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The Topaz solar Farm in Central California: Landsat images 2011 - 2014. Source: U.S. Geological Survey (USGS) Landsat Mission Gallery "Topaz Solar Farm, California," U.S. Department of the Interior / USGS and NASA.

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BOOK REVIEWS

The number of visits to the CSE website is witness to the journal's continuing success, a success already demonstrated by the February 2014 issue. Submissions have increased despite rigorous selection process or possible delay in publication of some papers.

The scientific overview in this issue covers a wide range of topics from safety of the territory, land consumption and water management. On the topic of sustainable mobility, the research concentrates both on bicycle/pedestrian mobility as an alternative, but extremely important means of transportation in the traditional city, and on the environmental compatibility of transportation hubs.

Another very current research topic in the field of building technologies concerns advanced techniques for surveying historic architecture, invaluable today in the restoration of monuments.

The articles on the area of energy efficiency address the topic of renewable energy in terms of reduction of production and management costs, as well being a guiding principle in urban regeneration processes.

The articles are summarized by topic in the following abstracts.

PLANNING AND LAND SAFETY

From quantitative to qualitative analysis of Land-Take. The application of a Composite Indicator in targeted policies for Land Take reduction (Salata, Gardi). The article concerns the construction of an experimental Composite Land Take Indicator in the case of study of the Lodi area in Northern Italy. The significant under-estimation of land take occurs in cases in which Corine Land Cover (CLC - an inventory of land cover distributed in 44 classes) is used on a local level when CLC seems to be sufficient for assessing a general amount of Land Take. The Composite Indicator seeks to support policy makers and planners in adopting more appropriate measures for applying European guidelines and protocols for Land Take management.

Urban storm water runoff and pressure on the sewer system (Ronczyk, Czigány, Horváth, Lóczy). The authors investigate the problems involved when excessive rainwater is released illegally into the sewer system in Pécs, a city in southwest Hungary in the environmentally sensitive context of the Mecsek Mountains. Special attention is placed on the analysis of the topographic factors contributing to excess runoff using a Digital Elevation Model. The study presents a typical example of how private preferences confront the public interest within an urban landscape. Controlling illegal release into a sewer system is an important task: research findings can be used in the design of a storm water runoff monitoring system.

SUSTAINABLE URBAN MOBILITY

Transportation and Territory in a Global Economy (Giordano). The ability to move easily, quickly and with low environmental impact within urban areas is a key factor in the quality of life in all modern metropolitan areas. Sustainability is uniquely considered to be the most innovative aspect because environmental impacts and fears relating to climate change and the progressive depletion of natural resources are viewed as priorities on all levels.In many manufacturing and commercial SMEs (Small-Medium Enterprises), planning activities in manufacturing and logistics, warehouse management, inventory and transportation management are not adequately supported by advanced computer systems. Similarly, transportation and logistics companies show considerable resistance to investing in Information Technology, a

prerequisite for the development of logistics outsourcing and advanced value-added services.

Green airport terminals: the state of the art in Italy. An overview of conditions in core network airports (Fossi, Esposito). The environmental, economic, and social importance of a sustainable approach to airport terminal design is recognized today as a true global challenge. This paper illustrates the results of a study of the state of the art of green terminal design in Italy with specific focus on the ten airports in the nation's core network. The importance of green terminal design is linked to the very short life cycle of the passenger terminal (10-20 years). In this article, a survey of qualitative and quantitative aspects seeks to portray a synthetic but efficient picture of the state of the art of green terminal design in Italy carried out under the auspices of the airports' technical departments.

Pedestrian mobility and accessibility planning: remarks on the implementation of travel time maps (Rossetti, Tiboni, Vetturi, Calderòn). In the evaluation of urban pedestrian areas, accessibility is a recurring theme that emphasizes the strong links between land use and mobility. In the past decade, dependence on GIS-based approaches for accessibility assessment and management has grown. Today, the crucial role of GIS techniques in accessibility analysis is well-established. This paper focuses on pedestrian accessibility as the major means of mobility on a neighborhood scale. The study seeks to measure the pedestrian accessibility of a given zone and to map the results in a GIS environment.

Cycling as a best practice for urban renovation. Case study: the City of Genoa (Pirlone, Candia). The paper analyzes urban cycling as a fundamental element in sustainable mobility. Many international case studies clearly show how it is possible to evolve modern cities into more liveable places by promoting cycling as a daily means of transportation. Different solutions that boost cycling in Genoa are presented. Several recommendations are proposed for producing a correct Sustainable Urban Mobility Plan in which the bicycle must be considered, along with other means of transportation, as an essential element in urban development and renovation.

ENVIRONMENTAL DESIGN

Micro-urbanism and identity. Case study: Bucharest; the city as palimpsest (Alexandra, Cornelia). Bucharest, a city whose many layers are composed of all of its historic eras, is currently undergoing rapid change that often leaves gaps in its urban structure. A central theme in contemporary Romanian society is the loss of a sense of belonging to a community primarily due to ambiguous relationships between history and everyday reality. The project illustrated in this paper is part of a series of urban interventions and proposals that explore waste sites and residual areas, along with the community's tendency to re-appropriate them. The study explores an intervention strategy that respects the spirit of place by pinpointing fragments having their own identities and defining a new layer to complete the urban fabric.

The representation of a cartographic information system. Experimental research on the Valle del Tronto (Pieragostini). The thesis proposes research in the field of representation and design in order to describe and disseminate information relating to environmental heritage, landscape

and urban environment with the aid of geographic information systems (GIS). The research sought to create a two- and three-dimensional model that portrays a global overview of the Tronto valley area in Italy.?The complexity of this case of study was the basis for the process of constructing the model and therefore of its information content. The final model is thus the re-composition of the geographical system data through a new computer system that can meet its tasks, creating a communication system that is effective in producing a graphic description of the territorial complexity.

BUILDING TECHNOLOGIES

Integrated and advanced survey techniques for the definition of lost features of historic architecture (D'Auria). Analysis of architecture characterized by geometric, functional and historic complexity requires the acquisition of metric data and iconographic and archival documents, followed by the correct interpretation of the information gathered to reliably reconstruct the salient characteristics possibly lost over time. The study is based on bibliographical sources, recent historical data, the analysis of ample iconographic documentation, as well as surveys of existing conditions using different techniques, primarily new technologies managed in an integrated manner. The surveys made use of the laser-scanner as well as aerial photogrammetry deploying different types of UAV (Unmanned Aerial Vehicle) and digital cameras.

Survey, documentary research and stratigraphic analyses of the Gothic church of S. Eligio al Mercato in Naples (De Feo). Digital survey techniques are essential tools in the field of architectural restoration as well as in the investigation of the stratigraphy of historic structures. They have the goal of placing these structures correctly in their proper eras. Their diffusion has been driven mainly by the reduction of the time needed for the survey phase, by the increased reliability of the representation of historic artifacts and by the development of three-dimensional models, here applied to a case of study of late medieval religious proto-Angevin architecture in Naples. Once the artifacts were surveyed with the laser scanner, a database was used to extrapolate important graphic representations such as the buildings' material survey and to process metric data statistically. Finally, data was compared with information deriving from documentary research.

ENERGY EFFICIENCY IN BUILDINGS AND NEIGHBORHOODS

Assessing risk and opportunities in a high-renewables scenario: local planning and new energy landscapes (Pezzagno, Rosini). With the significant exception of hydroelectric power plants and traditional biomass, renewable energy (RE) has thus far represented a limited share of primary global energy sources. Renewable generation technologies, in particular wind and solar power, have consistently followed a steep price-experience learning curve. The prospect for a power generation system strongly based on renewable sources represents a thrilling opportunity for climate change mitigation, but also raises concerns about their potential risks. First the analysis of the Italian scenario is examined. Subsequently the discussion, in terms of soil consumption and potential competition with agriculture, turns to the importance of a possible transition to a power generation system based on renewables.

Natural ventilation and passive cooling for the energy efficiency of residential buildings in a Mediterranean

climate (Tucci, Cimillo). New energy requirements for European buildings mandate Nearly Zero Energy standards within just a few years. In order to achieve such results, new buildings will have to combine high-performance envelopes, active energy-efficient systems, on-site renewable energy production and passive systems, which seem the most difficult to implement widely in conventional buildings despite their proven effectiveness. Natural and hybrid ventilation systems in a Mediterranean climate show huge potential in terms of energy savings and the improvement of indoor comfort, but the main obstacles to broader use of such systems lie in the difficulties and uncertainties in terms of design and reliable predictability of real performance. This paper describes a methodology for resolving such problems and presents two case studies that illustrate the process through the use of increasingly detailed analytic and simulation tools.

Urban regeneration as an opportunity for design-driven energy transition (Caruso). This article concerns the issue of energy transition, in particular the potential of a regenerative approach in implementing design strategies to improve energy efficiency and obtain high performance local systems. The gradual depletion of fossil resources drives the price of energy upwards with increasingly marked turbulence in global markets. Without appropriate technological/scientific solutions, society is compelled to direct its industrial strategies towards more sustainable methods that can prevent tragic human consequences, especially in light of the fact that the world population will number 9 billion by 2100. We can therefore foresee a transition from a highly centralized energy system to one characterized by greater diffusion: less vulnerable and more effective networks connected to grids that are smart, small and self-sustainable, but always well-controlled.

We hope that our readers find these articles of interest.

L.C.

EDITORIAL

Safety in urban environment

by Maurizio Tira

Two are the words of English language to convey the feeling of protection against threats: *security* and *safety*. *Security* expresses the reaction to social problems, typically the fear of personal attacks. It is highly perceived as a priority for the liveability of urban environment, especially from the elderly. *Safety* is the word used in the copious literature about risk assessment and mitigation, for conveying threats related to natural and man-made hazards. Whereas security is rather a result of social structure of our societies, nevertheless ITC devices are largely used to improve the feeling of being secure, namely the video surveillance systems.

Several disciplines deal with the complex topic of safety, as it touches most of our daily activities and scientific subjects: structural design, physical planning, road design, transportation engineering, geotechnical and hydraulic engineering, etc.. Being one of the key words of our review, it is unnecessary to underline the relevance of the topic being offered to the readers.

Less evident can be the relations between natural and man-made hazards and the urban schemes. The technologically advanced societies are facing growing challenges due to the increasing complexity of communities, whereas the poor countries are always suffering from the heavy economic losses, unbearable in a low income society.

From the outcomes of natural and man-made hazards on the world economy, hence the urgency for decision makers to allocate a growing part of the ever scarcer economic resources to risk mitigation.

The Global Platform for disaster risk reduction, held in Geneva in 2013 (DRR Report), found that *the global economy's transformation over the last 40 years has led to a growing accumulation of disaster risk. Annually, economic losses already amount to hundreds of billions of dollars and they are projected to double by 2030. Countless everyday local events and chronic stresses involving multiple risks are an ongoing burden for many communities. (...) Urban risk needs to be more fully understood. The risk of failures in technical systems also poses severe consequences that have often been overlooked. The dynamic and multidimensional aspects of risk require holistic and comparable methodologies for risk assessment to enable, science-based decision-making and identification of development opportunities.* Moreover, *disasters happen locally and solutions are to be found locally. This does not relieve national governments of their responsibilities to establish a framework and enabling environment for local action. However, municipalities and local authorities are in unique positions to lead and create opportunities for local partnerships and to take risk-informed decisions that protect the continued potential for economic and social development. Sound urban development and spatial planning, including attention to informal settlements, migration, safe housing, infrastructure and social services,* are crucial. Focus was also placed by the Platform on efforts to ensure that all schools and hospitals are built to resilient standards, that all necessary school and hospital preparedness measures are in place and that attention has been given to the needs of persons with disabilities.

In other words, it is said that the perspective of the weakest (the disabled) is the best approach to ensure safer places for all!

Another evidence: the need for holistic approach and for interdisciplinary studies clearly emerge from the expert panel. That's also lowly the goal of our review, an intersection of different knowledges.

For the sake of simplification and the convenient shortness of this editorial, we will briefly introduce the safety problems of urban settlements and the potential of technical disciplines to mitigate risk.

Disaster risk reduction is a world challenge. Fatalities and economic losses due to natural catastrophic events have increased in recent decades and some communities around the world face natural hazards almost daily.

Under climate change scenarios, the distribution and severity of extreme events is expected to become increasingly uncertain and unpredictable.

From a geographical "scale" point of view we can recognize hazards by type

- regional hazards: those having the potential to produce regional disaster (floods, volcanic hazards),
- multisite hazards: related to meteorological events that can virtually occur anywhere (storms, hailstorm, earthquake),
- local hazards: they may occur in a particularly vulnerable environment and may provoke extended effects with respect to the relatively small physically damaged area, whenever systemic and functional vulnerabilities are relevant (land-

slides, avalanches).

Adding to those the so-called man-made hazards, that are mostly scattered, with only some concentrations, depicts the scenario of most urban settlements.

From a geographical "distribution" point of view, in Europe a rather clear distinction can be made between:

- northern countries: floods and meteorological related hazards represent the main threat,
- Mediterranean countries: forest fires and main geological hazards, in particular earthquakes and volcanic activities.

Even man-made hazards have an unequal distribution in the northern and southern EU Countries. For example, road safety is a higher concern in the South Eastern EU Countries, whereas technological disasters are probably most feared in the former Socialist Nations.

Anyway, the more promising approach lies in the disaggregation of risk into its three main components.

A disaster is a probabilistic event, whose effects we try to mitigate through our actions. A disaster is a sudden, unexpected variation in the normal evolution of systems; following the definition of the United Nation Office for Disaster Risk Reduction-UNISDR it is *a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources*. It may also be defined as *a non-routine event in societies or their larger subsystems (e.g. regions, communities) involving socio-economic disruption and physical harm.*

For better understanding the potential for action related to the large variety of events, it is worth reminding the overall accepted definition of risk (see VARNES and IAEG, 1984):

RISK = f (Hazard, Exposure, Vulnerability)

Where:

- *hazard* represents the physical event, phenomenon or human activity with the potential to result in harm; any event can be described in terms of probability of occurrence and magnitude/intensity;
- *exposure* describes the socially valued elements that may potentially be damaged by an hazard, first of all human lives;
- *vulnerability* describes the susceptibility of exposed elements to losses, the degree of fragility of a natural or socio-economic community or system towards hazards.

As the formula is definable only in relation to specific events, what is generally agreed is that the combination of the three elements is such that risk is zero whenever any of the variables is zero. More precisely, we may let exposure and vulnerability tend to zero, whereas hazard is hardly resettable.

Such a disaggregation is extremely promising to better understanding the chances for action when combined with a classification of typologies and origins of disasters (Tira, 1997):

Typology	Origin	Disaster
Seismic phenomena	PHYSICAL	Earthquakes, Tsunami, Volcanic eruptions
Meteorological phenomena		Cyclones, Tornadoes, Heavy fog, Drought
Geological phenomena	COMPOSED	Floods, Landslides, Avalanche
Ecological disaster		Epidemics, Forest fires, Chemical contamination, Physical contamination, Bacteriological contamination, Radiological contamination
Accidents of transport	HUMAN	Plane crashes, Train crashes, Road accidents, Maritime accidents
Technological disasters		Breaking barriers, Collapse of bridges and structures
Major industrial accidents		Explosions, Fire, Biological and chemical contamination, Mining disasters
Terrorist acts		

In the proposed taxonomy, exposure and vulnerability may always be influenced by human activities, while only human events and – partially – composed ones are those where hazard can be reduced.

A *physical disaster*, for example, is an event where the causes are mainly or only natural. The earthquake is the best example: ordinary human activities (if we exclude fuel search, heavy mining, atomic explosions and gas storage) cannot trigger a seismic event. Consequently, our actions will concentrate on exposure and vulnerability mitigation, through active or passive measures.

A *composed (or intermediate) disaster* is an event where man actions can partly influence hazard, together with exposure and vulnerability. That is particularly evident when floods and landslides are concerned. Heavy rains are the natural cause behind flooding, but long term land use choices and short term governance models can heavily influence vulnerability.

The *human (man-made) disasters* are those where human responsibilities are prevailing on natural causes. Also in that case we should exclude – for example – the influence of meteorological conditions over road crashes or fire propagation.

It is clear that safety actions must be preferably devoted to the reduction of magnitude and intensity of threats, without excluding exposure and vulnerability mitigation.

Knowing the above, policies and techniques can focus on the more effective solutions, being active or passive measures.

Ordinary planning is first and foremost a pro-active approach to risk mitigation. We could probably think that erecting a river bank is the most important action against floods. Nevertheless, experience shows how the impermeabilisation of soils greatly influences the runoff and overflow development in a river basin, so land use plans are crucial. Nevertheless planning acts are rarely accepted when binding and affecting property rights, whereas works are welcomed as an explicit will of protection.

Furthermore, only plans can address the vulnerability of urban settlements, that goes beyond the fragility of single elements, involving the structure of settlements, the social and institutional organisation, that is the ability of reacting to urban failures. That's the reason why ever growing towns, increasingly complex and interrelated, are more vulnerable to external events, even if buildings and structures are well designed and properly realised.

Those are the reasons why planning in hazardous areas is at the core of planning theory and practice.
From the *epistemological* point of view, as planners are forced to rethink to urban habitat as a non-deterministic system.
From a *strategic* point of view, as taking risk into consideration entails the evaluation of the probable possible future, that is the assessment of the sustainable scenario for the future urban structure. Over the past 20 years it has become increasingly accepted that the principles and practices of sustainability must be integrated with those of risk mitigation.
From a *methodological* perspective, as in-depth analysis are indispensable to identify local hazards, vulnerabilities and exposed population and goods, so contributing to a wider and deeper understanding of the area.
From the point of view of *urban policies*, as hazards forces local communities to decide about the acceptable level of risk within the constraints of a limited budget, through participation processes.
The past experiences showed how urban *planning choices* implemented – for example – after an earthquake, can be crucial for the *economic recovery* and the social activities to restart in the affected areas. Without a proper urban governance, the earthquake tends to be a great accelerator of urban dysfunction already present, where the risk mitigation concern is almost absent and the urban system vulnerability is only partially compensated by the strengthening of the new buildings.
The role played by planning in mitigating future risk and governing development and reconstruction is then crucial as, theoretically speaking, the distinction between post and pre event planning is meaningless.
Few other active measures can be listed, referring to several disciplines. They suit more the man-made hazards, where a lot can be done to reduce the probability of man failure. Let's think to the evolution in remote control, to the safety devices in transport systems, etc..
Technological tools can help protecting also from natural hazards, when predictable: the monitoring systems, increasingly sophisticated and open to public are ever more accessible through tablets and i-phones.
Structural measures, generally referable to the retrofitting and strengthening of existing built stock, are typical passive measures, dimensioned to reduce vulnerability, so the probability and amount of damages.
A great debate can be arose about the cost of protection and the accepted level of residual risk, namely when facing several and different threats.
Geotechnical interventions, can be both active or passive measures, when preventing landslides or defending infrastructures from them.

Addressing safety includes, first and foremost, shifting from "a deterministic based tool box, routed in a deterministic view of society and personal behaviour", to the "probabilistic perspective of natural phenomena" (Imbesi, 1997) and their consequences.
Anyway several events are approached through the simplification of the scenario.
In other words, we try to depict one or more possible futures through static descriptions. Giving scenarios a rate of possibility, stochastic events may be described through deterministic representations (that is the case, for example, of seismic maps and classification).
The scenario should guide decision makers to acting. Nevertheless and paradoxically, as far as more the action is far from the expected event, so less it is perceived as crucial. Being probably rooted in human psychology, the fear of disaster prompts human beings to forget it and so negatively influences prevention.
With the same approach, most assessment of disaster impacts only focus on quantifying immediate direct damages and only in financial terms. The economic costs consist mainly of immediate damage assessment in order to provide governments and aid donors with estimates of the amount of funds required to address emergency and reconstruction needs, as well by insurance companies.
Long-term indirect costs in the flows of goods and services, reduced levels of production and non market impacts, such as environmental damage and psychosocial effects, are frequently omitted from such assessment.
The reliability and safety of urban systems must be an inalienable objective of ordinary planning activity. The need to plan the development of a specific region, also in terms of the potential risk to which it is exposed, is more and more evident since experience teaches that close attention to forecasting and prevention is as important as managing effectively the emergency under way.
The duty of correct regional planning is to provide the direction for growth that guarantees, in case of disaster, maintenance of a level of functionality and, therefore, of acceptable standards.
Ultimately, the problem is the definition of a urban response spectrum to the event, by borrowing the similar concept developed in the field of seismic engineering. A response spectrum is a scenario that allow decision makers to foster the next asset of urban environment. It is a way to be prepared, as disaster specialists have increasingly emphasized the importance of a proactive policy that can prevent or lessen losses, rather than a crisis-reactive approach taken when disaster strikes.

Traditionally Governments have attempted to tackle disasters after they have occurred, by means of measures aimed to mitigating the effects that future events might have on society.

But such measures have proved to be inadequate for bringing risk levels down to socially acceptable levels.
Roughly we could state that 1 € spent in mitigation activities is equal to 7-10 € spent in response!
The idea of realising safer cities, where people feel safe, has been rife for some time and occupied the minds of town planners and designers, but maybe not enough the agenda of decision makers.
That's probably the reason why United Nations have set up several decades of action to face disasters.
The General Assembly designated the 1990s as the *International Decade for Natural Disaster Reduction*. Its basic objective was to decrease the loss of life, property destruction and social and economic disruption caused by natural disasters, such as earthquakes, tsunamis, floods, landslides, volcanic eruptions, droughts, locust infestations, and other disasters of natural origin.
The 2005-2015 decade is devoted to *Water for life*.
The decade 2006-2016 is the Decade of *Recovery and Sustainable Development of the Affected Regions* (third decade after the Chernobyl disaster).
The decade 2010-2020, has been declared the United Nations *Decade for Deserts and the fight against desertification* and also devoted to *Action for Road safety*.
A countless number of resolutions and programmes are devoted to the topic, but interdisciplinary research still needs a step further.
We hope that the review could contribute to the discussion about risk mitigation, and moreover to the birth of a new environmental ethics, which is rooted in the consciousness that technological innovations are not preventing us from ever searching the balance between human activities, people and nature.

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Planning and Land Safety

From quantitative to qualitative analysis of Land-Take. The application of a Composite Indicator for targeted policies of Land Take reduction

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Keywords: land take; soil sealing; ecosystem services; land capability, composite indicator

Abstract

The processes of land take and soil sealing tend to receive more attention as threats to soil resources and Ecosystem Services (ES) provided by soil grow. The objectives of this paper are: 1) to assess the extent of land take (intended as the of artificial surfaces) in the Province of Lodi (Northern Italy) by evaluating the accuracy associated to the different scales of the cartography used; 2) to assess the effects of land take on the selected ES (in particular, supporting and regulating services). In case of study the ES assessed was the potential agricultural productivity, evaluated the Land Capability Classification[1] as proxy and integrated with additional information regarding the increase of impervious surfaces. Thus, the construction of an experimental Composite Indicator on Land Take has been provided.

The results have shown that important underestimation of land take occurs when Corine Land Cover[2] (CLC) is used at local level in Italy but, at the same time, when used in Country, CLC seems to be sufficient to assess the general amount of Land Take. Moreover, when a shift from the neutral assessment to practical policy orientation of Land Take reduction is requested, a higher degree of additional qualitative information necessary to steer planning options. The Composite Indicator is aimed to help policy makers and planners to adopt suitable measures by applying European guidelines and protocols for Land Take government.

1. Introduction

The term "land take" refers to a complex transformation process which involves land surface and is detected and mapped by Land Use Change (LUC) analysis (Hasse e Lathrop 2003; Antrop 2004). It is generally defined as the conversion of natural, seminatural or agricultural land uses into artificial land uses (European Commission, Guidelines on best practicies to limit, mitigate or compensate soil sealing 2012), as a consequence of urban growth. This process generally implies a reduction of the ecosystem services delivered by these areas, and in particular, capability to support agricultural productivity.

The large majority of soil indicators for Land Take assessment are consistent only as descriptive tools for soil scientists, but less consistent as tools to steer local policies for preserving soil degradation due to urbanization (Geneletti, Assessing the impact of laternative land-use zoning policies on future ecosystem services 2013).

Nowadays the data collected on the urbanization trend (land-cover classification, rate of change, urbanization per capita) is being well analyzed (Benini, *et al.* 2010; Bhatta, Saraswati e Bandyopadhyay 2010; Munafò 2013) (Pileri e Salata, L'intensità del consumo di suolo. Lombardia, Emilia Romagna, Friuli Venezia Giulia e Sardegna 2011) and the proposed European guidelines for land-take reduction are supported by national databases of land cover/use. Less analyses are focused on environmental effect of land take on ecosystem services (ES) (Daily, 1997; Costanza, *et al*., 1997), that are provided by natural soils (Helian, Shilong, Hang, & Xiaodong, 2011), especially the ones that require integrative analysis at local level across different disciplines (Breure, *et al*., 2012). Despite this, a great deal of recent research is dedicated to the use ES as a proxy for planning policy for sustainable management of soil (Artmann, 2014; Breure, *et al.*, 2012; Jansson, 2013; Li, *et al*., 2014).

There is still a gap between national policies and the construction of a theory of land resource management, includ-

1. Land Capability Classification (LCC) shows the suitability of soils for most kinds of agricultural activity. Capability classes are designed to indicate progressively limitations for agricultural uses.

2. In 1985 the Corine programme was initiated in the European Union. Corine means 'coordination of information on the environment' and it was a prototype project touching upon many different environmental issues. The Corine databases and several of its programmes have been taken over by the EEA. One of them is an inventory of land cover in 44 classes, and presented as a cartographic product, at a scale of 1:100 000. This database is operationally available for most areas of Europe. (definition given by European Environment Agency – Terminology and Discovery Service.

ing regulative (intended as quantitative target – e.g., 30 ha per day), planning (intended as local prescription – e.g., Urban Growth Boundaries) and fiscal measures (intended as special fees – e.g., additional taxes for land transformation) for limiting land take (Dale e Kline 2013). The goal of reducing land take with an integrative approach between analysis and policies of local land regulation needs to be supported by a deeper consideration of two crucial aspects: land-use detection and the development of synthetic indicators for a multidimensional approach to land-take evaluation.

Soil protection strategies based on policies, practices and planning tools directed towards land take reduction were progressively introduced by the Strategic Environmental Assessment (SEA Directive, 200142/EC). SEA is aimed at monitoring the land take phenomena, using environmental data, and assessing impacts of land use change due to urbanization (Treville 2011). The concept of environmental sustainability was enforced by SEA Directive, but repeatedly even fully exploited, SEA is not sufficiently qualified to perform a complete land take assessment. Mainly SEA uses a basic quantitative analysis rather than qualitative and coherent assessment of soil degradation to quantify the cumulative impact induced by land take (Tardieu, Roussel e Salles 2013). This happens even if predicting effects on ES has emerged as a crucial need in spatial planning and in the associated SEA (Geneletti, Reasons and options for integrating ecosystem services in strategic environmental assessment of spatial planning 2011).

Traditionally, LUC analysis only allows quantifying a single process, and not the effects that the changes in land use have on ES. For example, the traditional analysis of land take does not provide any information on potential food production (Gardi, Bosco e Rusco 2009; Gardi, Panagos e Van Liedekerke 2014). When a process of urbanization occurs, at least three critical processes are simultaneously happening: the first one is the simple variation of land covers which implies, among others, radical changes on carbon sequestration services (Lal 2004); the second one is the "sealing process" (Duley 1939; Scalenghe e Ajmone Marsan 2009) which implies the coverage of surfaces with impervious material and it generally implies major effects on soil buffering capacity; finally, the third process is represented by the alteration of potential productivity of soil (Helian, *et al*. 2011; Haines-Young e Potschin 2011) which directly affects the local and global food production and the related risks.

Above all, ordinary LUC analysis that is highly affected by land-use detection: the topography, variability among data, classification systems, projections systems and technologies adopted can cause a significant effect on the plain measure of land use areas.

As previously mentioned, planners have to analyze the problems through interdisciplinary research that shifts from traditional boundaries between the social sciences, humanities and natural sciences (Haberl & Wackernagel, 2004), going through the traditional study on surface covers and identifying new land use models (Geneletti, 2013). Therefore it is crucial to simplify the production of land-take indicators and (EAA 2011; Pileri, Misurare il cambiamento. Dalla percezione alla misura delle variazioni d'uso del suolo 2011) is crucial to simplify and qualify information on complex ongoing processes of land transformation. Reliable indicators are usually very specialized and soil-oriented, but not easily applicable in practical land-use planning or policies. The proposal of the present (research) paper, tested only from methodological standpoint, is that a composite indicator on land-take impact could help planners on the prescriptive level of soil uses. The paper will present the research output for a context-based assessment (Province of Lodi, Italy) of a composite indicator on land take (Land Take Impact - LTI) (Giovannini, *et al*. 2008). According to the OECD definition "A composite indicator is formed when individual indicators are compiled into a single index, on the basis of an underlying model of the multidimensional concept that is being measured" (OECD 2004).

Traditional LUC analysis (useful for "quantitative - target" policies for land-take limitation) will be integrated (and discussed) with additional qualitative information. The research shows limitations of considering LUC an efficient tool for supporting urban planning at local scale. In fact, the composite indicator on Land Take Impact (LTI) seems to demonstrate the natural limits and weaknesses of the traditional analysis as a technical tool to qualify land-take processes and suggests how ecosystem services support land-use management.

2. Land-use change analysis. From the traditional approach to innovative ones

Approximately 75% of Europe's population lives in urban environments and a quarter of EU's land surface has been directly affected by urbanization (EEA, 2006). This type of land-use change affects urban climate through alteration in surface-atmosphere interactions through energy fluxes (Nordbo, Jarvi, & Vesala, 2012). Land-use change has become a "hot topic", and this is normal in a global context of population growth (Cohen 1995; Rounsevell e Reay 2009).

The general impression is that the gap between analysis (quantification and qualification of land take phenomena) and regulation (improvement of particular land-use development patterns) is still unfilled (Nuissl, *et al*. 2009). Such problem occurs due to a deep epistemological issue: while "land cover" refers to the ecological state and physical appearance of the land surface based on a classification system, "land

use" refers to human purposes in relation to the land (Dale e Kline 2013; Turner II e Meyer 1994).
According to Nuissl *et al*. (2009), the tools focusing on the containment of land take are aimed to define two different aspects: reducing the amount of land development and improving land use patterns. While the first field theory is much more advanced and rooted in environmental sciences (Helming, *et al*. 2011), the second field is still uncovered by scientific studies (Haberl e Wackernagel 2004).
National agenda of environmental policies would need to be supported by aggregated data concerning the levels of urbanization: all the Nations engaged in the discussion of an instrument that will limit the further growth of urban areas (Germany, Netherlands, UK, etc.) are supported by national databases of land cover/use. However, a theoretical model for land use management at local scale specifically created for limiting land take is still lacking where advanced policies are designed (Dale e Kline 2013).
Local planning policies are unique and cannot be used as templates (Lenz e Peters 2006) as, in accordance with the subsidiarity principle, the lowest level possible should be responsible for land-use management, and planning instruments should directly control urban growth, but all too often they have failed to do so at local level despite the central guidelines, protocols and policies (EEA 2006).

2.1 Land-take detection

As introduced above, the comparability between different land-use databases is necessary for LUC analysis, in fact, it requires comparable land-use maps produced through the harmonized process, with the same scale of representation, the same number of land-use classes and the same minimum detectable areas (Benini, *et al*. 2010).
LUC analysis is one of the major tasks of landscape research, so far, has been implemented with the use of different temporal threshold databases of land use and the impact assessment of land-use transition, referred to land take and land abandonment, is one of the major tasks of landscape research (Wu e Hobbs 2002; Salata 2014).
Accurately detecting land use is a difficult challenge for the further development of relevant indicators of land take and for the purpose of its limitation. For instance, it is widely accepted that the reliability of aggregated land-use data at different scales is affected by different gradients of precision. An underestimation of artificial surface in the database of Corine Land Cover (CLC) is supposed to be evident because of its main technical parameters (Prokop, Jobstmann e Schonbauer 2011), but a misinterpretation of landscape indicators arises when users are not aware of the differences between data sources (Lenz e Peters 2006).
A comparison among land-use maps at different scales demonstrates that large scale land use databases can sometimes be sufficiently precise for spatial analysis. To test this hypothesis, a cartographic and statistic comparison among different land use databases is being presented here for two territorial contexts: the Province of Lodi, in the North-West of Italy, and the Region of Catalunya, in Spain.
The European database CLC will be tested at different scales: as in the Italian context, by comparing CLC[3] with the regional land-use database of Lombardy DUSAF[4] andg with a Topographic database of the Province of Lodi[5] (DB top), which is the cartographic instrument for the territorial government at local scale). In the Spanish context, CLC will be tested through a comparison with the Mapa de cobertes del sòl de Catalunya (MCSC-3)[6] which is the regional land-use database.
For the Italian case study the three databases are uniformly clipped and geospatially tested. A comparison among the databases is presented and the aspects under analysis are: variations, indexes and differences of accuracy.
The statistical comparison demonstrates how, in the Italian case, the aggregated data for the land-use classes is strongly influenced by land-take detection among different databases. Two significant points need to be highlighted: the statistical error in artificial surfaces between CLC and DB top (see table 1), and the differences between the detected land-use indexes. The sixty-two percent of the existent built-up system is not detected by CLC (Class 1), while for DUSAF the underestimation is only twelve percent. These results show the inadequacy of CLC for this specific scale of territorial investigation.

3**. Sources**: satellite images SPOT-4 HRVIR, SPOT 5 HRG e/o IRS P6 LISS III **Year**: 2006 **Scale**: 1:100.000 **Minimum unit**: 250.000 mq (25ha) **Legend**: Corine, 3 levels, tot 64 classes.

4**. Sources**: aerial photo by BLOM Crg **Year**: 2007 **Scale**: 1:10.000 **Minimum unit**: 1.600 mq **Legend**: Corine, 5 levels.

5**. Sources**: aerofoto di volo eseguito nel 2008 **Year**: 2008 **Scale**: 1:2.000 **Legend**: 88 classes.

6. **Sources**: *Imágenes de referencia SPOT5 fusión de imágenespancromática y multiespectral de 2,5 m de resoluciónespacial del año 2005 conjuntamente con doscoberturas de imágenes Landsat5 TM del año 2005 y ortofotos PNOA de losaños 2004 y 2006, como complemento***Year**: 2005 **Scale**: 1:25.000 **Minimum unit**: from 2 to 0,5 ha **Legend**: Legenda Siose.

Table 1 – Statistical comparison of cartographic databases for the Italian case.

land use class (absolute values)			
	CLC	DUSAF	Db top
	(ha)	(ha)	(ha)
artificial surfaces	6,818	9,825	11,047
agricultural areas	66,510	62,785	61,024
forest and seminatural	3,654	3,921	3,901
wetland and water	1,335	1,776	2,853
total	78,318	78,309	78,826

variations		
CLC | DUSAF	DUSAF | DB	CLC | DB
(ha)	(ha)	(ha)
-3,007	-1,221	-4,229
3,724	1,761	5,486
-266	19	-247
-441	-1,076	-1,518

land use class (distribution)			
	%	%	%
artificial surfaces	8.7	12.5	14.0
agricultural areas	84.9	80.2	77.4
forest and seminatural	4.7	5.0	4.9
wetland and water	1.7	2.3	3.6
total	100.0	100.0	100.0

proportion		
%	%	%
-30.6	-12.4	-62.0
5.9	2.8	8.2
-6.8	0.5	-6.8
-24.9	-60.6	-113.7

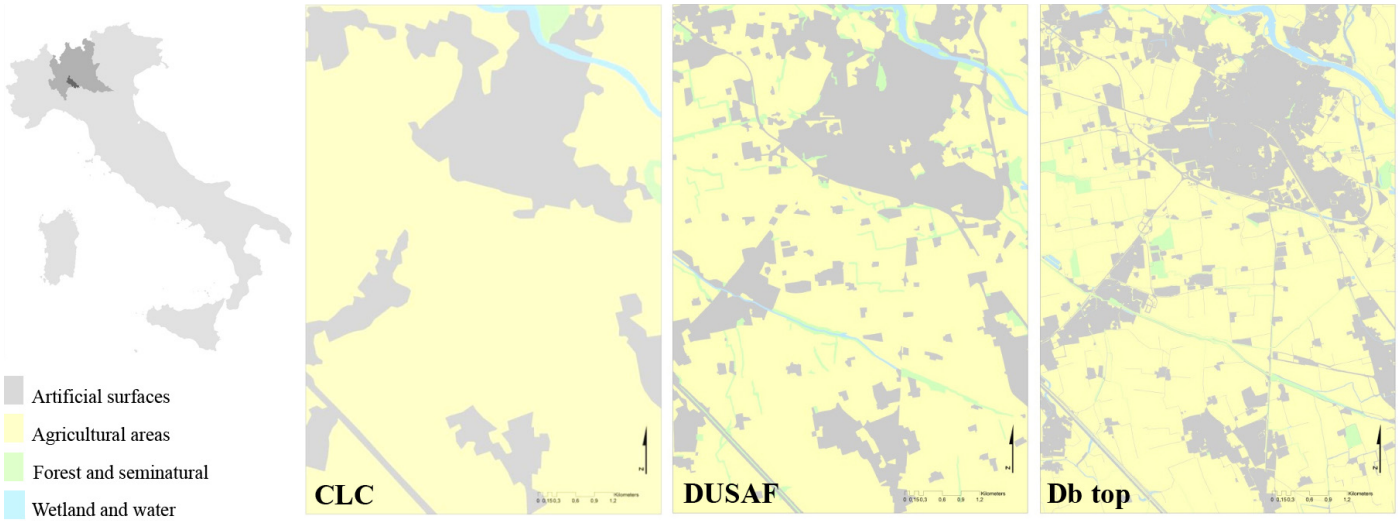

Figure 1 – Cartographical comparison of databases for the Italian case.

Table 2 – Statistical comparison of cartographic databases for the Spanish case.

land use class (absolute values)		
	CLC	MCSC-3
	(ha)	(ha)
artificial surfaces	69,631	71,175
agricultural areas	89,115	61,741
forest and seminatural	163,140	190,895
wetland and water	1,077	552
total	322,965	324,364

variations
CLC | MCSC-3
(ha)
-1,544
27,374
27,754
524

land use class (distribution)		
	%	%
artificial surfaces	21.6	21.9
agricultural areas	27.6	19.0
forest and seminatural	50.5	58.9
wetland and water	0.3	0.2
total	100.0	100.0

proportion
%
-2.2
44.3
-14.5
48.6

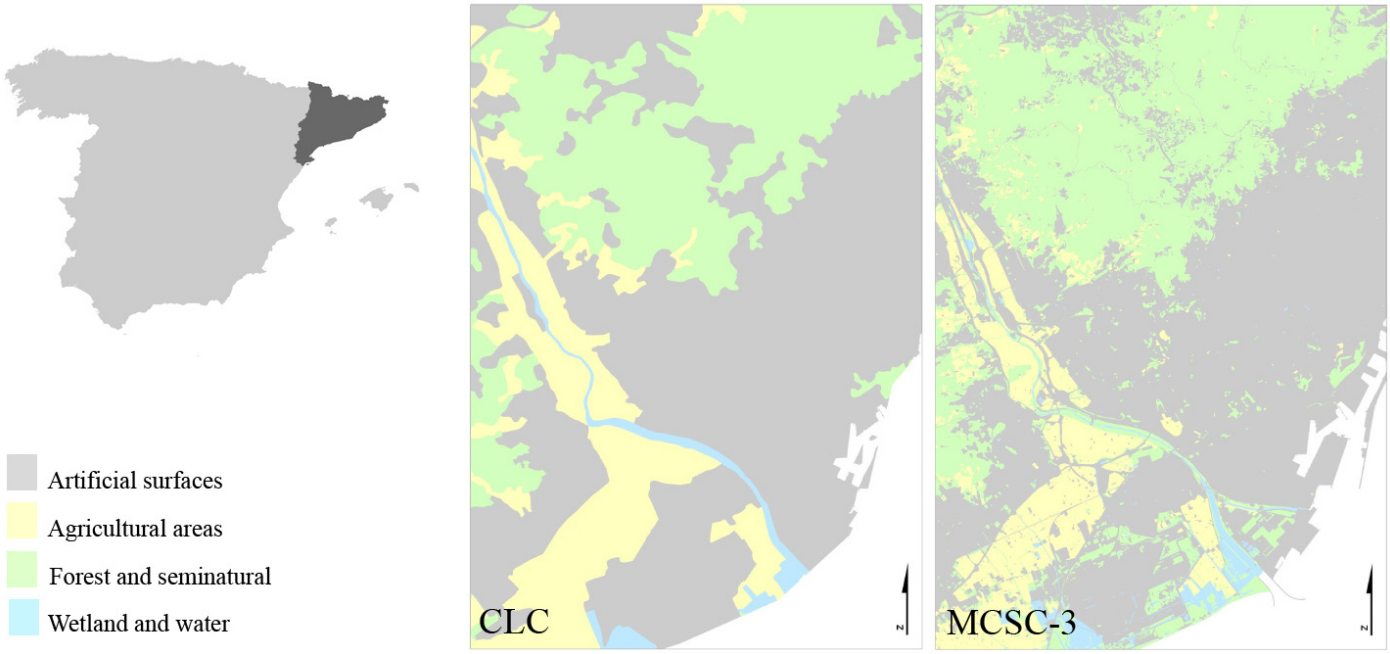

Figure 2 – Cartographical comparison of databases for the Spanish case study.

On the contrary, the analysis of CLC in Catalunya, and its comparison with MCSC-3 shows opposite results: the statistical error of artificial surfaces (table 2) and the difference between the detected land-use index, is much lower (0.3%), and not significant. This means that CLC data on aggregated land use in this specific context can be used for studies at regional scale.

Land take measures are strongly influenced by the land use detection and land-use detection depends on the "context-based" distribution and dispersion of settlements (Antrop 2004). The literature on urban sprawl distinguishes among compact, scattered, strip, poly-nucleated or leapfrogging development (Galster, *et al.* 2001); all these types of developments have direct influence on aggregated data of land use, and consequently on land take measures. The impact of this variability depends on the general characteristics of settlement distribution (Nuissl, *et al.* 2009) and it would be incorrect to standardize the error. As consequence an evaluation of the data sources is necessary before every LUC analysis. The case studies analyzed here show how LUC analysis is generally scale-dependent; this specific aspect is often neglected or insufficiently considered in landscape researches (Dale e Kline 2013; Lenz e Peters 2006).

2.2 A composite indicator of land take impact

The second main problem of LUC analysis is that it only quantifies a single process in the total amount of processes regarding the transformation of topsoil due to urbanization (in particular, it allows to quantify the process of urbanization).

But when a process of urbanization occurs, at least three critical processes, that have been under analysis by various disciplines, are simultaneously happening. One process is the plain variation of land covers indicated by LUC that is normally accounted for statistical changes of land use classes (Geneletti, Assessing the impact of laternative land-use zoning policies on future ecosystem services 2013). A second process is the "sealing process" (Duley 1939) which affects urban covers and has the biggest effect on ecosystems and landscape. Finally a third process, related to the first two, is the alteration in the capacity of soils to provide productive function of the total amount of ecosystem services (ES) (Helian, *et al*. 2011). One of the most crucial services in terms of biomass production is the "productive capacity" of soil, which can be related to the Land Capability Classification.

In fact, when a piece of agricultural land is urbanized, the productive capacity downgrades, and may be completely neglected in the future. In the case study of Lodi, productive capacity is also the major indicator of soil quality considering the fact that i) land take in the Province affects mainly agricultural fields, ii) agricultural land has a high suitability for productivity capacity because of the high fertility of such soils.

The aim of a composite indicator is to overcome the limitations of the traditional quantitative approaches of LUC analysis, thus leading research to a reflection on (1) the consistency of LUC analysis itself and (2) the possibility to keep ES evaluation within a single indicator.

Following the methodology proposed in the "Handbook on constructing composite indicators: methodology and user guide" (Giovannini, *et al*. 2008), targets are outlined as guide-

lines for the preliminary evaluation of the indicator's output[7].
After a GIS selection of land-take clusters in the Province of Lodi (years 1999 – 2007), an overlay of three maps was realized: (1) the selection of land-take polygons, (2) the evaluation of the sealing degree on selected land-take clusters, (3) the evaluation of Land Capability values on selected land-take clusters.
The first GIS output (1) has been developed within four operations:

- the topologic overlay between land use databases in two-time threshold DUSAF[8] (1999 – 2007);
- the creation of a new field ("flusso") where land use changes are reported at the second level of the legend;
- the selection of "land take" flows, composed by the variation of classes 2, 3, 4 and 5 changed into class 1 between 1999 and 2007;
- the creation of a 10-meter buffer on "land take" areas to correct some imprecisions among different databases.

The second and third GIS output (2) (3) have been developed within the following operations:

- the clip of DB top layers with "land take" buffered areas of DUSAF;
- the clip of LCC layers with "land take" buffered areas of DUSAF;
- the union (intersection) of clipped databases (DB top and LCC) with buffered areas of DUSAF;
- the assignment of specific values to each single attribute.

In particular, the development of last point requires-a reclassification and a sum of values for each registered phenomena: land take, sealing, downgrade of LCC.
The selected variables were ranked (from 0 to 5) on the base of the tables in the following report.
The overlay of the three thematic maps (intersection tools in ArcMap 10) has generated a single map where in each land-use cluster the sum of the three values is being reported[9].

The score of the final map, representing the sum of each registered impact, ranges from a maximum of 15 (summing single impact 5+5+5 per cluster cell) to a minimum of 0. The overlaying process is shown in the following figure (see figure 3).

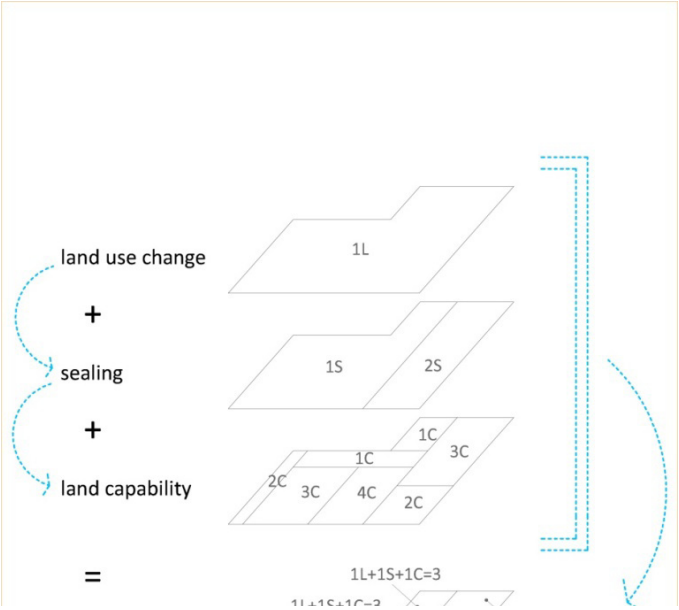

Figure 3 – Composite value as the sum of the single layer's value.

The composite indicator called "Land Take Impact" (LTI) is composed by the average impact per m² of each selected cluster.
The formula is as follows:

$$LT1 = \frac{\sum_{n=1}^{\infty} (\text{sq m} * \text{valtot})}{(\text{sq m tot})}$$

Where "valtot" is the composite value registered by the sum of the different impacts on land take clusters.
LTI can be both referred to provincial (in a greater degree) and municipal level. In the first case LTI represents the average impact of land take to the total land area involved in a process of artificialization in the Province. In the second case it is referred to a single municipality. Further both impacts (provincial and municipal) will be observed; in the latter case a comparative analysis between municipalities is shown. Within GIS operations, LTI was grouped in three ranges of values: from 0 to 6 (low impact), from 7 to 10 (medium impact), from 11 to 15 (high impact)[10].

7. four targets are mentioned in the Handbook:
- the creation of an indicator based on a scientifically grounded framework of the single variables; the evaluation of single variable values within an uniform ranking;
- the preliminary assessment of the correlation between selected variables;
- the absence of "discretization" and the maintenance of single land use clusters using a high-precision land use/cover database.

8. DUSAF is the regional land use/cover database in Lombardy. It is free and downloadable from the website of geoportal (http://www.cartografia.regione.lombardia.it/riregisdownload/). It was used to select the poligons where land take occurred during the observed period.

9. A cluster is the minimum geometric unit of land take polygons. For example, if a portion of soils is subjected to a land use variation (from agricultural land to urban land) then the "land take" area is composed by different clusters of impacts. If a new industrial plot of 1 ha is created, the part which is completely covered by streets or settlements (3,000 sq m) is subjected to high impact due to complete impermeabilization of covers, while a green parking area (7,000 sq m) which could be permeable at 50% could have a minor environmental impact. In this case in 1 ha of registered land take two different clusters of impact are recognized: 3,000 sq m high impact, 7,000 sq m medium impact. In the case, previously mentioned in the text, the average "clusterization" per hectar is equal to 23.9 cluster/ha

10. As introduced in the previous note this categorization is made using the layer properties on the new shapefile called LTI. The cat-

Table 3 – Ranking of Land Use Change flows between 1999 and 2007.

Land take (flows)	***Values (1 to 5)***
21 to 11 from arable land to urban fabric	***4***
21 to 12 from arable land to industrial, commercial and transport unit	***4***
21 to 13 from arable land to mine, dump and construction sites	***5***
21 to 14 from arable land to artificial, non agricultural vegetated areas	***0***
22 to 12 from permanent crops to industrial, commercial and transport unit	***5***
22 to 13 from permanent crops to mine, dump and construction sites	***5***
22 to 14 from permanent crops to artificial, non agricultural vegetated areas	***2***
23 to 11 from pastures to urban fabric	***4***
23 to 12 from pastures to industrial, commercial and transport unit	***4***
23 to 13 from pastures to mine, dump and construction sites	***5***
23 to 14 from pastures to artificial, non agricultural vegetated areas	***1***
31 to 11 from forest to urban fabric	***5***
31 to 12 from forest to industrial, commercial and transport unit	***5***
31 to 13 from forest to mine, dump and construction sites	***5***
31 to 14 from forest to artificial, non agricultural vegetated areas	***3***
32 to 11 from scrub and/or herbaceous vegetation association to urban fabric	***5***
32 to 12 from scrub and/or herbaceous vegetation association to industrial, commercial and transport unit	***5***
32 to 13 from scrub and/or herbaceous vegetation association to mine, dump and construction sites	***5***
32 to 14 from scrub and/or herbaceous vegetation association to artificial, non agricultural vegetated areas	***3***
33 to 13 from open spaces with little or no vegetation to mine, dump and construction sites	***5***
41 to 14 from inland wetlands to artificial, non agricultural vegetated areas	***3***
51 to 12 from inland waters to industrial, commercial and transport unit	***5***

Table 4 – Ranking of sealing degree.

Sealing	***Values (1 to 5)***
DBT - A010101 - Area of vehicular traffic	***5***
DBT - A010102 - Area of pedestrian circulation	***5***
DBT - A010103 - Area bicycle circulation	***5***
DBT - A010105 – Secondary roads	***2***
DBT - A010201 - Railway area	***4***
DBT - A020102 - Building	***5***
DBT - A020201 – Industrial platform	***5***
DBT - A020202 – Monumental artifact	***4***
DBT - A020203 – Artificial manufact	***5***
DBT - A020204 – Sports camps	***3***
DBT - A020206 - Ground impermeable cover	***5***
DBT - A020207 - Electricity pole	***1***
DBT - A020210 - Wall divisions	***5***
DBT - A050303 - Excavation area or dump	***4***
DBT - A050304 - Transformation area	***3***
DBT - A060401 - Green area and parks	***1***
DBT - A060105 - Pasture	***0***
DBT - A060106 – Arable land	***0***
DBT - A020401 - Retaining wall	***2***
DBT - A020502 - Embankments	***0***
DBT - A050393 - Open space with no vegetation	***0***
DBT - A060101 - Forests	***0***
DBT - A060102 – Scrub and/or herbaceous vegetation association	***0***
DBT - A060104 - Open space temporarily with no vegetation	***0***
DBT - A040103 – Artificial basin	***0***

Table 5 – Ranking of Land Capability degradation.

