of the inhabitants. In this sense, Asti had the opportunity to look at its brownfields in an innovative way, dealing with urban issues through a new method which can be applied in other cities around the world.

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# Conclusions

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This book presents the main activities and results achieved by the Italian partners within the CircUse Project, a European three-year activity which involved several subjects with different backgrounds and nationalities.

This chapter will summarize the contents of this publication trying to emphasize two concepts: that brownfield areas represent a problem that can be turned into an opportunity and that innovative instruments can help in defining the best way to redevelop our cities. An overview of the three sections is then presented: the concept of brownfield, the presentation of a new instrument and its application to a case study. The final paragraph includes the concluding remarks concerning the project, trying to underline the links between the different chapters and giving indications for possible future implementations.

## 1. Brownfields

Due to the increasing complexity of the productive sector, the industrial management mentality evolved towards a new paradigm based on the production of information and services, rather than manufactured goods. In this new context, brownfield regeneration represents both a need and a challenge for the future.

Cities need to define a new identity and to find new functions for abandoned industrial areas and this represents a common goal for many European countries.

The CircUse project represented a great opportunity for different bodies around Europe to deal with common problems related to the post-industrial era, such as brownfield areas and land consumption, with the aim of promoting a sustainable development for brownfields, greyfields and degraded greenfields[1] both in urban and peri-urban areas, and proposing a circular management of dismissed or underused land.

The theory of circular land use, developed with the contribution of partners from different European countries, will hopefully become a common practice for the future revitalization of brownfields.

Furthermore, in a period of deep crisis, the number of brownfield is dramatically increasing and their conversion into new activities is becoming more and more complex

[1] Categories of brownfields, as defined within the CircUse project, according to their previous use.

day by day and the on-going economic crisis will probably leave most of them vacant for long periods.

Abandoned areas are going to increase in all cities and regions, representing a risk and an element of degradation that can affect their surrounding context. In fact, as the "broken window" theory[2] states, keeping our neighbourhoods and cities in a well-ordered condition and repairing possible damages helps stop or reduce further vandalism and crimes, while abandoned buildings and areas, if not properly maintained, can easily encourage criminal phenomena and acts of vandalism.

In addition, any delay in renovation will worsen the degradation of neglected buildings and areas, making their recovery more difficult and expensive. Defining temporary uses for those areas or buildings can represent a good and low cost solution to this problem, and can become a launch pad to start new activities.

Unfortunately, in Italy, the main obstacle to a temporary use of abandoned areas is the lack of specific legal instruments. For this reason, the temporary use solution can become very expensive, because when a building or an area has to be temporarily adapted, Italian law imposes to follow the same rules and procedures required for permanent uses.

The same problem (i.e. lack of legislation) affects land consumption, which is not adequately taken into consideration by Italian legislation. Very few cases show an attempt to avoid land consumption by encouraging brownfield reuse, and consequently investors, to avoid the higher costs linked to demolition and potential remediation, choose to install their activities on empty areas, thus contributing to increase sprawling and urban decay, whose cost is not immediately quantifiable, though both will certainly have a negative impact on future generations.

## 2. A new instrument

In recent years citizens showed greater interest in participation and involvement in different fields of public decisions and, in particular, in planning questions. But the complexity of the planning discipline requires that a large number of variables should be considered, which cannot easily be evaluated and compared by simple observation and analysis.

Day after day the use of technologies is becoming more important and widespread, as they represent an important tool to simplify both the planning and the participatory processes, in a field characterized by an ever-increasing complexity.

Participation in the CircUse project represented an opportunity of defining new instruments based on innovative technologies, in order to support decision processes and to help understand the effects of land use decisions, as well as facilitate the involvement of citizens within decision processes.

In a complex world, the winning idea with the InViTo tool was to use existing instruments in a new way, rather than developing a totally new software.

The main qualities of the InViTo tool are its flexibility and real-time interaction. It is conceived to overcome the traditional assessment by scenarios, offering the chance to visualise large numbers of "What-if?" outputs, by assuring an extreme freedom in switching on/off the elements of any scenario taken into consideration. Furthermore, its interactivity in visualising scenarios helps foster public debates on the future of brownfields.

[2] A theory introduced in 1982 by social scientists James Q. Wilson and George L. Kelling.