Land Capability Classification	***Values (1 to 5)***
1	***5***
2	***4***
3	***3***
4	***2***
5	***1***

The resulting distribution is as follows:

- 87.2 ha of soils are subjected to a low impact, corresponding to values included between 0 and 6, thus to 6.3% of the total amount of land take registered between 1999 and 2007 in the Province of Lodi;
- 551.9 ha of soils are subjected to a medium impact, corresponding to values included between 7 and 10, thus to 40.3% of the total amount of land take registered between 1999 and 2007 in the Province of Lodi. This means that the variation of each single land-use cluster is characterized by medium levels of land-use transformations, medium levels of sealing and medium levels of capability, but a medium impact can be also composed by a low value in terms of land-use transition but high values of sealing and loss of capability;
- 733.5 ha of soils are subjected to a high impact, corresponding to values included between 11 and 15, thus to 53.4% of the total amount of land take registered between 1999 and 2007 in the Province of Lodi. This means that the variation of each single land-use cluster is characterized by medium or high levels of land-use transformations, sealing and loss of capability.

This preliminary classification serves to provide adequate information about the process of urbanization occurred in the Lodi Province, which was equated to 1,372.6 hectares between 1999 and 2007.

The absolute majority of clusters analyzed is subjected to relevant (high) impacts in terms of composite effects on soil.

The analysis of the main components has been implemented by testing a few linear combinations of the original data. Once the three selected variables were ranked from 0 to 5, a correlation index between them was calculated. A linear correlation has been issued between the vertical values of each cluster cell.

In the construction of composite indicators a lack of correlation among the main components is a useful property: it indicates that the main components are measuring different "statistical dimensions" of the data. Otherwise when single variables are accounted as highly correlated the new indicator suffers from inconsistency. In the case described low correlations between the three selected variables were detected.

In fact, the analysis of the correlation among the values (land-use change, sealing and capability classification, table 6 right part) demonstrates how independent the three variables are: all the correlation coefficients are not significant (0.03 is the correlation index between the sealing values and the capability ones; 0.02 is the correlation index between the LUC values and the capability ones).

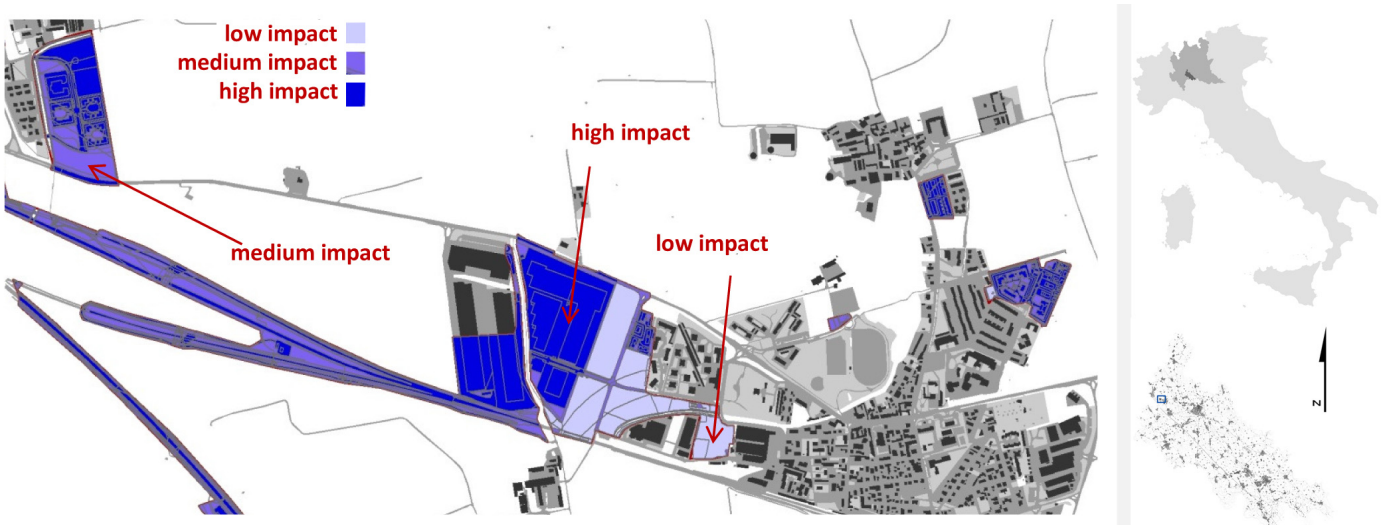

Figure 4 – LTI distribution of impacts (extract of Lodi's Province).

egorization is made using three classes ranged with a manual classification: low impact 0-6, medium impact 7-10, high impact 11-15.

Table 6 – Correlation between selected variables.

cluster	polygon	flusso	value_LUC	value_sealing	value_LCC	valtot		LUV and sealing	LUC and LCC	sealing and LCC
0	189711	2111	4	5	4	13		0,01	0,02	0,03
1	189711	2111	4	5	4	13				
2	189711	2111	4	5	4	13				
3	189711	2111	4	1	4	9				
4	189711	2111	4	1	4	9				
5	189711	2111	4	0	4	8				
6	189711	2111	4	0	4	8				
7	189711	2111	4	0	4	8				
8	189711	2111	4	0	4	8				
9	189739	2112	4	5	4	13				
10	189739	2112	4	5	4	13				
11	189739	2112	4	5	4	13				
12	189739	2112	4	5	4	13				
13	189739	2112	4	0	4	8				
14	189739	2112	4	0	4	8				
15	189739	2112	4	0	4	8				
16	189739	2112	4	0	4	8				
17	189739	2112	4	2	4	10				
18	188236	2112	4	5	4	13				
20	188236	2112	4	5	4	13				
20	188236	2112	4	5	4	13				

3. Results and Discussion

The analysis of LTI index indicates that, in a total of 32,810 selected clusters in the Province of Lodi, the impact includes values from 0/15 until to 15/15. Approximately 10,000 m^2 of soils are not subjected to any impact (even if those soils are subjected to land-take processes), and more than 280,000 m^2 of soil are subjected to a maximum impact. In the latter case most of the soils are composed by the infrastructure sediment constructed in agricultural areas with high values of capability: this specific land use variation implies high impermeabilization and high loss of agricultural productivity.

The average LTI in the Province of Lodi is 11/15 (10.65), corresponding to a medium/high level, which means that land take in Lodi normally occurs with a relevant impact.

The disaggregated analysis of LTI distribution for each single municipality indicates that the most relevant impact has occurred neither along the High Speed train corridor (built in the early 2000s) nor inside the main urban areas of the Province: the Municipalities of Lodi, Codogno and Casalpusterlengo.

This represents something unpredicted, if compared with traditional LUC analysis which addresses major impact of Land Take to highly populated municipality.

Marginal and small Municipalities such as Zelo Buon Persico, Mulazzano, Cervignano d'Adda, Maleo and others that are not included in the historical axes of settlement development are subjected to a high impact in terms of the environmental effects of land take.

Figure 5 – High Speed train corridor.

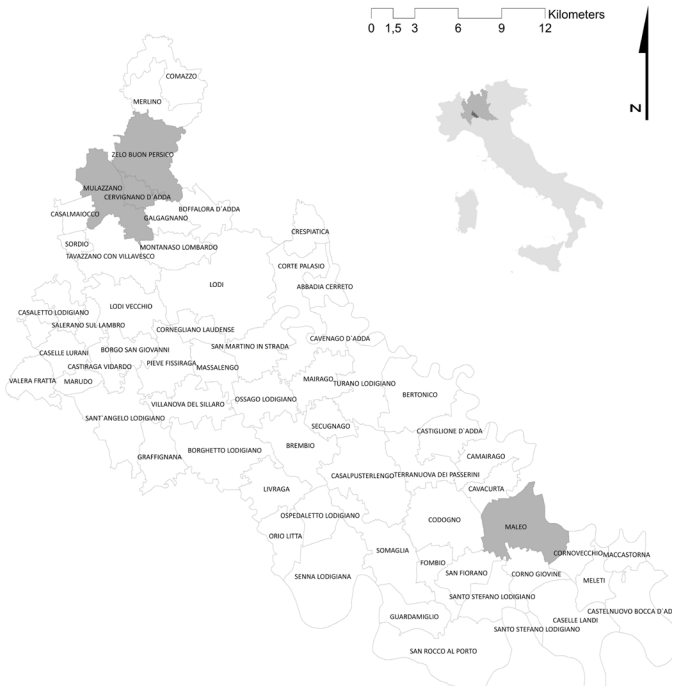

Figure 6 – Highest LTI distribution.

In addition to this, the independence of the two variables "land take" and "LTI" is stressed by the correlation index between the two variables, which equals 0.1.

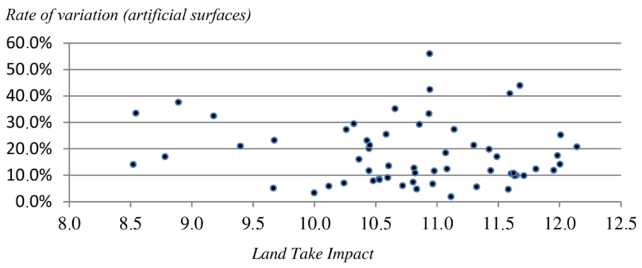

Figure 7 – Relation between impact (LTI) and quantity of land take (variation class 1).

As shown in Figure 7, the distribution of "variation of artificial surfaces" and "LTI" at municipal level does not show any clear relation between variables. The dots distribution is nonlinear, and a flattening of point on 10.0% (y axes) is recognizable where high impact occurs (between 10.5 and 12.0 values of LTI). This confirms the fact that municipalities with larger amounts of registered land take (in quantitative terms) do not correspond to the municipalities where the impact is high, and on the contrary, it is possible to confirm that where high impacts took place a low rate of variation of artificial surfaces is registered. In other terms, the graph demonstrates that the cumulative environmental impact caused by land take on soil is not represented by the simple increase of artificial surface but rather by the specific typology of land use change that has occurred. This, in turn, implies that, with specific regard to land-take phenomena, traditional LUC analysis is inefficient in identifying both the morphological problem (intended as the characterization of settlements in terms of density, continuity, concentration, clustering, centrality, nuclearity) and the environmental one.

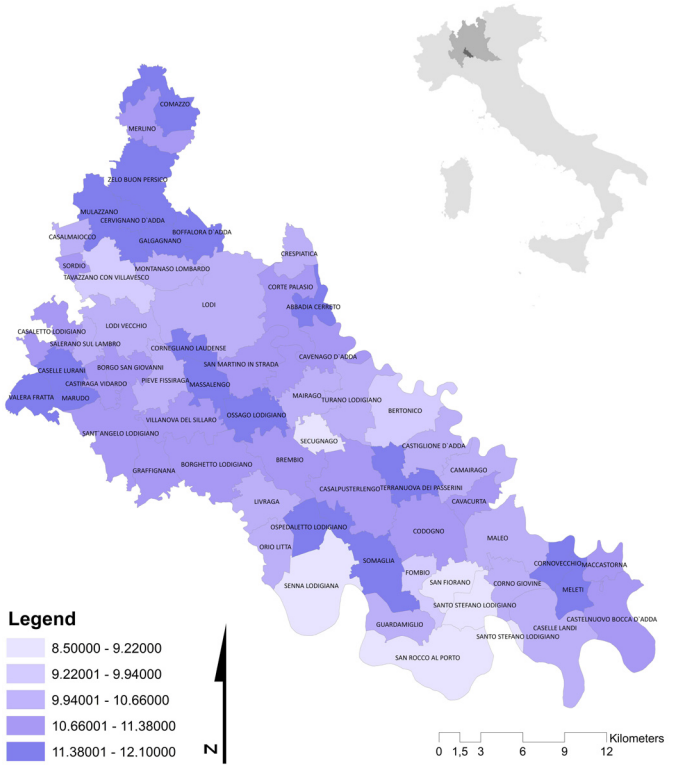

Figure 8 – Territorial distribution of LTI.

A second correlation index between population and LTI at municipal level shows the absence of significant relations between these variables as well (-0.03).

The graph in figure 9 shows a visible flattening of points along the average dimension of population (5,000 inhabitants, corresponding to more than half a percent of the total municipalities in Italy). Nevertheless the distribution confirms that the four less populated Municipalities are subjected to the greatest land take impacts, therefore proving that smaller municipalities are characterized by higher impacts. On the contrary, densely populated municipalities (the one between 10 and 20 thousand inhabitants, including the main municipality of Lodi which represents an outlier in the figure because of its overpopulated territory, more than 40 thousand inhabitants) are flattened between 10.0 and 11.0 level of LTI.

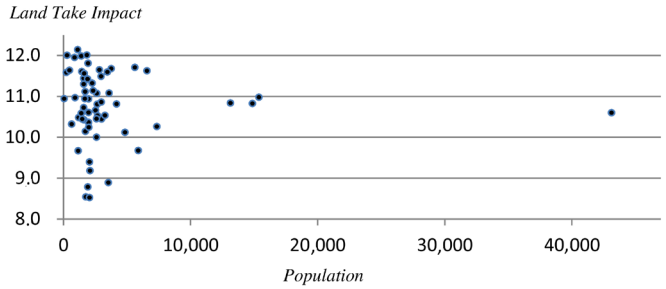

Figure 9 – Relation between inhabitants and LTI.

The first results demonstrate an incoherence in analyzing specific land-use patterns at local scale (phase??) as the traditional approach to land-use variation LUC is consistent in supporting analyses at aggregated scale. LUC analysis turns out to be inadequate for an in-depth evaluation of land take processes and their impact on the ES that can be delivered to these areas. Therefore the employment of the proposed indicator (LTI) for a multifunctional representation of land take is proposed as a methodological alternative (Helming, *et al*. 2011). The question, in fact, is how to address right policies for land take limitations according to the "multidimensional" aspect of the phenomena?

Based on the additional information provided by LTI, an operation of reclassification of values has been carried out for the following indicators: land take (hectares), percentage of artificial surfaces (%), increase rate of artificial surfaces (%), artificial footprint per capita (square meters of artificial surface per capita), LTI (values ranging from 1 to 15).

In the process of pattern interpretation the specific information provided by each indicator is taken into account. In order to visualize the different dimensions of land take, pentagonal graphs (spider chart) were used: the vertices of the figure represent the selected variables for a multidimensional representation of land-take effects.

As for LTI construction, the representation of spider charts, shown below, tends to hold together disjoint variables. We aimed to give an adequate representation of the "multidimensional" aspect driven by land take phenomena. The increase of artificial surface (which constitutes a pressure variable) is not directly dependent on the percentage of artificial surface (which is a state variable), and as demonstrated, LTI is not corresponding to the highest value of land take.

The most representative spider charts are reported and commented on below.

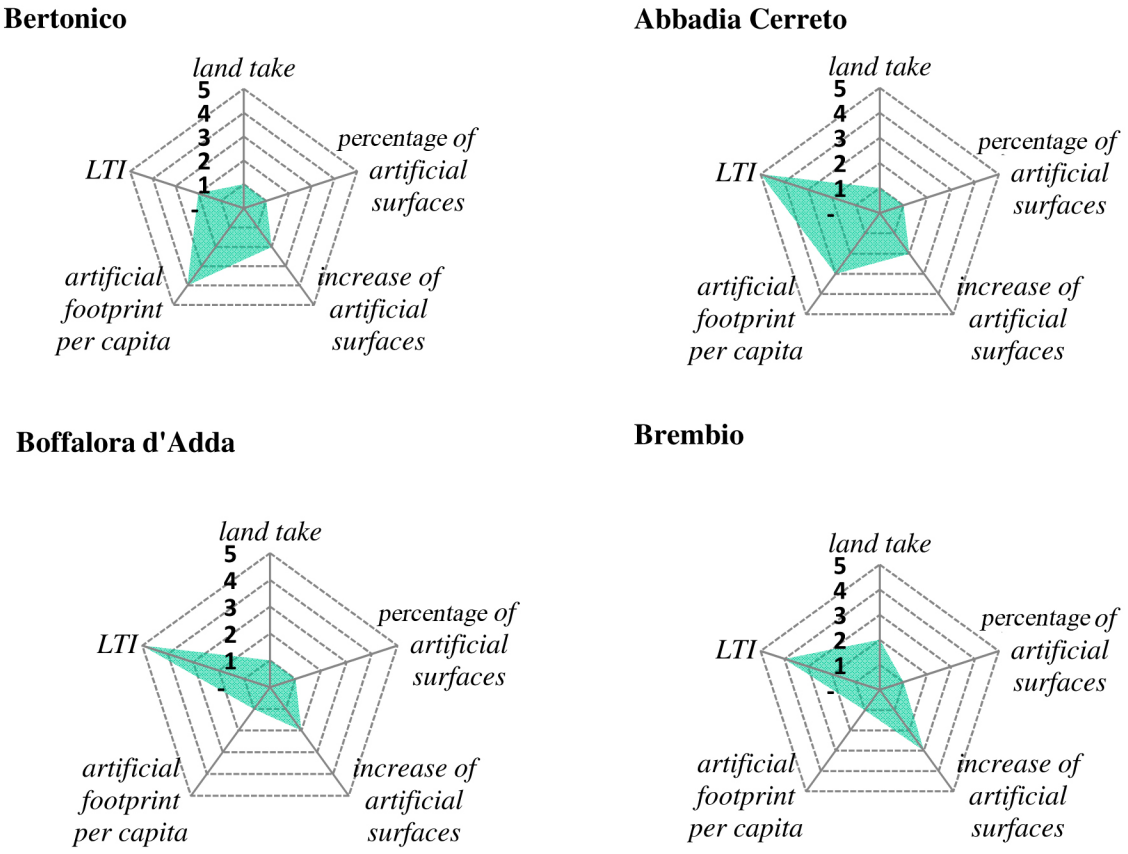

Figure 10 – Multidimensional analysis of land take.

3.1 The multidimensional levels of land take: an interpretation of the patterns

The pentagonal area covered by the spider graph represents the multidimensional levels of land take. An overview of all the graphs demonstrates the heterogeneity of land take process in different municipalities.

This type of representation provides an east-reading information which facilitates understanding that specific strategies for reducing the global impact of land take need to be considered. For example, it is shown how some patterns are balanced (defined as "centered"[11]), and others unbalanced ("cusped"[12]). The more centered the patterns, the more generally acceptable are the available options to limit, mitigate or compensate soil sealing. The options to reduce the impact of land take become more specific and limited the more unbalanced the patterns are.

The most representative patterns of land take are introduced and discussed further. For each pattern, a list of options on how to limit, mitigate or compensate soil sealing, based on the EC Guidelines(E. European Commission, Guidelines on best practicies to limit, mitigate or compensate soil sealing 2012) , is proposed.

Future options for the limitation:

- improving the quality of life in large urban areas (L1);
- strengthening public transport infrastructures (L2);
- increasing protection of soil at national level (L3);
- engaging in the integrated management of the stock of office buildings in cities (L4);
- enabling or strengthening the cooperation of neighboring local authorities on the development of commercial areas (L5);
- creating incentives directed at land recycling instead of developing new land (L6);
- taxing secondary residences (L7);
- raising the awareness of decision makers (L8);
- developing a philosophy centered on using land economically (L9);
- establishing funding programs as a "start-up" incentive for a more sustainable land management (L10;
- using cost calculator programs to define the inner-urban development potential (L11)

Future options for the mitigation:

- using permeable materials and surfaces (M1);
- developing green infrastructure (M2);
- incentivizing natural harvesting systems (M3)

Future options for the compensation:

- the reuse of urban topsoil (C1);
- the implementation of de-sealing techniques (soil recovery) (C2);
- the use of trading development certificates (C3);
- the definition of sealing fees (C4)

Below some land take patterns are reported and analytically categorized.

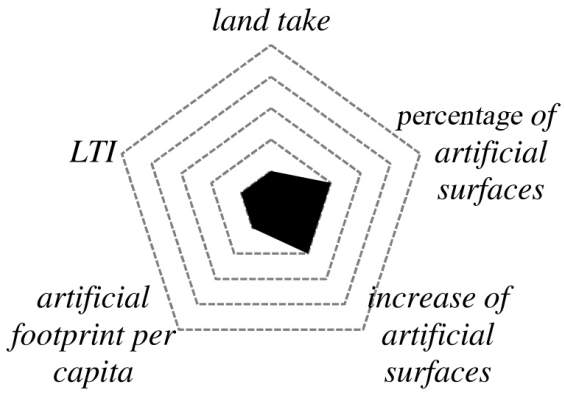

Figure 11 – Centered limited, low-covered area.

The pattern in figure 11 displays a low-covered area, meaning that the multidimensional levels of land take are limited: here low land take is detected, with a modest augmentation in the increase of artificial surfaces and a modest percentage of artificial covers.

As LTI demonstrates, the land take has a low impact on covers. Therefore measures L6, L7, L8, M1 and C1 are sufficient to reduce the rate and impact of land take for this specific pattern.

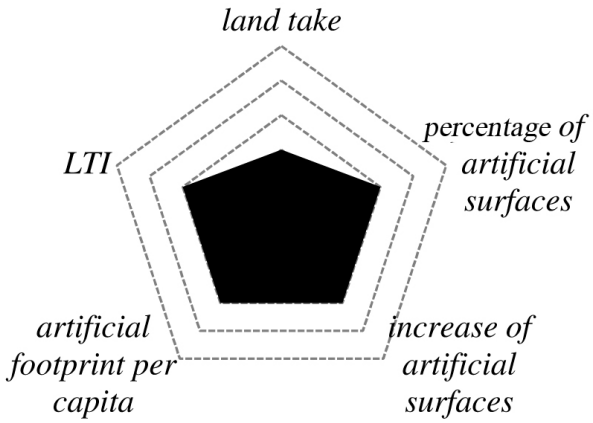

Figure 12 – Centered moderated, medium-covered area.

The pattern in figure 12 displays a medium-covered area wherein specific measures must be taken.

The level of land take in this case is not very high but all the

11. It means that the pentagonal coloured area of the chart is approximately equally distributed around the chart centre.

12. It means that the pentagonal coloured area of the chart is not equally distributed around the chart centre and forms specific axes or cusps.

other indicators illustrate a process of consistent augmenting of artificial surfaces with a medium artificial footprint per person and a medium impact of land take.
In this case a mixed use of limitative, mitigative and compensative measures helps to reduce the speed and impacts of land take. L2, L6, L7, L8, L9, M1 and C1 are required.

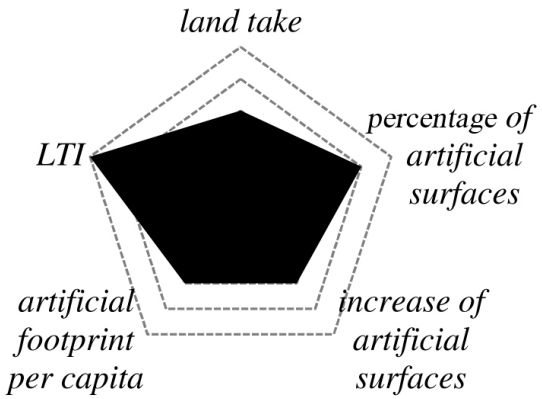

Figure 13 – Centered highly affected, highly-covered area.

The pattern in figure 13 displays a large amount of covered area. This suggesting that land take is problematic. Even if land take is not high, this pattern presents a consistent value of the existing and increasing artificial surfaces, and a consistent footprint with a high LTI: this means that the reduction of land take in this case is less important than the mitigation and compensation of its effect. As a result L6, L7, L8 are integrated by M1, M2, M3, C1, C2 and C4.

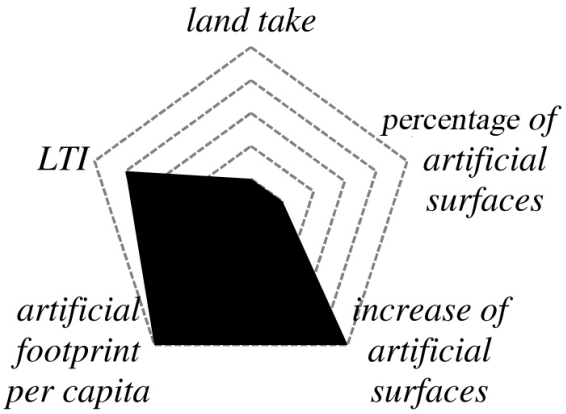

Figure 14 – Uncentered highly affected, highly-covered area.

The pattern in figure 14 is largely covered but unbalanced. This indicates that land take is problematic for specific aspects. In particular, this pattern demonstrates an important augmentation in artificial surfaces, a high artificial footprint and LTI, despite a low land take. This is the case of small municipalities where land take always has a high impact. In this case reduction is important, but mitigation and compensation are highly recommended. L6, L7, L8, M1, M2, C1, C2 and C4 are required.

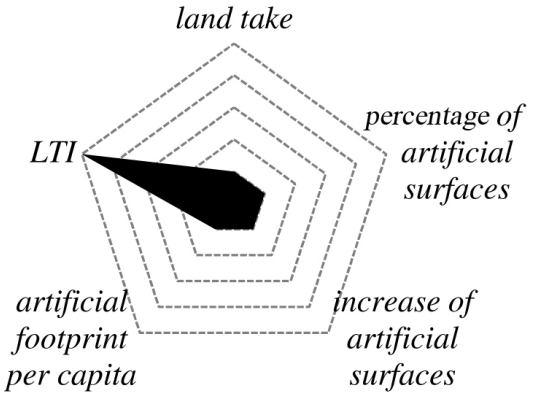

Figure 15 – Unbalanced 1-cusp, low-covered area.

The pattern in figure 15 displays a low-covered area but presents a visible cusp, which means that it is affected by a specific dimension of land take. This pattern shows that specific measures, rather than general policies, are required. In this case LTI is high even in the presence of a low land take, footprint and artificial surfaces. In order to reduce impacts, mostly mitigation measures should be adopted. L6, L8, M1, M2, M3, C1 are suggested.

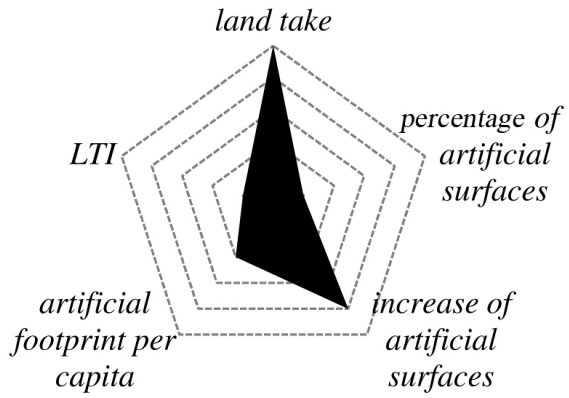

Figure 16 – Unbalanced 2-cusp, medium-covered area.

The pattern in figure 16 displays a medium-covered area and forms a particular shape: a double cusp. This implies that these two particular aspects of land take are more relevant than others. In this case land take and the increase of artificial surfaces are affecting land-use change with low impacts and with a medium footprint per capita. Consequently specific limitative options have to be considered. L1, L2, L4, L6, L7, L8, L9, M1, C1, C4 are required.

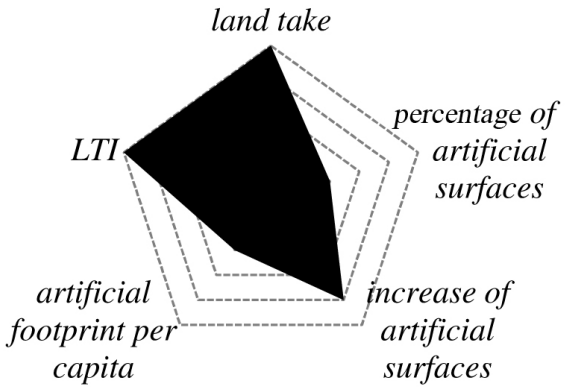

Figure 17 – Unbalanced-3 cusp, highly-covered area.

The pattern in figure 17 displays a highly-covered area, where the three spreading cusps, suggesting its problematic nature, represent specific aspects of land take. This case demonstrates a high land take, with an important increase of artificial areas even if the percentage of artificial area is low. Here the land take is affected by a high level of impact.
In this case an integrated approach of reduction, mitigation and compensation has to be adopted. Therefore L1, L2, L6, L7, L8, L9, M1, M2, C1, C3, C4 are suggested.

4. Conclusions

Despite a constant demand for urgent intervention and regulation that will tackle on the incessant consumption of open space calculated at an aggregated scale, it seems that the problems of improvement of particular land-use development patterns have not yet been properly addressed. Even if analysis on land take is becoming much more significant, less success cases of land take reduction is registered. Land use management and land government practices experience weak connection with scientific studies and indicators.
A simple contextualization of the analysis on land use and land cover give us simple but clear indications: traditional tools for land use/cover analysis are not adequate for the evaluation of impacts on ES and are insufficient to steer local policies for land conservation. The approach presented in our study, despite being preliminary and applicable mainly at regional scale, allows the introduction of a more global evaluation of the impact of land take on ES, with particular attention to the capability of food and biomass production.
In order to implement soil sealing guidelines and activate a sustainable soil and land governance, shifting from attributes to processes, a multidisciplinary approach is needed to bridge the gap between general, theoretical targets (e.g. land-take limitation) and the development of specific patterns of land-use management at local scale.
Some limitations of this approach should be mentioned: within our framework, some of the variables selected for representing the cumulative impact of land take (spider charts) are highly correlated, providing a high degree of redundant information. The need to overpass the simplistic approach of LUC analysis and to provide better information and more comprehensive data will enable policy and decision makers to activate right prescriptions, limitations or regulation for land use management. The study has generated a representation of trade-off between different “aspects” of land take, this information provides valuable support to planning, by narrowing some qualitative information for potential decisions.
The detailed analysis in the Province of Lodi shows that in the context of a highly developed informative system it is possible to incorporate different attributes and information on land-use change and covers with other high-precision databases.
The research also demonstrates that a complete assessment of the land-take process at local scale requires a global evaluation of different soil ecosystem services, and not only the simple accountancy of the land-take area.
As consequence local policies aiming at land-take limitation, mitigation or compensation need then to be supported by multidisciplinary researches and analyses.

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Urban stormwater runoff and pressure on the sewerage system in Pécs, Southwest-Hungary

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Keywords: urban hydrology, impervious surfaces, topography, stormwater runoff, sewerage system, DEM, Hungary

Abstract

Pécs is a city with rugged topography on the foothills of the Mecsek Mountains, Southwest-Hungary. As a consequence of uncontrolled city development in an environmentally sensitive area, the sewerage system is unable to cope with the additional pressure and overflow following torrential rainfalls and rapid stormwater runoff. The main objective of our study is to investigate the problems involved by extra rainwater released illegally into the sewerage network in the city. Special attention is paid to the analysis of the topographic factor contributing to enhanced runoff using Digital Elevation Model. A neighbourhood with particularly diverse topography, the Magyarürög Valley on the Mecsek foothills, where blocked stormwater drainage is a most serious problem, is selected for a representative case study. Residential buildings in different topographic positions, as potential sources of extra water inflow into the network, are referred into four classes of probable input into the system. The findings of the survey can be used in the design of a future stormwater runoff monitoring system. Controlling illegal release into the sewerage system is an important task since it could cause millions of Euros of losses to the community-owned waterworks. Our study presents a typical example how private preferences confront with public interest in an urban landscape.

Introduction

Natural runoff conditions are significantly modified by urban development and this constitutes a central issue in urban ecology. Two major types of interferences into urban runoff conditions are identified: the anthropogenically modified hydrological cycle and human-created artificial supply and waste-water disposal system (Douglas and James 2014). The environmental (hydrological) implications of planned and unplanned urban development are usually rather different (Sliuzas et al. 2010). During the stages of planned development (site planning, land subdivision, and provision of infrastructure), land is often cleared of vegetation. The creation of extensive bare surfaces and sealed terrain of housing and infrastructural developments (road building) change runoff conditions. Hard paved surfaces in urban areas prevent the natural dissipation of rainwater and substantially increase both volume and rate of runoff (Arnold & Gibbons 1996). Although infiltration into paved surfaces is generally less than into permeable surfaces, some researchers point out that it may still be significant through macro-cracks or joints in the pavement (Mansell & Rollet 2007). Its amount (usually much less than 10%), however, cannot be compared to runoff (up to 50%). The unfavourable impacts of development may be amended by native landscaping in the final stage of development (Diekelmann and Schuster 2002; Karvonen 2011).

In contrast, unplanned development often begins with land occupation and the hasty erection of temporary buildings (Sliuzas et al. 2010). If their owners do not have to be afraid of demolition, the neighbourhood stabilizes and residences will be gradually improved in quality. Access roads and utilities will also be supplied. Although most typical of Latin American cities, a similar chain of events also characterizes urban development in some neighbourhoods of Pécs.

In the developed world the combined stormwater and sewage system is replaced by sewer separation. This has several benefits:

- precludes the overflow of combined sewer;
- prevents flooding by increasing capacity;
- allows stormwater to be used as a resource.

Separation is now complete for the urban area of Pécs. This means that only illegal release into the separated stormwater collection network causes pressure during severe rainfall events, when there is a recurrent overflow hazard. The high runoff ratio from the paved surfaces of urban areas with high relief is most often not seen by inhabitants as a major environmental issue, merely as a technological problem to be served by water suppliers (Ronczyk & Lóczy 2006). With gradually reducing water tariffs, the Hungarian population is hardly aware of the costs involved by wastewater treatment.

Similarly to other cities, recently significant efforts have been exerted for sustainable stormwater management in Pécs, including bioretention swales and permeable pavement facilities. However, given the dissected topography and high relief of the city, partly built on the southern slopes of the Mecsek Mountains and the in the valleys of the Baranya Hills, excess urban runoff and localized inundations (urban flash floods – see e.g. Xia *et al.* 2011) remained common phenomena, especially during the late spring and early summer period

when torrential rainfalls occur (Czigány et al. 2010), possibly also associated with climate change (Blanka and Mezősi 2012). Today the total area of impervious surfaces in Pécs amounts to 37% (Ronczyk & Wilhelm 2006) – not particularly high in international comparison, but still significant.

While in hydrological literature the direct impact of runoff from impervious urban surfaces on streamflow is debated (see e.g. McCuen 1998 vs. Evett 1994), there is ample evidence that urbanization, with the accompanying loss of vegetation, replacement of soil with impervious surfaces, and routing stormwater runoff directly to stream channels, substantially transforms runoff conditions and streamflow crossing urban areas.

Objectives

Sewerage system design is a well-defined engineering task, where the emerging technical challenges can be solved applying the existing standards. During the calibration phase of the system it is easy to calculate sewage runoff from drinking water consumption. But in practice other factors – beyond the scope of engineering design – could substantially modify the amount of sewage to be accommodated. The paper deals with that portion of runoff which is illegally released into the sewerage network, where this potentially causes overflow and flooding. The main objective of our study is reveal these hidden factors, focusing on topographical influence upon surface runoff routes. It is pointed out that individual decisions of people in an environmentally sensitive area with insufficient infrastructure can cause environmental hazards difficult to mitigate.

Since Hungary's accession to the European Union large-scale investments have been implemented in Pécs, the seat of Baranya County (2014 population: 146,581), including the completion of the drinking water supply and sewerage network (figure 1). The opportunity to join to both networks is open to all residents of the city.

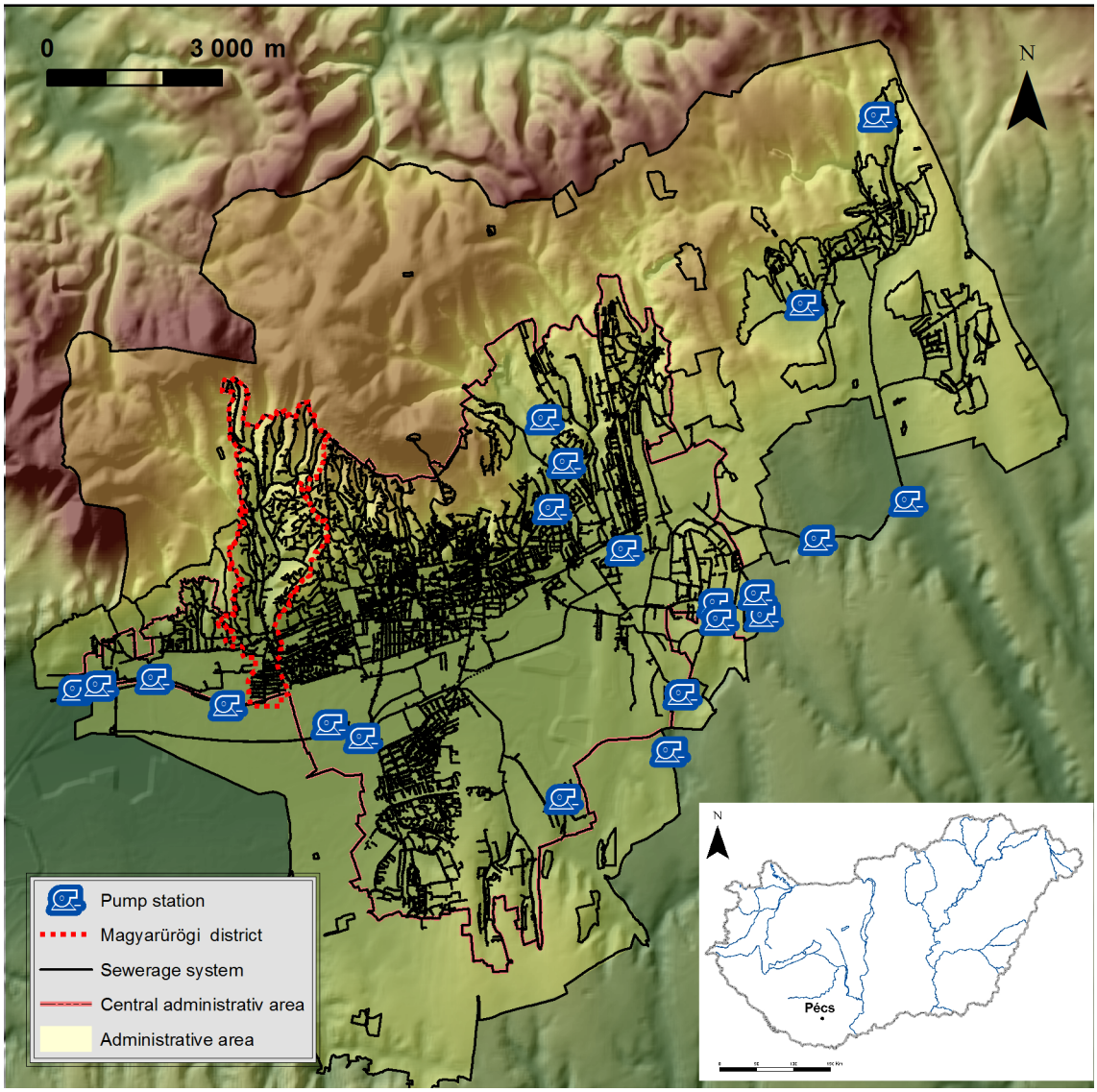

Figure 1 – The sewerage network of Pécs with locations of the 16 pumping stations.

The here presented research involved detailed analyses of physico-geographical factors, including runoff routes, hydrometeorological and hydrogeological conditions, land cover and urban structure which influence urban water management. The investigation focused on potential illegal inflow from plots against the background of the physico-geographical environment.

The primary goals were

a) to analyse rainfall and runoff conditions as a function of topography;

b) to determine whether excess stormwater runoff significantly contributes to increased volumes of sewage;

c) to localize and typify major source areas of runoff water and

d) to present the sewer overflow problem on a case study.

To achieve these goals integrated catchment modelling using GIS is employed to identify periods and locations critical for overflow due to torrential rainfalls. The findings provide the basis for designing a monitoring network. Through reliable prediction stormwater overflow could be prevented and severe economic losses avoided in the future.

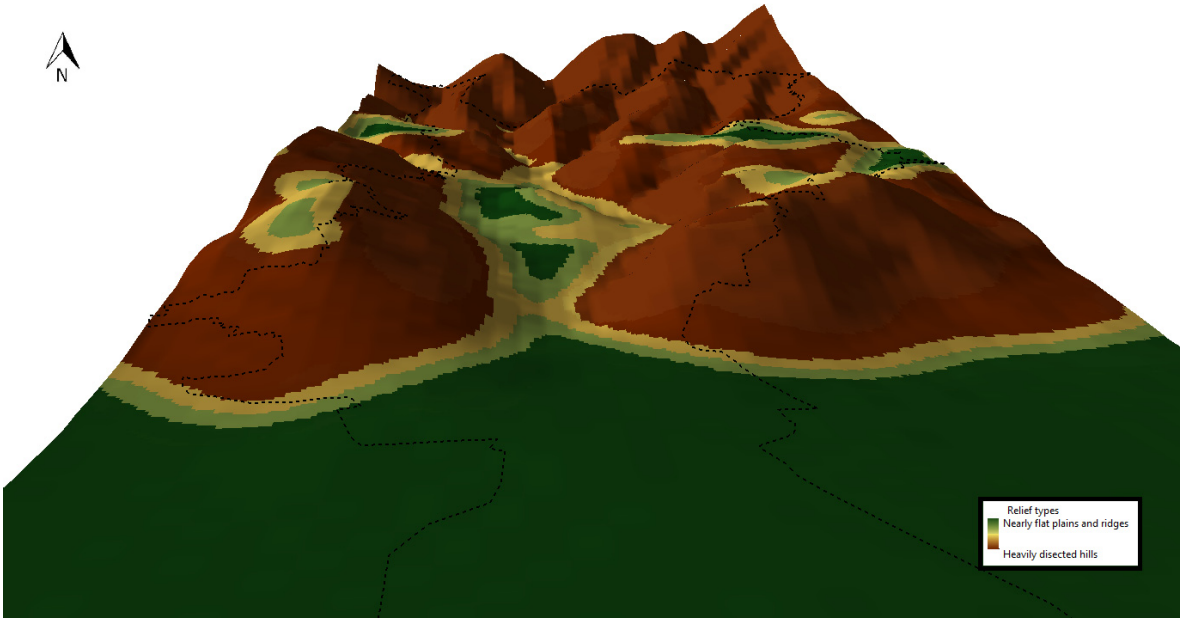

Figure 2 – Types of topography of the administrative area of Pécs (after Hammond 1964).

Study area

The administrative territory of Pécs (16,261 ha) is shared by three microregions of the mesoregion Mecsek Mountains and Tolna-Baranya Hills, which is part of the macroregion Transdanubian Hills in Hungary. Geologically, the area covers the anticline of the Western Mecsek Mountains. Its eastern limb of horsts of Middle Triassic carbonates (the Misina-Tubes range) provides the background for the built-up area, while in the east it drops steeply to the Pécsbánya syncline with economically important Jurassic black coal seams. The southwestern hillslopes of the mountains are built up of carbonaceous debris dismembered by tectonic and erosional processes into a series of anticlinal hills. Further to the south the city centre is located in the Pécs Basin, a recent subsidence area with flat floor. Rising above the basin, the marginal zone of the Pleistocene Baranya Hills follows. The average elevation of Pécs is 180 m above sea level; the highest point of the built-up area is 416 m, while the lowest is 115 m. This means an absolute relief of 301 m (figure 2).

This rugged topography of Pécs results in a heterogeneous spatial distribution of rainfall. Orographic effects on precipitation have already been determined by Simor (1938), who found a rainfall gradient of 26.3 m per 100 for the data from five rain gauges in Pécs and one at Szentlőrinc, 16 km to the west. The long-term mean annual precipitations at the various meteorological stations range from 663 to 839 mm (areal mean: 726 mm) (Bötkös 2006). During the period of 2009 to 2011, studied in this paper, peaks, indicating the impact of global climate change, were frequently observed (Ronczyk et al. 2014). Annual rainfall totals were below the long-term average values for the years of 2009 and 2011, while they significantly exceeded the mean value in 2010 (table 1).

The orographic effect is also detectable in 2010 and 2011. The annual amounts of precipitations and the approximate volume of stormwater runoff could be estimated for any units of study (sewerage subdistricts) in Pécs as a function of elevation. The hypsographic method is widely used in spatial rainfall interpolation (Goovaerts 2000).

Most of the city area (140 km^2) is drained by the Pécsi-víz Stream (length: 51.4 km) (figure 2). An inventory covers 152

springs in the city area, but their number (including non-catchment springs) can be even higher. Occasional measurements testify that the water yields of springs range from 0.001 to 0.15 $m^3 s^{-1}$. The annual yield of the most abundant natural karst spring (Tettye) reached 4.2 million m^3 in 1896 and 2.3 million m^3 in 2010 (ENVICOM 2003).

Table 1 – Mean annual precipitations at rain gauges in Pécs, 2009-2014.

Meteorological station	*Elevation (m)*	*Annual rainfall (mm)*					
		2009	*2010*	*2011*	*2012*	*2013*	*2014*
Ifjúság útja	174	632.4	1133	546.6	577.7	724.1	1026.5
Jegenyés utca	115	588.6	1078.4	505.1	614.9	736.6	1063.2
Erdész utca	382	791	1338.3	526.0	688	793	1033

In Pécs wastewater is collected by seven main collector systems (Ronczyk et al 2012). The total length of gravitational conducting pipes is 506.8 km. The longest network is that of Magyarürög (52 km). In our research we paid special attention to the variations in the physical environments and build-up conditions of the individual sewerage subdistricts. As an example, the topographic parameters of a typical watercourse, the Ürög Stream, derived from the DEM (table 2) was selected for a detailed analysis the findings of which are presented as a case study.

Table 2 – Topographic parameters of the watercourse of Magyarürög.

Name of catchment	*Magyarürög watercourse*
Recipient	Pécsi-víz Stream at rkm 41.772
Catchment area	14.1 km^2
Average elevation above sea level	306 m
Highest point	610 m
Lowest point	114 m
Absolute relief	496 m
Maximum relative relief	71 m/100 m
Average relief	21 m/100 m
Maximum slope	33°
Average slope	10.4°
Slope exposure	SW (on 4.7 ha: N)

Methods

In our research we used GIS analyses on Digital Elevation Model and its derivates as well as infrastructural and cadastral vector datasets. The topographic elements (natural streambeds, open ditches, closed canals, paved channels) were analysed for runoff routing. The sites of buildings lying within a fixed distance (25 m) from stormwater collecting utilities were selected. Stormwater conduction was regarded solved for such structures located on valley floors. For the rest of the residences elevation above sea level was identified and compared with the elevation of the sewerage network. To the buildings we rendered the closest point of the sewarage network and from the elevation of the building subtracted the elevation of that point. The sites where the building is situated more than 1 m lower than the sewerage network and, thus, releasing rainwater into the network is expensive, are not referred to those with potential hazard. Higher hazard is assumed for sites where the building lies next to the sewer and gravitational inflow is feasible. Another factor of hazard is steep slopes around the site since this involves extra costs of establishing cisterns on the plot.

Precipitation was measured at five locations with automated tipping bucket rain gauges since 2009, partly operated by the Faculty of Sciences, University of Pécs, and partly by the Hungarian Meteorological Service.

We also determined the types of extra water inflow into the sewers: direct (intentional) inflow and unintentional (accidental and natural) inflow. Both classes fall into subclasses: surface and subsurface inflow. Direct surface water inflow is typical of the highly urbanized districts of Pécs with high relief, while indirect inflow is observed in the lowland part of the city, where, during heavy rainfalls, water enters into the sewers through the manhole lids. The radius of direct surface inflow from springs and wells was estimated to be 50 m. Additional indirect inflow may be due to high groundwater table. Each category was mapped individually during the current project.

The employed digital elevation model (DEM), originally with a spatial resolution of 50 m, was obtained from the Institute of Geodesy, Cartography and Remote Sensing (FÖMI) and its resolution was enhanced to 10 m by using the elevation of the manhole lids. The elevation database of the manhole lids was obtained from the Tettye Forrásház Ltd, a water utilities company in Pécs. Spatial analyses were carried out in ArcGIS 10.2 software environment. The topographic parameters derived from the Digital Elevation Model are the extreme elevation values (the highest and lowest points), their difference (relief), mean elevation and vertical terrain dissection. The vertical terrain dissection index illustrates the topographic diversity of the city. This index is calculated as the percentage of maximum relative relief to absolute relief within circles of 300 m diameter. From the topographic parameters

relief types were identified and mapped.

Then the topographic data were coupled with demographic and sewage management data: character of the neighbourhood, population number and density, length of sewerage network, number of clearing shafts.

According to their elevation above sea level, the residential buildings were referred into four classes:

1, Buildings at -2 m position below the level of the sewerage pipes present minimum risk of rainwater pumped into the network.
2, Buildings between -2 m and +1 m position relative to the pipes can be connected to the network.
3, Similarly, buildings at +15 m may also be connected (with 50% probability).
4, The group of buildings between +1 m and +15 m have the highest probability to release rainwater into the sewerage network.

Results and discussion

The topographic parameters were calculated for 50 neighbourhoods. Those with the highest relief are shown in table 3.

Table 3 – Topographic parameters of selected neighbourhoods in Pécs (arranged according to elevation above sea level).

Neighbourhood	*Lowest point (m)*	*Highest point (m)*	*Absolute relief (m)*	*Mean elevation (m)*	*Vertical terrain dissection (m)*
Deindol	201.2	407.8	206.6	300.4	38.9
Szkókó	203.9	384.8	180.9	295.2	41.4
Szentmiklós	124.8	287.9	163.1	178.4	33.6
Makár	121.4	271.5	150.0	173.8	45.4
Magyarürög	139.9	285.7	145.8	196.2	29.8
Szentkút	234.8	370.9	136.1	304.4	33.5
Patacs	124.4	236.5	112.1	168.2	24.1
Kismélyvölgy	226.4	337.5	111.1	274.5	24.6
Zsebedomb	118.0	221.0	103.1	152.9	20.3
Donátus	179.0	280.2	101.2	245.4	21.0
Csoronika	148.0	248.5	100.5	193.9	28.7
Rácváros	127.7	171.3	43.6	140.9	8.9
Fogadó	109.2	132.7	23.5	119.4	4.4
Uránváros	117.3	132.3	15.0	122.1	3.2
Bolgárkert	118.9	133.9	15.0	124.7	3.3
Kovácstelep	121.4	133.2	11.8	126.1	2.8
Szigeti tanya	116.0	124.3	8.3	119.0	1.4

The typology of topography well demonstrates the diversity of the terrain (figure 2). A clear dominance of flat (34%) or gently rolling surfaces (28%) is seen, particularly if the areas not yet reclaimed after coal mining (50 hectares) and the plateaus rising above the foothills (16.5 hectares) are included.

The orographic effect on precipitation distribution is also detectable in 2010 and 2011. Rainfall gradient as a function of elevation reached 95 mm per 100 m for 2010 (r = 0.98623). In 2010, precipitation characteristics showed extreme values, i.e. annual totals, and especially monthly totals for May, June and September significantly exceeded the long term (30-year) mean values. In May and June 2010 two Mediterranean cyclones produced more than 200 and 150 mm of precipitation in three- and two-day periods, resp. The May 2010 monthly precipitation totals exceeded 200 mm for many parts of SW Hungary. The orographic effect for this month is again clearly shown for the extremely dry year of 2011 with monthly totals of a mere 0.1 mm for all four rain gauges in Pécs.