Although the instrument hasn't been extensively tested yet, it has received positive feedbacks by different experts from numerous countries, showing good chances of being applied in several situations.

Land use planning would benefit from the application of a decision support instrument like InViTo, as it could reduce the decision time and increase the accuracy and consciousness of decision-makers (through analysis of variance, the study of solidity and sensitivity variables, application of multi-criteria analysis). The implementation of this sDSS can reduce reluctance to redevelop brownfield sites associated with the uncertainty regarding risks (e.g. wrong location), redundant infrastructure, reclamation costs, high rehabilitation costs and low real estate value.

The main characteristics of InViTo, i.e. its flexibility and adaptability to different situations, combined with the possibility of a real-time interaction, recommend its use in various contexts, particularly in participatory processes and within public debates.

As the main limit of the first version of this tool was the complexity of its interface, a web-based version (InViTo 2.0) has been developed, to make it more accessible and user-friendly, so as to increase its usability in several contexts even by non-expert users.

## 3. The Asti case study

The CircUse approach invites to find lower impact solutions (in terms of durability and environmental/social impact) and firmer solutions (regarding cooperative decisions) to the common problem of brownfield redevelopment. The involvement of Asti in the Central Europe programme was an opportunity for the city to look at its brownfields from a new perspective.

For the city of Asti, the CircUse project was an occasion for carrying out a survey on the situation of all the vacant or underused areas spread throughout its territory. Furthermore, new studies on the sustainability of environmental reclamation techniques were carried out on the most polluted brownfield, a former chromium plating plant (Way Assauto).

The decision to re-open the issue, exploring new technologies, allows to re-consider possible interim uses, which has been impossible so far, due to the high costs of brownfield reclamation. As a matter of fact, the comparison with other towns with similar problems helped to improve the local perspective on the issue of brownfield redevelopment.

Through CircUse, Asti started to assimilate some good practices, such as involving and evaluating the requests of different stakeholders and defining new participation processes: a good practice that can be transferred to other similar cities around Europe.

An example of the new mindset characterizing the City of Asti is their refusal to opt for a shortcut to develop its territory (which was probably the creation of a new retail centre to replace the former chromium plating plant), and their choice of investigating the possibility of developing a business park, consistently with today's industrial paradigm.

This long-term vision, linked to the decision of testing a new and innovative instrument to support the decision process, represents for the city of Asti a good practice and a step ahead towards a Smart City vision.

## 4. Concluding remarks

The main aspect characterizing the CircUse project is the joint effort of different institutions to deal with the common issue of brownfield areas with a real operational

objective and the innovative approach of reuse. All of the partners developed their own solutions and shared their experiences and best practices during the meetings held in the various countries.

The most innovative aspect of the Italian experience within the CircUse project is the decision to approach two current issues, such as brownfield management and decision support tools, in an integrated way.

The Interactive Visualisation Tool (InViTo) developed within the project proved to be very useful to assess the suitability of certain areas for a specific purpose, rather than providing specific solutions. This makes the instrument particularly useful to evaluate new functions for abandoned or underused areas. Especially in the process of brownfield redevelopment, the use of a tool like the one developed by SiTI invites[3] to think about other aspects than the purely economic ones, thus helping to take decisions with a long-term perspective.

The integration of the sDSS developed by SiTI with the circular methodology developed within CircUse project is a very interesting approach that will allow to simplify the process of brownfield redevelopment in Asti and, hopefully, also in the other cities where the same integration will be tested.

The main features of those two instruments actually complement each other: if the CircUse methodology defines the land use concept expressed by the slogan «avoid-recycle-compensate», InViTo can represent the instrument to be used in order to identify the best way to recycle brownfields according to their specific context.

As a first implementation of InViTo to a real case – and although there are several aspects that could be further investigated – the Asti experience can offer a lot of cues for other case studies.

The contact with local stakeholders clearly showed the perceived needs and helped to build scenarios fitting the specific case study.

Although the Municipality of Asti have made an effort to integrate the procedures with the instruments proposed within the European project, the difficulties in their application reveal that public administrations in Italy still have a lot of work to do in this field.