Comparing the data for 2014 at rain gauges to the time series of the 20th century, the following comments are made. Precipitations in 2014 were somewhat below the 100-year average in January (-11.9%) and in June (-21.8%) and substantially below that in March (-64.5%) and November (-50%) (figure 3). In six months the precipitation surplus is high (79.2% on the average), in May more than twofold and in September almost threefold (182.2%). No monthly records, however, were set. The wettest month was May, followed by September, and March was the driest.

More detailed analyses focused on the impact of a Mediterranean cyclone (14-17 May) and a local convectional rainfall (3 August). From 14 to 17 May 2014 more than 100 mm fell with 0.4 mm/10 min average and 1.5 mm/10 min maximum intensity. In the eastern part of the city rainfall was continuous for 34 hours and 40 minutes. The precipitations ranged from 83 mm to 130.4 mm in the various neighbourhoods (figure 4). The August rainfall only caused minor flood waves in the western part of the city. Another Mediterranean cy-

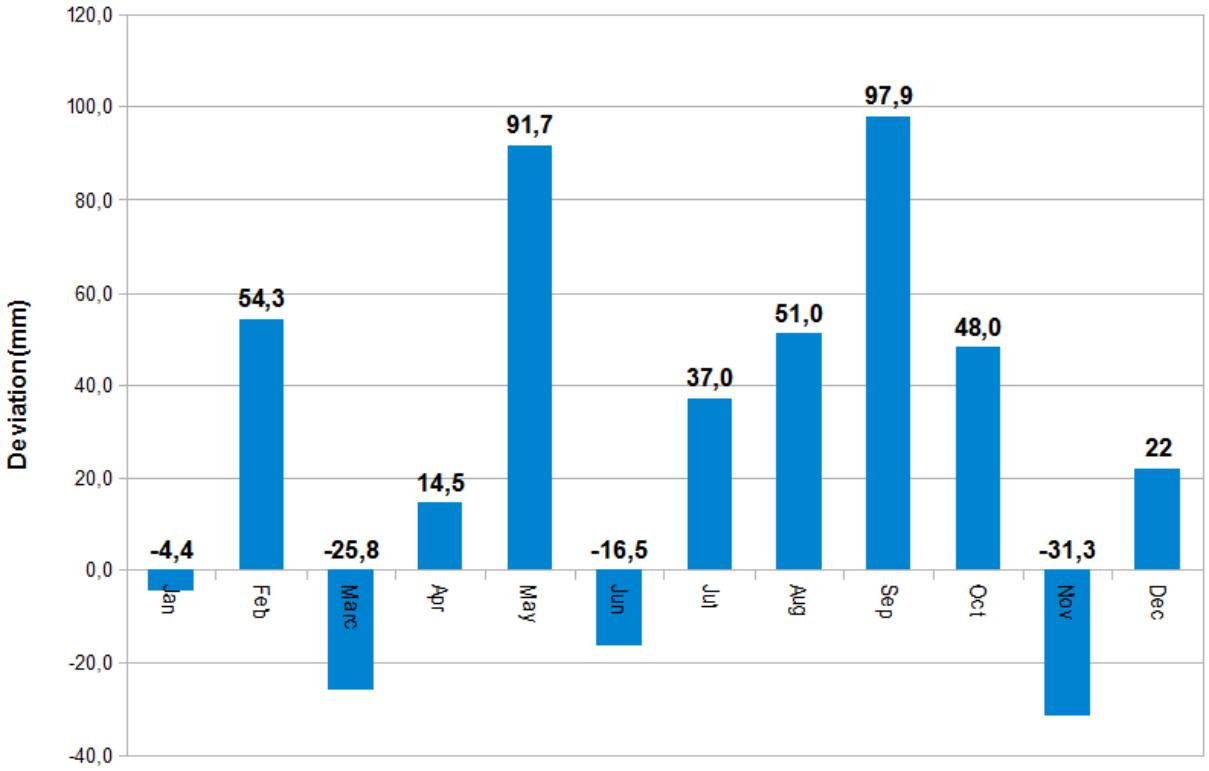

Figure 3 – Deviation of the 2014 precipitation figures from the 100-year average.

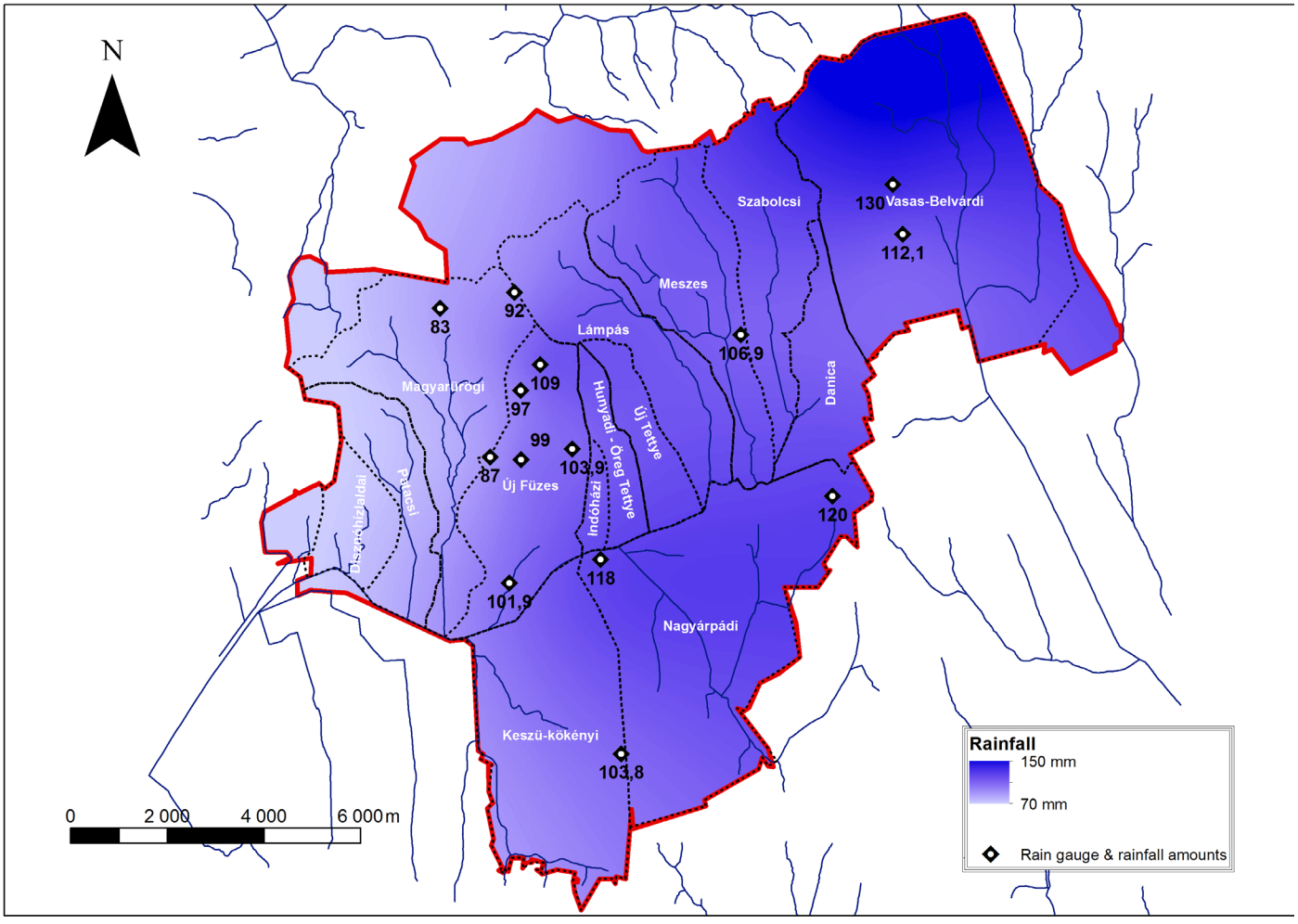

Figure 4 – Distribution of rainfall with neighbourhoods on 14-17 May 2014.

clone generated rains in more homogeneous distribution in the administrative area. The most intense rainfall occurred on 3 August, when intensity reached 9.5 mm/5 min at the Jegenyés Street. The collection interval of urban runoff was around 1 hour for the various catchments, which indicates a typical flash flood event (figure 5).

The results indicate that the monitoring system offers valuable assistance in identifying hot spots of flash flood hazard. Preventive measures could be concentrated on these focal areas.

As far as soil moisture regime is concerned, peaks coinciding with the rainy periods of May and August are conspicuous in the record. On 26 August 2014 a groundwater table sensor was also installed in the basin floor area of the city, where the sandy alluvia (partly anthropogenic fill) rapidly responds to changes in groundwater recharge. The minimum depth to groundwater table was observed on 24 October 2014 (-55 cm from the ground surface).

In order to truly depict spatial variations in the spatial distribution of pressure on the sewerage network, population and water infrastructural data for the individual neighbourhoods were also analysed (table 4). The wide range of population density indicates that the severity of hazard is highly variable even within the land use category of detached housing.

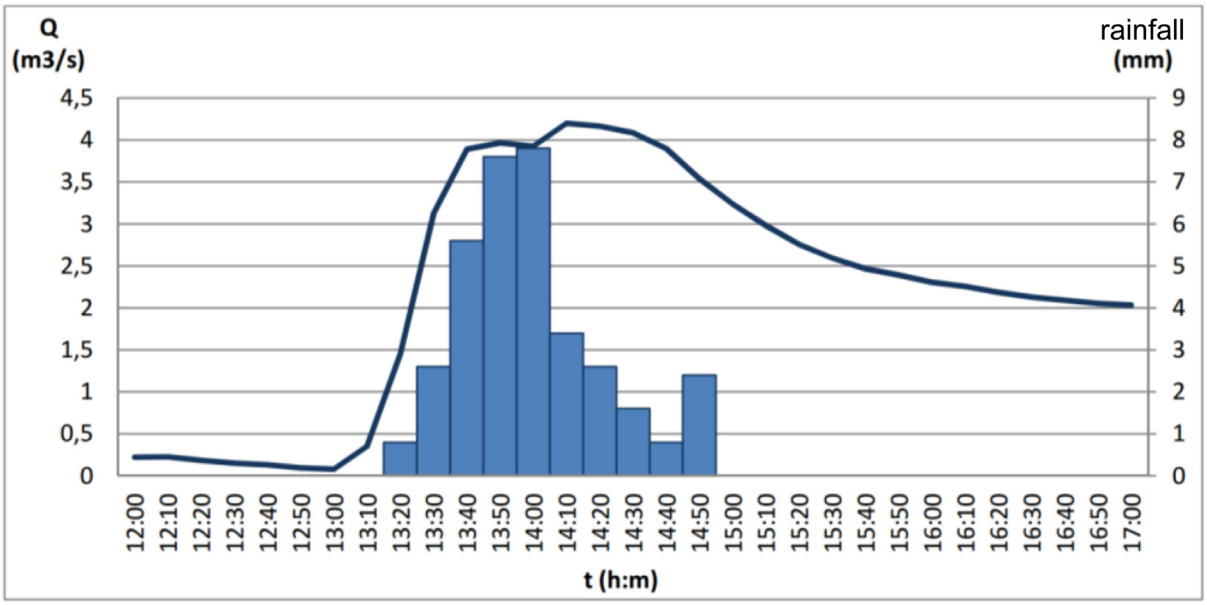

Figure 5 – Storm hydrograph of the Ürög Stream on 3 August 2014.

Table 4 – Population and water infrastructure data of selected neighbourhoods in Pécs (arranged according to population number).

Neighbourhood	*Main character*	*Resident population (2001)*	*Population density (people km^{-2})*	*Length of sewerage network (m)*	*Number of cleaning shafts*
Uránváros	housing estate	12,327	13,626	23,323	1,146
Makár	detached houses	5,337	3,459	20,775	758
Magyarürög	detached houses	3,016	1,355	19,110	644
Patacs	detached houses	2,406	852	11,544	421
Kovácstelep	detached houses	1,750	5,144	6,013	255
Szkókó	detached houses	1,657	1,984	11,034	426
Csoronika	detached houses	1,614	3,394	4,564	143
Deindol	detached houses	1,192	736	14,695	459
Rácváros	detached houses	894	2,073	5,196	185
Donátus	detached houses	879	878	11,171	338
Szentmiklós	resort	194	239	1,400	41
Zsebedomb	resort	187	185	2,446	47
Fogadó	industrial	124	407	5,812	150
Szentkút	resort	117	361	4,339	96
Bolgárkert	industrial	11	20	1,964	71
Szigeti tanya	industrial	n.a.	n.a.	432	0
Kismélyvölgy	detached	n.a.	n.a.	861	8

Case study

The network of the Magyarürög Valley catchment (5.7 km^2) illustrates the problems of sewage management in Pécs (figure 6). The gravitationally operated system collects runoff from the slopes of the Mecsek Mountains first developed as a green belt more than 50 years ago. The hardly regulated spreading of the settlement took place along narrow carriage roads leading to the vineyards and family homes were built often disregarding topographic conditions and infrastructural potentials. The situation was amended by the construction of sewers, a project that was completed in 2008. This development, however, generated a new wave of construction which will almost certainly not followed by the extension of the road and stormwater drainage network in the near future. The above factors may result in a situation where the possibility of the conduction of extra stormwater into the sewerage system cannot be excluded.

est in Pécs) and a 9.5° surface slope for pixels calculated from eight neighbouring pixels. Therefore, the operation costs of the sewerage system are relatively high. Erosional valleys cutting into masses of Lower Triassic sedimentary rocks by regression separate southward-stretching interfluvial ridges and increase relief (figure 7).

Confined groundwater derives from karst reservoirs and its movement is influenced by tectonic structures. Anticlines force waters to ascend to levels near the surface and can be exploited on the valley floors, while below the ridges they are found at several tens of metres of depth. In the valleys the density of springs is high. Although in the inventory only 10 springs are included, their true number must be much higher. Waters from springs issuing at former wine-cellars often drain into the sewerage network. Wells are 5-40 m deep and used to be important sources of drinking water before the development of piped drinking water supply.

In land use industrial and commercial estates with impervi-

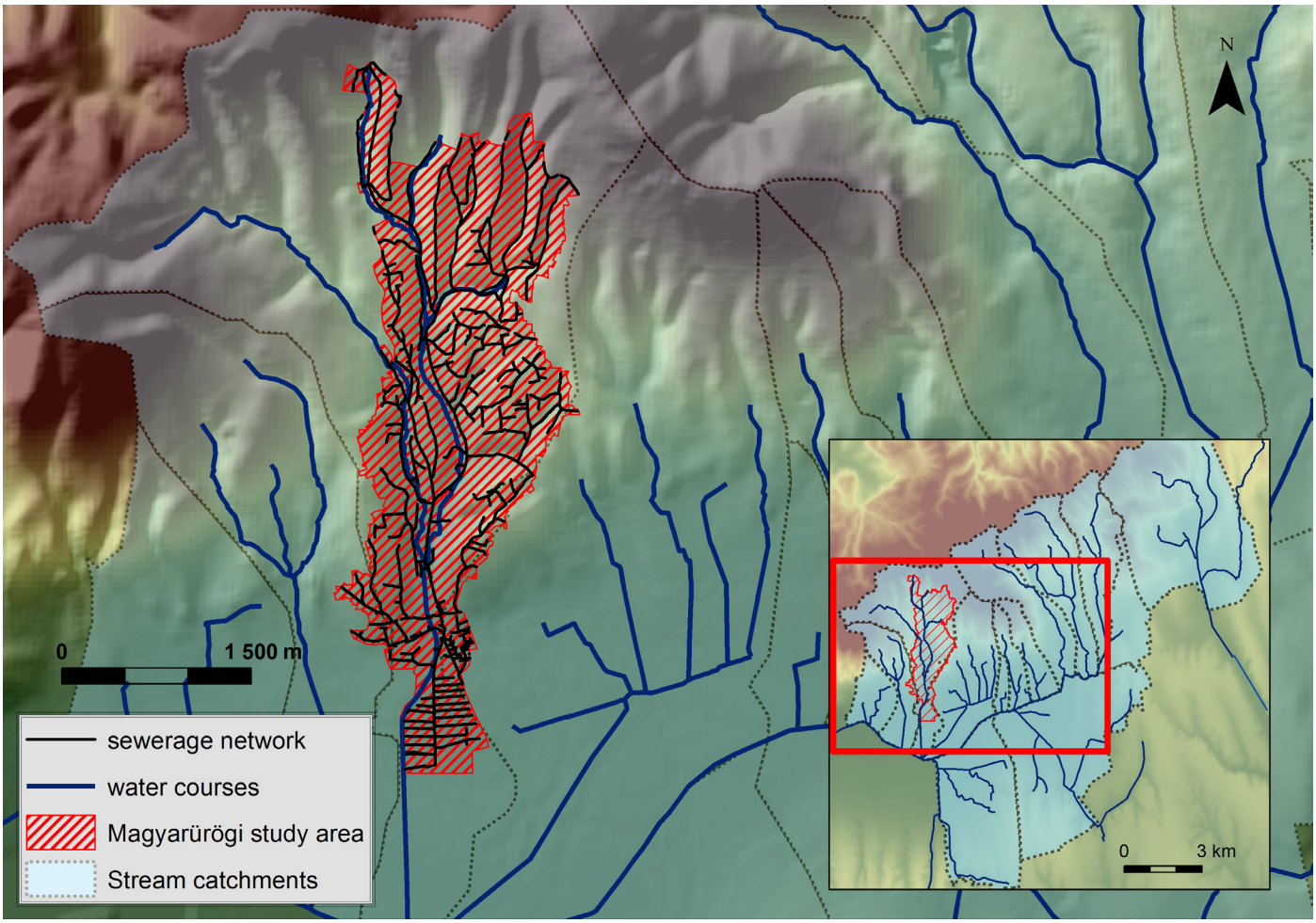

Figure 6 – Location and sewerage network of the Magyarürög subcatchment in the administrative area of Pécs. (source: Tettye Forrásház Ltd).

In the Magyarürög system, in spite of the sparse population, water consumption amounts to 1,202 m^3 day^{-1}. The length of the gravitational network is 52,622 m. This is a foothill area of high dissection with average relative relief: 18.6 m (the high-

ous surfaces represent a negligible proportion (1%), while forests on steep northern and northwestern slopes are extensive (15%). Orchards have been replaced by residential areas. Build-up density is around 50% in 59% of the area and

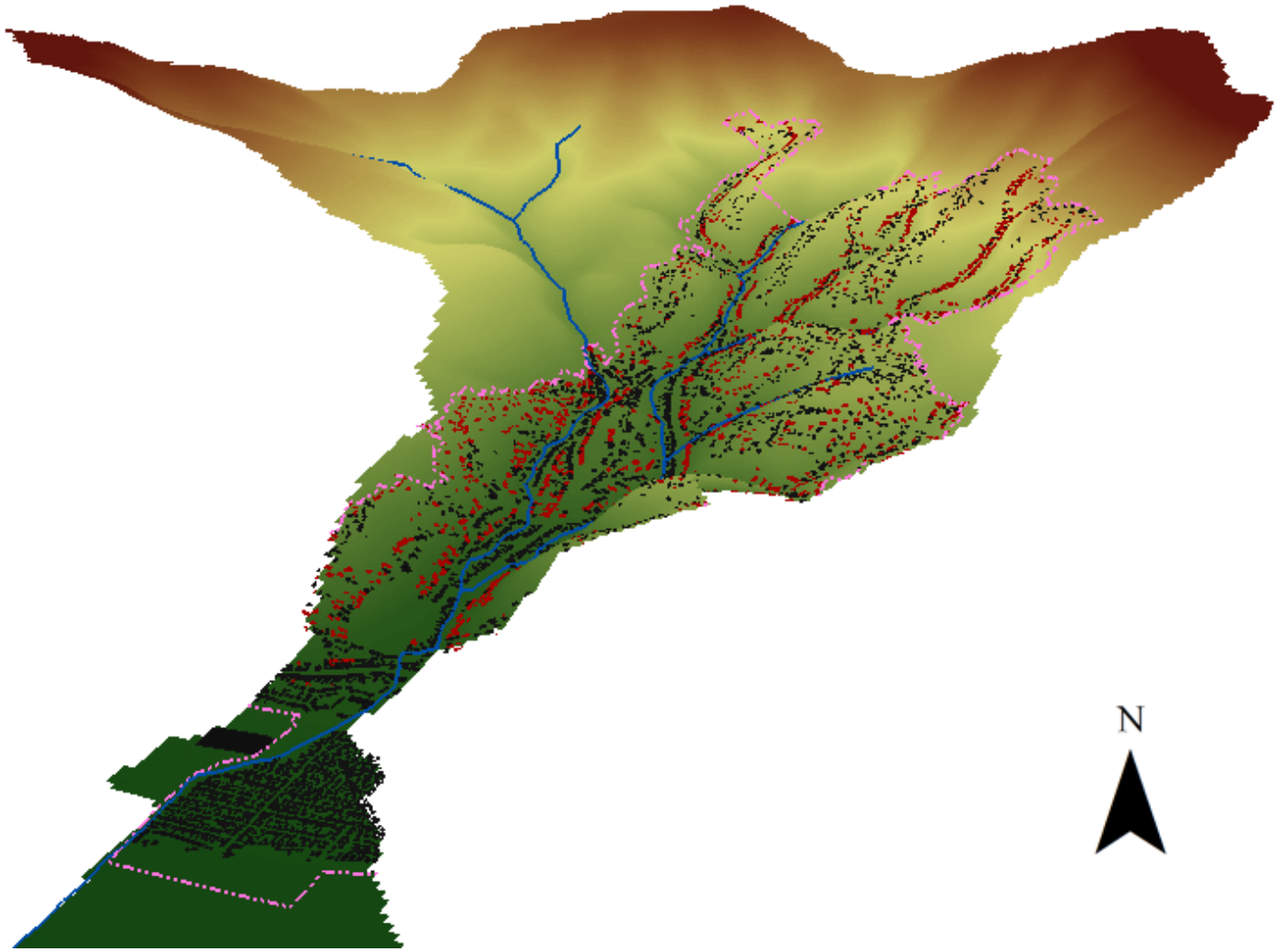

Figure 7 – DEM of the Magyarürög valley.

higher along the valley floors and broader ridges. The house-with-garden pattern allows sufficient infiltration and groundwater recharge. At the same time, the traditional land use pattern (orchards and vineyards with press-houses) is not compatible with modern requirements.

A problem for sewage collection is the fact that 56.6% of the area lies in more than 20 m distance from the next drainage facility. This means that in all higher-lying foothill terrains regulated rainwater drainage is virtually impossible. Even open ditches are unsuitable for this purpose and the sewerage is generally loaded with rainwater over 36% of the area. After a wetter autumn, groundwater is also conducted into the sewerage.

In the area of the case study 8,359 buildings of various kinds were investigated. Among them 2,551 fell into the class where release into the sewerage network is of high probability (figure 8). More than half (54%) of buildings (4,562) are assumed to connect to the network with some probability. For a relatively small number of households (1,246) is not expected to try to release stormwater into the sewerage. It is important to note that among the buildings with highest hazard (relative positions between 1 and 15 m), 1,932 only lie 5 m higher than the next sewer. All in all, for 76% stormwater inflow can be relatively easily implemented.

If differentiation is made according to relative position compared to the stormwater conduit network, it is found that 1,160 buildings which are 1-5 m higher than the sewer network are not connected to stormwater conduits. Among them 432 are larger than 50 m^2, 399 are residential buildings and 623 are located on slopes steeper than 10°. The total area of these plots is more than 64,000 m^2. Calculating with the long-term 658 mm average precipitation, more than 42,000 m^3 of sewage has to be treated, which means, at the actual rate, 50,000 euros extra costs for the water suppliers within this single subdistrict of the sewerage network.

Additional calculations highlight that the necessary investment into stormwater drainage would amount to 30 million euros for the entire city (Ronczyk and Lóczy 2006). The return interval for this investment is estimated for 60 years based on the present yearly losses. It is concluded that this interval is beyond any planning and political periods and, therefore, this is not a priority issue for any political party.

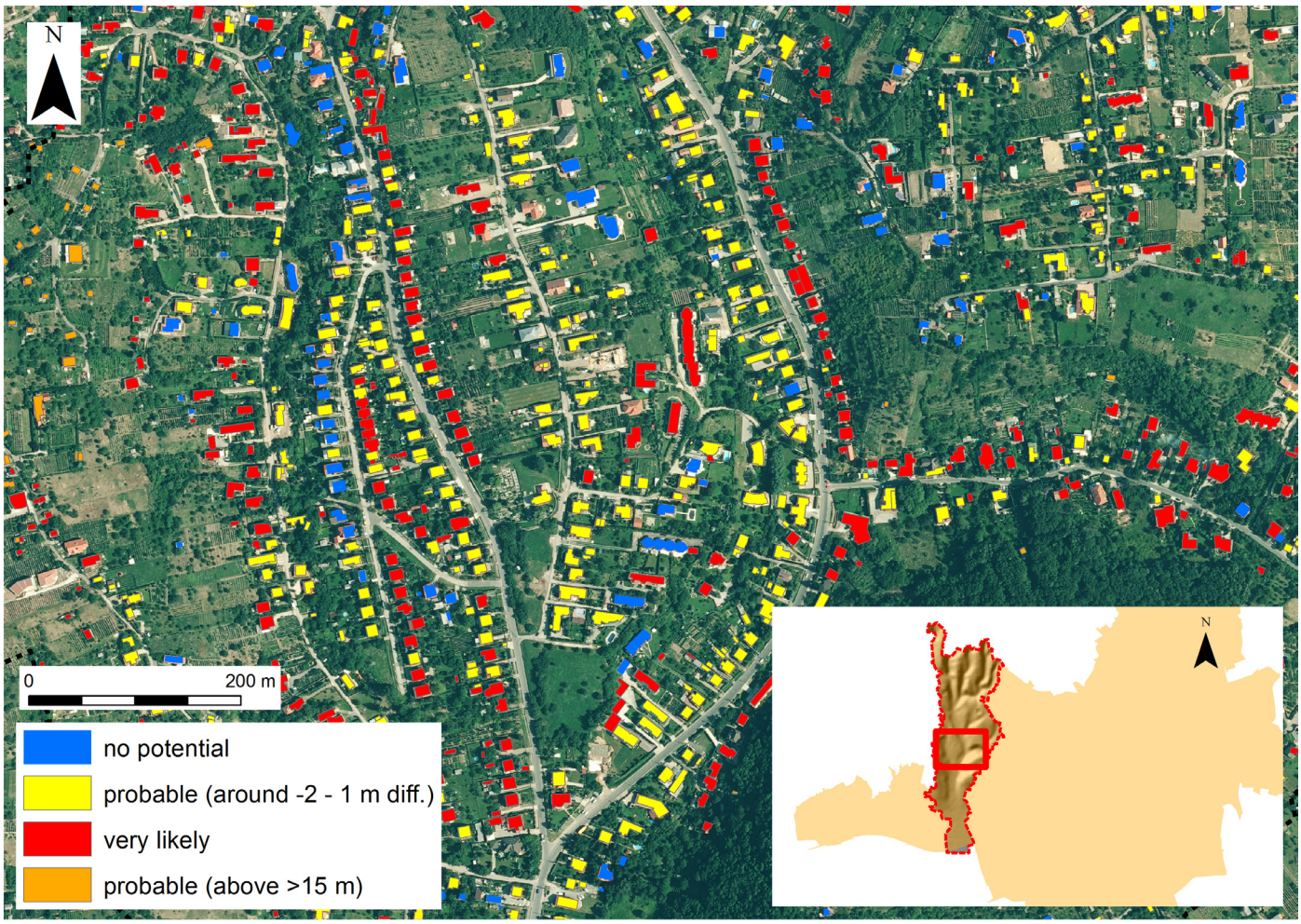

Figure 8 – Classification of buildings with potential contribution to pressure on the sewerage network in the Magyarürög Valley.

Conclusions

Unplanned urban development springing from individual interests, the changeable legal regulation environment and the particular physical environment jointly resulted in serious environmental problems in Pécs. The extra costs necessary to remedy this situation may rise to several millions of euros. The analyses presented in the paper are founded on GIS database and field checking and could be an economical solution for the screening of real estates requiring interventions, which is the first step towards the solution. It has to be supported, however, by a hydrometeorological and runoff monitoring system supplying real-time data on the loading of sewage subdistricts. Based on the results of monitoring, an automatic governance of pumping installations can be established and fining of sewage overflows can be prevented.
Regarding the intricate interactions of water management with the urban energetic and metabolic system, a collaboration of different disciplines is required. In the case of Pécs, a city with diverse topography (particularly striking in the case of the Magyarürög Valley of the Mecsek foothills), geomorphologists should also contribute to this collaboration. A complex treatment of the problem has to include the revision and strict enforcement of building regulation better observing the topographic conditions of the city, the continuous analysis of hydrological processes and raising the environmental awareness of the population.

Acknowledgements

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Sustainable Urban Mobility

Transports and Territories in a Global Economy

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Abstract

The main areas of worldwide economic interests are becoming more and more interdependent due the process of globalization. Therefore where, how, and how much to produce, in regard to the consumer markets, also become important elements for the processes of planning the networks and regulations for services management.

However, at global level, three large economic "Blocs" are being defined, that gradually drive the decisions of the various Countries towards making terrestrial infrastructural connections. For example, Eurasia, is a dynamic "Bloc".

At the same time the economic centre of gravity is getting lower, despite infrastructural efforts concentrated mainly in Central Europe, that are focused towards Eastern Europe.

The Mediterranean and Central Africa are involved by strong financial investments from sovereign wealth funds, in particular for the realization of major infrastructures; at this stage, ports and airports and major rail and road axes are the top priorities, that international investors are interested in.

Another key element is the connectivity of the networks in the logic of the major transport corridors to operate within the logic of the overall development.

The reduction of the accessibility of territories and of the connectivity of networks in a global process is one of the handicaps suffered by businesses, regarding both demand and offer.

The reduction of accessibility, in the past two decades, has been one of the causes of the Italian decline. There is nothing good in the reduction of traffic, and considering unnecessary the service transport policy and the infrastructures adequate and even redundant. This is the idea of sustainable decline.

The first idealization of the concept of "smart city" dates back to the beginning of the new millennium and is coined by William Mitchell, an America scholar who also coined the term "e-topia" to indicate the ideal city, a place that is able to make life easier and more attractive.

The ability to move easily within urban areas, quickly and with a low environmental impact, is considered a key factor for the quality of life in all modern metropolitan areas.

Sustainability is uniquely considered the most innovative aspect, because the environmental impact and fears related to climate change and the progressive depletion of natural resources are considered a priority at all levels.

In many manufacturing and commercial SMEs (Small-Medium Enterprises), planning activities in manufacturing and logistics, warehouse management, inventory and transportation management are not adequately supported by advanced computer systems.

Similarly, the transport and logistics companies show considerable resistance in investment for Information Technology, a prerequisite for the development of logistics outsourcing and advanced value-added services.

"A scientific development needs two "R", Rigour that can be given by mathematical methods, and Relevance, because problems must be real. Rigour without Relevance only leads to sterile models, however refined from some point of views, but useless to understand situations" (Sylos Labini , 2002).

Globalization and "The Butterfly Effect"

On December 29th, 1979, during the Annual Conference of the American Association for the Advancement of Science, Edward Lorenz a famous American mathematician, introduced the "Butterfly Effect": "*A beat of a butterfly's wings in Brazil, following a series of events, could cause an hurricane in Texas*".

Lorenz's quotation synthesizes the definition of the term "Globalization", as being the linear and nonlinear integrations and interactions in economic, political and religious fields, that represent the economic ecosystem formed after the breaking down of geo-economic barriers on a global scale.

Globalization can be summarized in three fundamental aspects:

a) interaction between the different elements under analysis;
b) rules, regulations and policies for their efficient management;
c) topics involved in these interactions.

As a starting point, we can distinguish the tangible and intangible interactions, based on the tangibility or not of the flow between the senders and receivers, that can be summarized as follows:

- Depending on the consistency of interchange, the transport and logistics sector or the telecommunications sector are the recognized players in the globalizing process;
- There is a direct proportionality between logistic and transport development, technological progress and the growth level of the economy.

For aspects regarding regulations for transport and logistics, European legislation has evolved in stages since the ECSC Treaty, art. 70, in which the transport sector was considered

to be isolated from the macroeconomy. The change of pace can be traced back to the Delors Report, "the White Paper" issued in 1986.

The transformation of the terminology, from a common to a single market, has also led to a change of the horizon towards which the EEC, later the EU, intended to go.

After about twenty-five years, the document 144 of the White Paper issued in 2011, "Roadmap to a Single European Transport Area", summarized the gradual thematic path that till then was trying to be pursued and which can be schematically presented as follows:

Economic growth → Freedom of movement → Accessibility and connectivity → Infrastructure and structuring of transport systems → Sustainability.

The implementation of the Community projects since 2003 with Marco Polo I, 2007 with Marco Polo II, and in 2010 with the regulation of the TEN-T network project, have tried to achieve the targets, but with disappointing results, due to:

– Difficulty in obtaining public and private financial resources, accentuated by the economic crisis of 2008, for the implementation of the planned investments regarding infrastructure on a European scale;
– Lack of coordination between the EU Governments, determined by the lack of economic and social uniformity existing among the various European Countries, and even between transport and logistics, and industrial and urban policies.

These two aspects are the determining factors of the difficulties in handling global processes, as the consequences of some components of the ecosystem have repercussions with a "butterfly effect".

The main areas of worldwide economic interests are becoming more and more interdependent due the process of globalization. Therefore where, how, and how much to produce, in regard to the consumer markets, also become important elements for the processes of planning the networks and regulations for services management.

However, at global level, three large economic "Blocs" are being defined, that gradually drive the decisions of the various Countries towards making terrestrial infrastructural connections. For example, Eurasia, is a dynamic "Bloc".

At the same time the economic centre of gravity is getting lower, despite infrastructural efforts concentrated mainly in Central Europe, that are focused towards Eastern Europe.

The Economic Blocs

The three Blocs that are nowadays redefining the map of economic, financial and migratory flows, are:

- Eurasia;
- the Western Bloc of North and South America;
- Africa.

Within each of these three great Blocs and through their interchanges, the worldwide evolution of development processes is accelerating. These basically depend on:

- transformation processes of the raw materials coming from Africa and directed mainly towards the "Chindia "(China-India) area;
- the consumer areas of North America and Europe that will be increasingly stabilised as countries that are more and more assemblers and less and less transformers,
- the challenge that is primarily played in the new consumer markets of Africa which, at the same time, are the richest sources of raw materials.

Within this context the economic-financial world players, through complex trade agreements, are seeking to define (at least) a medium-term geo-economic policy, with the awareness that business cycles are becoming shorter and shorter. In example, two projects can be mentioned:

- in the Euro-Asian area, new major rail corridors are being constructed, such as the Beijing-Hamburg which only takes 16 days and high speed Beijing-Brussels, which takes 27 days, and is an inland route covered by articulated vehicles.
- Big container ships, 18,000 TEUS (Twenty-foot-equivalent-units) will serve the major consumer markets also through a regular frequency service.

In this scenario, the geo-political balance in Africa plays an important role.

The Mediterranean and Central Africa are involved by strong financial investments from sovereign wealth funds, in particular for the realization of major infrastructures; at this stage, ports and airports and major rail and road axes are the top priorities, that international investors are interested in.

Against this complex world scenario, and considering the more and more unstable economic cycles, it is important to understand the policies necessary to ensure the processes of geo-political stability, even in the presence of the three following areas of global crises:

- the energy crisis announced a few years ago, and that manoeuvred oil prices to 145 US dollars per barrel, and then back to 40 USD after just five months, and is now stabilized at 50 USD;
- the financial crisis for all to see, due to globalisation that has driven consumerism and aggravated the public debt in Western countries; the public debt was financed by the Financial "surplus" of exporting countries such as China;
- climate changes that require significant Government interventions for the territory, the urban structures and transport models.

Southern Europe, and in particular the South of Italy, if appropriately modernised and with the strengthening of the

corridor policies, can realistically represent a great euro-Mediterranean platform with stretches of coastline becoming the jetty of the African front, with Italy as the port/waterfront that goes from Messina to China.
We should imagine the euro-Mediterranean platform as being flexible in respect of the economic development and geo-political safety, also due to the phenomena of strong migration flows of people from sub-Saharan Africa towards Europe.
In this context, the euro-Mediterranean platform based in Italy has a geo-economic-political role as a link between the main European and the Mediterranean cities, and elects Southern Europe as the centre of gravity of the Mediterranean, as a "free trade zone" (Conference of Barcelona, 1995).

The "free trade zone"

In 1995, the euro-Mediterranean conference in Barcelona indicated the possibility to create a "free trade zone" by 2010. As it is known, this perspective of co-operation has given more satisfactory results on a cultural level than on an economic one. Nevertheless, this perspective remains strategic in order to achieve a continuous as well as essential dialogue among Mediterranean civilisations.
The role of the South Italy will emerge more and more clearly when the above mentioned "free trade zone" will be implemented, in particular through the creation of a "Mediterranean intermodal transport system", which could became the key driver for the development of Southern Europe.
On the other hand European policies remain on a Central Europe axis, and the transnational intermodal transport system, in its role as the supporting back-bone of the urban framework of the new Europe, does not seem to respond to a unified strategy of possible developments, but it tries to defend what is focused on the Berlin-London-Paris main route.

An Open «Cyberspace»

To measure the "self-propelling" power of *hard* infrastructures and *soft* networks when revitalising even difficult areas, it is sufficient to consider that they are growing exponentially given the close relationship between transport and economic development. However, the post-industrial era drives on incessantly: on the one hand towards even more diversified specializations, and on the other hand towards an increasingly inclusive interdisciplinary reintegration.
This dual development determines a continuous multiplication of the networks for the exchange and distribution of the flows of information, goods and people, providing a more and more extended and articulated connection of the "planetary city" where the priority focus of policies can no longer be regarding production, but rather consumption. The customer is driving the re-engineering of production processes towards policies of production and "just in time" delivery where logistics is a key element.
This globalization process is irreversible and tends to create an "*open cyberspace*", which is more dynamic, complex and interactive. Therefore, its overwhelming pervasiveness is one of the "cornerstones" by which to establish the process of regeneration and economic-territorial rebalancing of national urban framework.
But how will a Euro-Mediterranean transport policy be configured in such a system? Will it be able to articulate and regenerate the urban structure of the economies, reviving the economy of the cities?
In general, the infrastructure system tends to integrate the trans-European corridors passing through Italy, the "*motorways of the sea*" and the trans-oceanic routes that cross the Mediterranean calling at major ports on the southern shores (**Tangiers, Oran, Algiers, Tunis, Sfax, Alexandria, Damietta, Port Said**), those to the east (**Haifa, Beirut, Latakia, Smyrna**) and the north (**Piraeus, Trieste, Venice, Gioia Tauro, Naples, Genoa, Marseille - Fos**).
This intermodal system is linked to the Trans-European Corridor I, Berlin-Monaco-Verona-Naples-Bari (La Valletta), and will play the role of "backbone" system, because it will link the European cities to those of the Mediterranean:

- enhancing the connection of Sicily with the continent had already been planned, suitably decommitting the transhipment ports, in particular Gioia Tauro for the *containers* and potentially also a Sicilian port to be classified as "of major international importance" (Law 30/98). Paradoxically, this plan was interrupted "truncating" the Corridor in Naples and pushing on the Naples-Bari axis to connect La Valletta (Malta);
- crossing the two East-West corridors, the **Corridor VIII** – **Naples-Bari-Sofia-Varna** on the Black Sea, open to the markets of the Balkans, Greece and Ukraine; and the **Mediterranean Corridor - Lisbon-Madrid-Milan-Kiev** linking the Atlantic coast to Russia;
- the **railway Corridor**, currently in progress, **Paris-Warsaw-Moscow-Beijing** covered by Trans-Eurasia Express, will connect the English Channel to the Chinese Yellow Sea (the Euro-Asian economic bloc). Is this connection an alternative to the Euro-Mediterranean corridor?

Will **Corridor I** be able to form the backbone of a great Euro-Mediterranean intermodal system?

Connecting the Network and Accessibility to the Territories

Another key element is the connectivity of the networks in the logic of the major transport corridors to operate within the logic of the overall development.

The reduction of the accessibility of territories and of the connectivity of networks in a global process is one of the handicaps suffered by businesses, regarding both demand and offer.

The reduction of accessibility, in the past two decades, has been one of the causes of the Italian decline. There is nothing good in the reduction of traffic, and considering unnecessary the service transport policy and the infrastructures adequate and even redundant. This is the idea of sustainable decline.

In these decades we are bring about the decline: we are now feeling it, but up to a few years ago it was only a quick way to indicate a forecast. The most worrying aspect in terms of mobility is the insufficient understanding of the phenomena.

To avoid these new dangers, we must react by recognising the damage of a "don't do" policy, i.e., of not having a vision of mobility and, consequently, of transport policy.

As a first approximation, we estimate in about 4 billion euro as the additional potential GDP we could have had available if only we had been able to maintain the same levels of accessibility as in 2000 (in any case already inadequate).

Losing accessibility results in fewer interchanges, lower sales and lower added value. It also implicates greater system inefficiencies that influence the surviving interchanges. This is a loss of GDP as well.

The same phenomenon, throughout the period 2001-2012 has registered a cumulative loss of GDP of 24 billion at current prices. Obviously, in these simple exercises we do not consider the general improvement of the production performance that would have been seen in response to the higher international competitiveness of our services, i.e. tourism and goods.

Indeed, the direct result is the cumulative evaluation of the additional GDP that Italy would have achieved over the period 2001-2012, if it had gradually taken effective action to bring the average accessibility to the levels of Germany; then, a total of 120 billion euro would have been recovered.

This analysis on territorial differences must also involve the transport system and logistics.

The *mobility divide* is represented by the differences in accessibility. Costs and transport time are totally different, when moving from the South of Italy to the North. The accessibility index calculated for Italy shows differences in a range from 8 to 1; this means that times and costs of transport, in the same conditions, can be even 8 times higher in some southern regions of Italy than in more accessible regions of the North.

The Smart City should not be Just a principle

The first idealization of the concept of "smart city" dates back to the beginning of the new millennium and is coined by William Mitchell, an America scholar who also coined the term "*e-topia*" to indicate the ideal city, a place that is able to make life easier and more attractive, by following five simple principles:

1. Dematerialszation, according to which, the digital development of the cities leads to a virtualization of many areas;
2. Demobilisation, according to which, the network allows a rethinking of the use of spaces and to change the travel needs, through the creation of multifunctional areas in our houses, at the workplace and for social life in general;
3. Mass customisation, so that the digital culture should not be an element of uniformity of behaviour but, on the contrary, should facilitate the development of individual creativity;
4. "Smart" functioning of urban spaces with interconnected buildings, in order to create a kind of urban nervous system, so that specific needs of the population can to be met automatically thanks to the interaction between people and objects.
5. A gradual transformation process, to allow the implementation of "*e-topia*" to have a positive effect on the quality of citizens' lives.

The smart city is an urban area managed by an effective policy, able to govern the territory, to better handle natural resources, to communicate with citizens through their different languages, to welcome them through an extensive network of services, to operate in a transparent and sustainable way through a participatory governance and a strategy consistent with the use of the most advanced technologies.

Therefore in the new scenario of urban development, a new generation of city is taking shape, the intelligence of which is measured by the evaluation of the requirements concerning efficiency, development and innovation in five main categories: **Connections, Human Capital, Culture, Creativity, Consumption.**

it is estimated that the process of transforming a metropolis requires an average investment of 3% of the GDP up to 2030; but the introduction of innovative technologies would allow advantages in efficiency, time and productivity, leading to an additional growth varying from 8-10% of GDP.

The Challenges of Urban Development

Most urban areas in Europe are facing a number of common issues, related not only to their physical expansion and population, but also to the environment and society. Traffic congestion, noise and air pollution, the urban overgrowth, as

well as social exclusion and road safety, are the challenges encountered on the path of a more sustainable urban development. Urban mobility is one of the most complex problems that cities must face and one of the sectors in which most nations are investing relevant amounts of money.
The ability to move easily within urban areas, quickly and with a low environmental impact, is considered a key factor for the quality of life in all modern metropolitan areas.
There are extensive ongoing works in many cities, since the current systems of urban mobility are considered inadequate to meet an ever-evolving demand. In addition, transport is responsible for 30.7% of the overall energy consumption in Europe, while in Italy the percentage rises to 33% mainly due to a high density of cars compared to the population.
It is estimated that by 2050, worldwide urban mobility will cost 830 billion Euro per year and it will use 17.3% of the Earth's bio-capacity, values which are 4-5 times higher than figures of twenty years ago.
Recently a study has been carried out in US to evaluate the mobility performance of 66 cities worldwide. From the analysis of eleven criteria, ranging from: the number of cars per capita, the average speed of trip, the carbon dioxide emissions of different means of transport, the existence of pedestrian and bicycle paths, the level of citizens' satisfaction in regard to the urban transport network, a score between zero to one hundred was given.
The result was an average score of 64.4 points world-wide, indicating that the sample cities registered only two-thirds of the performance that they could reach with a more efficient policy. Only 15% of the sample achieved a score above 75 points.

The Ranking of European Cities

Among the European cities that were analyzed, the highest score of 81.2, was for Amsterdam, followed by London with 78.5 points, while the cities with the lowest scores were Rome, 57.9 points and Athens, 53,3 points, compared to an overall average of 71 points.
Milan has a better situation than Rome, but is still well below the European average. The highest index of performance lies with the cities that registered a low percentage of daily trips made by car. In Amsterdam, only 27% of trips are made by a private car, and nearly half of them are done on foot or by bicycle. Similar percentages characterize other northern European cities, against the European average of around 40%.
On the contrary, in Rome 61% of the trips are carried out by car, only Athens has a higher score followed by Milan, which achieves a figure of around 55%.
Successful cities, such as Amsterdam and London, have found a balance between different ways of transport to discourage people from using the individual motorized transport. This has been possible through the strengthening of public transport, the implementation of advanced traffic management, the increase of private vehicles taxation and the introduction of road tolls.
In Europe journeys by public transport represent a share of about 39.4%, ranging from 24% in Rome to 54% in Oslo.
The problem of urban traffic severely affects the quality of life of Roman citizens, mainly caused by the limited extension of the metro system, which has only two lines. This shortage in Rome, compared to other European capitals, does not concern only the extension of the network, but also the inadequacy of the system to meet the considerable number of users, with the frequent phenomena of long waits and overcrowding, and as a consequent widespread use of private cars.
The city envisages important actions to upgrade the infrastructures for mobility, and some of them are already being implemented, with the target to double the underground network by 2020.
The city characterized by the highest number of subway lines is Paris, followed by Madrid, with two lines more than London. Whereas, the analysis of the extension of underground lines related to population, shows Stockholm to be the winner. Indeed, almost half of all trips there are made by public transport.
The subway system in Milan is barely competitive compared to other big cities, and the annual number of passengers is low, inferior to the that of than less populated cities. The gap is due to the poor efficiency of the public transport system, but also to the Italian mentality, particularly attached to the use of cars.
In Milan there are over 700,000 cars, which means that 55 cars are registered every 100 inhabitants, which is among the highest levels in Europe. However, people living in Milan use their cars for only 3% of their time, while leaving them parked for the remaining 97%. Parked cars occupy more than 3,000,000 square meters in the city.
In Italy, the urban mobility plans can be an effective tool to solve the above mentioned problems through an integrated political approach, based on principles of sustainability. The goal of these plans is to ensure that transport systems meet the wide range of social needs, at the same time minimising the negative impact on people, the environment and economy, and respecting the specific features of each urban area.
Besides the characteristics and goals of each case, all plans are linked by a long-term deadline, generally identified in 2020. Some cities have elaborated important examples of plans related to sustainable mobility whose effects will be

visible in ten or fifteen years.
An example of excellence is represented by Paris, which is distinguished by an efficient operational approach and a clear definition of the players involved, the actions and financial resources.
The plan sets five main goals, to be achieved in two stages, the first one by 2013 and the second one by 2020:

- Improve the quality of the air and in general reduce of the harmful impacts of transport.
- Guarantee to everybody the right of access to the city, with special care given to the vulnerable categories of people.
- Enhance the living conditions and safety of the spaces accessible to pedestrians, cyclists and passengers on public transport.
- Increase economic vitality and the development of the city through a more efficiency transport systems.
- Strength linkages between the city and wider territories, including the suburbs and surrounding towns.

In Milan, the new urban mobility plan for should be approved by 2015, with the aim of triggering a virtuous circle in the period after the Expo. Among the projects discussed, were the ring roads, the increase of investments dedicated to the metro-system; the upgrading of the rail system, the gradual pedestrianisation of the old city centre, the lowering of the speed limit in some areas, the reduction of the parking areas, the increase of cycle paths. To pursue these goals, however, in Milan there should be an improvement of the collaboration between the different levels of public institutions and between the public and private sectors.

The innovative aspect is Sustainability

Sustainability is uniquely considered the most innovative aspect, because the environmental impact and fears related to climate change and the progressive depletion of natural resources are considered a priority at all levels.
Recently there has been a worldwide survey on traffic congestion in several cities. Rome is the most congested city in Italy and the third in Europe, after Warsaw and Marseille.
The Italian capital has recorded a value of 34%, ten points higher than the European average and eight points higher than in Milan.
The city with less traffic is Amsterdam, followed by Copenhagen and Madrid. In these cities a high proportion of the population uses public transport or bicycle every day.
To reduce traffic and improve air quality, European cities are working to encourage the use of bicycles through strengthening bike paths, regulatory changes to protect cyclists, increasing taxes on cars and on the entrances to the city.
Nowadays, about 300 million bicycles are circulating in Europe, corresponding to one bicycle every 2.4 people. In countries such as the Netherlands and Denmark more than 30% of the population travels by bike, almost all roads have bike paths and even the secondary roads have parallel lanes for bicycles.
At the bottom of this ranking lies Athens, where bike lanes are almost non-existent. In Amsterdam, 40% of commuters go to work by bike: there are about 70,000 bikes circulating and there are huge parking lots that contain up to 10,000 bicycles.
Since theft is a problem even in the north European countries, a few years ago the city of Amsterdam has increased the fines for buying or selling bikes in the street and made sanctions against theft more severe.
Italian cities are backwards in respect of the main European cities and it is necessary to change the cultural attitude, as well as the rules regarding safety, since in the Italian mentality cycling is limited to leisure time. The sector is also considered as a priority in Milan, as the new mobility plan will extend the bike lanes from the current 70 to 300 kilometres in 2015 and 500 in the next decade.
The number and variety of sports facilities is another important competitive aspect of the cities, since the trend to practice a sport, both at amateur and professional level, is growing amongst the population. In the European Union it is estimated that about 18% of the population is enrolled in a sports centres against 10% in last decade.
Milan better equipped than the European average, counting on approximately 3,500 facilities, representing 26.2 facilities every 10,000 inhabitants, while in Rome the number of facilities is greater, but the ratio with the population is slightly below the European average. In Milan the football fields are dominant, as is the case in many other European cities, whereas in the north of Europe, facilities are mainly ice sports facilities.
Milan has made significant progress regarding sensitivity to environmental issues, recording an increase of 71.4% in recycled waste that currently covers 40% of municipal waste. Rome has also made significant progress, but still lags behind, as less than a quarter of the waste is recycled, while the cities that pay more attention to ecology are the Nordic capitals of Europe.
Amsterdam, Helsinki and Oslo lead the European ranking, having already reached 60% of recycled waste, while Copenhagen is settled at about 55%, thanks to an innovative plan, which sends to landfills only 3% of the total waste, thus reducing the harmful emissions and obtain a significant saving in energy.
The attention to ecological aspects in Copenhagen is confirmed by its designation as “the Greenest city in Europe” re-

cently obtained. The success key factor in Copenhagen has been the heavy investment in partnerships between public and private sectors that has allowed universities, companies and institutions to cooperate in the pursuit of common targets in terms of eco-innovation and sustainable employment.
The current trend for big cities is to focus on the sustainability of urban buildings, accounting for 40% of overall energy consumption in the world, much more than the transportation sector that consumes only 28%.
The only way to deal with the ongoing urban development is to building concentrated cities, with less suburban development, fewer roads and more public rail transport. In effect, the cities of the future will not be able to expand their limits on land and, therefore, will have to grow in height, in order to save resources, increase efficiency and, together, save energy consumption.
From this point of view the construction techniques are rapidly evolving, and soon a skyscraper will be able to become a self-sustaining ecosystem with rooftop gardens, trees on the staggered terraces, waste self-management, domestic waste incineration to produce heat, photovoltaic plants, etc.

The Italian Cities, backwards compared to Europe

The new society must be based on shared economic and ethical values and on a participatory democracy, paying attention to environmental aspects, being used to new rules and capable of using the technical innovations which are offered by science and engineering.
London is the most global metropolis, with a strong economic influence in Europe and throughout the world, characterized by a high degree of internationalization, skilled workforce, efficient urban planning, a wide and varied cultural offer, but also with attention to the vulnerable groups of population and to the environment.
Among the leading cities ranks Paris, which is one of the leading cities in all the concerned sectors, but an increasingly important role is played by the cities in northern Europe, which focus on technological innovation, attention to social problems, sharing of civic values and political choices and, above all, sustainability.
Italian cities are backwards in respect of European cities in terms of technology and, above all, environment, due to inadequate economic and social policies, but also to lack of organisation to affront the rapid changes imposed by the evolution of modern society.
Milan has recorded significant progress in nearly all sectors, undertaking numerous projects and pursuing the objectives with the right commitment. The main problems concern Rome, where there are several projects in hand, but which is struggling to implement the changes required.

A new intervention policy should start from the Cities

Currently, more than half of the world population lives in cities, and the first one hundred cities in the world generate 38% of the global GDP (Gross Domestic Product). Europe is the most urbanised continent in the world.
The progressive urbanisation of the planet and the rapid scientific and technological progress require a radical transformation of the organisation of urban spaces, with an ever greater attention given to sustainability.
We need cities that invest in human and social capital, in the participation processes, in education, in culture, in the infrastructure for the new communications and in many other areas:

a) inciting a sustainable economic development;
b) ensuring a high quality of life to all citizens;
c) foreseeing a responsible management of natural and social resources through a participatory governance. More and more the city assumes the role of driving force for economic development, attracting a growing share of population and concentrating economic activity, consumption and capital.

The most significant aspect of progress in the cities is the increasing attention given by individuals to the economic, cultural, and social opportunities than cities can offer.
Jacques Attali has effectively defined the city as “a living organism, a real heritage of innovative experiments”, specifying that it is not an independent body in respect of society, but rather the projection of the socio-economic structure and while it still has its contradictions and inequalities, it also has opportunities, wealth and socio-economic dynamism.
If the traditional city represented a space delimited by precise borders and occupied by a well-defined population, since the twentieth century this identification has been substituted with a less precise entity that is more flexible, characterized by increased population movements, activities and services and more flexible production patterns.
In this scenario, planning programmes designed to create single-purpose areas have been replaced by urban projects based on product differentiation, overlapping of uses, the reutilisation, rehabilitation and transformation of entire areas of the urban fabric.
The role of creative cities is to become the engine of sustainable development, by investing in diversified sectors and integrating the dominion of public goods with that of private capitals. The development of the city will no longer be based on only public spending, but on a collaboration between

public and private sectors, with a new social pact.
The radical changes in the role and structure of cities are driven by the rapid evolution of digital culture. The metropolis are turning into a kind of platform, designed to facilitate the connection between people, to encourage the creation of innovative initiatives, to attract talents and capitals, to meet the criteria of sustainability, to encourage collaborative behaviour.

What is the role of our companies

In euro-Mediterranean areas, due the current dynamics of world trade, it is not enough to have a favourable geographical position, nor the product quality to attract and develop good trade flows. This natural asset should be supported by careful business policies.
In this scenario the difficulties of our companies to be competitive, also in logistical terms, are caused by lack of public logistics, with the result that they cannot:

- trace the goods to their destination since there is still ex-works selling (updating of National Logistics Plan 2012-2020, July 2012)
- reduce the supply chain from production to distribution of the products to be exported; and assemble the semi-finished products to arrive at the final product for the export market.
- abbreviate the excess of mediation, managing the difficulty in creating a system on the logistical transport level.

In recent years in Italy, the demand for services such as Single-Window Customs, real transport services and logistic companies, analysis of the rules of international markets, etc. has led Italy to fall back on foreign operators.
On the Italian market, with varying degrees of difficulty for the various regions and for the supply chains mainly export-oriented, most shippers and couriers rely on foreign companies in order to reach their target markets.
There are two kinds of barriers to entry in these markets:

1) Due to the logistics-transport system, export companies tend not to be oriented towards "carriage pre-paid";
2) Operators' lack of understanding procedures and regulations due to the shortage of opportune assessments of new markets such as Eastern Europe, the Balkans, Africa, the Mediterranean.

Business behaviour has been identified and analyzed through an examination and assessment developed in the National Plan of Logistics and the research carried out by the Central Committee of Road Transport of the Italian Ministry of Infrastructure and Transport.
Information relating to the internationalisation process has been analyzed in a research focused on some traffic relations in the Mediterranean areas. - The international opening to the Italian regions, research prepared by the Research Department (SRM), year 2013 -
The strengths and weaknesses of the domestic companies are found both on the demand and the supply sides. Indeed, in both cases, the results found a "dwarfism" on the dimensional level (weakness), and a great capacity to reach markets (strengths).

The "Single Window Customs Service" towards collaborative behaviour

In world trade dynamics as we have already mentioned it is not enough to have a favourable geographical position and product quality to attract and develop trade flows. The first supporting procedure is to create a cycle focused on the activities of transport and logistics, increasingly important in order to reach markets.
Inefficiencies attributable to such activities cause a dilation of transfer times especially in port and airport and produce additional costs for Italian companies importing and exporting, with considerable waste of economic resources and loss of competitiveness compared to other European companies.
This situation leads many logistic and commercial companies to relocate part of their operations in other EU countries which are better organized.
The phenomena of traffic diversion to other EU Member States (Northern Europe and neighbouring countries such as Slovenia) would represent, according to some estimates, about 30% of the total traffic originated and destined to national consumer basin, causing a loss of positioning and obviously of importance in the international geo-economic context.
The situation can be corrected through a series of coordinated measures regarding the activities of assisting companies.
Companies must be guided in an institutional collaborative framework (win-win logic), reducing "down" times of bureaucracy to facilitate trade flows with foreign countries, with obvious advantages not only for the companies involved in the specific activities (e.g. shipper operators), but also for the whole production system.
Therefore this is an environment that allows, through a single access (Single Window Customs) to achieve different goals, with many advantages:

- reduction of bureaucratic delays and documentary mistakes;
- better use of human and financial resources which are at the disposal of private and public administration;
- possibility of more selective and precise controls (risk management) by company administrations;

- reduction of non-tariff barriers, that are not always quantifiable, but existing and due to organizational frictions.

Other critical issues to be overcome for competitive Logistics

In order to better analyse the phenomena that create problems and cause loss of competitiveness of Italian companies operating in international markets, both for demand and supply of logistics, a special Focus Group was organized. Below is a summary its main results. Substantially, the following issues emerged:

1. Poor spread of "Logistic Culture" and lack of skilled resources

The shortage of adequately skilled human resources prevents many companies to practically exploit the full potential that modern logistics and a proper handling of goods offer.

Furthermore, the poor "widespread culture", especially among the SMEs, determines that logistics is seen as a cost or, at the most, as a service to the customer rather than as an important resource for competitive advantage for companies.

Italy also lacks in institutional training paths: unlike France, Germany and England where logistics is already a topic in high schools. Only recently in Italy some schools have been experimenting a training course for "Perito Industriale in Logistica e Trasporti" (Industrial Operator in Logistics and Transports).

2. Low spread of Logistics outsourcing

Although Italy is today the fourth largest European logistics market, the use of outsourcing of logistics is relatively rare compared to the rest of Europe. In some regions, especially in the South, this policy is almost residual.

The majority of Italian companies manifest a low propensity in logistics outsourcing, for reasons related to both organizational factors (mainly small and medium companies that express a demand for logistics led by the "cost factor", which is very fragmented and personalized) and due to cultural reasons.

For example the immaturity of the services market, characterized by a high fragmentation of the companies providing logistics services whose scope is often limited to certain regional areas and which have no incentive either for aggregation or increasing in size.

The demand for outsourcing focuses mainly on basic services (drive, warehouse space rent, distribution, etc.), and is rather low for more complex services (order processing, auxiliary works, etc.).

Only in few sectors is there a spread of organizational models that have enabled the outsourcing of all the activities of cargo handling, both incoming and outgoing, which are currently limited to the automotive sector, clothing and consumer goods.

On the other hand, even in these areas, outsourcing collides with the absence of operators who have a national coverage, with high specialization.

3. Poor diffusion and standardization of IT and Telecommunication Systems for Logistics

In many manufacturing and commercial SMEs (Small-Medium Enterprises), planning activities in manufacturing and logistics, warehouse management, inventory and transportation management are not adequately supported by advanced computer systems.

Similarly, the transport and logistics companies show considerable resistance in investment for Information Technology, a prerequisite for the development of logistics outsourcing and advanced value-added services.

The reason is that the "cost" factor is still predominant in respect to the "quality of service". In other words, the market does not recognize its value.

In addition, the low level of computerisation of infrastructures and transportation hubs, as well as the poor diffusion of computerised procedures within port and airport customs causes delays in operations and, frequently, determines the choice to embank/disembark goods abroad (containers diverted to ports of the Northern Europe, freight truck flows towards the hub of Frankfurt).

In some cases, the absence of a national data transmission network and of a platform for the traceability if goods from some critical supply chains, causes the inefficiencies in the national transport system and also the lack of control over high-risk shipments for the community, such as the case of dangerous goods. The same can be considered as regards to data transmission support for the initiatives of city logistics.

4. Dissemination of "Ex-Works" Clause

A large part of the productive sectors that represent the demand for logistics services, especially manufacturing SMEs, has not recognized the need to express a strong control over the flow of materials and information, nor has regarded the efficiency of logistics processes as a specific resource for competitive advantage.

The reasons for this backwardness regarding logistics and transport in Italy depend largely on the demand, i.e., from the habit of companies, in particular SMEs, to neglects the organization of transport for embark/disembark, thus selling goods according to the "ex-works" clause and similarly, purchasing goods with "prepaid charges".

This implies that imports and exports of Italy are managed *extra moenia* by the logistics operators of our major trading

partners, such as France and Germany, which not surprisingly have acquired our logistics companies in the last 10 years. The logistics operators, on the other hand, continue to recede in the rates of foreign exchange trade for three reasons: the two factors that hamper crossing passes (transit costs and waiting time), the higher cost of local road transport compared to the cost of road Transport in Eastern Europe.
The final result of low competitiveness in businesses related to the national logistics system is that Italy, with its high export predisposition, buys more and more transport services from foreign companies.

5. Failure of optimisation among the players of extended Supply Chain

In recent years and in the near future, alongside the integration of the supply chain, we will continue to talk about "collaboration" among companies and among companies systems.
Until now, a "locking" approach of companies towards their business partners has always prevailed (suppliers, customers, contractors, etc.), with great difficulty in the exchange of information among relevant players in the same sector (manufacturing and distribution companies, logistics operators and carriers).
Only in a few advanced sectors, such as pharmaceuticals and automotive, has there been a sharing of information for a long time, which is essential for the logistics process, such as the delivery programme, production planning, promotional plans, etc.
In this way all the players share benefits in terms of reducing costs of emergency stocks, transport costs and inventory costs, according to the logic of the network economies.
In the consumer goods sector, on the other hand, despite the launch of the project ECR (Efficient Consumer Response) starting from the nineties, when there were distributors and manufacturers involved, in looking for mutual efficiencies along the logistics chain, less than 5% of the activity volumes has been managed from a collaborative point of view .

High incidence of downtime in Transportation

In Campania, a region of Italy, little attention has always been given to the problems related to the downtime in transport cycle, particularly in regards to waiting time for loading and unloading of vehicles.
The lack of cooperation and coordination between logistic players and commercial companies generates important repercussions on the parking times of vehicles and causes continuous friction regarding the high interface costs (for example for pallets management interchange); in that way the application of the Law 127/2010 could give good results.
These inefficiencies generate costs that could better be defined as waste, involving the entire logistics chain, shippers, carriers, consignees and the entire national economy.
The phenomena is particularly striking in the case of large retail distribution centres, in the field of consumer goods where it takes, on average, 3 hours waiting time. Time is a very precious resource: optimizing the use of time means making the whole supply chain more efficient, it reduces the logistic cost associated with the goods and reduces the external costs generated by transport. There are already some good results from some provisions contained in the Law 127/2010.
The focus on the emerging problems of the sectors permits the identification of the "virtuous path" that public action should take in order to remove such problems, that are essentially related to the following areas:

- promoting the adoption of **winning logistics models for specific sectors** through the training of industry committees or promotion agencies for the diffusion of *best practices*;
- **incentives to logistics outsourcing**, not only in the distribution phase but also for the supply of raw materials and/or semi-finished products, by spreading the practice of third parties also for deliveries in urban areas;
- developing **professional training** and research applied to the logistics and transport sectors;
- encouraging the development of **standards for the exchange of information and goods** and enabling a national data transmission network to support logistics and transports;
- reducing inefficiencies in transport stages of **loading/unloading,** spreading the practice of "scheduling" (or, introducing a logic of pricing based on "transport cycle time") and improving the organizational efficiency of logistics hubs for modal interchange (Law 127/2010);
- **simplifying procedures and bureaucracy** that reduce the competitiveness of companies operating in Italy and that slow down, and even exclude, foreign investment;
- **improving** area accessibility and network connectivity
- **initiating** training programmes integrating territories, transportation, logistics.

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"Green" terminals: the Italian state of the art. Qualitative overview of the current situation in core network airports

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Keywords: airport design, airport planning, core-network, environmental sustainability, green airport, Italian state of the art

Abstract

The paper reports the results of a study that was aimed at revealing the state of the art of green terminal design in Italy. The Italian airport network was reorganized in 2013 leading to a classification in core and comprehensive networks. The survey involved the ten infrastructures of the core network. A brief introduction of the network is provided in the paper.

The importance of green terminal design is due to the very short life cycle of passenger terminals (10-20 years). Moreover, the entire airport has a great impact on the environment. The European strategy, both in the construction and in the transportation industry, is focused on a sustainable approach both in the project design and in operation. Besides environmental sustainability, of course, social and economic sustainability have to be considered in airport planning and terminal design.

The study has been structured with reference to some key issues in the green approach. These were used to formulate a survey, that consisted of qualitative and quantitative questions. The aim has been to obtain a synthetic but efficient picture of the state of the art of Italian green terminal design, made by the technical departments of the airports themselves.

The study reveals a static situation concerning the level of sustainability of passenger terminals and an attention to sustainability topics which is not at a competitive level. While international airports are growing in competitiveness, adopting new and innovative green architectural technologies, in Italy the process is slower. The present airport terminals are, in most cases, old buildings, despite the fact that in other countries the life cycle of these structures is quite short. In fact, a terminal life cycle usually ends with the end of the effectiveness of the terminal itself. Italian Airports are now slowly recognizing the environmental, economic, and social importance of a sustainable approach in terminal design, while in other countries this is already considered a real challenge.

1. Introduction

The government directive act for the Italian airport development plan (January 2013) is aimed at a reorganization of the airport network in terms of infrastructure, management and service quality. This document incorporates European directives, which aim at the creation of a Trans-European Network-Transport (TEN-T) in the field of air transport, as well as in other transport sectors. The transport network TEN-T is intended to divide the Community transports into two levels: a Core network, the backbone of the European common market and a Comprehensive network, the global network that provides full coverage of European boundaries. , This action has identified airports belonging to the European Core network, namely those of primary interest, necessary to provide the main transport channels, both at European level, and the national level as well. This reorganization first introduces the Italian airport system.

Furthermore, a significant worldwide growth of air transport demand is expected in the next few years. Despite the economic crisis that has limited the numbers that had been foreseen in recent years, the demand continues to grow in Europe although not so rapidly. The decision to identify an airport Core network, means that the progressive growth in demand for air transport in Italy will be indirectly conveyed to a limited number of infrastructures, ten to be exact. It is hoped that there will be a rise in the level of quality, and thus, efficiency and safety of the service offered to passengers and benefits for European and national economies are also expected.

For this reason, our research focused on understanding the state of affairs in the ten airports that fall within the Italian Core network and the state of affairs regarding issues of primary importance concerning architecture, environment and territory. All the issues considered are equally important in airport terminal design, given the ambition and complexity of facilities of this type. The infrastructures included in the Core network are: Roma Fiumicino, Milano Malpensa, Milano Linate, Bergamo Orio al Serio, Venezia Tessera, Bologna Borgo Panicale, Napoli Capodichino, Palermo Punta Raisi, Torino, Genova.

2. Presentation of the problem

A. Aims of the survey

This study was conducted through a survey. The survey was carried out for the purpose of obtaining a concise picture of the Italian core network in relation to many issues: the

design of the terminal spaces considering the standardized international method, the level of attention and adoption of "green" building technologies, the development of economic strategies, the local territorial accessibility to strategic airport infrastructures, the architectural accessibility in passenger terminals. Ultimately, the survey was aimed at understanding the state of the art in Italy in order to encourage a discussion comparing them with the international targets and standards.

B. A list of the Italian Core network airports

A list of airports, addressed by the questionnaire used in our research is shown below. They are listed in descending order by number of passengers per year, with an indication of the location, name and acronym by IATA (International Air Transport Association) encoding:

- Roma Fiumicino "Leonardo da Vinci" (FCO)
- Milano Malpensa "Città di Milano" (MXP)
- Milano Linate "Enrico Forlanini" (LIN)
- Bergamo Orio al Serio "Il Caravaggio" (BGY)
- Venezia Tessera "Marco Polo" (VCE)
- Bologna Borgo Panigale "Guglielmo Marconi" (BLQ)
- Napoli Capodichino "Ugo Niutta" (NAP)
- Palermo Punta Raisi "Falcone e Borsellino" (PMO)
- Torino Caselle "Sandro Pertini" (TRN)
- Genova Sestri "Cristoforo Colombo" (GOA)

3. Performances taken into consideration

The analysis focuses on passenger terminals and, in some cases, on the infrastructure landside by exploring the issues that make its design a very complex and multifaceted challenge. For this reason, an introduction to the issues under

1 – The Italian Core and Comprehensive airport network.

investigation is provided in this section, namely the question of space design, intermodality, building technologies and the "green" terminal concepts.

A. Designing spaces through international standards

An airport passenger terminal is a building that is used to process the passengers from their entrance until boarding and from landing until exiting. Its main job is to accommodate the functions needed for boarding. Boarding stages are mutually consequential and the passengers have to go through all of them in order to reach their departure gate. Clearly,it is necessary that the whole process, say from the entrance to the gate, be extremely efficient. The requirements for efficiency are accompanied by the need to make the process enjoyable and pleasantly memorable. Passenger satisfaction is closely related to the duration of the process (i.e.,waiting times related to the length of the queues). In fact, in the design development (and beyond) we consider the comprehensive concept of passenger experience that today is one of the greatest concerns of an airport society.

Passenger flow peak (TPHP) is the reference for a terminal being dimensioned properly. As the passenger flow always varies, both during the day and throughout the year, the terminal has intensely busy times which must not undermine the processing system. Moreover, from the time that a new terminal is opened, there will be a continuous increase in flow over the years. The terminal building must be designed in a flexible way, to effectively process this growing flow until the end of its life cycle, followed by its demolition and replacement. In fact, the life cycle of the terminal is composed of one or more service cycles, which are characterized by the refurbishment or expansion of an existing terminal.

Given all this information and input, a proper design of terminal spaces is needed. Since 1975 IATA (International Air Transport Association) has offered and updated spatial standards for the evaluation of the terminal spaces and calculation formulas for airport design. Established Levels of Service (LoS) make it possible to assess the quality of the service offered to the passenger. To this purpose it is necessary to compare the design values with appropriate threshold values, expressed in m^2/pax or time, etc. Spatial performances are evaluated with a mark from A (which corresponds to the maximum) to F (that is the collapse of the processing system).

In addition, when designing and dimensioning the spaces of a terminal, paths should be plain and intuitive, with a clear orientation for passengers. A good orientation must also be guaranteed when designing the retail spaces (they are a source of huge non-aviation revenues for the airport companies), since these should not be a hindrance to the rigorous and timely processing of passengers. In Asia, the concentration of retail areas within the terminals is usually high. This turns out to offer a substantial revenue for the owner; for instance, in Indian airports, their revenue is in a range of 50% to 70 % of the total. Similar numbers are not achievable in Italy, where such services are seen by the Regulatory Authority as a barrier for a proper passenger processing.

Other important revenues for the airport society come from the real estate outside the airport boundaries. The terminal involved can accommodate activities that are in symbiosis with air transportation and that can benefit from proximity to the airport infrastructure. In fact, the airports have become over the years a "centrality" (as urban planners would say). These house different facilities and services all clustered around an intermodal hub. The more efficient the hub is, the more businesses that benefit from airport proximity will be located in its vicinity, as we can learn from the interesting examples of airport cities (the core concept of an "aerotropolis") around the world. For instance in Asia, while we can find activities such as "techno cities" in the airport surroundings (e.g. Hyderabad Airport, India), it is also possible to find real "aerotropolises" (e.g. Andal, Cochin e Bangalore).

B. Building technologies in a "green" terminal

1) Disposable airport terminals

When there is an initial oversizing of the terminal, there will be a progressive saturation of its capacity which will happen in a few years. At that point, the airport company will face a crossroads: the choice of decommissioning the terminal to build a new one properly sized or the alternative of expanding the existing one. In each of these cases, the predominant element is speed and systemic concept of the construction/demolition processess. It is necessary to reduce the inconvenience for passengers, for airlines and, thus for the airport owner itself. From an operational standpoint, a terminal expansion becomes operative gradually, module by module, up to full operation until the end of construction. Work is accelerated during the design stage, by the restricting the use of traditional technologies It would require time for drying and it also has environmental and economic impacts for demolition.

When dealing with a building with a very short life cycle (of a few decades, varying between different countries and case by case), another key issue is the environmental impact created by the installation and disposal of a huge quantity of materials in a short time. Consequently, construction elements that can be easily reused and recycled/recyclable should be favoured for waste reduction. Therefore the continuous growth and evolution of the terminal should encourage the selection of certified materials.

2) Energy efficiency

The efficiency of the terminal begins with the preliminary planning stage, and continues with the detailed design and

the design for construction. In each stage the temporary nature of the terminal itself should always be considered. As explained in the previous paragraph, terminal life cycle is scheduled in a few years, given the increasing quantity of passenger traffic and the related need for infrastructure development. A period of 10-20 years is frequently observed. Therefore it is necessary to use recyclable and reusable components,and it is evident that there should be a preference for dry laying rather than wet.
This, on the one hand, requires less energy for their disposal, and, on the other hand, prevents waste of energy for the production of new material. For instance, metals are currently used in constructions with large spans. Energy costs for recycling are less than the ones required in the production phase.
An airport terminal is an industrial building of considerable size, whose operating costs are independent from the number of passengers going through it. Energy consumption is necessary to provide lighting; to provide operation of electronic devices and equipment necessary to perform boarding activities, and to provide heating and cooling systems. While it is important to increase green energy consumption, it is also necessary to optimize the use of energy itself.
In recent years, many Italian airports have solved the problem of reducing their power consumption, through a review of the electricity management plans and through simple maintenance tasks such as replacing light fixtures with LED elements. Others have introduced systems for green energy production, by applying them on the envelope of the terminals themselves.
Moreover, the designer plays an important role by introducing efficient and innovative systems for energy use optimization. An interesting example is the Bangkok International Airport terminal, designed by JAHN Architects. Columns of air treatment have been properly studied. These ensure that only the lower volume of air (the ones actually lived in by passengers) is heated/cooled. The remaining air volume becomes an insulation cushion that stands between the envelope and the lower air volume.
Furthermore, in airport terminals it is difficult to control the heat loss, because of the presence of large glass surfaces, required for natural lighting. There must be a proper balance between thermal insulation and large air volumes to be treated. This also has to be considered by the design team, who must come up with effective and experimental solutions. The goal is to design a structure that could be built rapidly. This would produce considerable life cycle savings through proper green solutions. Furthermore, it could be aesthetically improved by good design.

C. Green Airports

Let us now widen our focus and move on from the terminal area to the entire airport view. This includes runways, taxiways, aprons, hangars, control towers, offices, and other facilities. In short, the airport infrastructure looks like a city. As such, it imports goods and produces wastes, it consumes energy in relation to the various functions and services by its subsystems, and consumes large amounts of water for very different purposes.
Given the European policy framework, environmental sustainability becomes one of the requirements in airport design and operation. The European Climate-Energy Package is meant to establish a goal for European partners in terms of climate change prevention. This goal was known as "20/20/20", and has now been updated with new goals for 2030: Europe should reduce gas emissions by 40%, increase energy savings to 27% and increase green energy consumption to 27%. In the transport industry this goal has also been set for 2030. This step is intended to reduce CO2 emissions until 2050. By this time, CO2 emissions are going to be 60% lower than in 1990. The near future and the immediate present in Italy for airport planning are taking these international objectives into consideration.

D. Designing accessibility

1) Local accessibility and environmental sustainability
An airport is the gate to a city and its surroundings; in many cases it is the gate to the country, for people and goods. It is a node where many transport modes get in touch: air, road, railway. For this reason it is essential that the intermodality of this hub work well and efficiently, in order to give support to the local, national and international economies. By 2050 the main European airports are going to be connected with high speed train service. This is a common goal for the European economy. It is also an essential step for achieving European environmental goals, with a considerable reduction of CO2 emissions. In fact, European travelers are already able to reach most airports by train (almost 50%); in the USA passengers still prefer to reach airports by car. High speed train service could increase these numbers.

2) Design for all for social sustainability
When assessing sustainability it is necessary to consider also the social aspects of a global increase in passenger flow. With an increasing number of passengers worldwide, even the number of elderly passengers, children, and disabled increases. A sustainable design should provide terminals with space accessibility and should address every passenger category. Design for all should mean, for instance, that the main spaces for queuing should be provided with seats; it should mean a reduction in the distances to be covered by foot and it should mean clear signage and a good light-design.

4. Results

A. Methodology

This survey involved the infrastructure development and planning offices of ten airports that are part of the Italian Core Network. A questionnaire was submitted, dealing with the main topics that have been written about in the preceding paragraphs.

The following airports answered the survey: Genova (GOA), Torino (TRN), Napoli (NAP), Venezia (VCE), Milano Linate (LIN), Milano Malpensa (MPX).

In some cases it was necessary to submit a second version of the same questionnaire; this was shorter and thus did not take into consideration some of the topics.

Further data were used for running controls and making additionss to the data collected. These additional data were collected through documentary research. The references in this case were: web databases, program contracts, service charters.

In this paper we will not show all the graphs and tables that were compiled and created using the results of the survey, in order to give a more concise overview, however, we will touch upon every consideration that ensued from the answers received.

The purpose of the questionnaire was to comprehend and outline the approach to sustainability and related issues for each of the airports involved from a qualitative point of view. The aim was not, therefore, a detailed technical assessment for each of the topics covered; in fact, this should be further investigated through separate and properly conceived and designed surveys.

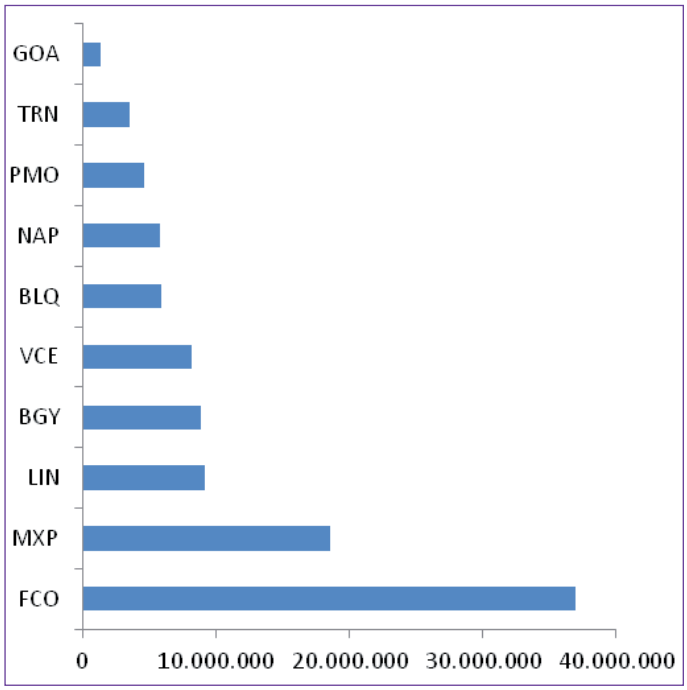
The airports addressed in this paper with their IATA codes, are:

- Roma Fiumicino "Leonardo da Vinci" (FCO)
- Milano Malpensa "Città di Milano" (MXP)
- Milano Linate "Enrico Forlanini" (LIN)
- Bergamo Orio al Serio "Il Caravaggio" (BGY)
- Venezia Tessera "Marco Polo" (VCE)
- Bologna Borgo Panigale "Guglielmo Marconi" (BLQ)
- Napoli Capodichino "Ugo Niutta" (NAP)
- Palermo Punta Raisi "Falcone e Borsellino" (PMO)
- Torino Caselle "Sandro Pertini" (TRN)
- Genova Sestri "Cristoforo Colombo" (GOA)

B) Qualitative profile of the airports

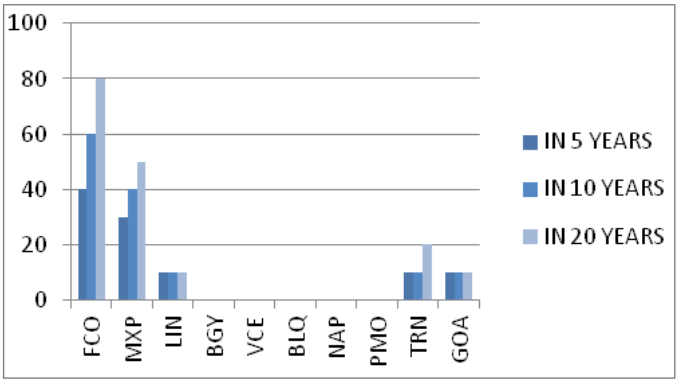
1) Size, numbers and future growth

The 10 core network airports are not the first ten airports for their annual numbers of passengers and cargo. In Italy, airport capacity is limited. The only airport that exceeds 30 million passengers per year is FCO. The concentration of infrastructures belonging to the Core network is in proximity to the major economic centers of the country, in consistency with European goals. The rest of the countrys is served by the Comprehensive network airports.



2 – Core network airports for passenger flow in 2013. Reference: Assaeroporti data.

Fiumicino is the main Italian airport and the number of annual passengers (chart 2) leads to a higher number in square-feet for the terminal system, a higher number of runways, annual movements, consumptions and savings than any other Italian airport (table 4). Second comes the Milan area which, with its three airports, exceeds the Rome-Fiumicino numbers. All the other infrastructures follow in the list (chart 2). The list ends with Genova, with its limited cargo and passenger numbers per year, although this airport is near to a leading Italian sea port.



3 – Passenger traffic forecasts, in ranges. Source: survey.

The expected growth of passenger flow is proportional to the current number of annual passengers (chart 3). Within the

next 20 years Fiumicino is going to reach the threshold of 80 million passengers, with respect to a current amount below the threshold of 40 million. Genova now accomodates traffic amounting to 1,380 M, while it is expected that in 2027 it will meet and exceed the threshold of 3 million passengers. In both cases the number of passengers at a distance of roughly two decades doubles.

It is easy to evaluate the larger airports in the range indicated in the survey (chart 3). The review should be conducted by means of reduced ranges in order to also evaluate the growth of smaller airports. In any case, the data shown in chart 3 are significant, because in the next few years the threshold of 10 million pax per year will not easily be exceeded.

Below is a table summarizing some key information processed by the Italian Civil Aviation Authority (ENAC), in order to complete the framework for the infrastructures that were observed in the survey (table 1).

Given the topics set out above, we asked the offices participating in the survey to express a qualitative judgment about the adequacy of their current terminal systems. This qualitative opinion was given about the adequacy of their current terminals with respect to the forecast of increase in passenger flow. More than half of the responses received indicated a lack of capacity of the infrastructures as now configured. This is an interesting factor that should be carefully analyzed in the planning actions of each one of the survey participants.

C) Green Airports and Green Terminals

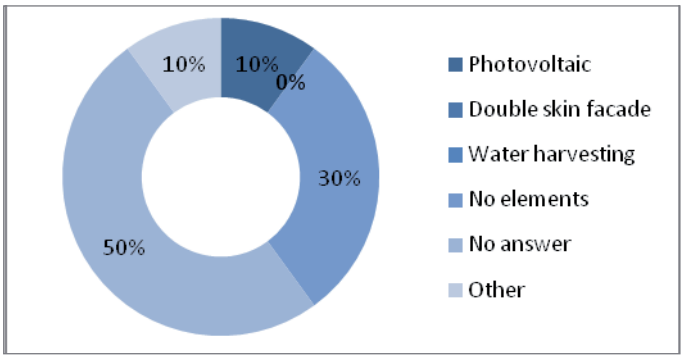
When addressing the question of green terminals, reference should be made to a considerable number of evaluation criteria. As described in the opening paragraph, some topics of interest were identified. For a quick understanding and an immediate response to the questionnaire, technological solutions adopted in terminal buildings and the materials used were investigated.

The power management and consumption of a terminal system begins with a proper design of the envelope. The envelope was examined for its contribution (positive and negative). Then we asked the recipients some questions, in order to understand if the envelope was properly designed, with satisfactory results in terms of heat loss and energy savings. It was shown that most of the envelopes analyzed were designed without the use of technological solutions contributing to the reduction of energy consumption; no further maintenance work offered any solutions of this kind (chart 5). The contribution of the envelope to power management could be "active"; in this case the reduction of power consumption is met by the envelope energy production supporting the plant system. Active envelope technologies are typically solar or photovoltaic panels. The contribution could also be passive; in this case, these technologies minimize the activity of the plants in the terminal by controlling heat transfer and lighting. For instance, passive technologies are screening systems for the control of solar radiation and for the reduction of glare; buffer spaces for the protection from cold and heat in both the winter and summer periods. As chart 5 clearly shows, since the actual terminal systems are not recent buildings, the attention to integration in the envelope of green technologies is quite low. Therefore the envelopes were not designed already integrated with photovoltaic systems (whose contribution in the energy balance of a passenger terminal is, in any case, very small). The envelopes were been provided with passive solutions in relation to the local solar diagrams: neither solar greenhouses, nor double skin for the reduction of heat loss, nor screening devices.

There are many constraints and issues in airport design . These come from international standards, the masterplan, the functional requirements that impose fixed patterns for the circulation of the flows and so, up to now the environmental requirements and technologies associated with these have been of minor importance. But a proper planning must take into account sustainability issues.

4 – Italian Core network airports. Source: Enac (2012) Italian Aiports Atlas.

	Pax.	Mov.	cargo (t)	RW	Surface (m^2)	Pax area	Commercial
FCO	36.980.911	309.719	143.244	4	318.200	48%	15%
MXP	18.537.301	174.892	414.317	2	315.000	40%	11%
LIN	9.229.890	120.463	19.807	2	85.000	33%	17%
BGY	8.890.720	74.220	117.005	2	35.000	44%	14%
VCE	8.188.455	84.233	40.887	2	53.000	48%	13%
BLQ	5.958.648	67.529	40.645	1	44.000	49%	10%
NAP	5.801.836	61.113	5.282	1	30.700	58%	20%
PMO	4.608.533	42.925	2.367	2	35.400	50%	3%
TRN	3.521.847	51.773	10.543	1	51.150	51%	27%
GOA	1.381.693	24.416	3.430	1	12.500	51%	17%

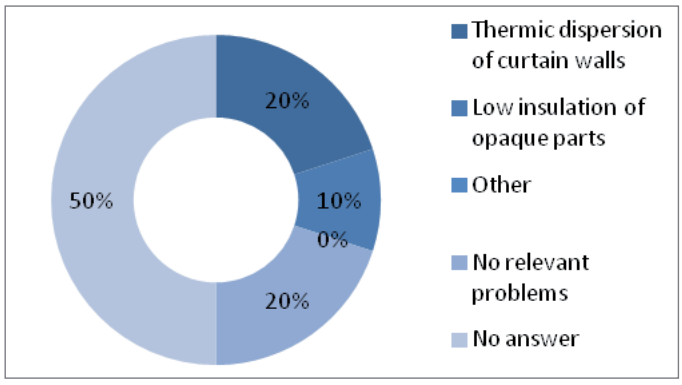


5 – Active or passive power integration envelope systems. Source: survey.

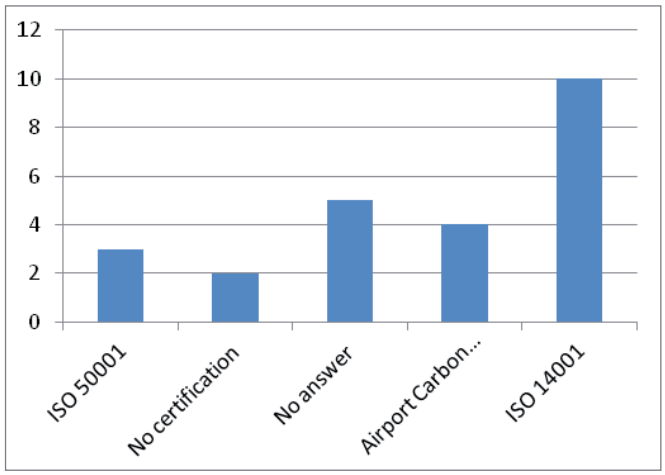
Moreover, the insulation performance of the envelope is not satisfactory. The terminal envelope is inadequate both in the transparent parts and in some cases in the opaque parts (chart 6). In fact, three airport planning offices reported that the glass parts showed excessive loss. They intend to limit this deficiency with actions such as applying films on curtain walls in order to limit the dispersion and accumulation of heat.

However, curtain walls are essential in a passenger terminal. In fact, given the size of the terminal floors they are necessary to ensure an adequate natural lighting.

There are numerous kinds of environmental certifications of the buildings and they have proliferated in recent years. The most common certification scoring method is certainly LEED, the American protocol recognized worldwide especially for buildings (in this specific case, the terminal). Green Airplanes and Energy Star are always used by Americans; the UK recognizes the Breeam, and the list goes on. Consistent with what has been written so far, none of the terminals we examined is LEED certified. Only a few cases have an environmental certification of the infrastructure (eg: Airport Carbon Accreditation). The Airport Carbon Accreditation assesses the performance in terms of CO2 emissions. Three airports have an ISO 50001 (Energy Management Systems) certification.

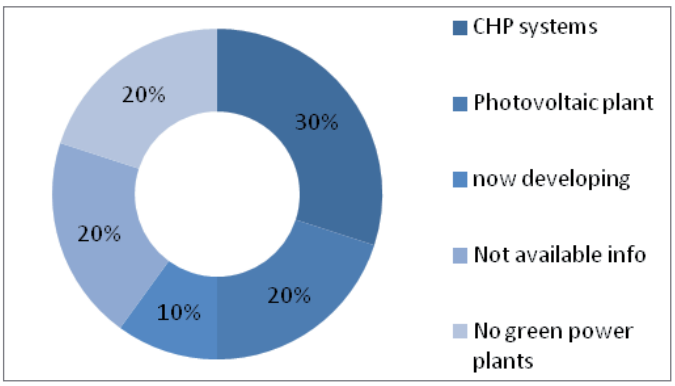


6 – Level of satisfaction with the envelope insulation performance. Source: survey.

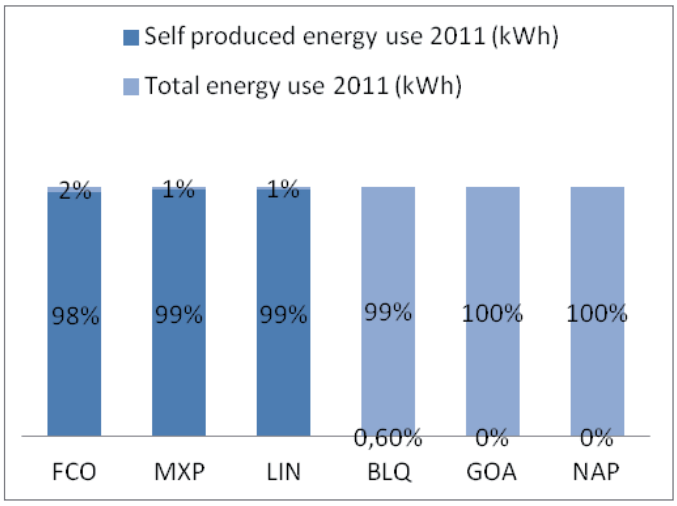


7 – Environmental certifications: infrastructure and terminal. Source: survey.

The power requirement of an airport is significant, depending on the number of facilities, on the extension of the areas and volumes and on the climate. The power is mostly taken from the outside. In some cases, it is integrated with energy produced directly by facilities of the airport. This is the case of power plants for the production of renewable energy. These are integrated to the building envelope or, more often, consist of independent plans. The numbers (in kWh) actually consumed are not available in all cases. Energy is produced directly at the airport when its size would cause excessive expenditure. In these cases, the airports become self-sufficient. Coverage of energy needs is achieved by CHP plants, which in some cases produce energy that is sold even outside. As revealed in chart 9, these numbers are very high (eg: 167 852 926 kWh for CHP consumed by FCO in 2011). In the present analysis the production of energy for CHP has also been factored in . CHP systems provide a savings thanks to the production in the same process of heat and electricity, through a reuse of damps for heating. Given the huge consumption and thus the power production necessary for an airport, a process of this kind has a much greater impact on the environment, compared to a photovoltaic system, since its efficiency is much lower (charts 8, 9).

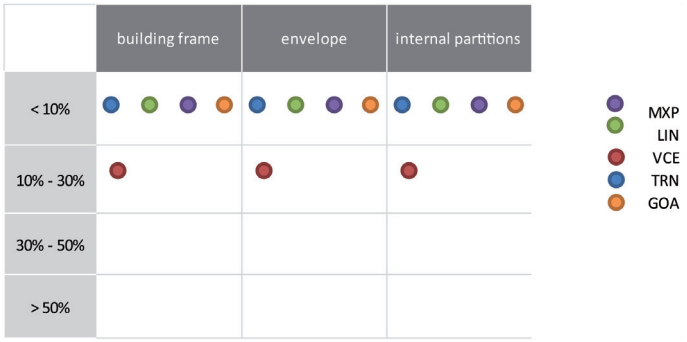


8 – Power plants in situ. Source: survey and financial statements.



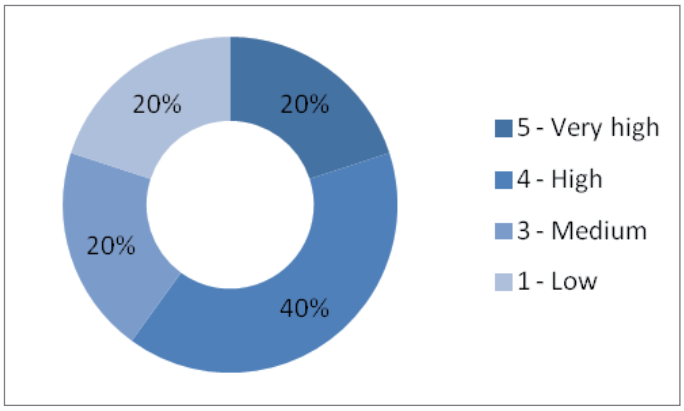
9 – Power consumption in relation to self sufficiency. Source: survey and financial statements.

The offices participating in the survey gave an indication of the percentage of building materials (used in their terminals) equipped with environmental certification; the numbers are very low and only in one case exceeded 10% (table 10). To use certified materials in terminal design (for a completely new building or for retrofitting the envelope) means choosing a production process with lower environmental impact; choosing to userecycled materials in a new product; choosing the possibility of recycling the material itself at the end of its life. Moreover, we have previously addressed the issue of Airport Carbon Accreditation. This kind of certification takes into account a huge number of parameters, including: direct emissions; indirect major energy-related electricity purchased and heat; indirect emissions such as secondary transport materials, outsourced activities, waste disposal. In a passenger terminal this issue can be controlled by choosing certified building products.



10 – Certified materials in airport terminals. Source: survey.

In conclusion, an easy to understand graph summarizing the contents of the previous charts is shown below. The airports participating in the survey were required to make an assessment about the importance of sustainable technologies and approach in their planning and in development policies, at the state of the art (chart 11). The answers are a confirmation of the results assessed by previous charts.



11 – Importance of green efforts in airport planning actions. Source: survey.

D) Airport accessibility

In a second stage, we analyzed accessibility. This means local accessibility but also accessibility in terms of design for all, as illustrated in the opening paragraph.
Intermodality is a critical element in the Italian network. This is crucial to increase the catchment area of the airports, to give a positive contribution to the national and local economies, and to contain the environmental impact of the national transport system. Throughout the country there is a lack of overlap between the various transport networks (and their hubs), as we are going to demonstrate below.
The airports studied are interconnected with road transport. They all have a number of parking areas for private vehicles, a primary source of non-aviation revenues; they are also well connected with the nearest towns by bus services, which have their appropriate parking areas or stations.
Unfortunately, the airports are mostly lacking direct rail connections. In many cases, it is necessary to cover the gap between the railstations and the airports by a special bus service. This is a confirmation of the absence of overlap of our transport networks. This deficiency worsens considerably if we look at the high-speed rail. An efficient connection with the high-speed rail is a target for the national agenda, and will be implemented in the next few years. In fact, the connection between air transport and high-speed trains began with the new connection Venice-Fiumicino (4 high-speed trains a day since December 2014). But t considering the growth of the passenger flow per year this decision was made by authorities too late. Unlike Italy, in Asia when dealing with these problems the planner starts from scratch. Asian airports are often built without having to deal with any existing infrastructure; while designing an airport, the planner imme-

diately envisioned a connection with high-speed trains. The result is much greater efficiency.

5. Discussion

The analysis carried out so far reveals the complexity of the national scenario. It is hard to find an example of a terminal building designed according to sustainability requirements, that could become a model for national and international designers. The planners have to deal with old buildings, which have grown for decades through additions and refurbishments.

Moreover, the national situation is fragmented: we have many small and limited infrastructures. The efficiency of the terminal begins in the preliminary planning phase and continues with the detailed design and the design for construction. In each phase sustainability should be achieved through the identification of requirements at a proper level of detail. The response to these requirements by the design team should then be verified at the end of each phase by the airport owner, who must also make sure that all the other requirements involved have been satisfied. In a preliminary and detailed design phase they are, for example, the compliance with capacity and flexibility needs and a proper management of the flows, issues that the airport owner is usually more concerned with, since they directly influence passenger experience. Attention has to be directed to these issues too, in agreement with the European trend both in the air transport sector and in the construction industry. Moreover, a sustainable approach to airport planning and design clearly has a direct strategic impact on cost savings during the life cycle of the infrastructure.

This survey aims to detect the state of affairs in Italy and environmental sustainability has been set as its major issue, but the revolution in planning and design should also include an integration with social and economic sustainability, as parts of the same sustainability concept.

This is an issue that, after much delay, is now finally consolidating. Again, the struggle to implement these requirements depends very much on the fact that our country always tends to maintain the existing rather than to get rid of what no longer satisfies efficiency levels.

Acknowledgments

To conclude this paper we would like to thank the 10 airports contacted during the survey; their patience in giving us their time and data made this study possible.

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Pedestrian mobility and accessibility planning: some remarks towards the implementation of travel time maps

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Keywords: Accessibility; Pedestrian mobility; Organic Urban Planning; GIS; Backtracking algorithms

Abstract

The objective of the paper is to propose a methodology for evaluating pedestrian accessibility in urban areas.
Accessibility is a quite recurring topic in the scientific literature, and emphasizes the strong interrelationships between land use and mobility. In the last decade, dependence on GIS-based approaches for accessibility assessment and management has grown considerably, and the crucial role of GIS techniques for the analysis of accessibility is nowadays well established.
With particular reference to the Organic Urban Planning vision developed in Italy in the '60s in Italy, the paper focuses on pedestrian accessibility as major mobility mode at the scale of the neighborhood.
But how is it possible to measure the level of pedestrian accessibility of a given territory and to map the results in a GIS environment?
First of all, there is a need to collect the different layers of information related to pedestrian mobility for the area, with particular reference to the road network, the location of pedestrian paths and sidewalks as well as the presence of physical barriers in the area that impede pedestrian permeability (built environments, railways, waterways surface...).
The proposed assessment methodology is based on the detailed discretization of the area being analyzed in a uniform grid of cells. In this grid a calculation algorithm is applied. This algorithm, on the basis of the information layers that overlap in each cell, assigns each cell a pedestrian travel time and evaluates the existing connections between the cell in question, and the cells adjacent to it. This model allows the creation of thematic maps that show the timing of pedestrian access to each cell.

1. Towards Accessibility Planning

1.1 Accessibility definitions

Many authors agree that a shift from Mobility-Oriented to Accessibility-Based Transport Planning is nowadays the key towards Sustainable Transport Planning (see, i.a., Banister, 2008; Bertolini & Le Clercq, 2002; Handy, 2002; Marshall, 2001). The World Business Council for Sustainable Development (WBSCD, 2001) states that «for mobility to be sustainable, it must improve accessibility while avoiding disruptions in societal, environmental, and economic well-being that more than offset the benefits of the accessibility improvements».
But what does accessibility exactly mean? How can it be measured and improved?
Accessibility is an essential feature of a well-functioning city or region, and represents a fundamental principle, because it provides a framework for understanding the reciprocal relationships between land use and mobility (Hull, Silva & Bertolini, 2012).
The Oxford English Dictionary defines mobility as «the ability to move or to be moved freely and easily», while accessibility as «the quality of being accessible», where accessible is an adjective used to describe a place that is «able to be reached or entered».
In the context of urban and transport planning, accessibility expresses the interactions between the activities located in a region and the transportation system serving it. There are many definitions of accessibility available in the scientific literature, and there is no universally used definition. According to Litman (2011), «accessibility refers to the ease of reaching goods, services, activities and destinations, which together are called opportunities». Le Clercq and Bertolini (2003) define accessibility as «the number and diversity of activity places that can be reached within an acceptable travel time...; what acceptable travelling time is depends on the purpose of the trip».
But, among the firsts and most quoted definitions of accessibility from the urban planning perspective there is probably the one of Hansen (1959), that refers to accessibility as «the potential of opportunities for interaction». In the '50s, the first efforts were made in the USA to study the interrelationship between transport and the spatial development of cities. Hansen, in his paper "How accessibility shapes land use" (Hansen, 1956), proposed the first mathematical formulations of accessibility and, hence, he was able to demonstrate for the city of Washington that locations with good accessibility had a higher possibility of being developed, and at a higher density, than remote locations (Wegener & Fürst, 1999).