Finally, beyond the important results achieved within the project by the various partners, another great result of the cooperation among different European institutions, dealing with common issues, is the effort to define a shared language and common rules. Bringing European people together around shared values and interests contributes to a greater unity between European countries in order to increase a common sense of affiliation: in other words, it contributes to the creation of Europe.

[3] InViTo is an acronym for Interactive Visualisation Tool, as well as a reference to the Italian word *invito,* which means 'invitation'.

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**Isabella M. Lami** - Isabella Maria Lami, PhD, is assistant professor of Planning Evaluation and Project Appraisal at the Politecnico of Torino and a research collaborator at SiTI (Higher Institute on Territorial Systems for Innovation). She has expertise in multicriteria analysis methods and spatial decision processes within the context of territorial transformations, particularly in connection with large transport infrastructure. She was coordinator of the transnational network Urban Planning Systems in Europe – Urbax2, involving 15 partners from universities and public administrations in 9 different European countries, within the Leonardo da Vinci programme. She is currently coordinator of the activities regarding the assessment process and decision making on the Corridor 24 development, within the European Project 'Code24'. Dr Lami has published books and papers on both national and international scientific journals, and received several awards for her work.

**Cristina Marietta** - Cristina Marietta is an Architect graduated at Politecnico di Torino. Researcher in SiTI (Higher Institute on Territorial System for Innovation) since 2006, she has been working on urban and territorial issues, specifically on the Intermediate city, urban renewal and public space quality. She has recently been working on impact assessment and Decision Support Systems.

**Ognen Marina** - Ognen Marina, PhD in Architecture and Urbanism, is a practicing architect and a professor at the Faculty of Architecture, University "St. Cyril and Methodius" in Skopje. His main field of interest is research on dynamic 3D city models and on novel structures in architecture. He is particularly interested in the processes of urban transformation and urban innovation through hybridization, in the context of transitional societies. He is active in the promotion of novel tools in the development of urban environment that could enhance a better citizen participation and their cooperation with decision makers and designers. He is a member of ENHR and an author of several papers and publications related to the analysis, assessment and modeling of urban development and of its impact on cities and society.

**Giulia Marra** - Double Master degree in Architecture, Giulia Marra graduated in 2009 with a thesis concerning the evaluation of housing participatory approaches for informal settlements upgrading in Buenos Aires. Since then, she has worked for urban planning public authorities, international universities and design studios in Torino, Buenos Aires and Moscow. She is currently collaborating with SiTI (Higher Institute on Territorial System for Innovation) and

with Politecnico di Torino, as an assistant professor in Urban Sociology. She is a founder member of two cultural organizations: "Izmo – made to gather", focused on participatory processes, local development, architecture, design and ICT – and "URBE – Rigenerazione Urbana", within which she promotes brownfield redevelopment through temporary use projects. She is particularly interested in cultural policies and urban practices and transformation processes.

**Elena Masala** - PhD in Architecture, in 2003 Elena Masala started working as a Research Fellow at Politecnico di Torino (Italy). Since 2010, she has been carrying out her activity at SiTI – Higher Institute on Territorial Systems for Innovation –, in the research field of geovisualisation. Her experience ranges from 3D modeling to video animations, from Geographic Information Systems (GIS) to interactive visualisations, with a strong experience on virtual environments. Her work aims at supporting spatial planning and decision-making processes by means of visual analysis, data exploration and communication. Her activity focuses on the usability of Planning and spatial Decision Support Systems (PSS and sDSS) to be applied in the operational research. She is member of some COST Actions and she is author of several publications issued in both national and international books and journals.

**Giulia Melis** - Architect, MSc in History and Conservation of Architectural and Environmental Heritage. Since 2007 she has been collaborating with SiTI – Higher Institute on Territorial Systems for Innovation, where she holds a position as a researcher at Urban Planning and Land Use management Unit. She is involved in several projects on strategic planning and urban renewal, and her main research interests focus on the definition and assessment of urban development scenarios through spatial Decision Support System (sDSS) tools and participatory approaches, the re-use of urban areas and brownfield revitalization, as well as the impact of built environment on citizens' health and health inequalities. Furthermore, she gained relevant international experience thanks to the involvement in several European projects and networks (FP7, COST Actions, Central Europe programme). At Politecnico di Torino, she has carried out teaching experiences, being an assistant and a lecturer in the courses of Geography and Urban Renewal.