But the concept of accessibility was really linked to transportation systems only since the end of the '70s (Nuzzolo & Coppola, 2013). According to a definition proposed by Dalvi (1978), accessibility denotes the ease with which any land-use activity can be reached from a location, using a particular transport system. Leonardi (1978) referred to accessibility as «the consumer surplus, or net benefit, that people achieve from using the transport and land-use system».
In 1996 the United States Department of Environment released its Planning Policy Guidance on Town Centres and Retail Developments, where accessibility was included as planning principle and defined as «the ease and convenience of access to spatially distributed opportunities with a choice of travel including the quality, quantity and type of car parking, the frequency and quality of public transport services, the range of customer origins served and the quality of provision for pedestrians and cyclists» (U.S. Department of Environment, 1996). From this perspective, it emerges clearly that the choice of the travel mode is an important attribute of accessibility: a destination is more optimally accessible if it can be reached by a wider range of transportation modes.

1.2 What does accessibility planning means?

The theory of accessibility within the framework of land-use and transport interactions was, subsequently, developed by Wegener & Fürst (1999). Their research is based on the recognition that trip and location decisions co-determine each other and thence, transport and land-use planning need to be coordinated. This is schematised in the so called "land-use transport feedback cycle" (figure 1), in which accessibility plays a crucial role.

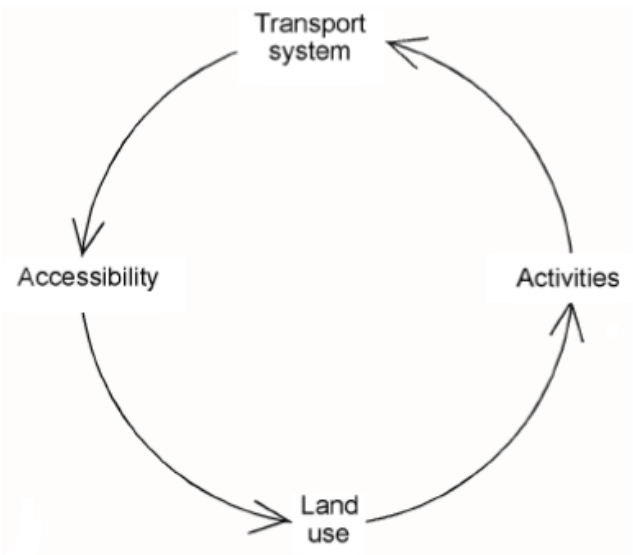

Figure 1 – The land-use transport feedback cycle as schematized by Wegener & Fürst. Source: Wegener & Fürst, 1999.

As it emerges from the cycle, the distribution of land uses (e.g. residential, industrial or commercial) over a given territory determines the locations of human activities such as living, working, shopping, education or leisure. But, the distribution of human activities in space requires spatial interactions in the transport system to overcome the distance between the locations of activities. Therefore, the distribution of infrastructure in the transport system creates opportunities for spatial interactions and can be measured as accessibility. Hence, the distribution of accessibility in space co-determines location decisions and so results in changes of the land-use system (Wegener & Fürst, 1999).
More recently, Susan Handy (2002) suggested a radical shift from planning for mobility, to planning for accessibility. Handy defines mobility as the potential for movement, the ability to get from one place to another, and accessibility as the potential for interacting among different and distributed urban activities. In Handy's view, the final aim of accessibility planning is to increase the number of opportunities, within a fixed time, while mobility aims at increasing the number of kilometres travelled.
What people need is not a generic mobility but, rather, the opportunity to participate in spatially disjointed activities (Bertolini & Le Clercq, 2003). In other words, while mobility represents the "ease of movement", accessibility describes the "ease of reaching the desired activities". Mobility-enhancing strategies generally focus on improving the flow of traffic and improving the performance of the road system: e.g. the level of service is measured in terms of average speed and traffic intensity. Therefore, the construction of new roads and the expansion of existing roads represent the dominant transportation strategy.
Rather than to increase by any means the potential for movement, often without taking into account the externalities of mobility, accessibility enhancing strategies aim to increase access to needed and desired activities, by bringing activities closer to people, enhancing the alternative for reaching those activities, and expanding the choices among activities. Accessibility, encapsulates more than a measure of vehicle speed: the concept incorporates a focus on the proximity of origins to destinations, the concentration or spatiality of activities, the quality of mobility systems available to overcome spatial separation, and the perceptions, interests and preferences of people who live and work there (Hull et alii, 2012). According to accessibility principles, a destination is more optimally accessible if it can be reached with a wider range of means of transport. Transport planning and location of attraction points, like public services, should take into account the whole sequence of movements that constitute a journey, identifying appropriate solutions in close collaboration with urban planning.

For these reasons, it is not mobility, but accessibility that should be identified as the transportation system's inherent goal, and against which its negative external effects have to be balanced (Le Clercq & Bertolini, 2003). A focus on accessibility instead that on mobility stresses, once again, the fact that land use has major impacts on transportation issues.

1.3 How to measure accessibility

But, how can we actually measure accessibility?
Measuring accessibility is complex. Gould stated that «Accessibility…is a slippery notion…one of those common terms that everyone uses until faced with the problem of defining and measuring it» (Gould, 1969). Therefore, Geurs & van Eck (2001) argue that the definition of the concept of accessibility depends on the objective for which it is intended.
Accessibility analysis may be performed both ex-ante and ex-post. Ex-ante analysis aim at evaluating which is the optimal location of an attraction point or of a new urban development in relation to a given transportation network, and how the accessibility may change according to changes in the transportation offer (in this case the accessibility analysis may be seen as a decision support system). On the other hand, ex-post assessments are used to evaluate if the current transportation system provides enough access to a given territory. Accessibility analysis should consider different means of transport, with particular regard to non motorised mobility (walking and cycling) and collective transport.
In the context of this paper, accessibility will be assessed mainly using maps developed in a Geographical Information System (GIS) environment.
Isochrones represent the simplest accessibility measure and aim at identifying the area that is within a certain distance or time of a given origin or destination. An isochron is a line on a map connecting points having equal travel times, distances or costs. To realise precise isochrones the mobility infrastructure (e.g. road network, public transport lines…) is needed, in terms of road network, public transport routes, stops and stations, and walking and cycling paths depending on the transportation mode for which the isochrones map is built (Brainard et al., 1997; Calderon et al., 2014)). Otherwise, it is possible to use a "buffer" tool to realise simple or multiple-ring circle isochrones implemented using an average speed or distance for the chosen transportation mode. However, the outcomes of a buffer analysis demand an attentive consideration, because buffers are not capable to consider barriers like rivers, railways…
Isochrones are particularly suited for representing catchment areas: e.g. public transport catchment areas, as the portion of a given territory served by public transport facilities, or catchment areas of any important public service, like schools, hospitals, public gardens…. In this second case it is important to distinguish between "local" services, which should be reachable on foot, and other services. Isochrones can also be used to compare catchment areas based on different transportation modes.
A development of isochrones draws on the so called contour measures. Contour measures define catchment areas by drawing one or more travel time contours (i.e. isochrones) around a node and, then, adding up the number of opportunities (jobs, facilities,…) within each contour (Curtis & Scheurer, 2010; Geurs & van Eck, 2001; Papa & Angiello, 2012). Contour measures appraise the amount of opportunities reachable in a given time, distance or cost. The location of the opportunities is needed.
Finally, potential measures are very similar to contour measures although accessibility levels are considered to decay with distance of opportunities from origin. Thus, potential measures reflect the distance deterrence of accessibility (Papa & Angiello, 2012; Silva, 2013).
In the literature there are many other examples of increasingly more complex accessibility measures, that include competition measures, utility measures, network measures… (see, i.a., Curtis & Scheurer, 2010). And, in the last decades many and complex accessibility instruments and mathematical models have been built: a collection and description of some of them is presented in Hull, Silva & Bertolini, 2012.

2. Accessibility and pedestrian mobility in the Organic Urban Planning vision

2.1 The Organic Urban Planning vision

At the end of the '50s Vincenzo Columbo, Professor of Urban Engineering at the Polytechnic University of Milan, elaborated a vision of the urban structure that he labelled as "Organic". Within his vision, Columbo defined urban elementary units: neighbourhoods (*unità di vicinato*), districts (*unità di quartiere*) and communities (*comunità*) (Columbo, 1966).
The units were defined in relation to the daily movements of their inhabitants. For example, according to the organic urban planning vision, the neighbourhood is the place of proximity, where the elementary functions of daily life are located (basic shops, kindergartens…), while in the district the social life takes place and life centres (civil, religious and commercial functions) are located. Columbo's research aimed at giving a structure to living spaces by relating them to daily activities of his contemporary society. The organic urban planning vision is based on the analysis of technical implications arising from the satisfaction of individual and social human needs. Starting from the features of the technical layout of a

city (house, social services, shops, markets, schools, hospitals, urban parks and open spaces, streets, technological networks,..), the model has the objective to satisfy the specific needs of the citizen as an individual or as a community member, through the best use of those facilities (Busi, 2005). In this model the concept of neighbourhood is very important, and it is based on the criterion that the system of mobility for excellence, for moving into the neighbourhood, is walking. Columbo also systematised the "life centre" concept. With reference to their function, life centres can be civil, religious or commercial. As reminded also by Busi (2009), life centres tend to align themselves along an axis, which is called the axis of life. The axis of life, that is essentially characterised by pedestrian movement, refers to an urban linearity structured to make the best use of services and aimed at socialising (Busi, 2009).

and at the same time an effective area of influence for the project of a bus line.» (Tira, 2011).
And nowadays probably it is more than ever necessary to focus the attention on the individuals and to reaffirm a people-centred planning vision (see, i.a., Tiboni and Rossetti, 2012). Therefore, starting from Vincenzo Columbo's assumptions, since the '90s Roberto Busi has developed the «Friendly city» concept, and he founded at the University of Brescia a research centre for Friendly Cities called CeSCAm (Centro Studi Città Amica). Among the CeSCAm activities there are researches on the quality of life and on urban safety issues.

2.2 Accessibility in the Friendly City

As explained earlier in the paper, accessibility focuses transport planning on the connection of people and activities in-

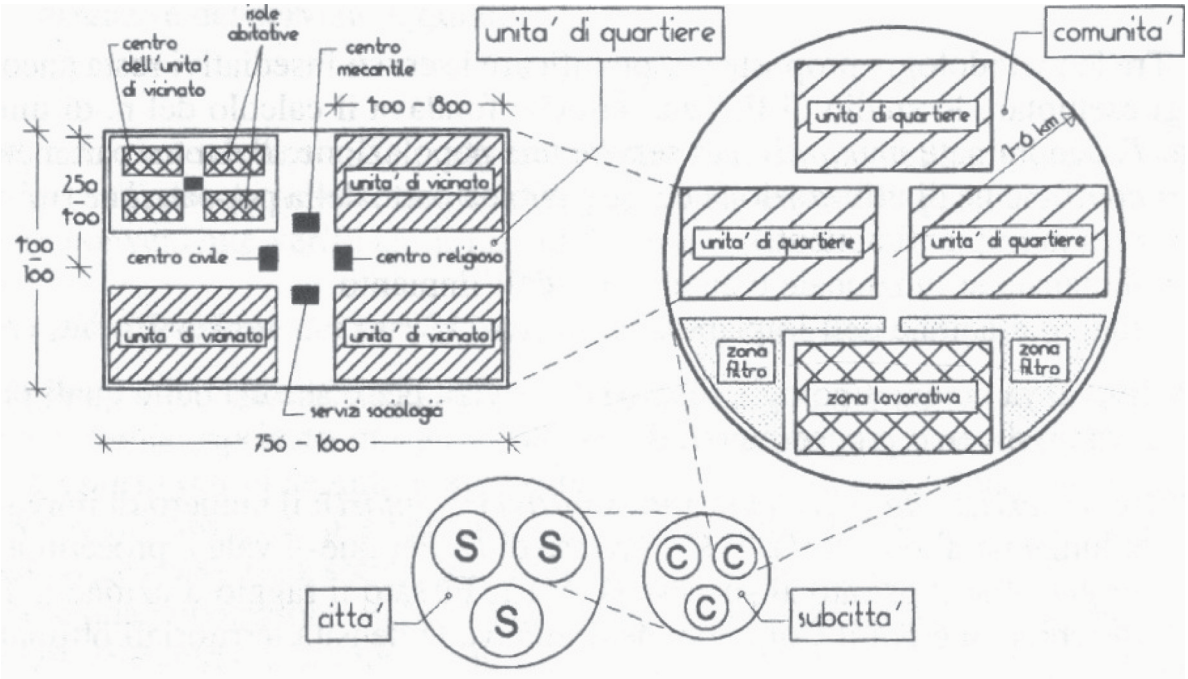

Figure 2 – The Organic Urban Planning vision. Urban structure scheme, articulated in neighborhoods (*unità di vicinato*), districts (*unità di quartiere*) and communities (*comunità*). Source: Columbo, 1966.

The "organic urban planning" vision was subsequently developed at the University of Brescia, in research works coordinated by Roberto Busi. Since the beginning of the '90s, Busi and his team have developed the theme of the Friendly City starting from Columbo's assumptions.
Tira (2011) argues that Columbo's "organic" vision is still alive and may be used to provide a solution to the problem of integrating urban planning and mobility. For example, as Tira states «the optimal distance of housing to public services is approximatly the same as the best bus stop range. The neighbourhood may therefore be an elementary urban unit

stead of on the transport system and enables the integration of land use and transport planning. Therefore, accessibility planning represents a shift of focus from the means, e.g. infrastructures and their performance, to the ends: the fulfilment of people's expectations (Silva, 2013). Accessibility involves a person-centred planning view: thinking in terms of accessibility represents a way of thinking in terms of people and individuals rather than on traffic. Furthermore, a focus on urban accessibility gives a further contribution towards a problem solving approach to urban form and mobility in contemporary towns.

For all these reasons, accessibility is a key concept within the People Friendly city vision (Tiboni and Rossetti, 2014). And Busi (2013) argues that researchers and urban planners should have in mind that the final aim of mobility is reaching the final destination, possibly in an easy and pleasant way.
People's daily lives are made up of a growing diversity of activities and locations, and mobility holds all of this together. People live in one place, work in a second, and shop, care for another person or seek entertainment in another (Bertolini, 2012). But, in Busi's opinion «the city and the land are too often designed in such a way as to prevent them being used easily and calmly by the most vulnerable citizens. The city is therefore seen by them to be inaccessible and even hostile» (Busi, 2009).
According to Tira (1999), accessibility means that the use of a space is guaranteed for everybody. Therefore, land uses, public spaces, facilities and residential areas should be planned and designed considering the possibility to be reached, and considering the different modes of transport.
This is why, in the friendly city, accessibility is strongly related to multi modality and to the concept of the "chain model" of movements: according to this model, door to door mobility (e.g. from house to workplace or to desired activity) goes through a combination of different modes, with the pedestrian movement always in odd number position (Busi, 2013; Busi, 2011). The final aim of the chain is to guarantee access to the final destination; therefore each ring in the chain should work properly, starting from pedestrian movements.

3. Developing an algorithm to assess pedestrian travel times

The crucial role of GIS-based analysis to assess and manage accessibility issues in nowadays established, at least within the scientific community. Arguably, the dependence on GIS techniques for accessibility analysis has significantly risen in the last decade (see, i.a., Delamater et al., 2012; Hull, Silva and Bertolini, 2012; Bonotti *et al.*, 2015;). GIS programs are well-known in the scientific literature for their capapibility to analyse, model and visualise geographical data. Furtherore, a GIS map can incorporate many and various layers of information that are associated to a geographical database, and that can be displayed in innovative ways (Wu & Hine, 2003).
But how is it possible to measure the level of pedestrian accessibility of a given territory and to map the results in a GIS environment? This section describes a methodology to assess pedestrian travel times starting from a land use georeferenced database.
First of all, there is a need to collect the different layers of information related to pedestrian mobility for the area, with particular reference to the road network, the location of pedestrian paths and sidewalks as well as the presence of physical barriers in the area that impede pedestrian permeability (built environments, railways, waterways surfaces...).
Then, the proposed assessment methodology bases on the detailed discretization of the area being analyzed in a uniform grid of cells. In this grid a calculation algorithm is applied. This algorithm, on the basis of the information layers that overlap in each cell, assigns each cell a pedestrian travel time and evaluates the existing connections between the cell in question, and the cells adjacent to it. This model allows the creation of thematic maps that show the timing of pedestrian access to each cell. But how does the model work?
The model is based on a uniform grid of squared cells, interconnected according to the following scheme: from the X cell it is possible to move to cells 1, 2, 3 and 4. The crossing time is an attribute of each cell, and can be modified as needed.

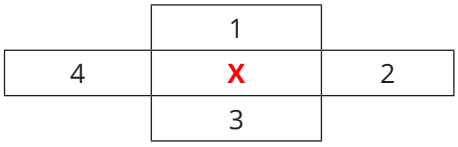

Figure 3 – A scheme of the grid that compose the proposed model.

The mathematical algorithm determines the time needed to reach each cell of the matrix, starting from an assigned cell, and determining the path with the shortest travel time. The algorithm is used to search for access time to the destination cell, and bases on a group of recursive algorithms known as 'Backtracking algorithms' (Wirth, 1976), widely applied within the Information Sciences to solve optimization problems. The method applies a kind of floodfill starting from the destination cell and following a backwards path, and tracing the total time as a strategy to exit the recursive procedure.
The elementary recursive procedure is reported in the following script. The series of four recursive controls indicates the order of possible links for each cell (figure 2). However the links can be applied also using other processes, e.g. by implementing a base matrix for the links made by 9 cells, and using a penalized time of √2 along the diagonals.

```
procedure TryNext(i,j:integer;TotalTime:real);
begin
 if Matrix[i,j].time> TotalTime then
   begin
    Matrix[i,j].tempo:= TotalTime;
    if i>1  then TryNext(i-1,j,TotalTime+Matrix[i,j].CrossingTime);
    if j<ny then TryNext(i,j+1,TotalTime+Matrix[i,j].CrossingTime);
    if i<nx then TryNext(i+1,j,TotalTime+Matrix[i,j].CrossingTime);
    if j>1  then TryNext(i,j-1,TotalTime+Matrix[i,j].CrossingTime);
   end;
end;
```

Furthermore, the algorithm can be generalized by the creation of 'virtual links' among two different cells outside the base matrix, even far from each other. Those virtual links can be applied to model public transport links between two cells, as shown in figure 4.

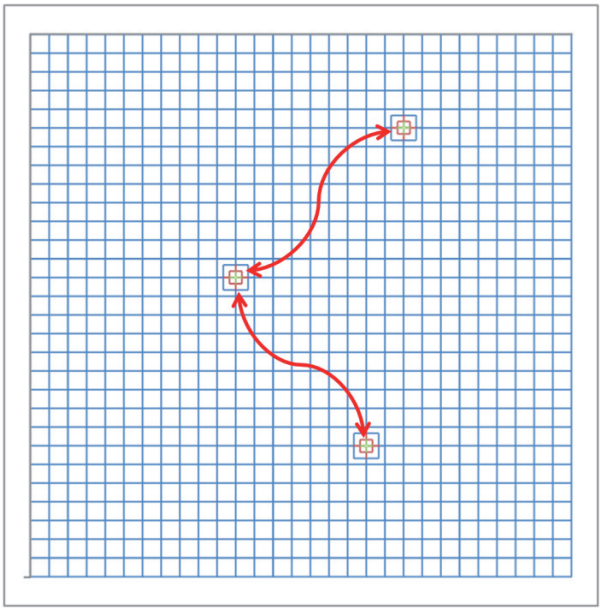

Figure 4 – How 'virtual links' among cells work.

Grid dimensions can be theoretically unlimited, but maximum dimensions of 2000x2000 cells are recommended. In this latter case, computation times are approximately 15 minutes.
The firsts simulations of the model were run on a 20x20 grid, and led to the results shown in the following figures (figures 5, 6, 7), in which the red dot indicates the starting point of the computation and the numbers express the travel time to reach the dot in minutes.

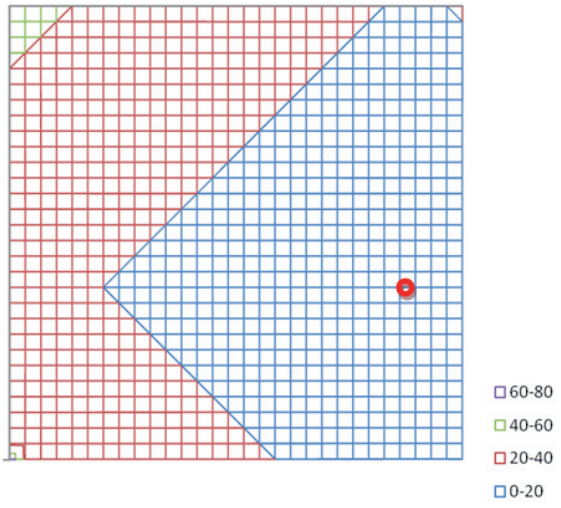

Figure 5 – First simulation. Uniform matrix (with no obstacles).

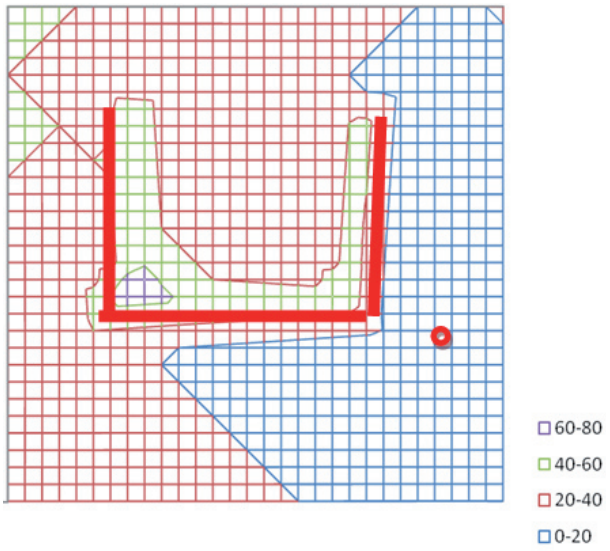

Figure 6 – Second simulation. The matrix has a U-shaped obstacle (e.g. a building), without permeability at all.

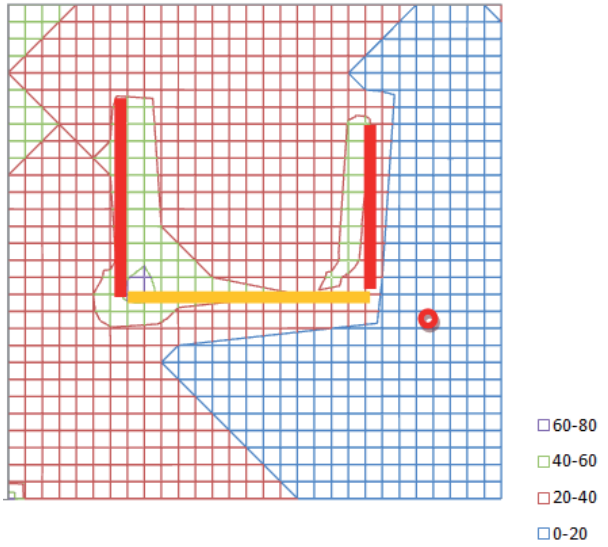

Figure 7 – Third simulation. The matrix has a U-shaped obstacle (e.g. a building), with a reduced permeability.

4. A pilot application of the methodology: the case study of San Polo district in Brescia

To test the proposed methodology, a first application on a real case study was performed. The chosen pilot area is the neighborhood of San Polo, in the outskirts of Brescia, a middle-sized city in the North of Italy. San Polo is a district that was built in the '80s on a design by the architect Leonardo Benevolo. The whole district today counts approximately 20,000 inhabitants, and is composed by medium to high-density buildings, mainly subsidized housing.
First of all, georeferenced data for the district were collected.

Those mainly include the boundaries of the neighborhood as defined by the municipality, the topographical database and a land use shapefile (figure 8).

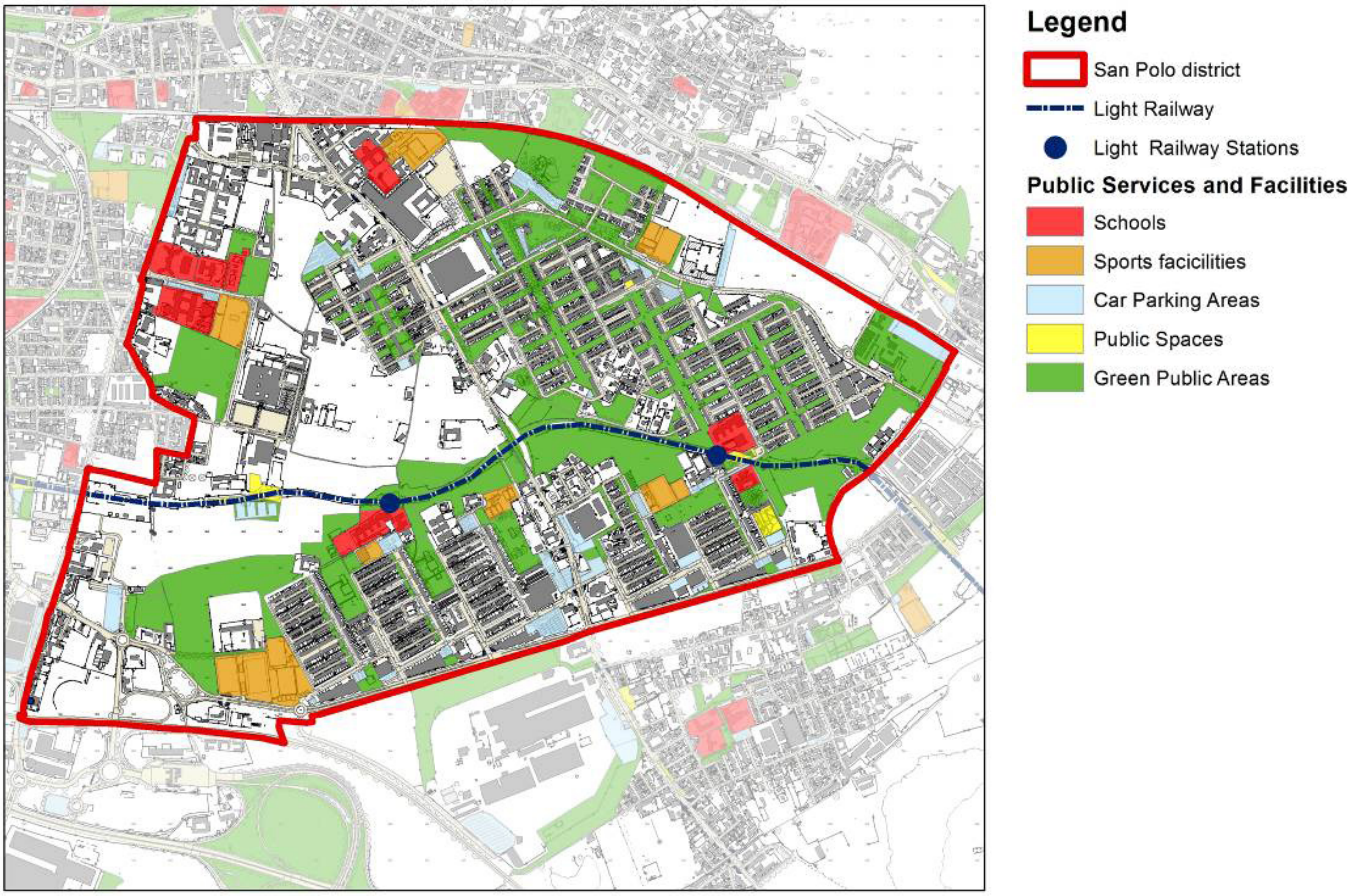

Figure 8 – A map of San Polo district containing the topographical database and the land uses.

Then, a discretization of the territory was built through a uniform matrix of cell. The grid for San Polo was created using the ET-Geowizard tool, a free extension of the ArcGIS software. The Vector grid tool of the ET-Geowizard automatically creates a polyline or polygon vector grid using user defined extents and cell size. In this case, a polygonal shapefile was created, using the boundaries of San Polo district as extents and a cell size of 10x10 m. The result consists in a rectangular grid of 74,259 cells, covering an area of 742.59 hectares of land. In the attribute table of the vector grid, the ET-Geowizard tool creates two types of Identifiers for each record: a field named 'ET_ID' containing the identification number of each cell, and a field named 'ET_Index' that contains the field and the record of the cell in the matrix. This is a crucial field, because it makes possible the link between the shapefile and the computation algorithm.

To each cell of the grid a crossing time was assigned according to the following table (table 1), that consider the possible land uses of each cell. Crossing speeds were chosen considering an average walking speed of 3 km/h (the speed that a child usually walks). A slower speed was chosen for parks and green areas due to curvier paths. However, those speeds can be changed and chosen in cooperation with decision makers.

With reference to table 1, a field was added to the attribute table of the matrix and filled in with the crossing time assigned to each cell. Then, the table was exported in ASCII format to run the algorithm.

For this case study, two destination points were chosen: the two light metro stations that are located in San Polo (*San Polo* and *San Polo Parco* stations). The two cells in the grid that are located on the stations were detected and chosen as starting points to run the algorithm. The results of the algorithm, e.g. the attribute table of the grid with a new field containing travel times from every cell to the destination point, were then reconverted to a shapefile, by joining the resulting table in ASCII format with the vector grid using as common field the ET_index.

The algorithm was run twice: the first time using as starting point *San Polo Parco* light metro station, and the second time using *San Polo* metro station. The results are shown in the following figures (figure 10 and figure 11), where travel times are expressed in minutes.

Table 1 – Pedestrian crossing speed and times assigned to each cell of the district with reference to the land use of the cell.

Land use	Crossing speed	Crossing time
Roads	3 km/h	Cell size/crossing speed
Public spaces	3 km/h	Cell size/crossing speed
Parks and Green areas	2 km/h	Cell size/crossing speed
Obstacles (buildings, railways, water surfaces, …)	0 km/h	Very long (endless)

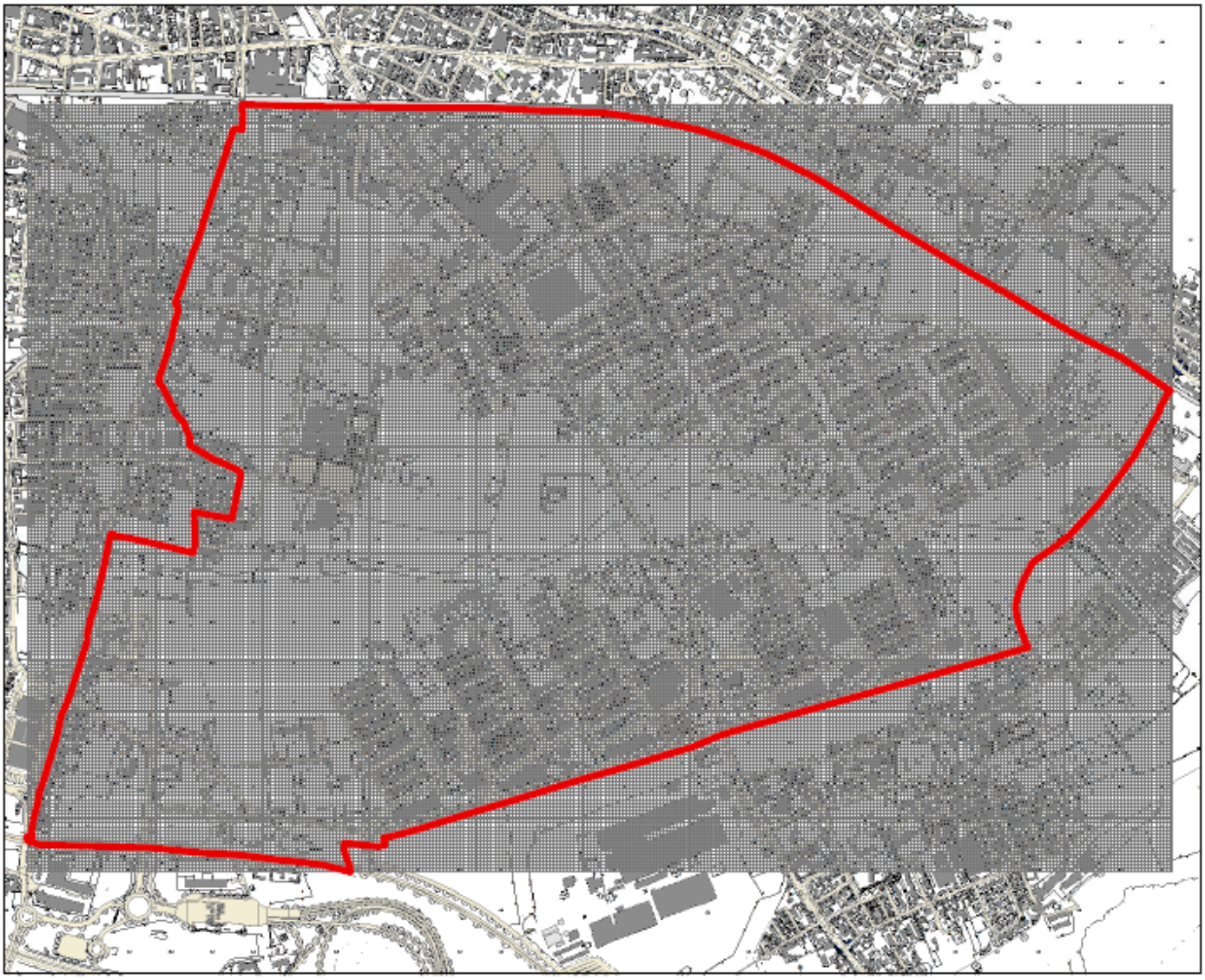

Figure 9 – The vector grid created for San Polo.

Finally, for each cell of the grid, the minimum between the two travel times to reach the stations was calculated, and the results are shown in figure 12. Therefore, figure 12 highlights travel times from each point of San Polo district to the closest light metro station.

5. Further developments and final remarks

The paper presented a tool to assess the pedestrian travel times to public services and facilities. Those times, according to the Organic Urban Planning vision, plays a crucial role at the scale of the neighbourhood, where pedestrian mobility should be encouraged and access to services and facilities should take place preferably by foot.

At the moment, an improvement of the tool is under development, with the aim to consider the public transport use as complementary to pedestrian movement. Therefore, the computation algorithm can include space-temporal tunnels at public transport nodes (metro stations, bus stops…). Those tunnels work as virtual links among cells that are far from each other, and are characterized by a travel time equal to

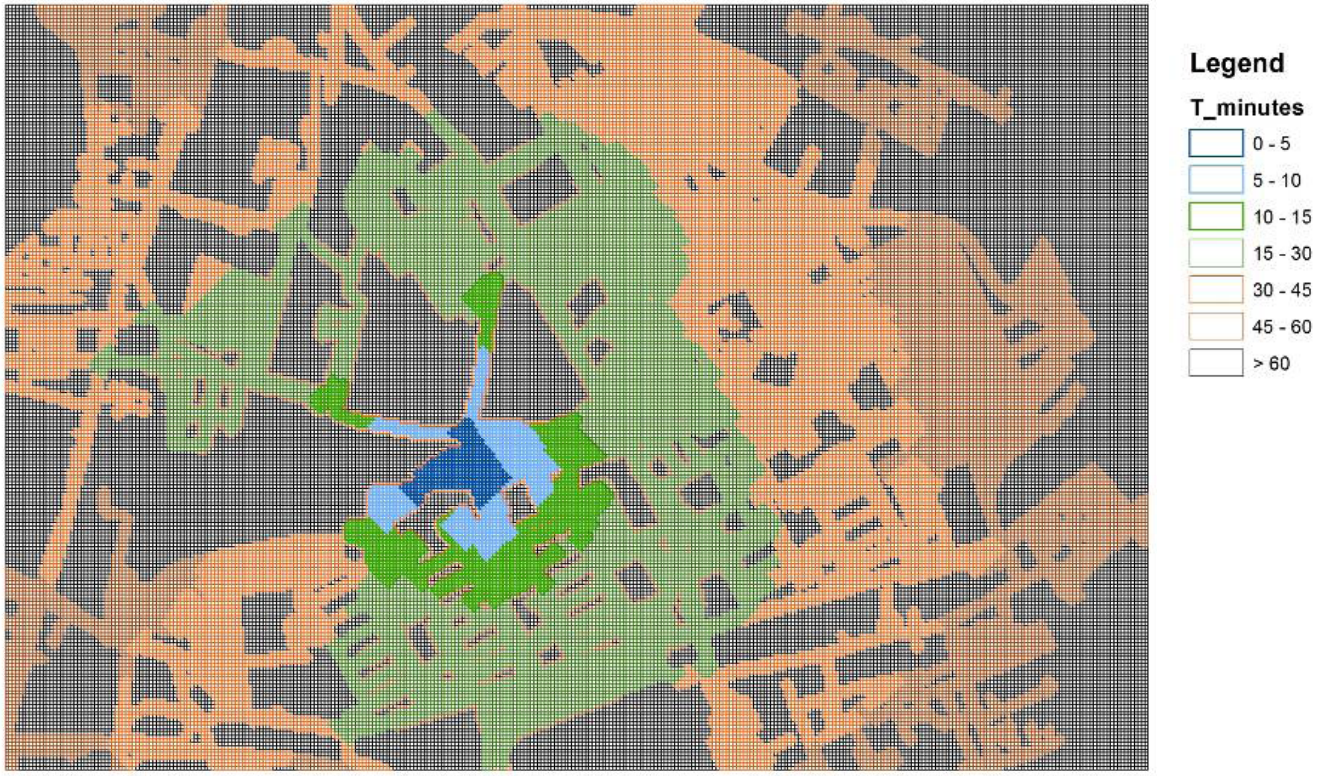

Figure 10 – Pedestrian travel times [minutes] to reach San Polo Parco light metro station.

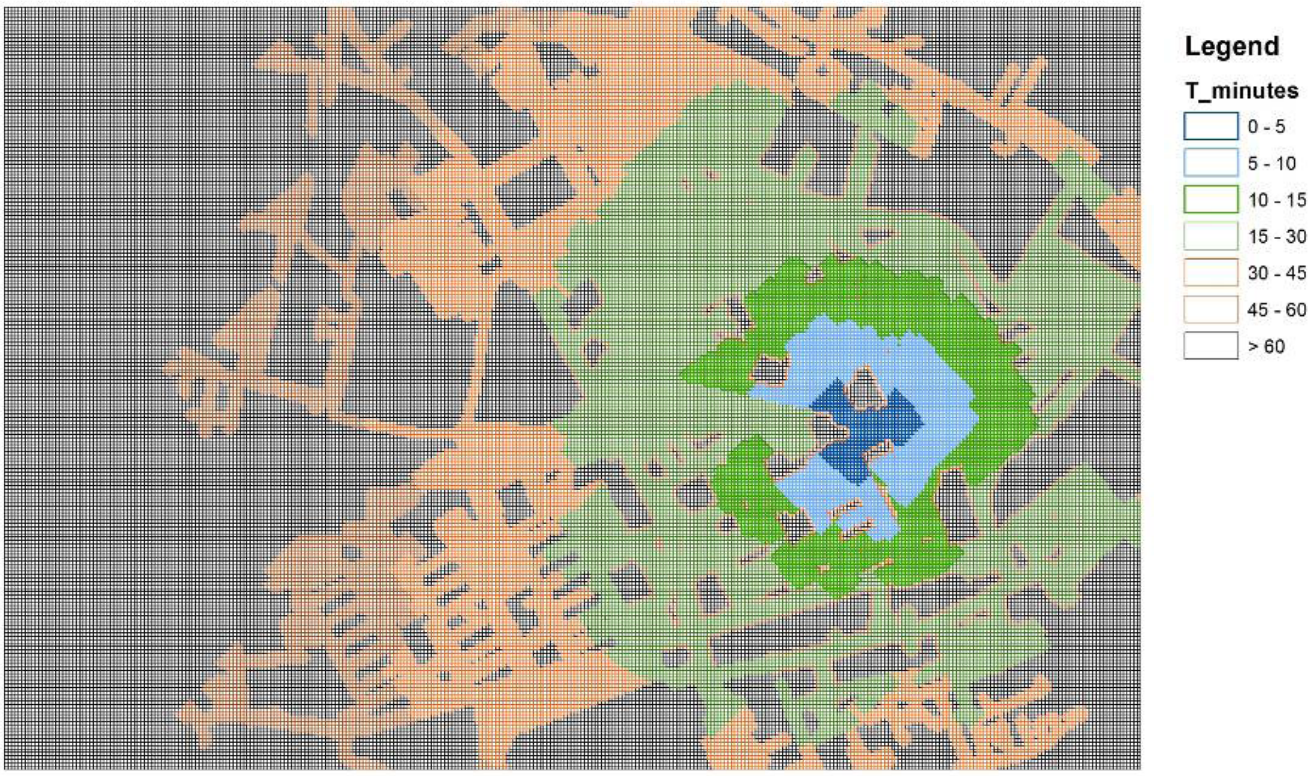

Figure 11 – Pedestrian travel times [minutes] to reach San Polo light metro station.

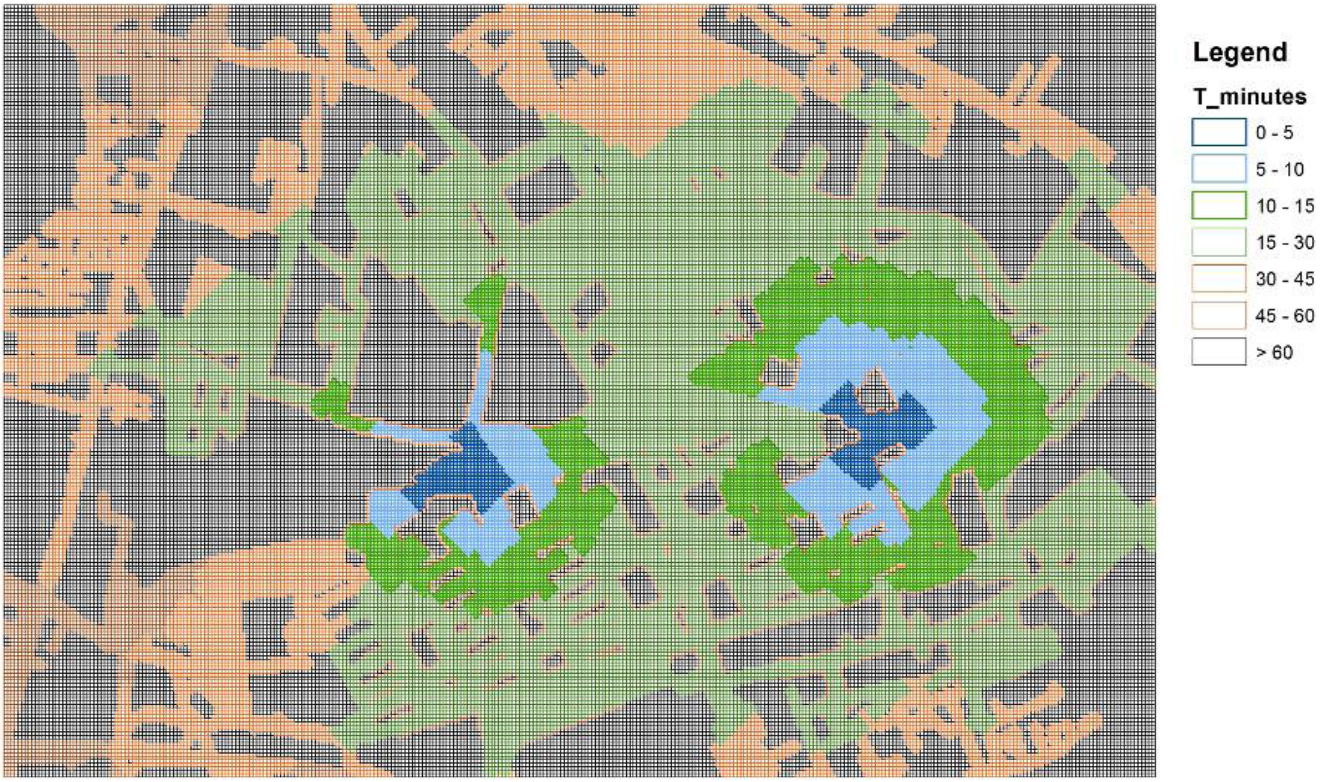

Figure 12 – Minimum pedestrian travel times [minutes] to reach one of the two light metro stations.

public transport travel times, including average waiting times at the public transport stops. The methodology can be used to study ex-ante the accessibility improvements that the introduction of new public transport lines, or their modification, can have on the territory.

Furthermore, a further development of the tool can also take into account the spatial distribution of the population. If the population is georeferenced, the attribute 'population density' or 'number of residents' could be assigned to each cell, and could be used as a weight in the computation process.

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Cycling as best practice for urban renovation. Study case: The city of Genoa

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Keywords: Cycling, renovation, best practice

Abstract[1]

This paper analysis urban cycling as a fundamental element of sustainable mobility. There are many International examples that clearly show how is possible to evolve modern cities into more livable spaces promoting cycling as a dayli way of trasport. Italy has to learn from other European experiences to ensure a better quality of life to its citizens and to renovate its urban configuration. The authors present different solutions that can be undertaken to boost cycling in Genoa. Several recommendations are reported to do a correct Sustainable Urban Mobility Plan where cycling have to be considered as well as the other mean of transport becoming an essential element for urban development and renovation.

1. Cycling as best practice

The developing world is rapidly urbanizing and urban mobility it's become a global challenge. Transports and mobility are fundamental for every kind of urban policy; they are related to all territorial ambits and scales. Key issues of urban mobility are: free-flowing and greener towns and cities (lees air pollution, noise,...), smarter urban mobility and urban transport which is accessible, safe and secure for all citizens. Urban mobility impacts not only the health and wellbeing of urban residents, but it's also capital for economic productivity (traffic congestion management,...), energy efficiency and environmental preservation of urban areas.

This paper analysis urban cycling as a fundamental element of sustainable mobility, a form of mobility that is sustainable, energy-efficient and respectful of the environment. Sustainable mobility achieves the main goals of mobility and safety, but also cares about many other important issues facing environmental, economic and social problems. This kind of mobility seeks to improve public health, preserve natural resources, support energy security, developing green economy sectors and providing mobility to disadvantaged people. "Sustainable mobility provides an alternative paradigm within which to investigate the complexity of cities, and to strengthen the links between land use and transport. The city is the most sustainable urban form and it has to provide the location where most (70–80%) of the world's population will live" (Banister, 2008).

A correct Sustainable Urban Mobility Plan (SUMP)[2] has to integrate urban mobility into extra-urban transport, encouraging a shift toward more sustainable modes as public transport, cycling or walking. A SUMP takes into consideration all the possible interactions between different problems, always keeping in mind the components (environmental, economic and social) of sustainability. Planning for urban transport future must take the citizens as the focus: as travelers, as business people, as consumers, as customers,... Last but not least a Sustainable Urban Mobility Plan as to consider cycling as a daily way of transport not only an hobby. Cycling can have many advantages as a short-distance means of travel in urban areas: it is environmentally friendly – without emissions and noise nuisance; provides cost-effective mobility and offers an opportunity for health and physical fitness by regular exercise. Bicycles are the ideal form of transport for distances up to five kilometers, so considering that 10% of car journeys are shorter than a kilometer, 30% are shorter than three kilometers and 50% are shorter than five kilometers it's possible to understand cycling potentiality.

"Academic research has also boomed in recent years, with a vast increase in research and publication on all aspects of cycling" (Buehler, Pucher, 2012). The authors analyzed different International best practices about cycling to capitalize and disseminate these experiences to other Italian realities, in particular the case of Genoa has been studied. Different aspects of cycling has been considered: daily travels (home to work travel), cycle lane planning, calm traffic actions and different interventions to promote and to increase cycling.

Bicycles utilization varies widely, whereas bicycles account

1. Francesca Pirlone wrote the first chapter "Cycling as best practice" and the last one "Cycling proposals and recommendation for the city of Genoa". The described researches in the last chapter are undertaken inside the Urban Planning classes of the Department of Civil, Chemical and Environmental Engineering (years 2012/13 – 2013/14) of which Francesca Pirlone is the charged professor.
Selena Candia wrote the second chapter "How Cycling could contribute to city renovation – International good practices" and the third one "Study case: the city of Genoa".

2. European Commission, Directorate-General for Mobility and Transport, Guidelines Developing and implementing a sustainable urban mobility plan, Brussels 2013.

for 27% of total mileage in the Netherlands, where the average distance cycled per inhabitant in a year exceeds 1 000 kilometers, far less use is made of bicycles in most other countries with similar geographical and economic conditions. Nevertheless cycling can be considered one of the best practice in sustainable transport in conformity with the general best practice definition a method or technique that has consistently shown results superior to those achieved with other means. Indeed cycling benefits generally surpass the benefits related to other mean of transport: frequent use of the bicycle is a very good way to have regular physical activity, cycling doesn't contribute to air pollution and doesn't produce any noise. The adoption of cycling can also have significant impact in mitigating a variety of the costs associated both with the usage of public and private transportation methods. These costs are related to time, congestion, vehicle operating expenses and health. But if the benefits of cycling are many the relative cost are not so high in comparison to other mean of transport: 1km of Motorway/Road costs the equivalent of 110 kms of bikeway and 1km of Bus way costs the equivalent of 138 kms of bikeway.

Of primary importance to transfer a best practice from a city to another, it's to ensure that the context from which the practice is derived is comparable to the context in which it will be applied. External conditions have to include advantageous or disadvantageous political and economic conditions, social drivers or inhibitors, citizens habits,... So it's necessary to choose the best correction factors to use. One of this factors that mainly influences cycling success is the diffusion of a cycling culture between both citizens. Also the presence or the absence of a strong political commitment could strongly influence cycling diffusion.

Cycle cities are the future and cycling could be the catalyst for a 21st Century urban renovation. Italy has to learn from other European experiences to ensure a better quality of life to its citizens and to renovate its urban configuration.

2. How Cycling could contribute to city renovation. International good practices

There are many International examples that clearly show how is possible to evolve modern cities into more livable spaces. "A growing number of policy experts, urban planners, and transportation experts are concerned that we have built our communities so it is difficult, and in many cases dangerous, to walk or bike and have thus engineered physical activity out of our daily lives. Approaches to urban design termed Smart Growth and New Urbanism have emerged in response to the need to improve air quality, solve traffic congestion, and promote better overall quality of life" (Saelens et al., 2003). It's possible to tackle the overwhelming challenges of this urban age supporting sustainable development and bicycles are key actors to plan future liveable cities. Cycling holds an unique transformative influence for cities, playing an active role in sustainable urbanism and development. The bicycle has not to be used as a gap-filler but as an element for the success of urban development: bicycles are a transformative tool to bring human scale back into towns. The misuse of modern urban space is partially caused by cars, they consume enormous resources and are impacting on the environment. Pollution constitutes not only a threat to the historic heritage but is above all a health danger through both atmospheric pollution and noise. It must be also considered the economic cost of traffic jams that has now reached critical proportions. Different studies show that traffic congestion costs Europe about 1% of Gross Domestic Product (GDP) every year. Even if the bicycle is not the only solution to traffic and environmental problems in towns, it represents a solution which fits perfectly into any general policy which seeks to re-enhance the urban environment and improve the quality of a town and it mobilizes comparatively few financial resources. By combining measures to promote cycling and public transport, towns can succeed in lowering the car use rate and every day many European cities demonstrate that a reduction in the use of private cars is not just desirable but feasible. Amsterdam, Barcelona, Bremen, Copenhagen, Edinburgh, Ferrara, Graz and Strasbourg apply incentives that favor public transport, car-sharing and bicycles, along with restrictive measures on the use of private cars in town centers. These cities do not harm their economic growth or access to their shopping centers. In fact, they promote them because they understand that uncontrolled use of cars for individual journeys is no longer compatible with easy mobility for the majority of citizens. It's also important to remember that bicyclists represent potential customers who can bring revenue into the community/city. And when a particular bicycling destination is so appealing to bicyclists that they will come from far away to enjoy it, the money they bring with them can be significant. More money stand for a richer city that can fund renovation projects becoming more and more appealing. How various cycling cultures across the globe can learn from each other? Here below are reported some best practices analyzed by this research as: Seville, Munich and Bordeaux. Each of this example is significant for a specific cycling aspect. Seville shows how a strong investment in cycling infrastructure could convince people to shift toward cycling; Munich example demonstrates the importance of a good cycling campaign and the importance of a widely integrated network; Bordeaux is a best practice for cycle tourism.

Seville, the capital of Andalucia in the far south of Spain, has become a good example for sustainable transport[3]. It is a liv-

3. Walker P., How Seville transformed itself into the cycling capital of

ing proof that any urban area can get lots of people on the bikes investing in cycling infrastructures providing safe lanes on which they can ride. Seville's success was so important and evident – the number of bike trips multiplied 11-fold in a few years – that municipal officials have just started extending the model to other cities in the region. The average number of bikes used daily in the city rose from just over 6,000 to more than 70,000. Seville also has a bike sharing system, like those in Paris and London, called SEVici, with 2,500 bikes and 250 docking stations. Before the lanes were built, Seville had about 10 bikes shops. Now it has around 50 multiplying economic benefits. The effect is also being felt in Seville's vital tourism industry. On Tripadvisor, the traveler-recommended places of attractions and activities in the city are always connected to bike tours.

Munich is planning to increase cycling levels with impressive investments above all in marketing to give the bicycle a higher status among the citizens[4]. A good campaign could really shift a significant number of people toward cycling and Munich is aware of that. The city already has good cycling infrastructures but continues planning for more. Almost the 20% of travels are made riding a bicycles and the 80% of the population own a bicycle. Munich is also a best practice for cycling integration with other means of transport. It's easy for its citizens to park their bicycles and take trains, trams, ... Moreover it's also for them possible to take the bicycle on public transport.

Bordeaux is the first cycling city of France with more than 200 km of cycling lane inside the city and 400 including the surrounding[5]. The city decided to boost soft urban transportation system – tram lines and cycling networks - since 2002 when it was listed as a UNESCO World Heritage Site. All these cycling lane kilometers are ideal for cycle tourists, that are more and more choosing Bordeaux for their journeys mixing sport with food and wine degustation. This growth of tourists, caused by cycle tourism, is very positive not only for city businesses but also for local product trade. Tourism development also encouraged city renovation.

3 Study case: the city of Genoa

Genoa is sixth largest city in Italy with a population of 594,904. it's one of Europe's largest cities on the Mediterranean Sea and the largest seaport in Italy. The city stretches along the coast for about 30 kilometers and its territory is extended between the Mediterranean sea and the Apennine. Genoa has a Mediterranean climate. The average yearly temperature is around 19 °C during the day and 13 °C at night. This

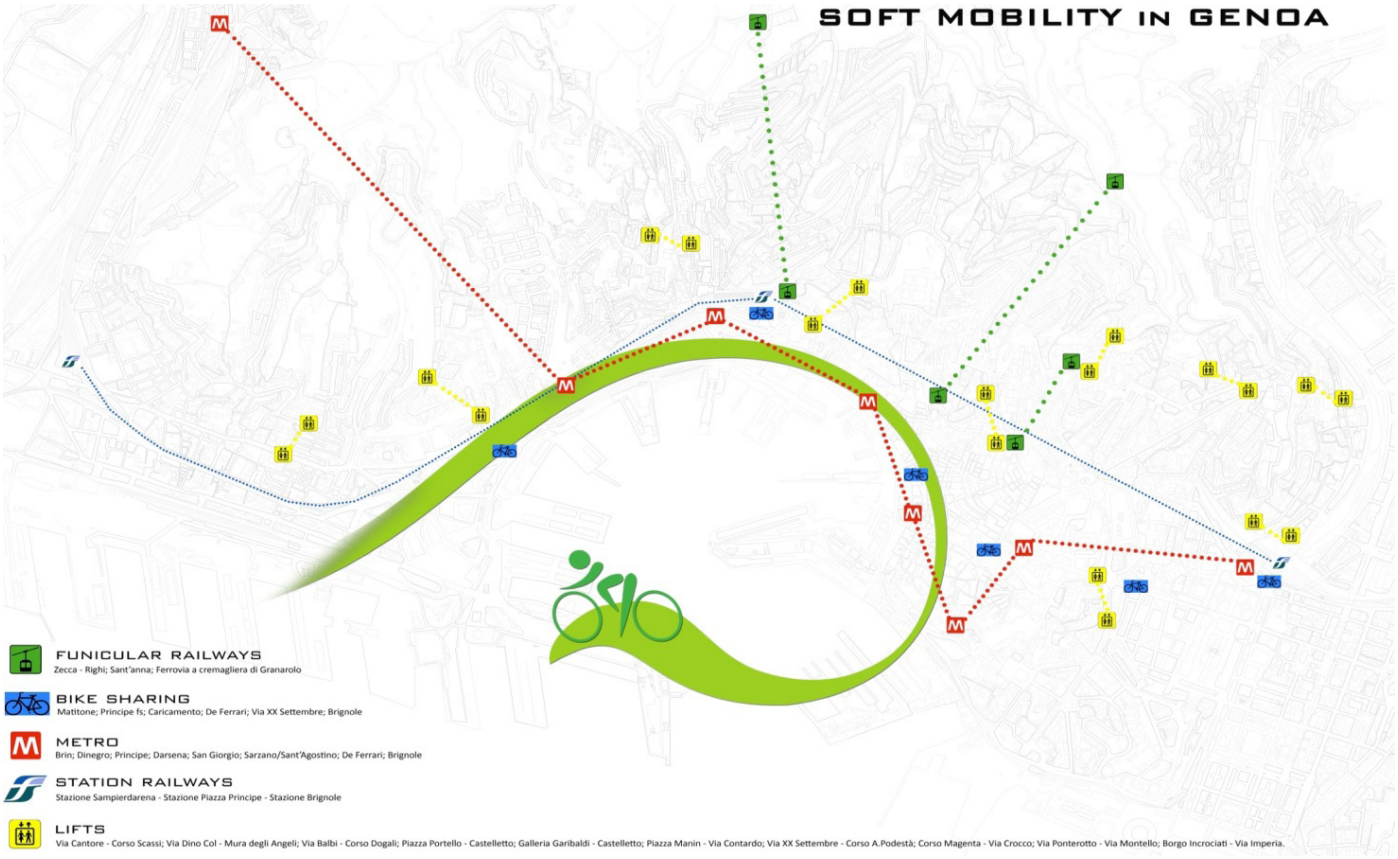


Figure 1 – Soft mobility in Genoa.

southern Europe, The Guardian 2015.

4. Copenhagenizeeu, The 20 Most Bike-Friendly Cities In The World, 2013.

climate is really optimum for cycling.
Genoa old town is a labyrinth of ancient lanes, palaces, medieval walls, turrets and bell towers. Streets here are very narrows, sometimes even only 1,50 meter larger. For this reason almost all the city center is a pedestrian zone; cars are not allowed to circulate inside almost everywhere. Bicycles instead can drive everywhere in the city center without restrictions. Genoa's territory is very hilly with a long flat costal road that links all the districts built on the hills. Others flat area are along the main torrents: Bisagno and Polcevera. For this reason in Genoa there are many electric bicycles, more than other European cities. The majority of Genoa's population chooses sustainable transport mainly walking and public transport but the levels of cycling are really low (see figure 2). A recent survey reported that cycling in Genoa is less than 1%, this level is particularly low even compared to other cities in Italy and Europe with similar geography and climate. This research investigates main factors that are limiting cycling in Genoa:

- streets have not been designed specifically to facilitate or encourage cycling. They are in fact narrow and due to the hilly terrain, characterized by steep inclines;
- slopes;
- lack of cycling infrastructures;
- lack of a real cycling culture;
- people from Genoa consider cycling dangerous.

Nevertheless in the last three years is more easy to find new bikers in Genoa. This is due to different reasons: cause to the global crisis is more difficult for people to maintain car cost (insurance, fuel, ...); people are more aware of environmental problems and bicycles are a very ecologic mean of transport; cycling culture is spreading around Europe. This demonstrates that with good cycling implementation plan is possible to enhance this positive trend of bikers' growth. It's very important to realize new infrastructures, safer lanes and promotion campaigns to boost people in favor of cycling. The 29% of cycling travels are made to go to work, the 23% for leisure, the 6% to go shopping and the 6% as an inter-modality way.

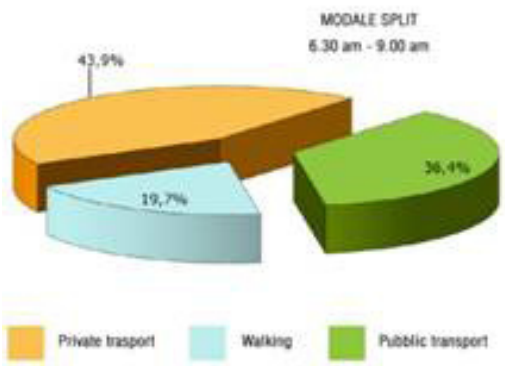


Figure 2 – Way of travel in Genoa. Source: Municipality of Genoa.

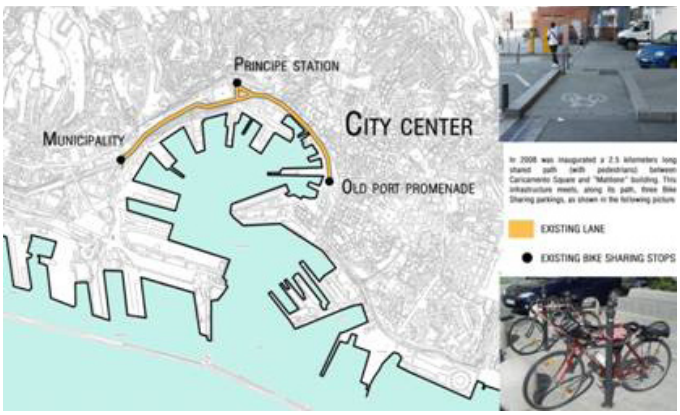


Figure 3 – Genoa's existing cycle lane.

The first bicycle lane in Genoa was inaugurated 2008 (see figure 3), but this infrastructure can't guarantee biker safety because it's only 2.5 kilometers of long shared path (with pedestrian). This infrastructure meets, along its path three bike sharing parking and it ends in the city center, where almost everywhere, cars are not allowed to enter. Genoa old town is a pedestrian area where bicycles can circulate but there is any specific signage for them. This lack of signage is very dangerous because could cause accidents between bicycles and pedestrians.
Different initiatives shows that people in Genoa are becoming aware about cycling benefits. For example with the initiative Bike to work, bikers organize their itinerary to go to work with other bikers, they meet each other on the street and then they ride together to the city center. This is possible thanks to a specific web site[5] where bikers can find their own itineraries. This system gets the way to work safer for bikers, because it's easy for a biker to be seen by cars if he rides in a compact group. Moreover each Bike to work group has a leader, an expert city biker who teaches to the other simply advises to survive in the traffic. Considering cycling as form of transport to go to work is one of the easiest ways to fit exercise into daily routine. It makes people save money and it is good for the environment.
In Genoa there is also a very small bike sharing system with four bike stations. Members receive a contactless membership card which allows them to unlock the bikes from the docking station and cycling around the city. The annual cost of this card is 40 €, with 5€ of recharge and 5€ of insurance. People have to pay an extra euro for each half an hour of riding except the first one. Data analyzed by the Municipality of Genoa show that the 40% of transfer using the bike sharing system, aren't done to go to work but for short occasional travels (for example to go shopping). This bike sharing system used for the first two years (2008-2010) electric bicycles. After that period all the electrical bikes were replaced with

5. http://www.adbgenova.it/bike2work

normal ones because different problems due to electric batteries (that were not so reliable) were verified. Public investments in cycling infrastructures are indispensable to support the use of bicycles. The Genoa experience shows that the lack of a wide cycling network and of a strong cycling policy prevent people from cycling. The general suggestion is "do it good or don't it at all" (Pascal, 2014).

4. Cycling proposals and recommendation for the city of Genoa

Different solutions can be undertaken to boost cycling in Genoa. The University of Genoa – Department of Civil, Chemical and Environmental Engineering – is analyzing best practices about Soft mobility and it is formulating new solutions and proposals[6].

As it's reported in the previous chapter cycling in Genoa has to face to several problems, such as slopes, intersections, safety, lack of a real cycling culture,... All these problems could be solved with a good cycling implementation plan. It's true that Genoa has many slopes but the majority of people live along the costal line or along the two main streams on the level ground. A cycle lane along the sea and these valleys could connect almost all Genoa's districts making people cycling in flats. To reach also the houses built on the mountains, the cycling implementation plan has to be integrated with other public transport systems as lifts, funiculars and buses in a correct Sustainable Urban Mobility Plan (SUMP). Other problems such as interactions and safety could be easily solved with different systems: colored cycle tracks, advanced stop lines and traffic signals. Colored cycle tracks have a physical separation between motorized traffic and cyclists, instead of a simple stripe and the place dedicated to cyclist is colored to make cycling lanes more visible; Advanced stop lines are marked box where cyclist can wait when traffic lights are red, they are place in front of motor vehicles making cyclists more visible to drivers while giving them a head start through the intersection when the lights turn green; Traffic Signals are signals dedicated to cyclists which facilitate the bicycle usage, they can manage and coordinate traffic (motorized and non-motorized) and increase safety. All these systems are used in many cycle cities such as Seville, Bordeaux, Munich,... and they could be considered as a best practice transferable to Genoa reality. The main problems in Genoa - according to this research - are related to policy makers' support and local culture. With a strong political commitment it's possible to achieve a correct SUMP giving to local people all the infrastructures that they need to ride safely. Local interest, thank to a cultural shift to cycling, could encourage policy makers to boost cycling. These two elements have to coexist to fulfill concrete results. In Genoa slopes and narrow streets are mentioned as an excuse by both policy makers and local people. It's easier to say that Genoa it's different from other towns, where cycling is largely used, instead of adopting a correct cycling implementation plan or changing local habits. Most of the major cycle cities have to face several problems connect to climate that are not present in Genoa where people can benefit from Mediterranean weather. A high quality network of cycle routes - along the sea and the two main stream - could connect people to the places they want to go to. Moreover it's possible to gain more space for cycle tracks making specific agreements with the Port Authority. In Genoa streets are not really huge to contain cycle lanes in both directions but along the cost, inside the port area, a lot of place is underutilized. Another solution could be to create mixed paths – pedestrian and cycling – in every district allowing motorized traffic only in the border streets.

Here below are reported tree project proposals that seek to renovate the city of Genoa towards cycling. These three ideas have to be considered as a part inside a general Sustainable Urban Mobility Plan as described above. The first project is about Genoa's inner city regeneration. Analyzing the existing interactions between all the possible means of transport inside the old town of Genoa it was possible to identify two main systems. The first one is an external path that surrounds the city center. According to this system is possible for people traveling by busses or cars to enter Genoa's old town. The second is a system composed by many narrow streets that form the historical urban tissue. This is accessible only on foot or by bike. The project aims to connect and integrate these two systems with a new one dedicated to bicycles. This cycle path strengths and enhances the connections between the city center and the rest of Genoa giving a central role to this part of town. The historic center of Genoa is a place to be explored and lived not only walking but also cycling by local city members and by tourists. Cycle tourism is a growing sector (see figure 4).

Cities have to consider it to attract more and more tourists. This is possible giving the right services (bike sharing, cycle lanes, parking for bicycles, interactive maps,..). The cycle path inside Genoa city center seeks to make the city more attractive and liveable. Touristic tours will be accessible for bikers and they would be allowed to drive from a place to another using also public transport as busses or trains. Public or private investors could be interested in funding such infrastructures to boost tourism because more tourists stand for more money and local economic growth for public (transport, museums, ...) and private (hotel, restaurants, ...)

6. These researches are undertaken inside the Urban Planning classes of the Department of Civil, Chemical and Environmental Engineering (years 2012/13 – 2013/14).

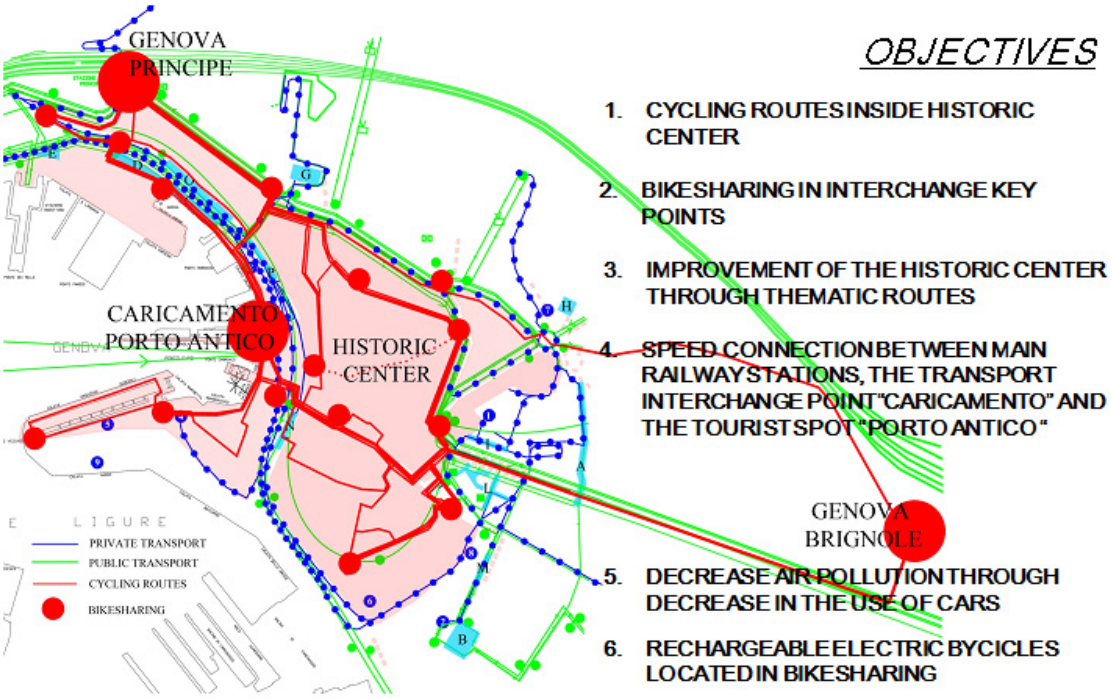


Figure 4 – Cycling inside Genoa old town: Objectives. First project proposal.

sectors. This project outlines different thematic zones and paths to better respond to tourist and city member needs. For example there is a thematic path that links all the historical monuments and museums. This path will be recognizable by a colored mark (see figure 5).

The second project, here reported, analyses Genoa's existing cycling lane highlighting its critical elements (obstacles, bumps, bus stops, crossroads,...see figures 6-7). For each of them the project proposes new solutions to obtain a cycling network without interruptions. Actually the spatial continuity isn't guarantee because the territory of Genoa is managed by two different Authorities: the Municipality and the Port Authority. This project create an unified cycle lane cooperating with both this Authorities. Moreover this new lane it's considered as a renovation element. Specific solutions will be undertaken to get the crossed part of town more liveable such as new gardens, benches and new trees will be planted to protect the pedestrian and cycling path.

The objective of the third project Monrail and cycle path is to understand and explore the complexity of one of city's internal valley – along the stream Bisagno -. In particular the public and private transport is analyzed. After a previous analysis about all the existent constraints according to local urban plans – PUC/ Genoa Local Plan, PUM/ Local Mobility Plan, it was possible to set real proposition to solve local traffic congestion problems. The solution is organized in two parts. One regards public transportation and foresees to create a new monorail service. The second wants to define a 4 km cycle lane. These infrastructures will renovate this part of town, developing local opportunities of growth. Moreover the project connects, in a soft way, four important sites: the local fair, the central railway line, the stadium and the main cemetery (see figures 8-9).

All these proposals show how cycling could be important for urban renovation not only for city centers but also for outside districts. Cycling could be seen as a catalyst factor for economic development and social inclusion. Cycling has many other benefits: it's a clean and economical way of transport and it's really healthy. All these examples prove the advantages of a sustainable urban transformation, but how is it possible to pass from idea to real? How is it possible to deeply transform/renovate modern towns starting from cycling? This paper found two key factors liming or facilitating cycling: Cycling Policy and Cycling Culture.

- Cycling Policy: Public Authorities have to boost cycling providing safe, accessible and convenient facilities and supporting, encouraging the use of bicycles. A good cycling policy has to produce cycling development plans – Master plans – and to guarantee a continuous cycling support even after police maker changings. A strong local commitment could also attract private investors. Municipalities are the initiator of the cycling investment but a key role can be play by private companies in exchange for advertisement. Many International examples[7] prove that a perfect balance between private and

7. The Barclays Cycle Hire (London, UK) is a good example of combination of public and private investment. Initiated by the municipal government the private investment involved is substantial: Barclays contributed 25 million pounds in exchange for being the name carrier of the prestigious project

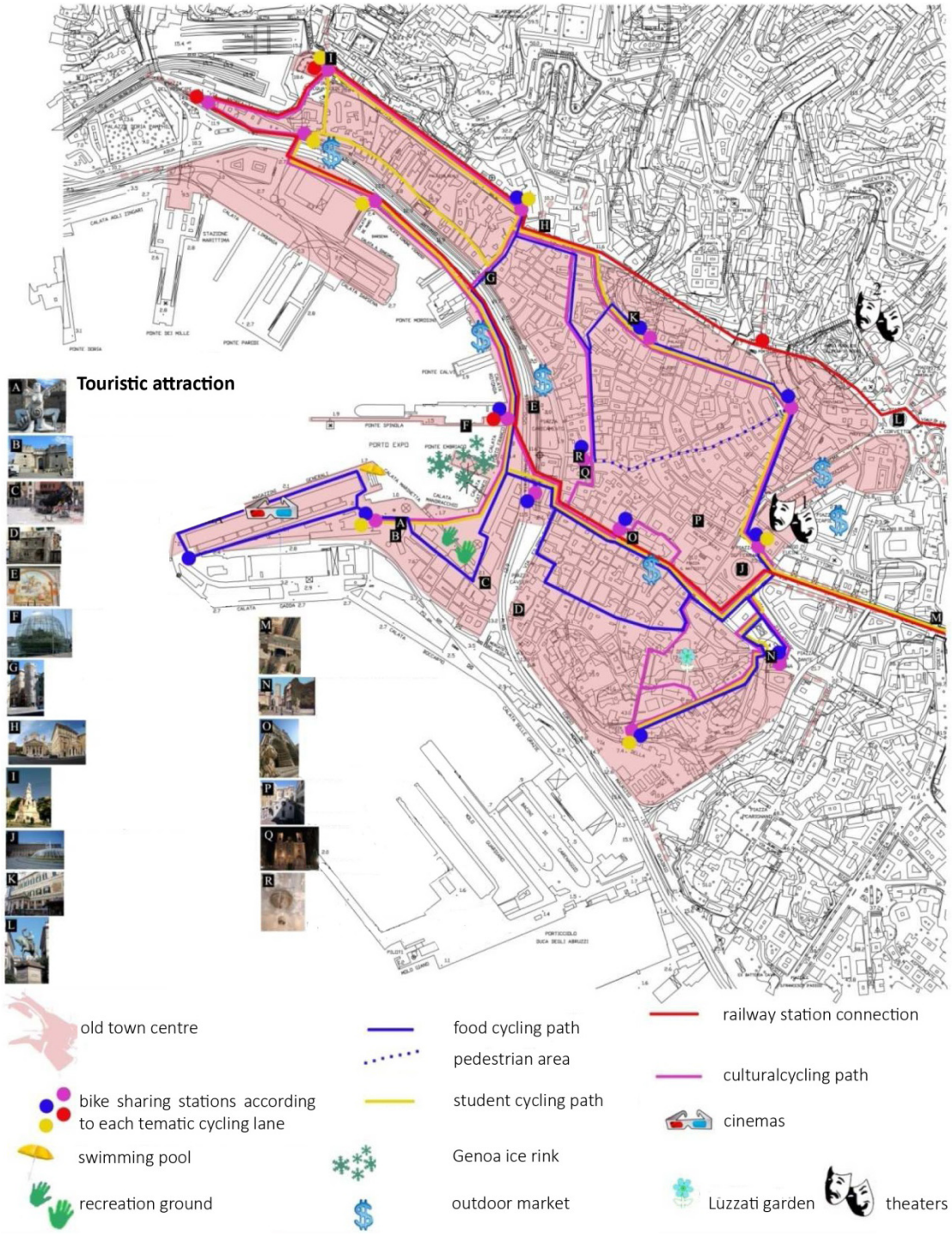
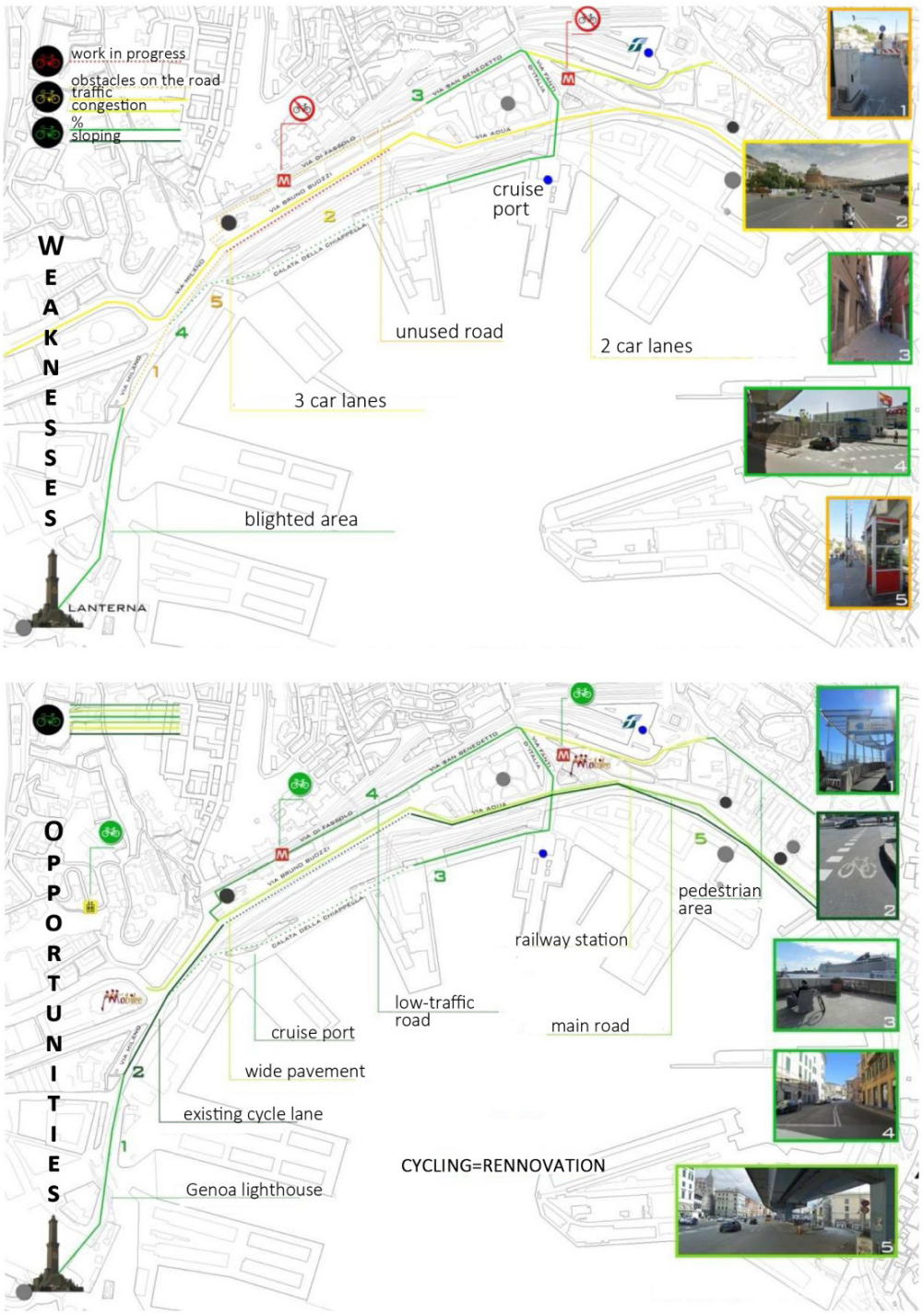


Figure 5 – Cycling inside Genoa old town: Master plan. First project proposal.

public investment could be reached. It's essential to integrate cycling policies with other policies addressing land use, environment and business. These policies have also to be coherent; this requires co-ordination among various levels of government and sectors, with input from cycling stakeholders – including national, regional and local governmental bodies, non-governmental organizations, cycling associations and the bicycle manufacturing industry. Regional and local Authorities are responsible for detailed cycling implementation plans; national Authorities commitment is essential in setting the best legal and financial framework to guarantee successful cycling initiatives. Unfortunately even if cycling can have many advantages cycling remains somewhat marginal in transport policy discussions in many Countries and national budgetary allocation reflects this status.

- Cycling Culture: Cycling policies and measures alone cannot assure the use of bicycles for urban travels. Bicycle use varies from city to city. While more than 50% of all trips are made by bicycle in some cities, cycling as a means of travel is almost non-existent in others. Behind these variations lie dif-



Figures 6-7 – Cycling as renovation: weaknesses, opportunities. Second project proposal.

ferent factors relating to the economy, topology, climate and culture. But it's this last category to really influence cycling because it's possible to see people cycling in country with really adverse weather condition as Denmark and cycling could be equally diffuse in poor or rich countries. Of primary importance it's to establish a culture which favors the increased use of bicycles for all age groups promoting cycling as an healthy way to travel. The UK National Cycling Strategy explicitly refers to Culture shift - changing attitudes. The aim of this plan is to raise the status and awareness of cycling amongst transport providers, service providers and employers as well as potential cyclists and other road users. To do that a specific communication programme has been set. This culture shift wants to spread the message that cycling is a practical, safe and enjoyable form of daily transport and the communication program has to generate a culture change for cycling. After few years from the UK National Strategy adoption more and more people use their bicycles, especially for local trips. Moreover different investment in cycling infrastructures provided safer conditions on the road and a critical mass of cyclists was

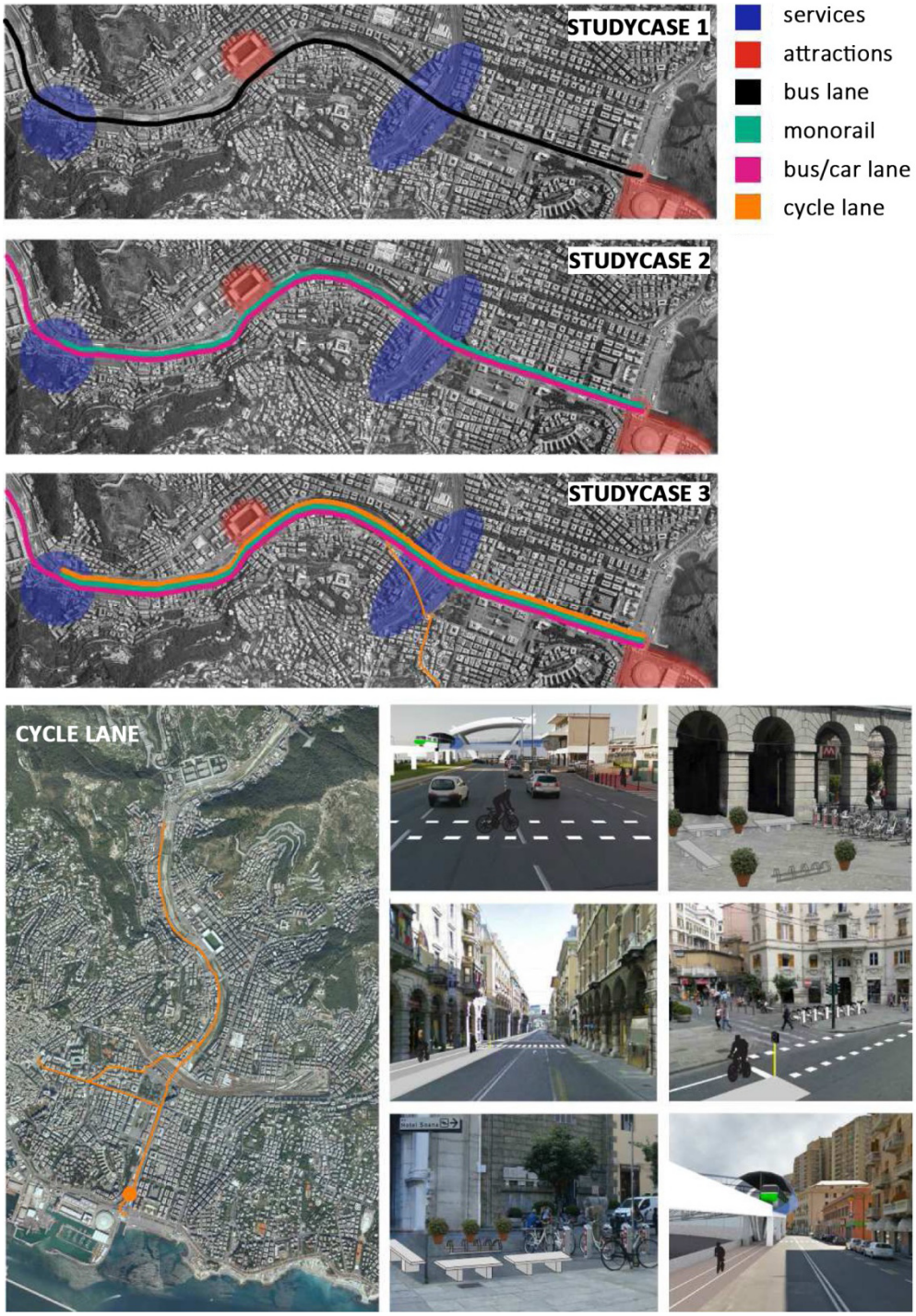


Figure 8-9 – Monorail and cycle path: study cases and rendering. Third project proposal.

encouraged. Then cycling feeds on its success making streets safer and cleaner for everyone.

There are real and perceived barriers that obstacle urban cycling – with the exception of a few countries –. Real barriers are caused by the lack of infrastructures and so by the absence of a good cycling policy; perceived barriers depend on the presence or not of a widespread cycling culture. Local Authorities have to be aware about the key factors above mentioned when they decide to boost cycling as a daily way of transport. These recommendations are also fundamental to do a correct Sustainable Urban Mobility Plan where cycling have to be considered as well as the other mean of transport becoming an essential element for urban development and renovation.

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Environmental design

Micro-urbanism and identity. Case study_Bucharest, the city as palimpsest

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Keywords: Palimpsest, urban fragment, identity, micro-urbanism, urban acupuncture

Abstract

Bucharest, a palimpsest city composed of all its historical stages, starting with natural writings and erasures of urban text til rough displacements, is currently the witness of rapid changes that often leave gaps in the urban structure. In this process the public space becomes most affected, because an arbitrary intervention of the post-communist period fails to mediate the relationship between public and private. A central theme of contemporary Romanian society is the loss of a sense of belonging to a community, primarily due to ambiguous relations established between historical and everyday reality.

*As Stefan Ghenciulescu noticed in his article "*Unpublic.Urban Space in Bucharest after 1989", (...) islands of order, cleanliness and even luxury exist close to vacant deserted places. Public domain has become a battleground of interests and insignia. There are still existing rules but they are often bypassed or ignored. There is not an empty field but does not seem to be part of a coherent system. Therefore I think we can talk about city territory as an archipelago of private spaces.[1] *In this context, the article aims to draw attention to an acute current issue. The emergence of discontinuities in the city structure creates the tendency of using space for a different purpose than the initial one, reaching a point where the mediation between social and urban space occurs.*

The project is part of a series of urban interventions-proposals on urban level that identify waste sites, vague areas, along with the community tendency to appropriate them. This type of local-scale interventions, without having a permanent character, represents a socio-urban hybrid that turns a local tendency into a temporary occupancy vision of space, based on its dominant character. The study objective is to identify an intervention strategy that respects the spirit of place, and in the same time that will identify the fragments along with their own identity and write a new layer filling in the urban tissue. Thus, the urban tissue is handed back to the inhabitants through a punctual intervention, a strategy in which the process in itself becomes the most significant element of urban cohesion.

First approach

Nowadays, in the way of approaching (expressions of survival public feelings) there are a lot of examples showing how residual space could be occupied. Many of these examples show up as temporay structures. Turning privat spaces (left already residual) in spaces belonging to community is a society act, a mediation between public and privat relationships. A short walk on the streets of Bucharest, you will soon notice the presence of these residual spaces. The article intends to describe a case-sample belonging to the historical center (Calea Mosilor) as part of a process of *vague spaces* temporarly requalifications. First, the residual spaces will be identified (together with their situation/status) and after they will be reactivated as part of the community through a series of steps that involves both urban and social levels. *The invisible conflict caused by historical convulsions generates periodically urban form and architectural expression.*[2]

Case study_Bucharest

In its urban history, Bucharest can be seen from two perspectives - on the one hand as a palimpsest city, which suffered in the same time natural evolutive transformation, and serious political will insertions, brutal erasures and unnatural re-writings, and on the other hand as juxtaposition of urban fragments with their own identity as a result of specific urban evolution. The lecture of the city on different levels is influenced by the heterogeneity of composition - layers are overlapping, gathering, displace or replace each other. In the case of Bucharest, the overlaying is visible both on the level of successive writings and on the level of juxtaposition – of the spatial co-presence of writings.

Thus we have two types of urban reading – a reading of overlapping layers and a reading that regards urban fragments defined as typology and identity. In most cases, for reasons of historical evolution due to natural or violent deletions, at the intersection of these fragments or even within the same fragment appeared "ambiguous" areas that need to be reconnected to the urban fabric. In this context, the question that arises is what type of urban intervention is needed for giving quality to the space and respecting *the spirit of place*. The new layer that is writing is required to consider both the

1. Stefan Ghenciulescu - *Nepublic. Spatiul uban in Bucuresti dupa 1989* in StudioBasar – Evacuarea fantomei, Visual Introspection Center, Bucharest 2010, p. 177.

2. StudioBasar – *Evacuarea fantomei,* Visual Introspection Center, Bucharest 2010

existing layers of urban palimpsest and the identity of the parts. Thus what we considered to be a suitable intervention strategy for this complex urban situation is the intervention at local scale, the micro-urbanity or urban acupuncture, which takes into account the witness-layers and respects the identity of the fragments.

The research is conducted on two levels – a discussion about the evolution of historical layers – the layers are overlapping, are joining, displacing or replacing each other, along with the city seen as a juxtaposition of fragments that together lead to the identification of an intervention strategy based on process and not on the final object, a strategy that identifies problem-areas and propose local interventions of urban requalification.

The concept of palimpsest

Tha concept of *palimpsest* is in the first place a concept that belongs to the field of writing and which, applied to the city, brings to the fore the size of reading the historical overlaying. Palimpsest involves a number of identifiable spatial and temporal moments - writing, erasing and re-writing - which can be seen in several ways: the proper meaning of the concept designates the re-used parchment that maintains traces of previous writings and in the same time receives new scriptures; on the temporal aspect, the palimpsest means the present involving both past and future, means that any writing occurs in the presence of other writings.

By taking the metaphor on architecture and city level, the parallel between the text and urban texture regards the city as a superposition of layers (each with its own rules of composition) and meanings; the city as palimpsest means in the same time the archive and resource; the palimpsest moments and the type of urban writing are giving signs about the ideology that transformed the urban parchment and about the possible directions of evolution.

The city as palimpsest, the city of urban fragments

Bucharest is a palimpsest to the construction of which contributed all moments, but that hardly reveals itself. This is because the reading grid shows that since the nineteenth century, Bucharest palimpsest is largely the product of violent erasures through authoritarian gesture. This aspect of the transformation of urban palimpsest frequently creates imbalance in the witness layers and of the subconscious of the place, through the character and strength that was required. Bucharest faced historical, political and social mutations concentrated in a period of only two centuries: all meant authoritarian wills, which produced such erasures, and the lost layers can often be found only on the level of collective memory.

In this way can be identified historically – chronological and typological – several stages of evolution embedded in the urban texture that influences both the plan of transforming the city itself and the perceptive plan.

1. Bucharest before the middle of the nineteenth century: the initial writing generates a free and rarefied structure at the intersection between rural and urban, with a calligraphy in Balkanian style; palimpsest appears as writing and erasing sequences naturally occurred, in an evolutionary way is predominant the writing that territorializes and the co-presence of layers, and is translated into urban reality through a series of parish nucleuses and densities coagulated around them.

2. Bucharest of the second half of the nineteenth century and early twentieth century is marked by a rapid westernization, caused by general modernization of society; predominant writing is a consequence of the adoption and adaptation of the French model.

3. Bucharest between the two world wars, which was integrated into the direction of the previous period, but is marked by a rapid connection to modernist trends. In both periods occured, in addition to the original writing, certain replacements and overlays that con-reside with the previous layers and are considered as a necessary evolution.

4. Post-war Bucharest sees the urban development and social structure strongly marked by the change of regime (with all that this implied) in specific ways and shades that can be highlighted into several periods: the period immediately following the war - marked by the reconstruction, the period of the 1950 – affiliated to the Stalinist regime, the period during 1960-1970 – the intensive building period – modernist and functionalist housing – then the period of dictatorship until 1989. In each of these periods, ways of writing, deleting (organic or violent) and re-writing (as replacement, modification or co-presence) marked in different ways the urban palimpsest.

Thus, the first period has meant an evolution in post-war reconstruction purposes, continuing the previous writing, in some cases over the erasures of war, trying to recover and complete the existent layer. As Ana Maria Zahariade recalls in the work, *The architecture of the communist project,* the year 1952 is referential for the paradigm shift, since *it becomes the official debut of the new architecture production listening to the ideology of the communist project. Everything is modeled after the Stalinist experience, which becomes, moreover, the reference and celebration term - "the model".*[3]

Paradoxically in its continuing, *socialist realist writing – Soviet, Stalinist* – although resentful trumpeting *the cleaning of the old*

3. Zahariade, Ana Maria - *Arhitectura în proiectul comunist.* România 1944-1989, Simetria Publisher, Bucharest 2011, p. 139.

Figure 1 – 1852 Bucharest plan.

regime traces, will not overlap aggressive on previous layers but will find its place in the existing tissue, inserting themselves without major changes or leaving scars. Returning to *modern calligraphy*, that features the following period, it is largely indifferent to previous writings (the very definition of this calligraphy type). This period is associated with continuing operations and complementing many existing areas, operations until the late 1970s characterized by co-presence, changes and fewer replacements. But mostly, it is associated with intensifying housing building (collective, templates, standard), mostly related to industrial development areas, and which extended the urban writing on a very large surface of urban residential districts or neighborhoods-bedroom, homogenizing the territory.

Moreover, their monotonous writing occurred (mostly) outside *the fullness* of the existing calligraphy, broadened the palimps-

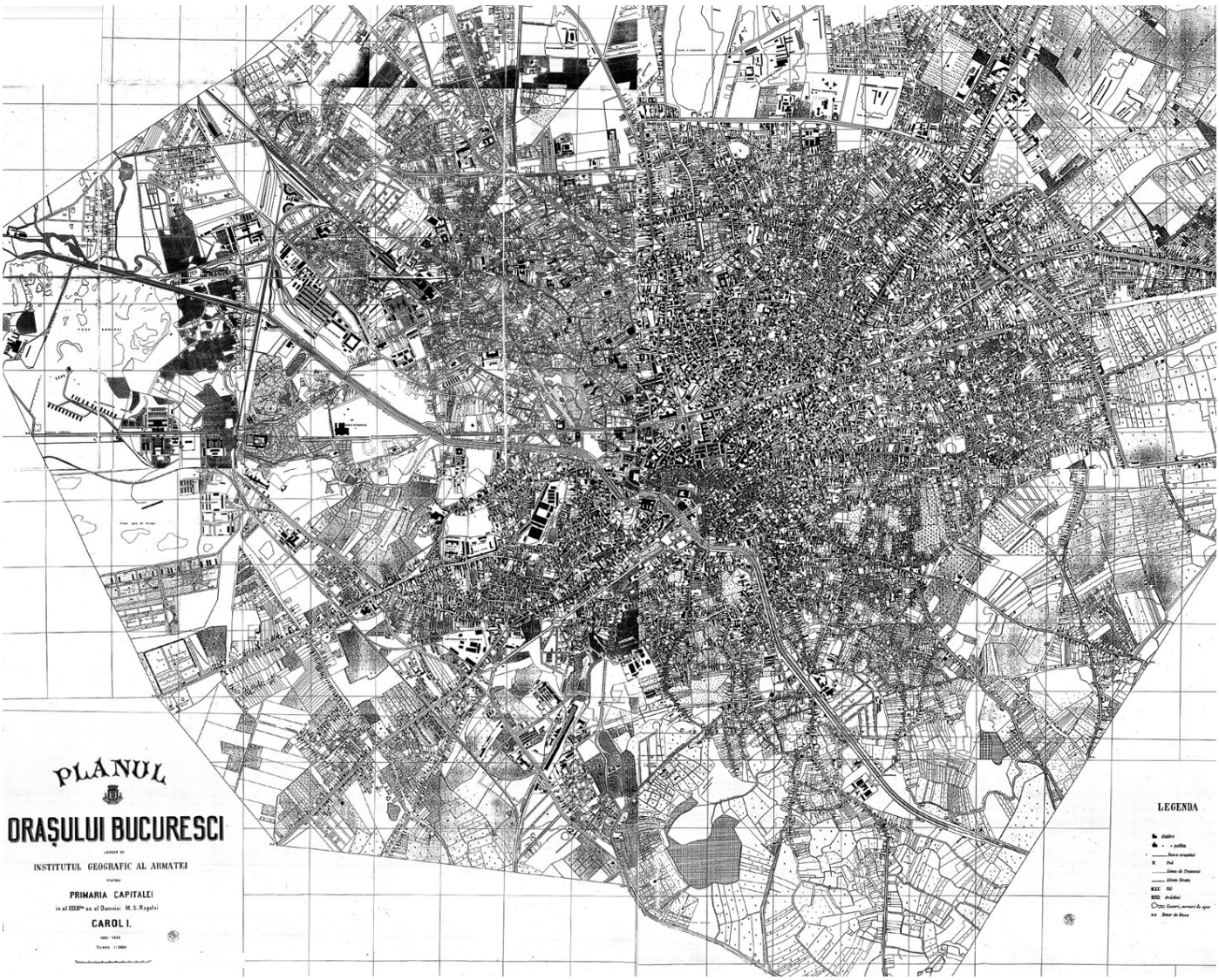

Figure 2 – 1895 Bucharest plan.

est area with another calligraphy, but without significant deletions. The writing of political power will increase after 1971, when *Ceausescu public criticizes the model of free urbanism and the lack of attention from the architects to traditional values and national specificities; he talks about (of course with the inability language of the moment) the street, avenue, traditional town ...* [4]
What at first seems to encourage debate and creativity is actually a total closure. This type of radical writing will become very visible after the 1977 earthquake, which itself was a violent erasure, taken as a pretext for monopoly over urban image. It is the beginning of reaching the pinnacle of political control, started in 1945 - *the state as the sole investor, promoter and client. We are witnessing the rise of a "post-Stalinist Stalinism" whose culmination is the construction of the Civic Center in Bucharest. All demonstrates: the irrational investment (by the way, not all clearly provided by the state plans), systematization of villages, massive demolitions through which the memory of the city is really deleted and replaced with the following blocks to live in (...).* [5]
In this way, the subsequent violent erasure due to the will of political power was superimposed a brutal and non-calligraphic writing, whose specific is clearly distinguishable by its destructive force as against previous layers.
5. The post-communist Bucharest is the layer that we are writing: is in the process of defining and includes all stages of urban palimpsest. Although the destructive dictatorship was disappeared, in the same time at this stage appear to intervene violent deletions (sometimes very violent), but whose reasons consists in a completely different ideology - the financial interest or pragmatism of the market.
All these stages make up the complex characteristic three-dimensional texture, non-homogeneous, translated through levels and layers adjacent or overlapping in a spatial and plani-

4. Zahariade, Ana Maria - Arhitectura în proiectul comunist. România 1944-1989, Simetria Publisher, Bucharest 2011, p. 143.

5. Zahariade, Ana Maria - Arhitectura în proiectul comunist. România 1944-1989, Simetria Publisher, Bucharest 2011, p. 143.

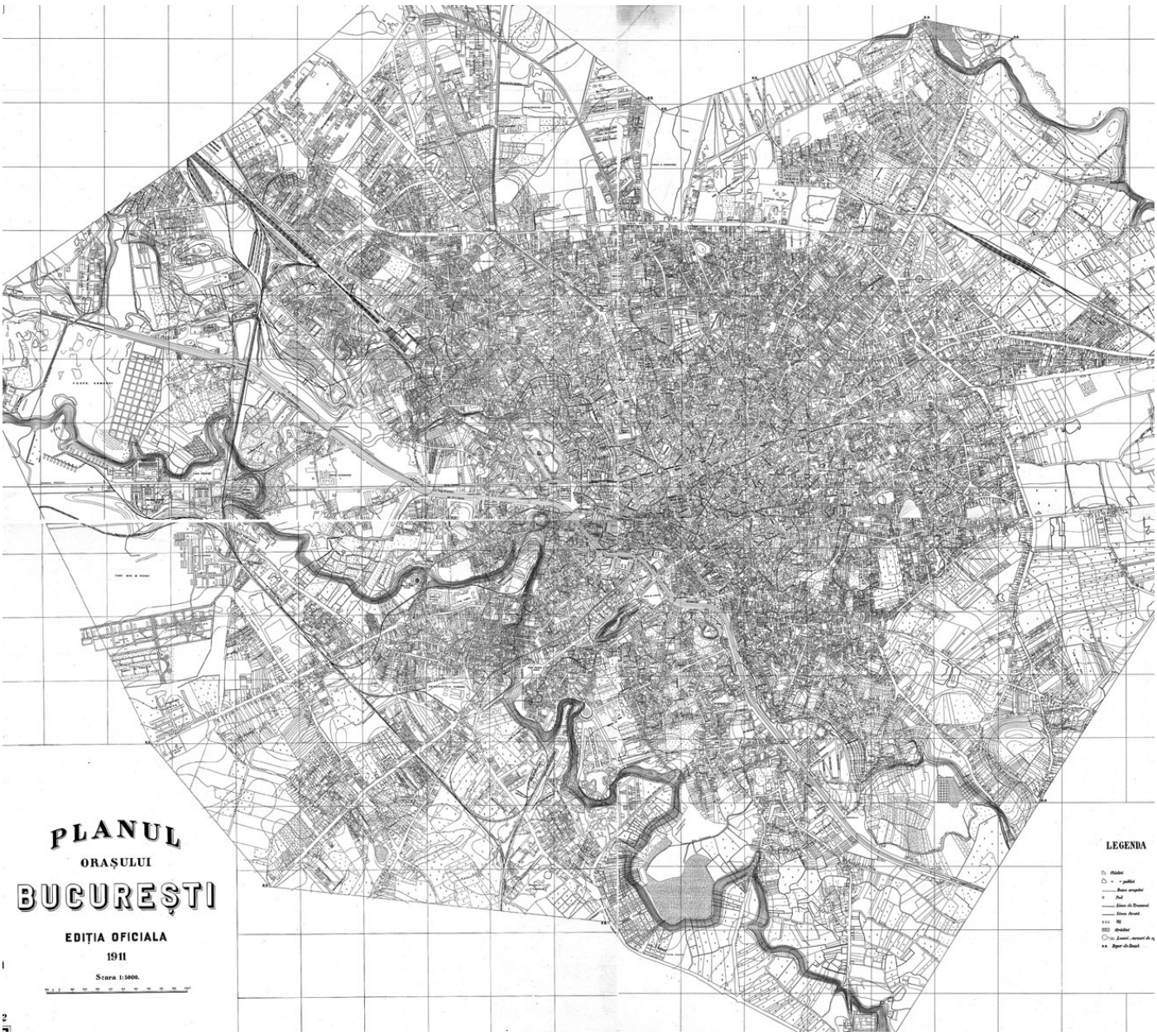

Figure 3 – 1911 Bucharest plan.

metric way. Looking Bucharest as a palimpsest are revealing areas with different concentrations of scripts, that are forming individual nuclei results of natural evolution of urban tissue and whose characteristic is the absence of violent erasure superimposed on a relatively uniform writing, or adjoining areas of different writing, most often involving the step of violent deletion. *At first is striking the picturesque image, than the architectural quality, and in the end we discover countless urban fragments, coherent itself, combined in a manner difficult to understand in the first place. Gradually is found the consistency of a cohesive urban settlement, resulting in overlapping of urban components from different periods of time.* [6]

On the thread of time, this palimpsest which starts initially from development around parish nuclei in the premodern period, turns into an irregular urban tissue gradually evolving, as we have shown above, by adding successive layers. In this way we have an overlap of tendences - on the one hand this fragmented disposal, characterized by homogenous typologycal and identity areas, which were preserved as urban cores in the tissue of the city, on the other hand the layers are overlapping and joining or replacing. But both directins would be read together as part of the same process of urban transformation.