**Stefano Pensa** - Stefano Pensa completed his PhD in Architecture and Building Design in 2013, with a thesis concerning the use of geovisualisation tools as a support for spatial planning and decision-making processes. He currently works as a researcher at SiTI (Higher Institute on Territorial Systems for Innovation), in Torino, where he carries out applied research and works at several European projects. His scientific interests range from the visualisation of spatial data to interactive systems, from web mapping to VGI. He also actively participates to a number of COST Actions. He is the author of several national and international publications and he has been an invited speaker to a number of workshops.

**Marcella Poncini** - Marcella Poncini graduated in Land and Urban Planning at Politecnico di Torino in 2008. Her first employment was as a researcher at Siti, working on complex strategic programmes. After that, she has been collaborating with several public authorities (Regione Piemonte, Provincia di Torino, other Municipalities) about environmental and territorial issues. Also, she's co-operating with local development agencies involved in European projects (Med, Central Europe, Interreg), as well as leading training activities addressed to primary and secondary school students about sustainability and energy saving. Recently she has worked for the Municipality of Asti, as an external expert for the CircUse project.

**Thomas Preuß** - Dipl.-Ing. agr. Thomas Preuß, born in 1965, graduated in Agricultural Sciences (Dipl.-Ing. agr.) and he has worked as a project manager and senior research fellow at the German Institute of Urban Affairs (Deutsches Institut für Urbanistik, DIFU), Berlin, Dpt. Environment, since 1993. His main research fields are: circular flow land use management, brownfield redevelopment, soil protection, environmental justice, urban ecology, nature protection and local agenda 21. He has long-standing scientific project experience on national, European (e.g. Interreg, IEE) and international (e.g. U.S.) level, as well as long-standing experience with scientific program support, process moderation and simulation games in a municipal and regional administration context.

**Anna Starzewska-Sikorska** - Dr Anna Starzewska-Sikorska has been working in the Institute for Ecology of Industrial Areas in Katowice, Poland, for 35 years. Her professional activities concentrate on development of environmental policy instruments such as environmental impact assessment, strategic environmental assessment, environmental auditing, environmental management in land use planning, and solid waste management. She is an authorised expert of the Polish Ministry of the Environment in the field of EIA and strategic environmental assessment. She is experienced in the co-ordination of national and transnational projects on brownfield redevelopment, environment and health, and she has recently been the co-ordinator of the Central Europe project 'Circular flow land use management'.

**Matteo Tabasso** - Master of Science degree in Architecture and Urban Planning at Politecnico di Torino (Italy). Since 1999 he has developed an extended experience in transport and urban planning working for both public authorities and research institutions. Since July 2006 he has been working at SiTI as a project manager, coordinating various research projects on urban planning issues. Furthermore, he gained relevant international experience thanks to his involvement in several European funded projects and networks aiming at implementing innovative solutions for reclaiming degraded urban and industrial areas, analysing the relationship between planning and transport in order to develop accessibility instruments to be used in planning processes.

**Maic Verbücheln** - Dipl.-Ing. (FH) Maic Verbücheln, born in 1973, graduated in Biotechnology (Dipl.-Ing.). He has been project manager and senior research fellow at the German Institute of Urban Affairs (Deutsches Institut für Urbanistik, DIFU), Berlin, Dpt. Environment, since 2007. His main research fields are: circular flow land use management, waste management, climate mitigation and adaptation; he has long-standing scientific project experience on national (BMU, UBA, BBSR), European (e.g. IEE, Central Europe) and international (e.g. First Solar of U.S.) level, as well as long-standing experience with scientific program support, project management, process moderation dissemination, national and international seminars and conferences.

**Barbara Vojvodíková** - Doc. Ing. Barbara Vojvodíková, PhD, is a senior academic, involved in several Czech institutions. She holds a position as the Head of the Department of Regional Studies at the College of Regional Development in Prague, and also works as a lecturer at the VŠB Technical university of Ostrava, where she habilitated in 2006. She specialises in evaluation of regional disparities and specifics of brownfield reuse. She leads and coordinates national and international projects, initiates project partnerships and contributes to a large spectrum of IURS promotional activities.



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