The reality of both urban architecture - the traditional one, the single-family house, and that "socialist" one, the blocs with tens of apartments - is currently being questioned and challenged by post-December systematization, triggered by the investors and property

6. Lascu, Nicolae in Cina, Giuseppe – Bucuresti, de la sat la metropola. Identitate urbana si noi tendinte, Capitel Publisher, Bucharest 2010, p. 9.

Figure 4 – 1987 Bucharest plan.

developers appearance, driven by the desire of maximum profit.[7] Thus, this latter layer continuously writing in not often related to the existing urban fabric and creates contrasting images that denies the identity of the place. Each stage that replaces the previous stage often generates interstitial spaces difficult to read, but in the same time characteristic, singular, and an alter-

7. Giurescu, C. Dinu – Arhitectura Bucurestilor incotro?, Vremea Publisher, Bucuresti 2010, p. 10.

nance of densities that varies in a nonhomogeneous manner.
Currently the city is suffering unnatural transformations, partial results of the pressure of real estate market whose main characteristic is a distinctive raport to the existing urban valuable tissue. Such fragments appear incomplete in the urban fabric, both results of natural evolution and transformation of the present, areas that give rise to residual spaces that disrupt urban structure. Writing the new layer means first identifying these fragments and their "understanding" in relation to their context, followed by proposals that can revitalize, can reactivate the fragments. In this case these fragments can be seen in two situations – on the one hand they turned into residual spaces, passage gaps that people bypass, and on the other hand they were taken into possession for various commercial activities changing their initial status but becoming part of community life. The main goal of this study is precisely the urban and social reactivation through punctual interventions that bring forward a current issue of the city – this waste space with uncertain status.

Micro-urbanism and urban acupuncture [Calea Mosilor and the historical center]

Because a feature of the city is the public space reduced to street level and not to the urban piazza, a dominant characteristic along urban evolution, the case study illustration is chosen as a street with a particular character, that belongs to the historic center but in the same time a number of factors that we will detail in the following are transforming many fragments of it into a residual space.

Indeed, unlike Western European city tradition, in Bucharest premodern public space is not defined in relation to logic of linear perspective, geometrical relationships to connect each building with the surrounding space according to holistic thinking. Urban piazzas are not the central urban points of the city; traditionally, the Romanians did not meet into the piazza or urban square, but on the street.[8]

On the level of urban palimpsest, the first category, in which aggressive deletions are less visible and in which the development of urban tissue was more natural and gentle, is currently the most assaulted by uncontrolled liberalism of the moment. Therefore we present briefly through the palimpsest concept such an area, belonging to the historical center and describing a common hipostasis in the urban texture of Bucharest, being representative for the co-presence of layers, with writings that complement and contribute to the city poetics.

Calea Mosilor or Podul Targului din Afara, as it was called in the past, it was one of the most important and oldest acces routes to the city, with commercial value, an area where natural urban evolution represents the witness layer, and the violent intervention was reduced to solitary presence (we refer to the old part of Calea Mosilor, whose route has remained unchanged since the establishment of the city). Calea Mosilor can be perceived as a specific fragment of traditional Bucharest, a palimpsest whose writing and erasure are juxtaposing, following mostly the natural evolution of the urban fabric. Seen in historical perspective, the street and adjacent area are belonging to the generator nucleus of the city development. From an evolutionary standpoint, the street retains its original configuration and its predominantly commercial character, being bordered by old merchant houses and inns former, but there are currently in a state of continuous degradation. At typo-morphological level, the fragmentation appears as a result of dis-placements and replacements of certain areas with typologies on a different scale from the initial one or with residual spaces.

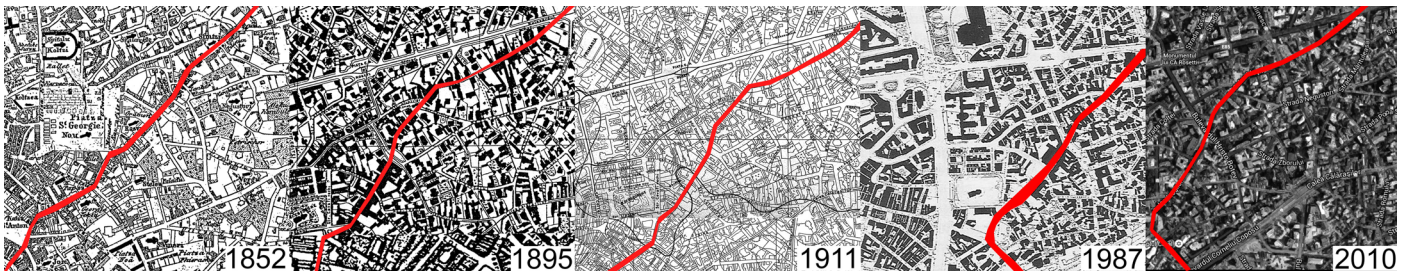

Figure 5 – Calea Mosilor urbanistic evolution.

In terms of social majority population is either gypsies (consequence of the process of communist nationalization) who lives in conditions of extreme poverty, or old merchant families whose economic power is relatively low. This whole place is in a process of degradation with consequences both in the public space and in the private sectors. On the other hand the area is depleted of spaces for socialization, becoming an overall vacant land with random and uncharacteristic occupancy for the importance of these places related to the history and evolution of the city. Therefore it becomes essential the way it intervenes in these residual spaces with uncertain status.

The main issue of the area is both on urban and social level. *The remaining spaces* are thus one of the solutions with poten-

8. Cina, Giuseppe – Bucuresti, de la sat la metropola. Identitate urbana si noi tendinte, Capitel Publisher, Bucharest 2010, p. 81.

Figure 6 – Residual spaces Calea Mosilor.

tial for both urban requalifications by inserting commercial or cultural site-specific temporary functions, and at the social level, involving the whole community. Some of these places have already been undertaken by people using temporary markets or playgrounds. Others were improperly allocated for parking spaces, or as a support for various advertisements.

In this sense, what we are proposing in the present study is primarily an identification of the causes for which multiple areas of downtown became residual spaces, results of historical nature or of the present housing market, as we showed in the first part of the paper, and also a reallocation of spaces left by to the community. Even if the property status, often uncertain (can belong to the state or private individuals), can become vulnerable to a permanent intervention, through a public-private partnership they might be included in a system of temporary inserts which till their definitive insertion to the construction-completion process of the built spaces are diventing social aggregation spaces.

The intervention steps

- identifying the residual spaces along with their causes that led to this transformation of local urban structure;
- highlighting the dominant character of the place along with the role it has on urban and social level;
- identifying the disfunctionalities on circulations and function level, trying to maintain the character of the existing tissue;
- outlining possible directions of transformation depending on the valences of the place and on the way the community invested them;
- creating a public-private partnership (in situations where it is necessary);
- urban requalification through temporary structures that change the perception and appropriation of space;
- in this way the residual spaces receive a new visual and functional identity.

In this regard we have identified along the historical axis Calea Mosilor a series of spaces with uncertain character - some of them private spaces left in a state of decay, some public spaces used for improper activities (temporary parking spaces or for waste disposal). After a detailed study we tried to shape the character of each place separately, relying in particular on the current tendency and how they are invested by the community, noting that although their use is improper the community is trying to appropriate them. Thus, the voids left by urban palimpsest will become community spaces, a series of wells along an axis, like beads strung on a thread. Besides their individual treatment, what we tried to do through this

Figure 7 – Social (community) activities.

project was to create a system of interconnected public spaces by type activities and treatment at the level of materiality and texture. The suggested activities tries to involve people of different ages, people living in neighborhood or anywhere else in Bucharest. The main focus of the activities is teamwork, creating spaces where people can learn new things, play and enjoy spending time together. So what we tried to do was a number of urban rooms interconnected that extract their essence from the spirit of the place and are trying to redefine the sense of belonging to a community.

The project tries to re-connect, re-weave the urban warp and re-create both on physically and memory level the continuity of the urban fabric. Punctual interventions in the urban micro-unit transform a residual space into a public space that unifies and replenishes the whole text. Temporary structures and activities proposed (street performances, themed markets, interactive play areas etc.) will redefine the character of the street.

Conclusions

Bucharest is part of the cities that can be seen on urban level as palimpsest cities, and in the same time as city of fragments. Because the city was composed of a juxtaposition and superposition of layers, the lecture of the city is complex, generating a process of re-composition, re-interpretation and valuation of its components. Besides outlined coherent urban spaces, inside the urban texture appeared also residual spaces, spaces that in time were disconnected from the general tissue. For reconnection, these spaces require a new approach and understanding.

The discovery of symbolic conditions and of its significance, and also the incrustations of history perceptible in the situation of overlapping different layers of physical plane of Bucharest evolution as palimpsest, it is a re-composition, re-interpretation, valuing the meaning on several levels. On urban level, Bucharest as a palimpsest appears both as a juxtaposition of layers and as an overlay. The lecture of the city on different stages is influenced by the heterogeneous character of composition. Finally, we will resume some of the significance of what Augustine Ioan calls to be the *text-territory*, this urban palimpsest loaded with writings, signs and meanings.

The text-territory is therefore not only a site for a future building or only one archaeologically investigated for preservation. Unlike these two, text-territory is forward-looking, and in that very manner of its discovery realizes his future status somewhere

Figure 8.1 – Green room[10].

Figure 8.2 – Multicultural room.

new, old.[9]

9. Ioan, Augustin – Pentru re-increstinarea zidirii, LiterNet Publisher 2005.

10. Every room is designed as an open space. Every space contains urban furniture made of different recycled materials (wood, concrete, bricks, plastic bottles etc), playgrounds for children and green patterns with vegetation. Occasionally, every room will host different performance, workshops and presentations.
THE MULTICULTURAL ROOM: It is a place where people belonging to different cultures could meet. People can sample specific food, beverages and present their traditions.
THE PERFORMANCE ROOM: theater, mini concerts, different foregrounds with stories
THE GREEN ROOM: reclaims the old traditional market
THE CRAFTY ROOMS: places where people revive old traditions
THE SILENT ROOM: a place where you can enjoy the pleasure of reading a book or listen to the music.
THE PLAYING ROOM: the place melts games for children and for adults in a different way.

Figure 8.3 – Performance room.

Figure 8.4 – The playng room.

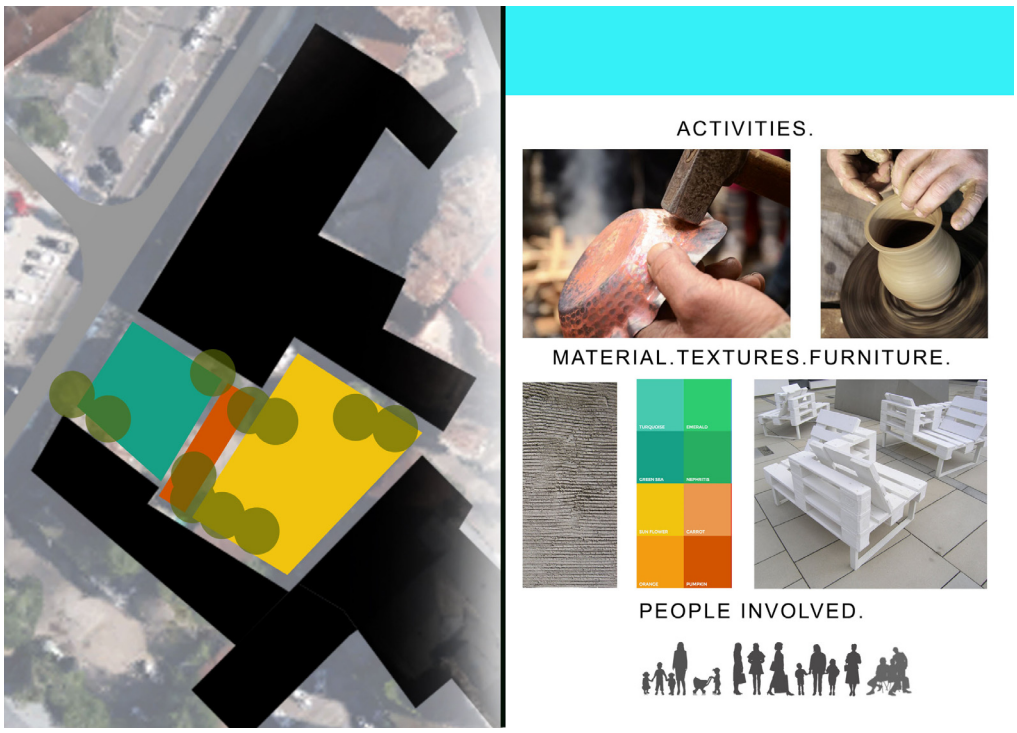

Figure 8.5 – Crafty room.

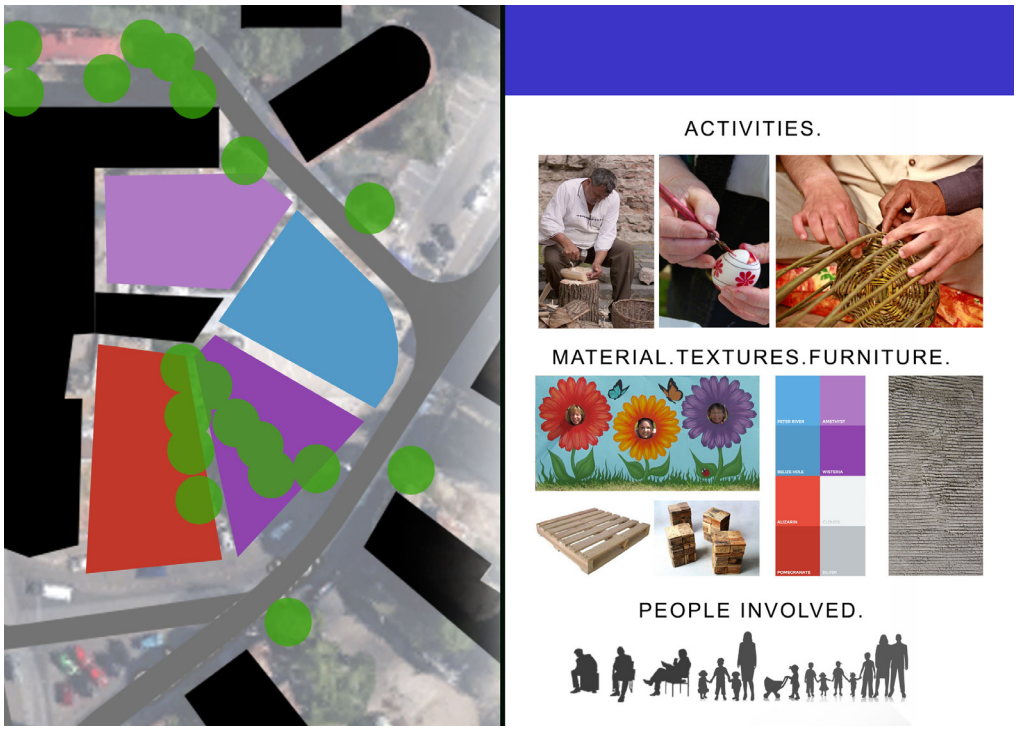

Figure 8.6 – Crafty room.

Figure 8.7 – Silent room.

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The representation cartographic and GIS. Sperimental investigation on medium and low Valle del Tronto

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Keywords: grepresentation, drawing, environment, information system, GIS.

Abstract

Thise thesis relates to research in the area of representation and design, which in this context means describing and disseminating information related to the environmental heritage, the landscape, and the urban environment.
The objective is to represent an area of land, that of the Tronto Valley, by means of a system for collecting, processing, and organising data to be contextualised at a later date with the help of a geographic information system (GIS).
The innovative aspect of the thesis lies in the representation of data with a graphical language that can communicate information gathered at different scales. Furthermore, an attempt was made to create a two- or three-dimensional model that allows the valley to be read globally.
The thesis started with research related to what has now developed into the representation of land according to morphological, hydrographic, human, and ecological aspects. In this way it was possible to define various analysis categories and at the same time assess the potential or weaknesses of the methods used.
To understand the relationships between the various data, objective, "real" data-reduction systems were compared by means of abstraction and selection in order to facilitate the systems' overall communication capacities through thematic reduction.
The complexity of the case study necessitated in-depth analysis and descriptions Graphical indicators were used that were appropriate for translating the data in its entirety together with the underlying relationships among the various types present within the subsequent system.
This complexity formed the basis for construction of the model and therefore of its information content. In this way, territorial representation becomes the object of a formal graphical communication projectcommunicating a territory is the basis of its representation!
The final model is therefore the re-composition of geographical data by means of a new computer system capable of doing so, creating a communication system that is effective in producing a graphical description of territorial complexity.

The thesis is about the representation and design, considered as a tool for the description and diffusion of information relating to the patrimony, landscaping and urban environment.
The target is the simultaneous representation of a lot of information in the territory, of Valle del Tronto, through a system of collection , elaboration and organization of data inserted and analysed at a later stage, represented through a geographical information system.
For the definition of this methodology it was necessary to outline a cognitive framework through which we can reach an identification of themes structuring the project and the organization of research.
At a later stage the categories of analysis were defined to carry out the investigation, and the methods and forms to realize the knowledge, in two complementary phases, the one concerning acquisition of data and the other about the construction of the information through its representation.
"Different are the areas that can be of interest by GIS application: from the computerization of PRG (general regulation plans) to the network organization, from the verifying system of territory fiscal frameworks to the urban traffic plans, from GIS for the civil protection (seismical maps, building vulnerability, road practicability, ...), from the naturalistic resources to the cultural heritage for tourism, from the sustainable development to the bio-diversity.
Geography, environment, the Internet and GIS, basically seem tightly tied and we could expect to find a large number of applications on the web that make information georeferenced available through interfaces of GIS types with data layer interactively questionable by the users. In reality this does not happen"[1].
The thesis therefore deals with the innovative aspect of the data representation through a graphic language, able to communicate the information gathered at different levels of representation.
The visualization through the GIS is often limited to one single representation: two-dimensional or three-dimensional, then the thesis tries to realize a two-dimensional/three-dimensional model that allows a correct reading of the territorial system.

1. Sofia Pescarin, *Le applicazioni WebGIS per l'ambiente*, Mondo- GIS, 2002, n°32, pp.54-55.

The software Autocad Map3D was chosen as a tool for exporting the documentation on the web.
Thus one can two-dimensionally and three-dimensionally describe the territory and export the documentation in a format which is consultable via web.
Because of this, the release of information is an indispensable aspect today, so that planning and ground analysis are constantly up to date, the research aims at the realization of a data system accessible via web.
The research has a finite territory as a sample, whose characteristics are recognizable and comparable with other areas. The geographical territory of the representation is Valle del Tronto.
The choice of the sample was validated throught the sperimental phase.
The valley is a very diffused model of landscape in Italy as it is in the rest of the world. It is also subject to various studies because its nature is particularly prone to being anthropic, confirming what stated by Prof. Motta "Alberti in *De re Aedificatoria* quotes exclusively literary taken from antique sources" that illustrates the relationship themes between the city and river which crosses it, such as for example the system of water supply to fulfil various urban functions, the defence system that in some crossing points of the river has exceptional places, themes that permit further recreation and variation of the described solutions. Filerete in *Trattato di architettura* uses analogical procedures to connote the valley Inda illustrating the Padani river sights, as an analogy that exists between the confluence of the Po and theTicino in Pavia and the sight is the form of the city itself [...] Scamozzi in the idea of *Architettura Universale* applies maths and geometrical schematizations of the geographers and astronomers to configurate a relationship between cities and the plain crossed by rivers"[2].
Prof. Martone declares "the cartographic representation, whichever type of elaboration chosen, is however an instrument of knowledge and valuation of the territory as regard synthesis of morphological, biological and anthropic data; only by this we can understand the only valuable asset of mankind which is earth, in terms of protection and safeguard"[3]. Therefore the elements that characterize the valley are the following:
- the morphological and hydro-graphic elements: ridges con-ridges, gullies terraced lakes etc...;
- the ecological elements essentially consist of tree species and herbaceous that are found in various forms on a large part of the surface;
- the anthropic elements: ridge settlers, hillside settlers, valley settlers, roads con-ridges, roads in the valley etc.

The graphical description of the elements requires some precautions, according to Nicola Surian's analysis presented in *Linee guida per l'analisi geomorfologica degli alvei fluviali e delle loro tendenze evolutive*[4] "the riverbed is represented through a path, the point of origin coincides with the relatively highest point (mountain), the extreme point coincides with the relatively lower point (sea). "A preliminary operation to the measurement of morphological parameters of the riverbed and subdivision of the water course study homogeneous morphological characteristics. [...] The sub-division in homogeneous morphological traits can take the following aspect into account:
- morphology of the valley (amplitude and confinement grade of the watercourse);
- valley direction or in plain, of watercourse;
- planimetric morphology of the riverbank, presence of natural or artificial hydrological discontinuity.

The length of a stretch is usually between 1 and 5 km"[5].
According to what Prof. Albisinni and Prof. De Carlo wrote "for the study of artificial elements we will have to refer to the stages of anthropization of the area, which suggest by themselves the main connections with its natural components. The examination of the historical events in the area allows us to retrace the crucial moments of anthropization to examine the effects produced by it"[6].
In support of the motivation that has led us to the choice to represent the Valle del Tronto with new informatic systems, it's necessary to partly expose a prepared report by the Marche Region which defines the main characteristics "The Region is characterized by the lacking presence of flat areas of a certain relevance; the plains occupy only the 11% of the territory, limited to valley floors and the areas around the river mouth [...] between the mountains and the coast an extended hilly band that declines towards the sea is included. The regional territory can therefore be divided in two orographic sectors, the first mainly mountainous and the second typically hilly. The outlined above is complicated by the presence of three bands detected and perpendicular to the evolution of the main ridge linking the Apennines to the coast. [...]"[7]. Secchi, by drafting the detailed plan for Ascoli Piceno, asserts that "La valle del Tronto is today a strong ur-

2. Giancarlo Motta, Antonia Pizzigoni, Carlo Ravagnati, *L'architettura delle acque e della terra*, Franco Angeli, 2006, pp.108-109.

3. Maria Martone, *Il disegno per il territorio*, da Quesito – Studi e ricerche per il disegno e la documentazione dei beni culturali, maggio 2007, p.90.

4. Nicola Surian, Massimo Rinaldi, Luisa Pellegrini, *Linee guida per l'analisi geomorfologica degli alvei fluviali e delle loro tendenze evolutive*, Cleup, 2009.

5. *Ibidem*.

6. Piero Albisinni, Laura De Carlo, Biagio Roma, *Un disegno per il riuso – Metodi di indagine e di progetto per il recupero del patrimonio edilizio nei centri storici minori*, Edizioni Kappa, 1983, p.31.

7. Regione Marche, Inventario e Carta Forestale della Regione Marche – Relazione generale, I.P.L.A. S.p.A, Torino, 2000, pp.25-26.

banized and infrastructured territory, economically and socially integrated, but maybe inadequately designed. [...]In the centre of the valley we distinguish three fundamental parts: the flooding plain, the embankments (...), and finally, three different types of river terraces. At a higher altitude, between the plain and the slope, just above a line across where prestigious 'villas' are found, there are two different hillsides: soft, sunny and cultivated northwards; shady, wooded and steep in the south. The agricultural activity, the fields and the vineyards design, create a regular geometrical shape on the first one , an agricultural landscape of great sweetness; while the forest and the badlands mark in more a severe and dramatic way the second one. On top of the hills one can see the villages that mark the Marchigian territory along the main and secondary ridges, in a sequence that from the mountains descends to the sea. A lot of these centres, in their recent expansion have taken on the slopes , invading them with scattered houses and small neighbourhoods, getting closer to the broad lines of communication roads and railways that run on the valley floor in the nearby industrial area projects of recent settlement"[8].

Based on what said above, the Valle del Tronto is very extended and according to scientific experiences previously analysed, we decided to limit the study to a homogeneous section of the valley, in this way the experimentation is not overloaded by the amount of data, so the analysis of the GIS representation can be more penetrating. The research is based on the medium valley, and includes the towns of: Ancarano, Appignano del Tronto, Castignano, Castel di Lama, Castorano, Colli del Tronto, Controguerra, Offida, Spinetoli.

The stretch of the valley has an extension of 20 km and it joins the Marchigian ridges with the Abbruzzo's ones along 4 km, in parallel to the course of the river Tronto.

The data are referred to the geomorphological characteristics that come from: interregional authority of the Tronto river basin and urbanistic office of Ascoli Piceno district. Some of these are in raster format and others in vectorial format.

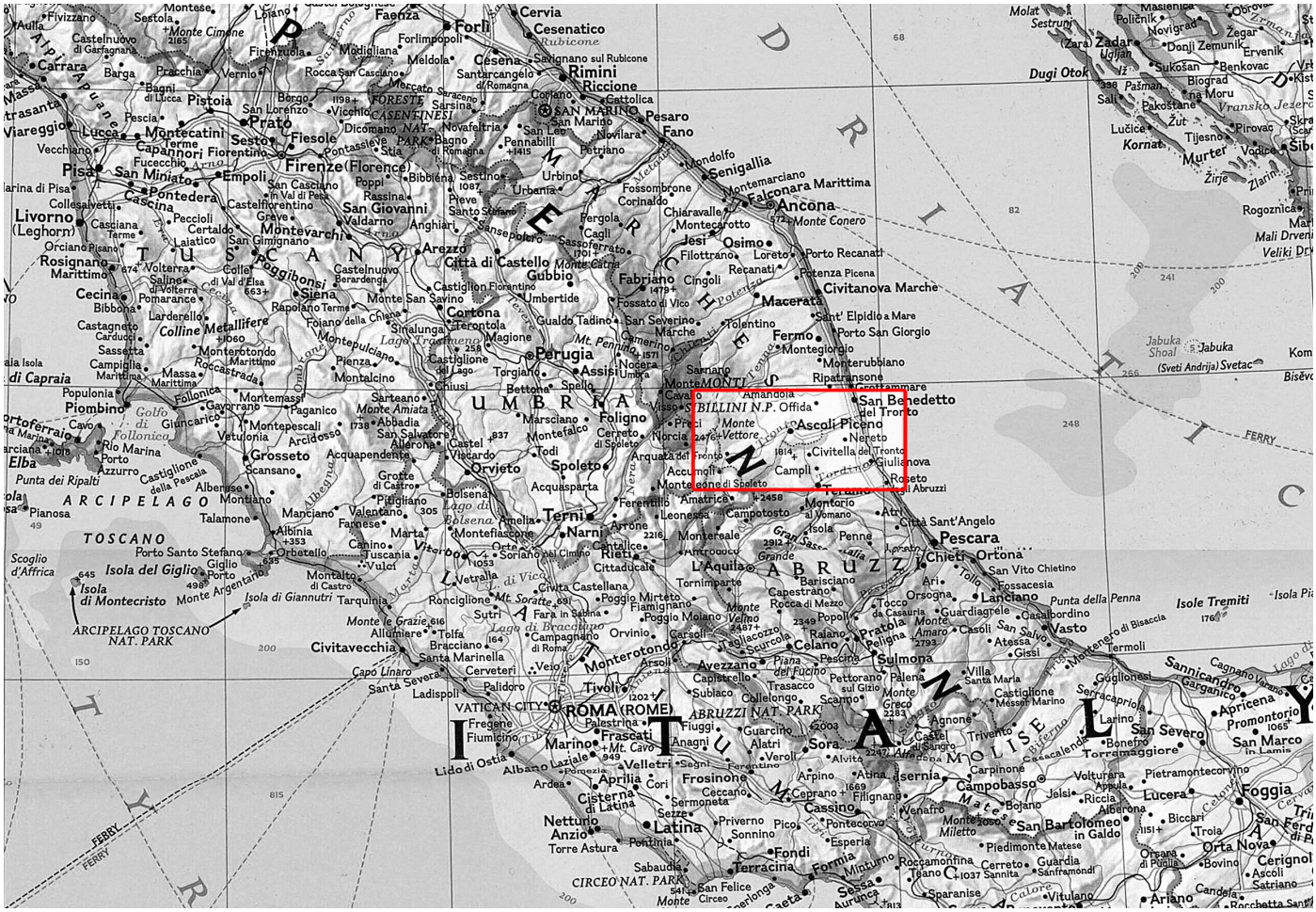

Figure 1 – Map Italy and identification of the Valle del Tronto.

The anthropic data come from a database of the municipali-

8. Bernardo Secchi, Valerio Borzacchini, Sandro D'Auria ed Alberto Monti, *La valle del Tronto: molte delle informazioni riferite a questo tipo di luogo provengono dal Piano particolareggiato esecutivo del centro storico di Ascoli Piceno*, Ascoli Piceno, 1993, pp.14-22.

Figure 2 – Photo of Valle del Tronto.

ties crossed by the stretch of valley and they are in vectorial format extracted from PRG, in a scale from 1:2000, updated approximately between the years 2007 and 2010.

As regard the ecological data it has been examined a research taken from the report "Procedure digitali per una nuova cartografia" of the Camerino University's Unity of Research belonging to the School of Architecture and Design.

Being the sources of various origins and with different graphic languages of description, every type of data was assigned a layer easy to be processed after the uploading in the GIS according to the UTM WGS84[9].

The graphic interface was realized via several applications (Autocad, Map3D, Civil 3D, Raster Design), and we recall that this operation is part of BIM concept (Build Information Modelling).

The elaboration process is based on the membership to data category (geomorphological, anthropic, ecological), however there were some exceptions depending on the knowledge of the territory.

The central elements of this elaboration was the methods of representation of the territory with graphic signs: points, (poly) lines, polygons, icons, symbols, and representation scales that better suit the data reading.

The study has interested also the definition and distinction that is between 'icon' and 'symbol' whose elements are frequently adopted in the territorial representation and often misinterpreted in data synthesis present in the GIS.

9. WGS84: World Geodetic System del 1984, è un datum molto diffuso e viene essenzialmente utilizzato per i GPS (*http://www.sharpgis.net/post/2007/05/Spatial-references2ccoordinatesystems2c-projections2c-datums2c-ellipsoids-e28093-confusing.aspx, articolo di Morten Nielsen*).

The elaboration of the geomorphological model is distinct in two phases: the construction of an orographic three-dimensional model and the two-dimensional representation of the valley stretch, seen under the appropriate scales.

Since the orographic model of the River Tronto is in scale 1:10000 and CTR of Abruzzo Region is in scale 1:5000, the unique scale 1:1000 was used for two reasons firstly for the elaboration time, secondly for the quantity of data used, in fact the stretch of valley has a surface which extends mostly into the side affected by the CTR of the Authority basin of the River Tronto.

The elaboration three-dimensional of orographic model has been done with isolines and spot heights.

Geometrical anomalies were eliminated, TIN and successive GRID models were created.

The TIN model can be seen from a scale 1:5000 (without having difficulty for the geometries that outline geomorphological characteristics).

Some representation styles were applied to TIN model in the software, for example: the triangles of slopes, the colour scale of the slopes, the cloud of points, etc... .

Based on the type of style given, some considerations have been made: up to which scale of visualization the data are readable, if the style used is adequate for understanding of the geomorphological features, if improvement and balance of representation to the specific analysis is possible, and so on.

From the results obtained on the model, we understand that some styles are bound to the

visualization scale and hence of reproduction; other charac-

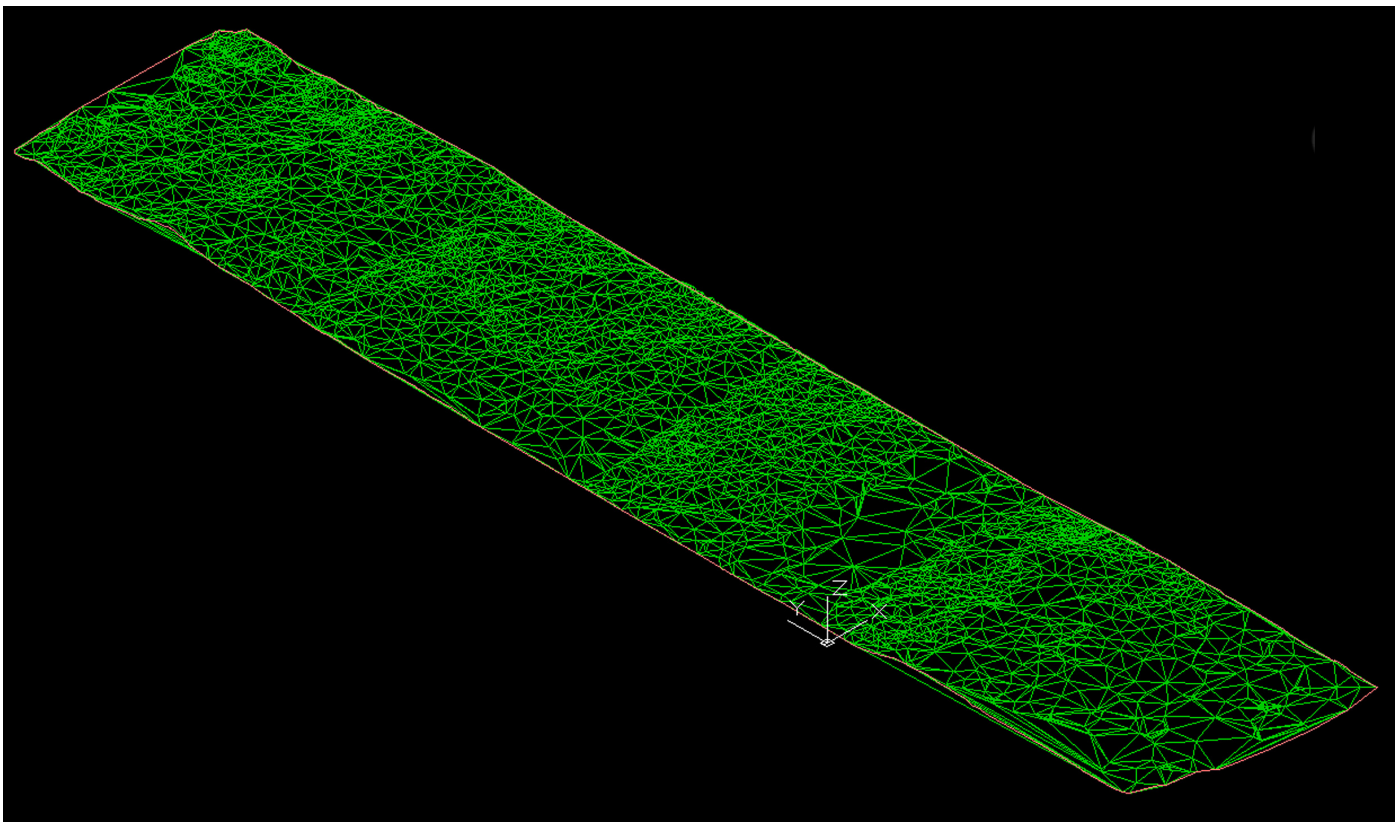

Figure 3 – Representation of the TIN surface through the Civil 3D software and the awarding of the style “triangles”.

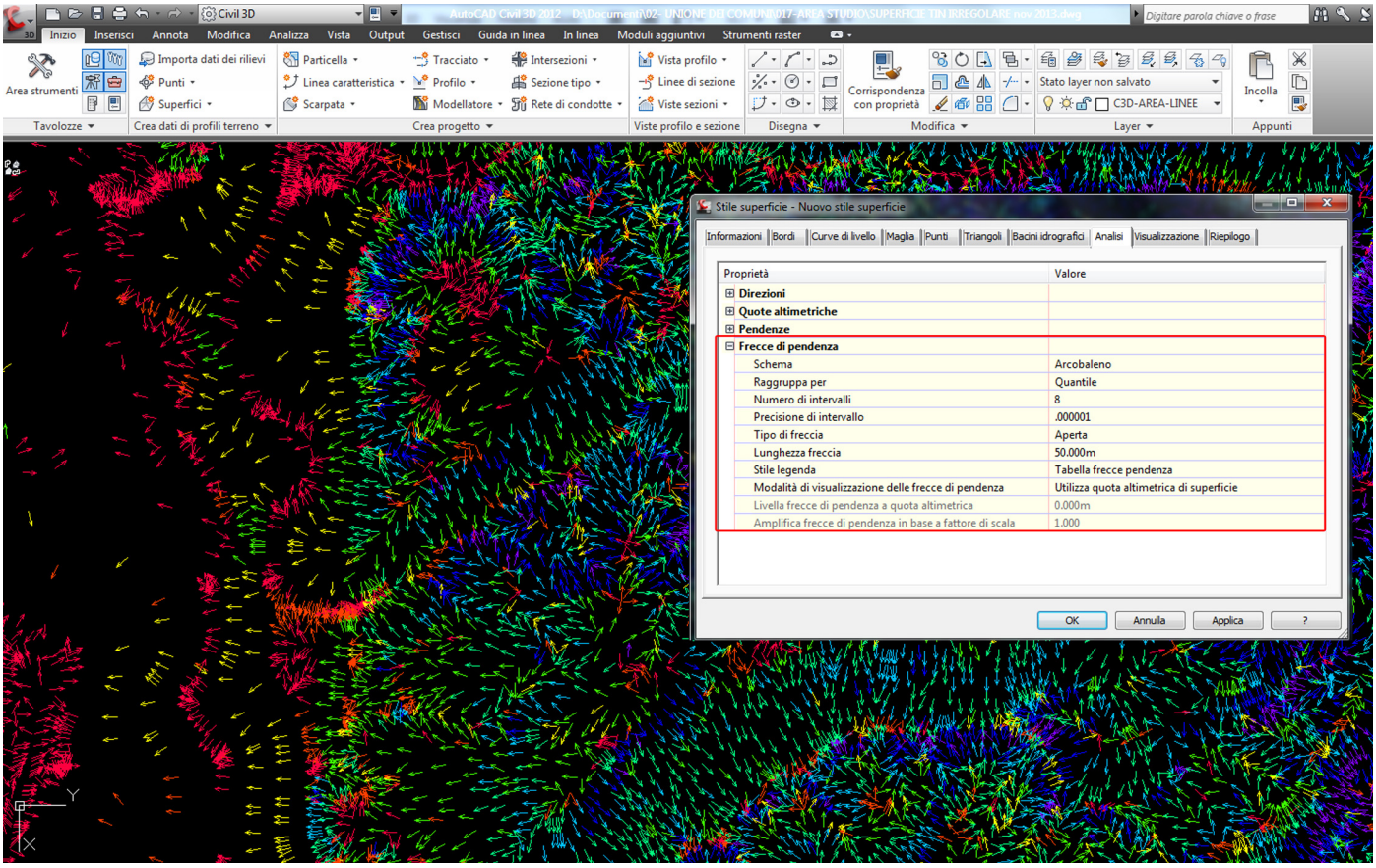

Figure 4 – Representation of the TIN surface through style “slope arrows” in Civil 3D software.

teristics are clearly visualized from a certain scale on.
The GRID model comes from the elaboration of the TIN model: the mesh of triangles, triangles was regularized to 5 metres on each side, the choice depends mainly on the managing files with the software. Indeed, implementing the mesh dimension, the time of data elaboration is greater and the definition remains "the same".
The WGS84 was associated to the GRID permitting other data with the same coordinates to connect, some visual styles previously adopted for the TIN were applied and finally profiles were extrapolated perpendicularly to the axis of the river. From this the visual styles assigned previously to the TIN were incomprehensible for the GRID, the file extrapolations is significant for the reading of the slopes as so for the choice for the definition scale, that in automatic way consents to read the peaks and the depressed areas.

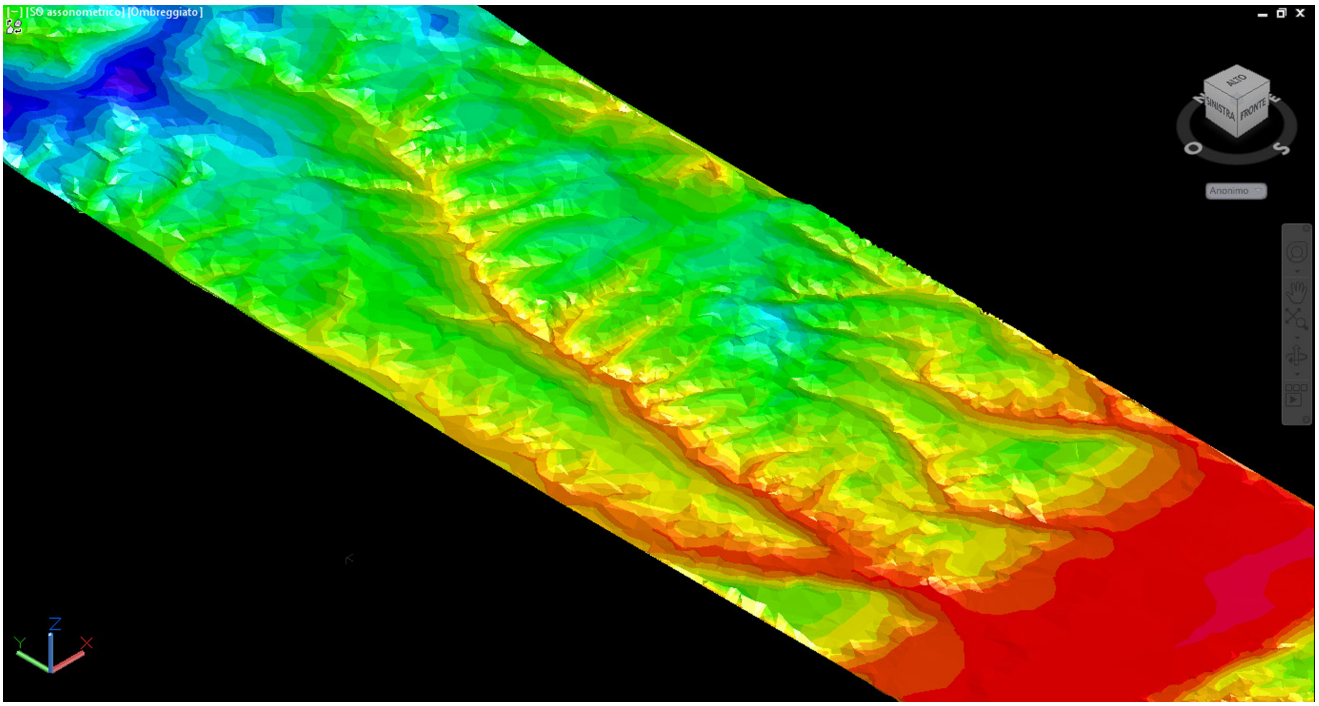

Figure 5 – Isometric representation of the TIN assignment with the style "color scale gradients".

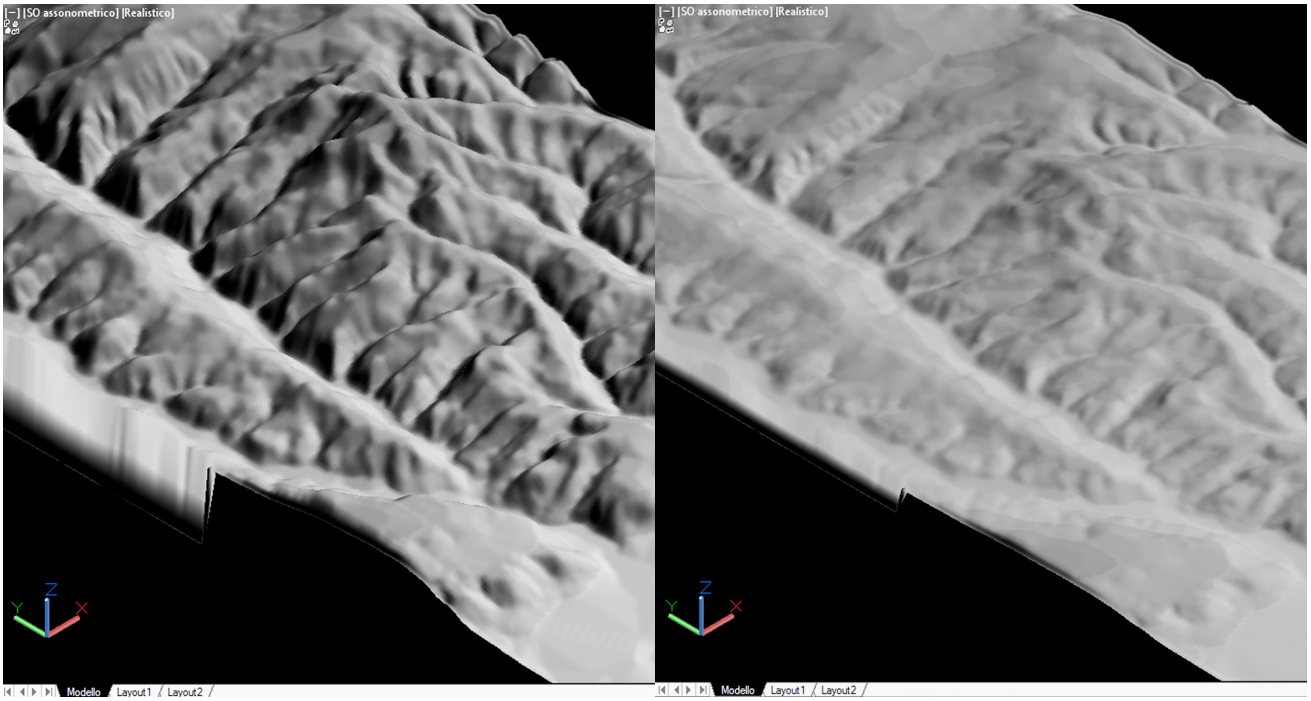

Figure 6 – Representation of the DEM with the color style and emphasis on the elevation. Both views are isometric and the same display scale.

The DEM was produced from GRID, which being a raster image is visualized as a surface, however the last Map3D version consents the visualization in 3D and to control the elevation quotes. It's possible to associate a visual style to the DEM with an overlap of a colour scale in which bands depend on the altitude interval chosen.
In this experimental phase some analysis are pointed out: to which scale of visualization.
One clearly reads the data, which styles of visualization are really necessary to comprehend the orography, which new styles permit to improve the data reading. From the tests made we can see that the DEM image can be visualized up to a certain scale magnification beyond which is not possible to understand the data, the definition in this case depends on the elaboration that is made in that moment from the data.
By addressing the parameter style it's necessary to specify that in the software Map3D we visualize DEM from both 2D and 3D point of view: this setting is important to distinguish the depressed areas with respect to the peaks.
The next passage of the experimentation was the georeferencing of the orthophoto map, firstly the technical characteristics of each table: image dimension is approximately 13500 x11000 pixel and graphical resolution of 500 pixel/inch.
The tables concerning the stretch of valley have been assembled in succession. Before saving the file in jpeg, more trials have been made that would permit an easy elaboration in Map3D.
The software used for the georeferencing is Raster Design.
After assigning the coordinates to the image, it has been connected to the GIS system.
The most interesting result is given with the three-dimensional view, in fact the image is positioned exactly on the DEM surface, so that one can read the orography and anthropogeography.
In the three-dimensional view the data is clearly visible only for rather small scale displays.
As, for example, the scale 1:25000, for the bigger scales the orthophoto paper image is undefined. To overcome the problem it is necessary to modify the image resolution jpeg at the expense of processing time.
The two-dimensional geomorphological model is realized with cartographic CTR information.
An important contribute is given by the publication of "*Un disegno per il riuso",* in which interesting thematic maps of topographic characteristics of the valley of Aniene have been designed[10].
The geometric entities behind the 2D representation in the GIS are: points, (poly)lines, Polygons and each sign has been associated to a style.
The choice of each parameter that defines the style needs to perform various tests in order to solve the questions associated with the scale of visualization and representation. In the

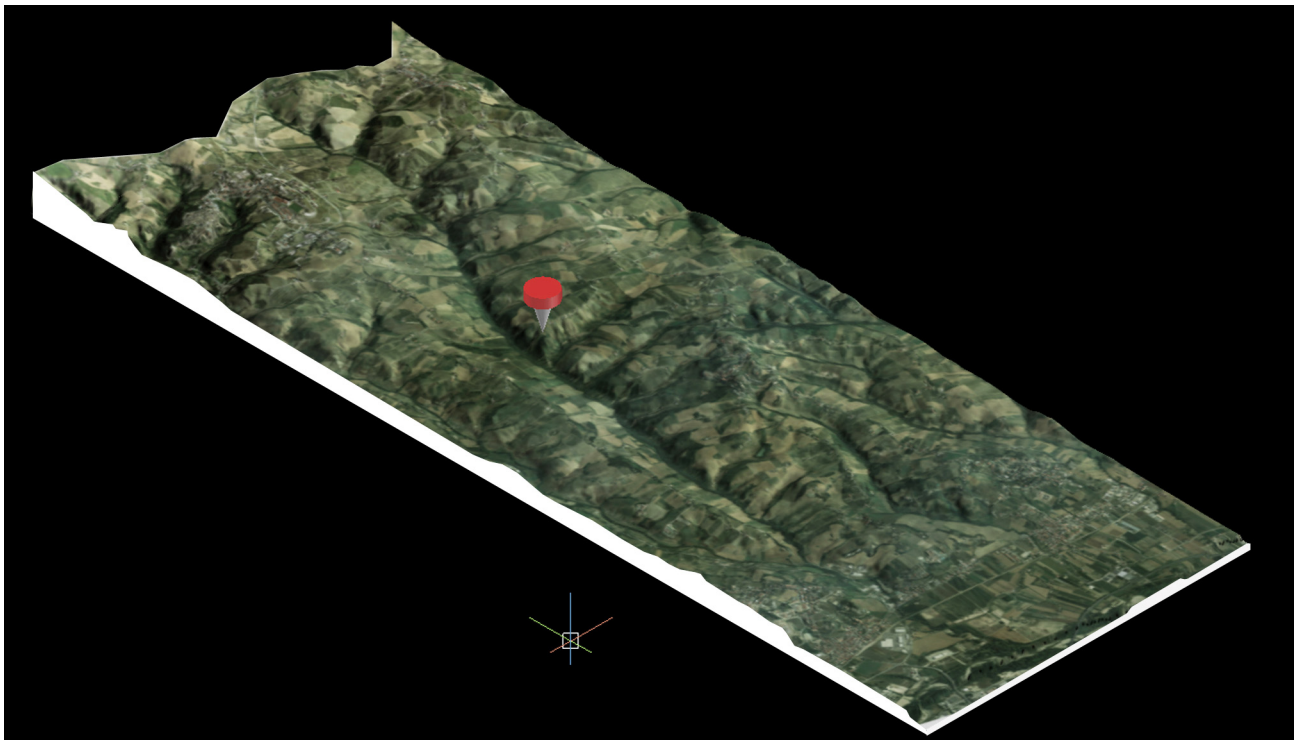

Figure 7 – Orthophotos displayed through isometric view. The sharpness decreases as the display scale, this is due to the type of image resolution orthophoto.

10. Laura De Carlo, Piero Albisinni, op.cit., pp.28-30.

two-dimensional representation data in vectorial form are present while the raster images have been excluded because of the long elaboration times.
A parameter that is often overlooked but that affects the data representation, especially if placed in two-dimensional view, is the background colour on which the geometrical elements are designed, even if in this case it is necessary to perform more tests to obtain a comprehensible representation.
Another difficulty for the clear reading of geomorphological elements depends on the number of visualized information to a scale of representation and the type of sign used; In fact the isolines can be read on very big scales (from 1:2000 to 1:10000), the tops and/or ditches can also be read on reduce scales (from 1:2000 to 1:50000).
In the construction one must decide which data to visualize and possible overlaps. This shrewdness gives the model a way of being clear and makes the choice of the scale of visualization easier because data of the same entity and definition can be reunited in one screen.
In the two-dimensional representation there are orographic

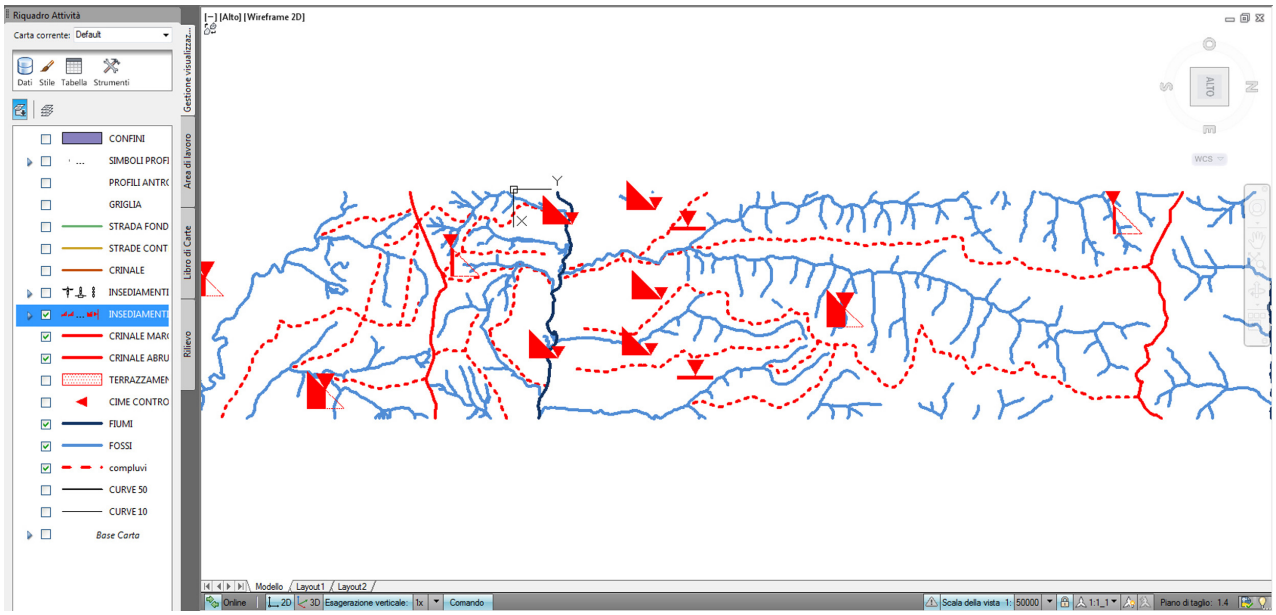

Figure 8 – Graphic of orographic and hydrographic aspects of the study through a graphic obtained with signs and symbols (display scale 1: 50000).

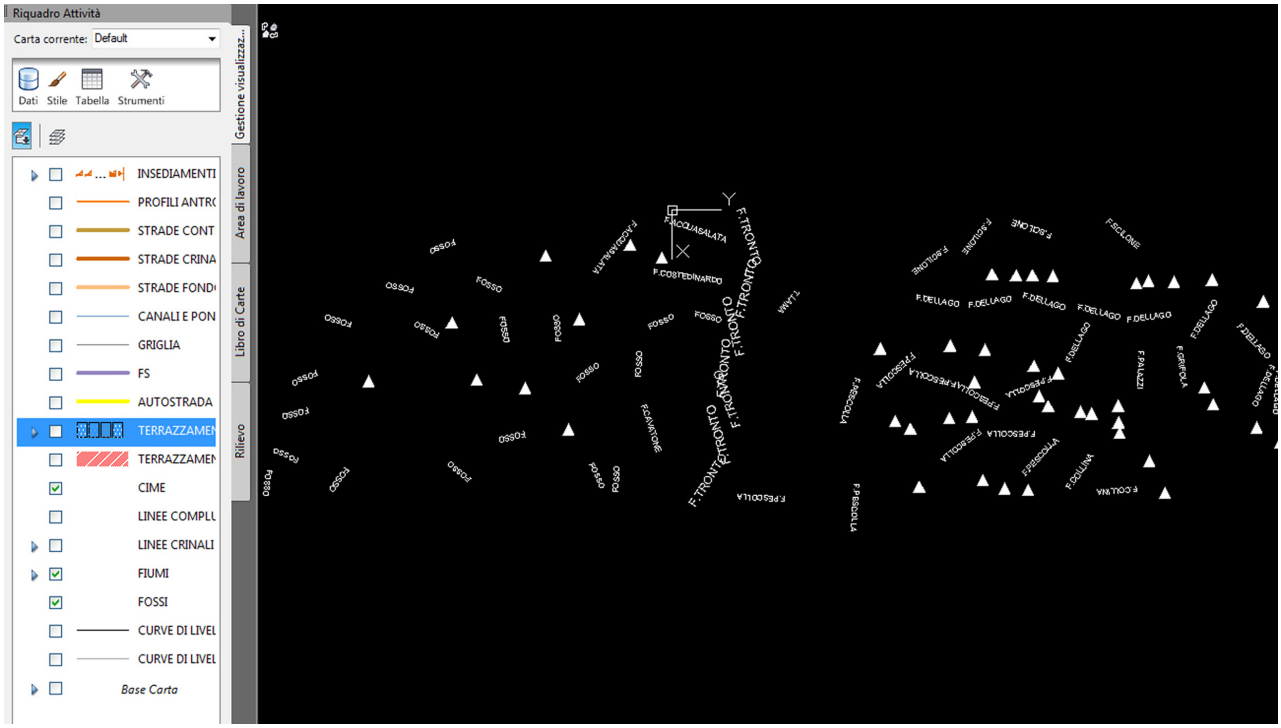

Figure 9 – Processing of graphic character orographic and hydrographic of the study area through representation for signs and symbols on a black background (display scale 1: 50000).

data and hydrographic data.
The orographic data are described by isolines and symbols support the description of the items, as, for example, the tops, the ridges, the compluvium and terracing.
The use of the sign as a representation of some geomorphological elements, has been fundamental for the description of heterogeneous data.
The hydrographic data are described across lines and assume a different style depending on the meaning (river, torrent, ditch).
In the case of hydrographic data described with lines, the problem with the scale visualization is determined by the thickness of the sign: in fact some lines in reduced scales are thin and incomprehensible, therefore a range scale is necessary to be fixed.
In the two-dimensional representation as well as the design plan view of data the design of the orthogonal profile axis on the river Tronto was included: this allowed to read and to comprehend the relationships underlying between orographic, hydrographic and urban settlements.
In the GIS attributes are associated to the data: identification code, geometrical information and other indications formulated by the system user, hence, once defined the geometrical data, the next step is the formulation of topological data and the formulation of spatial queries that show the characteristics of the territory.
The GIS responds to the queries formulated by the user indicating the element corresponding to the answer on the map, assigning to them a colour and type of sign to be recognized with respect to other geometrical data.
An important moment for representation in the GIS is the description in signs of settlement characteristics.
The aim of this experimental part consists in verifying different types and ways of analysis even in function of the different representation modalities.
In the text "*Un disegno per il riuso"* the choice of "an area that comprehends three systems of valleys [...] that mainly qualify the territory with its specific infrastructure characteristics [...] and the topological relationships of urban areas"[11] has permitted to organize the settlement systems in: linear schemes (also known as zone of Acropolis with medieval origin) or radial scheme.
"A classificatory operation of this type involves such a degree of schematization that we cannot consider the many variations of the relationship between edification and site that determines the identification of such urban reality"[12], so these considerations have allowed to reorganize the elaboration phase of the anthropic model.
Observing the morphology and studying the historical stages of the populated areas, the principal characters that define the anthropic model were identified as well.
Amongst the studied texts to individualize the settlement signs of the valley stretch analysed, the book of Luigi Piccinato "*l'Urbanistica medioevale"* says that "the typical configuration of the ground, on which many towns have arisen from X to XIII century in the area of Italy identified with Lazio, on the promontory resultant from the confluence of two rivers or torrents strongly recessed in the ground, has created a very common and interesting type: what we could call 'zone of Acropolis' (*fuso di Acropoli*). Which really isn't an exclusive characteristic of promontory cities, typical situation of Lazio Umbro-Sabino, but also many more urban creations of Tuscany and Marche from IX to XI century, set on the hills of elongated shapes, therefore orographically similar to those of citadels of Lazio. Many of these have then been set on abandoned Etruscan citadels for centuries; on the ruins they have reclined, and have taken, with the position provided, the city walls and maybe also the road schemes"[13].
The description of Piccinato clearly shows how the first settlements were collocated on the valley sides, thus across the orography of the territory, the first urban centres were conformed.
Another important evaluation on the Marchigian settlements is given by Sergio Anselmi in the Marche volume of the collection "l'*Architettura popolare"* in Italia in which he states that "[...] such phenomenon is because of a settlement structure development, in which the original conformation of the natural environment and the economic and social process who preside the transformation are related, at least in some historical phases, in a very singular way. [...] It's feasible and historically established the consideration of the Marche as one of the areas in Italy that has assumed in time [...] a polycentric organization and dimensionally articulated in each of the territorial areas – coastal, hilly and mountain – and across the numerous valleys, that with limited amplitude and variable depths, flow out perpendicularly to the Adriatic coast. [...] the prevalence of the agricultural economy, partly tied up to the modern times [...] has affected the development of the Regional territory, preventing the formation of urban centres of economic and demographic dominance, *favouring* [...] t*he growth of small and medium centres*, characterized by a diffusion of decorous buildings, by an unusual medium quality of the artefacts and, [...] by a wide selection of services and infrastructures"[14].
From the reflections mentioned and from the observation of historical maps, it emerges that the urban shape of the first

11. *Ibidem*.
12. *Ibidem*.
13. Luigi Piccinato, *Urbanistica medioevale*, Edizioni Dedalo, Bari, 1993, pp.28-29.
14. Sergio Anselmi e Giovanni Volpe, *L'architettura popolare in Italia - Marche*, edizioni Laterza, Bari, 1987, pp.11-14.

settlements, that is the one of the ridge, have maintained its original characteristics.
The settlements of halfway and valley bottom, according to the study of historical maps, are supposed to be born around the year 1816 and that, only after an intense rehabilitation and improvement of the infrastructures, have been expanded as well.
The experimental phase, having as object the elaboration of the three-dimensional *model of anthropic data,* is characterized by the relation of the DEM surface with the principal elements of anthropization (urban fabric, infrastructures, emergencies, etc).
The procedure began with the realization of a new GIS document, inserting the DEM surface used for the 3D geomorphological model and the representation of schematic volumes of urban fabric present in the stretch of the valley analysed.
The volumes obtained are the result of an accurate comparison with the informative material. The final elaboration defines the dimension of the stretch of valley chosen, the informative scales available, and the set goals, therefore it was decided to limit the visualization of the data up to the scale 1:5000, because further enlargement would have determined time and ways of elaboration different from those established.
The result is not adequate to the expectations: the identification of the historic centre, the urban expansions occurred outside the walls, the principal routes linking urban centres, the micro centres that partly occupy the agricultural land, etc. As a consequence, another model with the help of three-dimensional symbols (different because of colour geometry and dimension) which represents in the best possible way the characteristics of the settlement has been designed.
Another passage was the joining of the signs to the DEM in the GIS.
In this case it was necessary to make dimensional changes to have a clear reading even in smaller scales (1:10000, 1:20000, etc).
Regarding the infrastructures, the elaboration of the three-dimensional model was focused on the historical roads (those that have signed the anthropic process).
The representation of the infrastructures in the three-dimensional model, is obtained by lines, to every type a style was given and this has allowed to easily identify information in the overlap of the DEM. After the elaboration, there was a careful observation of the isometric views and of the repre-

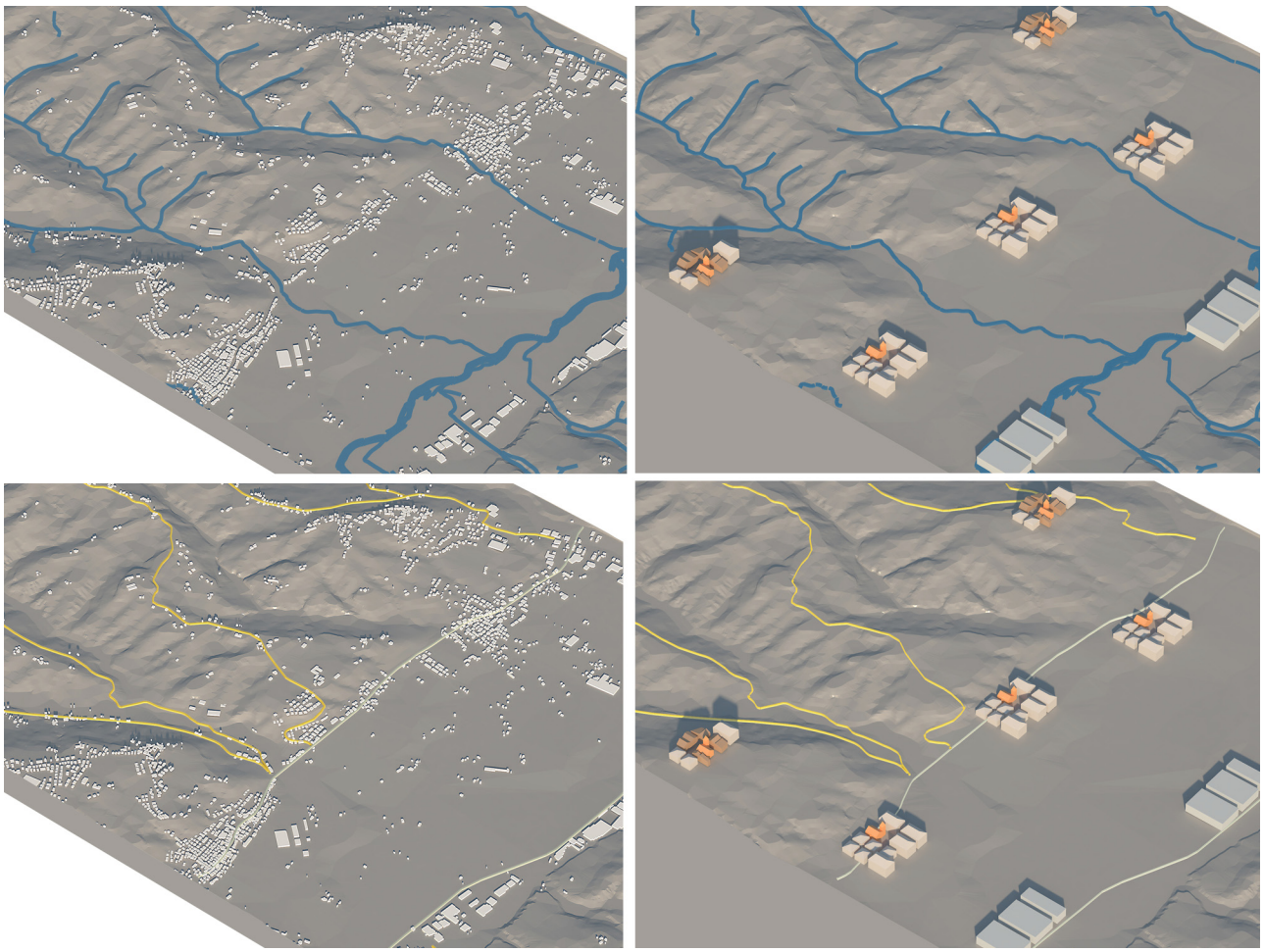

Figure 10 – Isometric representation of the TIN, the cubic building, three-dimensional symbol, watercourses and road axes to different display scales.

sentation scales so as to identify the scale range within which the display of data was efficient.

The two-dimensional representation is intended as a view from above, however to this reading the representation profiles, already used for the 2D geomorphological model, were reckoned, in this case the symbols of the settlement centres were added, because the relationship between these two is very strong.

Amongst the various goals set in this phase there is the demonstration that the type of representation chosen and the definition scale influence the efficiency of utilization of the GIS.

If the representation made with the GIS is dynamic and in continuous growth, the communication of the information can result inadequate for the knowledge of the territory, as object of study. The construction of image of synthesis has in fact introduced a new condition in the representation of elaborated graphic, such as the elaborated model with the informative systems become adjectives to the model of reality and its representation becomes the application. Indeed it is possible to manipulate the model and make different types of representations functionally expressive to the different analysis.

The graphic representation has kept in consideration all the characteristics.

As already done for the geomorphological model, some anthropic elements have been translated in graphic symbols, mainly in the case of data visualization on a small scale 1:20000.

The queries were associated to the two dimensional model which help to know the anthropic information in a simple and automatic manner.

For the ecological category mainly characterized by the use of the land, the research studied was "*Procedure digitali per*

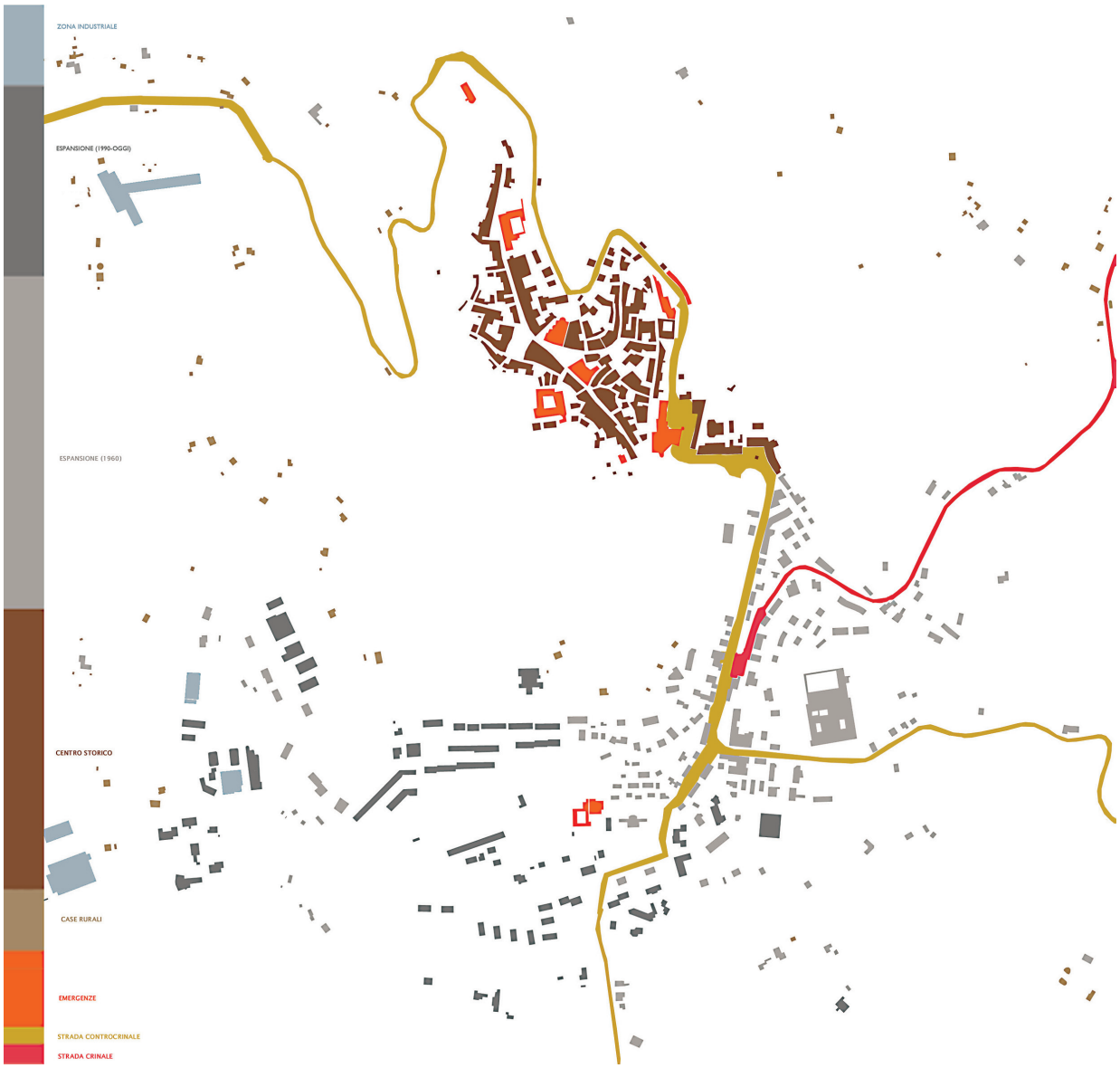

Figure 11 – Ideogramma gave the example of anthropogenic (detail of the settlement of the ridge of Offida).

una nuova cartografia" by Serena Sgariglia [PRIN 2006][15]which has part of the stretch valley examined as a case of study .

The research "proposes to illustrate some procedures identified through specific experimentation, in which the GIS open source chosen have been forced and folded with the purpose of producing accurate cartography in detail, from the different themes and different scales , integrating therefore traditional representation systems with new representative modalities. [...]

Amongst the different possibilities offered by GIS technology there is the one to make the historic cartographic documentation more comparable with the up to date ones, made of substantial importance to understand the transformation of anthropic space and therefore each process of knowledge and development of the environment. In this direction the reasons of the experimentation described is to be traced ,its goal was also to build a geographic documentation project which detailed the ground use in the territory of Appignano del Tronto and to highlight some of the identifying characteristics of the share cropping landscape"[16].

The study is composed of elaborative and cognitive phases, being the motivations of the choice of this area --- based on "valuation of different nature, that is integrating the relative data in support of physical-orographic, with those of geological nature, and with those of ground use"[17]. Following the description of the research we learn that "the first operations conducted concerned the georeferencing [...], working on the union of the eighteen maps that define the area of study[...] It was evaluated that the possible error coming from the video union of historical maps could be however comparable with that of the choice of adopting the Regional Technical Map with a scale of minor detail, therefore theoretically which much less accuracy"[18].

A further elaboration phase of the research regarded "the video digitalization of every single Particle using the QGIS software"[19].

A very laborious operation was the path trace of cadastral parcels across the Gregorian cadastre sheets, and subsequently filling the attributes table and the transformation of the perimeters of the rateable particles in areas across the inclusion of the centroids (operation which consents the connection between vector files and spatial database).

Sgariglia claims that "the data of major interest inserted for

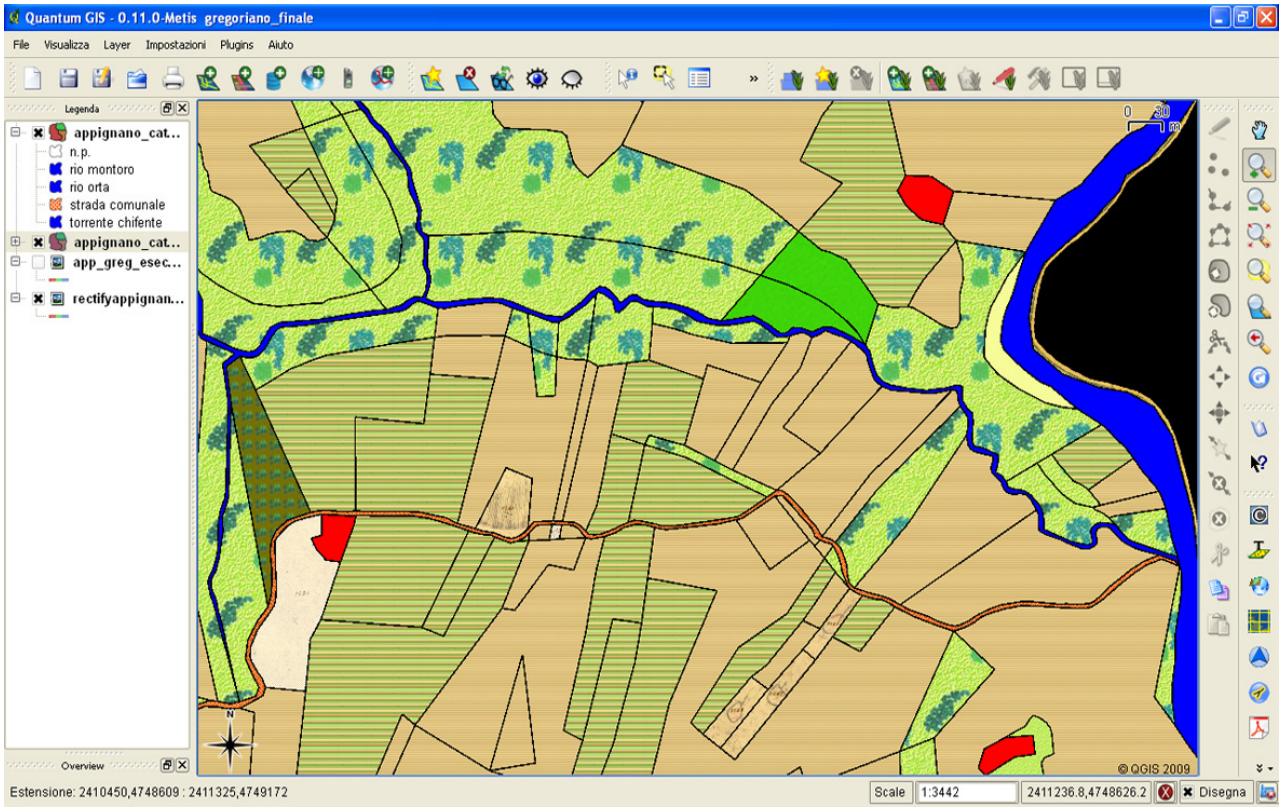

Figure 12 – Particularly the Charter issue of land use: the open space. The polygons are related to the built up in red, blue streams, the different uses of soils are presented with different textures.

15. Pubblicazione PRIN 2006 dal titolo "*Sistemi informativi integrati per la tutela, la conservazione e la valorizzazione del patrimonio architettonico e urbano*", coordinato dal prof. Mario Centofanti, p. 292-301.

16. *Ibidem.*

17. *Ibidem.*

18. *Ibidem.*

19. *Ibidem.*

the research has been the one relative to the use of the land for open spaces and to the building characteristics for the construction in the historic centre. In the first case it has been possible, using some of the simplified software features QGIS (of which in particular the ones dressing the cartographic space that consent the importing of punctual symbologies and personalized colour polygonal backgrounds) elaborate thematic maps in analogy with graphic modes of *cabrei* (collection of maps) and land registers of Marchigian history"[20].

The work done on the analysed research was very complex because it gives significance to enrich the Marchigian database regarding the use of the ground, the building appliances and of the infrastructure of the roads; the database Abruzzo had to be simplified by grouping some of the themes considered similar.

" [...] Created a single structure both for different vector layers and data base, after having them populated, an operation of patch files vector was processed , to recompose in a single cartographic project describing the entire valley transept [...] the image obtained indicates that the cartographic homogeneity corresponds to a non homogeneous o landscape of the two regions, where the Marchigian one is characterized by a regular design of the ploughing fields, while in the Abruzzese one the anthropic presence is less significant"[21].

In conclusion, this study was useful to represent a territory of a complex reality, multiple aspects are analyzed to come to a qualitative and quantitative mostly exhaustive comprehension. It means also to reproduce the current status and the history of the territory, the birth and the phases of its evolution that have modified it through the time.

Such a complex analysis needs to be referred to skills and fields of different studies that can lead to specific elaborations either detailed or partial[22].

Therefore, one of the main themes in the representation of the territory is to provide evidence of this , taking advantage of different analytical contributions but defining a "system" of unitary representation.

The territory representation is intended also as a construction of a relation system made of signs and graphic languages in which collocate data and build information aimed at the documentation, knowledge, management and protection of the territory.

The GIS has favoured in this sense the territorial representation responding to the request of a complex description of the places, to the in-depth analysis of the scales, however in the "classic" representation there is a discretion between the graphic language and communicated information that favours the data legibility. In the GIS the management of multiple data does not always coincides with an efficient representative, mainly for the frequent skips of the reading scale of a territory portion.

These problems emerged in this research trip.

To study the geographical valley system, a reduction and a simplification through models that could entirely describe it were made.

The final model is therefore the re-composition of data of the geographical system, by means of a new system which realizes a more efficient graphic communication suitable for the complexity of the description.

20. *Ibidem.*

21. *Ibidem.*

22. Shannon McElvaney, *Geodesign. Case Studies in Regional and Urban Planning,* Environmental Systems Research Institute, 2012.

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Building Technologies

Integrated and advanced techniques of survey for the definition of lost facies of the monumental architecture

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Keywords: laser-scanning, aerial photogrammetry, architectural survey, philological reconstruction

Abstract

The analysis of an architecture characterized by geometrical, functional and historical complexity requires the fundamental and crucial acquisition of metrics data, iconographic and archival documents, followed by a correct comparison and interpretation of the collected information. The aim of this process is to give a precise critical interpretation of the building - or some of its specific areas - as close as possible to reality such as to allow a reliable reconstruction of those aspects that got possibly lost over time.

In the specific case, this approach wants to offer a vital support to the study of those aspects of the monumental architecture that have been heavily altered by inappropriate interventions.

In this paper, the methodological process is related to a quite large number of interventions on Villa Mondragone in Monte Porzio Catone (Rome), the largest among the princely houses of the Tuscolan Complex. The task, here, is to get an accurate reconstruction of the facades facing Piazzale Maggiore, a large inner courtyard of the vast complex, focusing in particular on the latest large process of transformation, started nearly a century ago.

We based our study on bibliographical sources, on recent years' historical data researches and on the analysis of the iconographic documentation, as well as on surveys of the state of fact by using different techniques. A considerable support to the research came from the use of the new survey technologies, which the main object of this article. These technologies have been managed in an integrated manner on the areas of interest. They have helped to obtain considerably accurate surveys such as to guarantee a high degree of reliability to the reconstructive hypotheses subsequently processed.

On one hand, the survey has relied on the capabilities of the laser-scanner, and of the other hand on the aerial photogrammetry with operations done with different types of UAV (unmanned aerial vehicle) and digital cameras. A series of different reasons required the use of various tools for indirect survey, as shown in the text. The most important one is due to the relevant dimensional characteristics of the building and the surrounding context.

This work is part of a broader line of research on the Ville Tuscolane and here it mainly refers to the applications of the most advanced systems for surveying and modeling of monumental architecture of historical interest. It has provided interesting food for thought and technological and methodological comparison on the theme of philological reconstruction of the lost internal fronts of Piazzale Maggiore of Villa Mondragone. This was possible thanks to some similar elements on the facade facing the outside of the Manica Lunga (the longest eastern side of of the building enclosing the court) emerged during the surveys of this front.

The complex of the *Ville Tuscolane* and the evolutionary phases of *Villa Mondragone*

The Complex of the *Ville Tuscolane* consists of twelve monumental buildings erected around the town of Frascati from the middle of the sixteenth century and used as a summer residence of the papal court and the noble families linked to it. The trend of the construction of the Villas was probably due to the particular orographic and geological characteristics of the area, which led the ancient Romans to do the same: the dry and windy climate in summer and mild in winter, soil fertility, the presence of water, the availability of many high quality building materials (like the Sperone Stone of Tusculum, the Peperino, the Basalt, the pozzolanic ash). This territory was also suitable as a settlement since the old ages, because it was strategic location for Rome and the Roman countryside (suitable for both defensive purposes as well as for the panorama).

The Renaissance Roman aristocracy, for the early mentioned reasons, settled on the Tuscolani Hills with the idea of having a Casino (a home country of the nobles) where to stay according to the criteria of the Romans "otium et studium". The floor plan of these first units was initially inspired to the traditional Tuscan villa-castle characterized by corner towers and the airy loggias. Later, the complex of villas saw the growth of all the original plans through the addition of new wings that followed the strict rules of symmetry and volumes and that characterized, in principle, the architecture of the buildings as we see them today. In this way, the facades facing towards the north (towards the valley) was marked by austere openings, much smaller than those on the Southern facades which, along with the arcades of the ground floor, made more articulate and bright prospects. Moreover, given

the orographic conditions, containing walls were created both downstream and upstream to allow to have flat surfaces.

Between the late sixteenth and early seventeenth century the Villas were subject to other small construction projects and major changes in the external territory, with the placing of gardens and parks. In conjunction with the transfer of the pope's summer residence to Castel Gandolfo (which took place in 1626 for Pope Urban VIII's decision), the attention towards the *Ville Tuscolane* faded and many residents began a slow process of functional transformation that was the first of the causes of alteration of the original structures. Moreover, from the late nineteenth century and throughout the first half of the last century, irreversible changes to the twelve Renaissance buildings happened due to the switches in ownership and to the continuous interventions of functional recovery that may have directly or indirectly been due to the Second World War. In many cases these transformations were far from the canons of philological restoration, with the loss of historic stratification of these monuments.

Villa Mondragone also followed the same evolution of splendor and decadence of other *Ville Tuscolane*. As a matter of fact, after the relocation of the papal summer residence to Castel Gandolfo, the entire complex suffered an increasing decline, which peaked in the early decades of the nineteenth century. At this time some events (in particular, an earthquake of 1806 and the cantonment in 1821 of thousands of Austrian soldiers and knight sheading to the Two Sicily Kingdom) damaged the building so badly as to rouse the population and administrators of Frascati.

This ruinous decline was witnessed by few iconographic documents and some descriptions of the time complaining about, for example, the lack of roof, walls largely collapsed and windows without frames, especially on the west wing of the building (the so-called *Manica Lunga*), as well as disconnection of the floor of the vast courtyard called *Piazzale Maggiore*. A condition, this, that led the artifact next to the condition of ruin.

Only from the second half of 1800, *Villa Mondragone* was saved from its disastrous fate with the decision of the Prince Borghese, who had also tried to start a restoration (substantial one in many ways) in 1853, to conclude an agreement with Jesuits for which the noble family made the property available to a Jesuit College at no cost in exchange for the restoration of the *Villa*. The Jesuits performed many restoration projects in Mondragone since 1865. One of the most important was closing the windows of the arches facing Piazza Maggiore with decorative glasses. Other interventions concern the building installations, the construction of many toilets, re-flooring, the restoration of the stone covering the main staircase and the closure of hundreds of putlog holes.

Since the beginning of the teaching activities of the Noble College, continuous changes were made to the building to meet the growing demand for enrollment and the consequent need for optimization of space and functions. The success of Collegium Tusculanum greatly increased by the end of the nineteenth century when, in addition to the nobles, the doors were opened also to the rich bourgeoisie and upper classes of society. When, in 1895, the finances of Prince Borghese was running out, the College was saved by the Jesuits who acquired the property. They immediately changed their behavior in relation to the property. To cope with the many inscriptions which were again multiplied thanks to the equalization of the *Nobile Collegio Mondragone* to the Royal Institutes, in 1926 they closed the cloister porch on three sides allocating there the refectory.

They had to move from room to room like the noble's apartments. Therefore, when the building was transformed into a College, students had to go out in the yard to go in different classrooms. For this reason they were to construct large corridors on the ground, first and second floor. For this reason, since 1929, the Rector of the College, Aristide Delmirani, choose the engineer-architect Clemente Busiri Vici to design the transformation of the complex. In less than four years new volumes were built. They are mostly large corridors connecting the various floors of the west and south wings facing the *Piazzale Maggiore*, a gym-corridor on the east side and a few rooms for religious in roof-terrace, upsetting the original layout of facades of this courtyard of the building (figure 1).

To hide the differences between the new parts of the building with the ancient, Busiri Vici adopted the solution of dismantling and replacing the panels of Sperone Stone of Tusculum on new and advanced facades. This operation was performed badly and executed only in part for obvious geometric considerations (advancement fronts perpendicular within a concave corner leads to overlapping) and radically change the peculiarities that are present in the corners and in the original facades of the *Manica Lunga*.

In regards to the interventions designed and conducted by Clemente Busiri Vici, we find clear examples of how the process of acquisition of knowledge cannot be based only on the study of historical sources but must be necessarily supported by accurate surveys that are interpreted and read through the eye of a technical researcher.

Laser scanning and photogrammetric survey of the *Manica Lunga* and the southern wing. Methodological, operational and technological aspects

As pointed out in the abstract, the survey based on integrated and evolved techniques (laser-scanning and aerial photo-

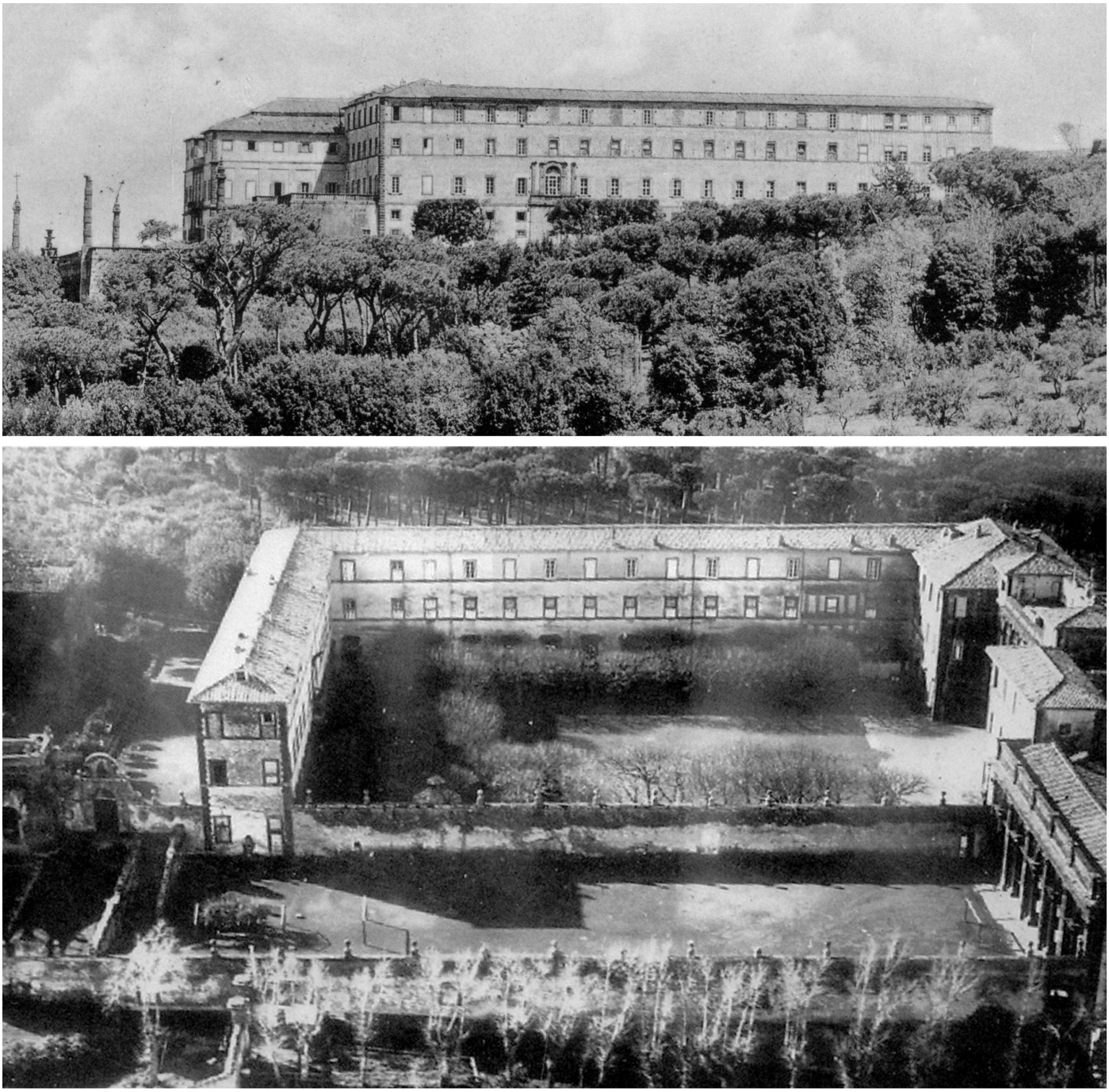

Figure 1 – Detail of antique postcard representing the external western facade of the *Manica Lunga* (top); aerial photo before 1929 representing the internal eastern façade of the *Manica Lunga* (down).

grammetry) of the environment of the *Manica Lunga* and the *braccio meridionale*, built at the beginning of the 900's, and in particular of the facades facing both the *Piazzale Maggiore* and the outside of the *Villa* have provided, as you will see, an interesting point of discussion regarding the accurate reconstruction of *Villa Mondragone*.

Since it is the survey of a building characterized by a large sized structures, it was necessary to draw up detailed preliminary project of data acquisition steps, verify the geometry and dimensions of the artifact, and the accessibility to places. For this reason, laser scanning was chosen to survey the interior of the *Manica Lunga*, and the corresponding facade that faces *Piazzale Maggiore*. The aerial photogrammetry (using UAV) was used to survey the other facade of the *Manica Lunga*, the outer-western wall and the roof of the building, to complete the three-dimensional model.

The decision to use the laser scanner to survey ancient buildings seems, in many cases, obvious due to the numerous and well-known advantages it offers in terms of precision, accuracy, and speed in which information is acquired and data is processed. In our case, however, the orographic conditions and natural objects surrounding the *Villa* (including the pres-

ence of other artifacts, as well as tall trees, which are very close to the facade) does not allow an easy and profitable use of laser scanning for the survey of the external facades (figure 2). This issue has been resolved by using UAV for aerial shots. The possibility to raise cameras has allowed to perform photographic survey of the architectural surfaces were being studied. The numerous images taken were then used for subsequent photogrammetric operations to reconstruct the three-dimensional model of the building.

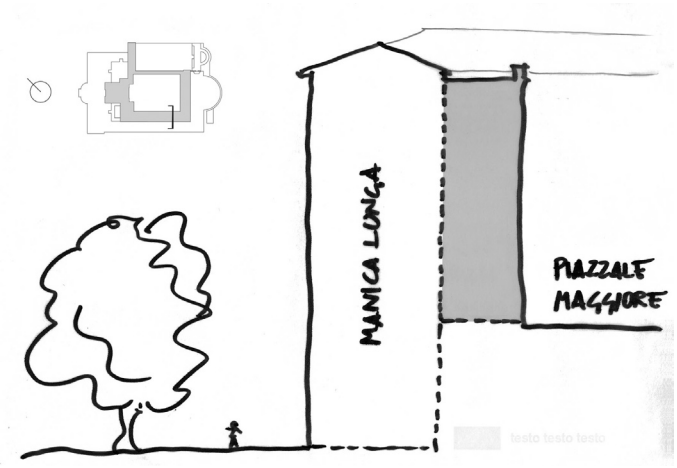

Figure 2 – Sketch of cross section on the *Manica Lunga*. In grey extension of 1929.

Laser scanner technology allows to acquire digitally three-dimensional objects of various sizes in the form of point clouds. The automatic data acquisition erases the previous discretization of the point to be mesured, indispensable step when directly surveying or when using total station. The 3D acquisition systems are differentiated according to the way in which they operate. In particular, within the class of laser scanners used for the survey of the architecture and territory, there is a clear distinction between phase shift scanners (Range Image Scanner) and time of flight scanner. The two types of scanning technology mentioned differ in the way they acquire information. These differences include, the speed of data acquisition, the accuracy, and the range. The TOF method guarantees an accuracy of up to 5mm and a maximum range that varies between 800 and 1000 meters. The RIL, however, has a greater range of accuracy (up to 2mm) but has a more limited scope that only reaches a maximum length of 300 meters.
Comparing the scanner to a light source, there should be enough points of acquisition in order to cover all of the shadow areas caused by the object, undercuts, recesses, and other various inevitable impediments. When estimating the calculation of the final density of the points acquired, one must consider that the overlap of multiple scans increases the density of the point clouds, and this overlap must be equal to about one third of the area acquired in order to ensure a sufficient margin for the final recording. This phase, also called the post-processing phase, is conducted with reverse engineering software, which allows to align the various point clouds captured from different scanning stations. This process may be conducted manually, by identifying at least three pairs of homologous points on two successive scans, or in a semi-automatic manner, exploiting the presence of the target recognized directly by the software. To obtain even more accurate three-dimensional models it is possible to integrate the three-dimensional survey with digital photogrammetry. Most of the laser devices are equipped with an inner camera, which acquires images.The same reverse engineering software allows to align coordinates of the image pixels with those of the points surveyed, applying the photograph on the 3D model and responding to the demand of realism of the 3D model.
The laser scanner used for this case study was the 'Faro Focus 3D x 130' that, under optimal environmental conditions, guarantees a scanning range of between 60 centimeters and 130 meters, a measuring speed of up to 976,000 points per second, and a margin of error between -2 and +2 mm. There were two settings used for the 75 scans (table 1): one for the external (1/2 resolution: one point acquired every 3 mm to a distance of 10 meters; quality 3x: scanning speed of 244,000 points per second; 84 images per scan; length of scan – 10 minutes and 31 seconds): one for the internal (1/5 resolution: one point acquired every 7mm to a distance of 10 meters; quality 4x: scanning speed of 122,000 points per second; 84 images per second; length of scan – 35 minutes and 42 seconds).The settings of the scanner were chosen due to the level of resolution we expected of the final output (figure 3).

Table 1 – Laser scanner settings.

	Spaces	
	External	Indoor
Resolution	1/2 1 pt. each 3.1 mm at 10 m	1/5 1 pt. each 7.6 mm at 10 m
Quality	3X	4X
Speed (pt./sec.)	244.000	122.000
Duration single scan (sec.)	631	222
Number of scans	29	46

The post-processing phase is, in general, the most challenging. The software used was the Faro Scene in its version 5.2.The first operation was to create a new project: the software automatically organized the data in a general file and in a series of smaller sized files, in which they were archived in a 'ranking order', not only the raw scans , but also the chronological

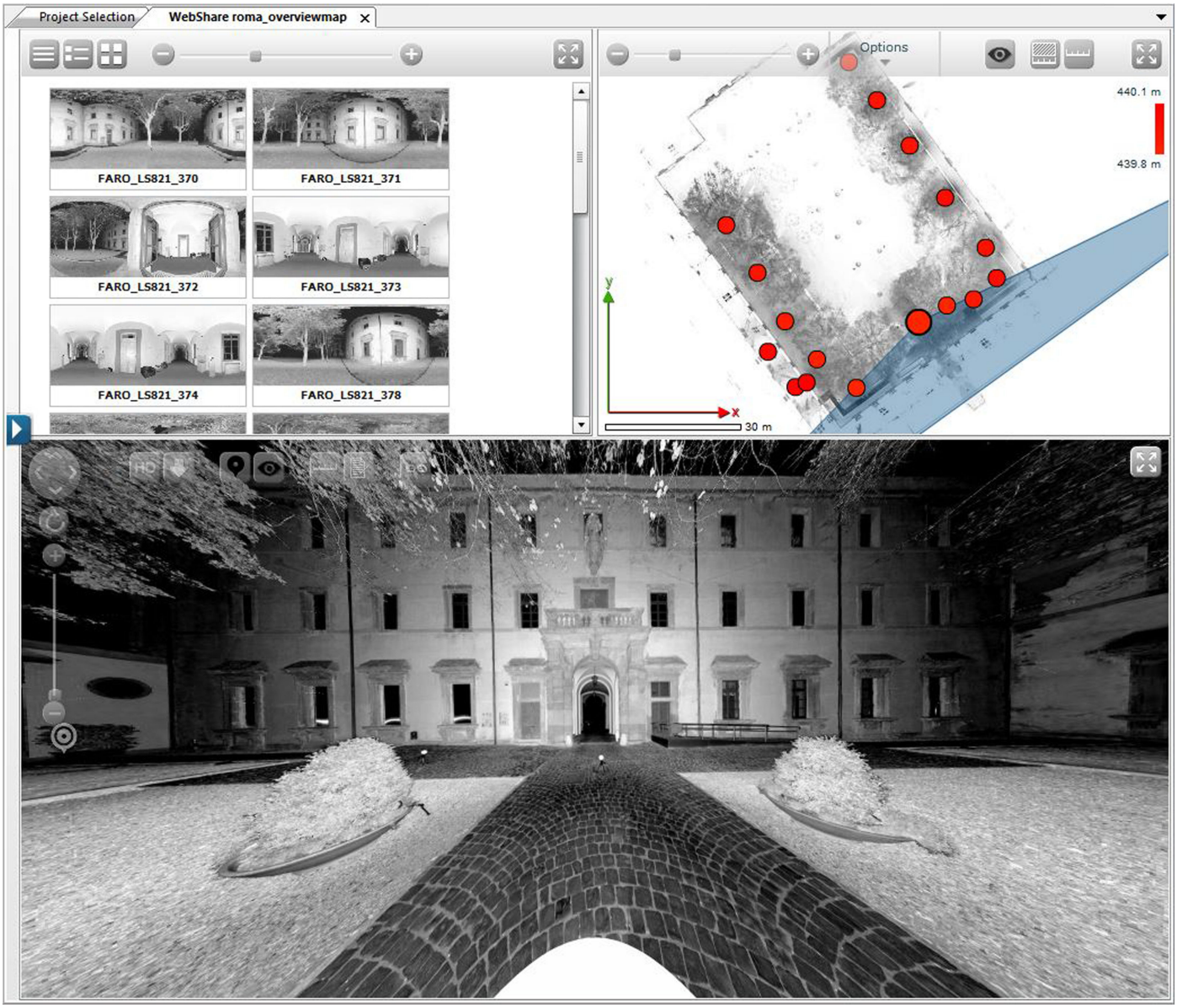

Figure 3 – Overview map with scan positions in *Piazzale Maggiore*.

steps performed within the operation. Within the software, these steps are labeled 'revision'. Once all the scans had been imported into the created project, it was necessary to proceed to their alignment, meaning their positioning in respect to one system of reference. This operation was done semi-automatically because, in the phase of survey, spherical targets were placed on site and chessboard targets were placed on the vertical surfaces (figure 4). The three-dimensional model obtained has more than 400 million points and represents, in true form, a very extensive portion of the *Villa Mondragone,* in this case the first two parts added in 1929, and all the internal facades of the *Piazzale Maggiore* (figure 5).

The photogrammetry area, as said, was used to survey, not only the roof of the *Villa Mondragone*, but above all, the external facades of the *Manica Lunga.* The photogrammetry represents a technique that has been used for a century in the cartographical sense configured with the most trusted method of acquisition of metrical and thematic data that has also been successfully used in the field of architecture. It, infact, allows us to define the object's position, shape, and dimension using the information (the homologous point) contained in the photographic image taken from different perspectives of each individual object. In short, the main principle is based on the stereoscopic vision. In general, three are the steps involved in the photogrammetric survey: the acquisition in which is defined the characteristics of the photographic image, the orientation, meaning the registration of the image and the consequent realization of a three-dimensional models; the restitution, regarding all of the operational outputs and measurements.

For the case-study discussed in this paper, we have used two UAV, equipped with different types of digital cameras. For the

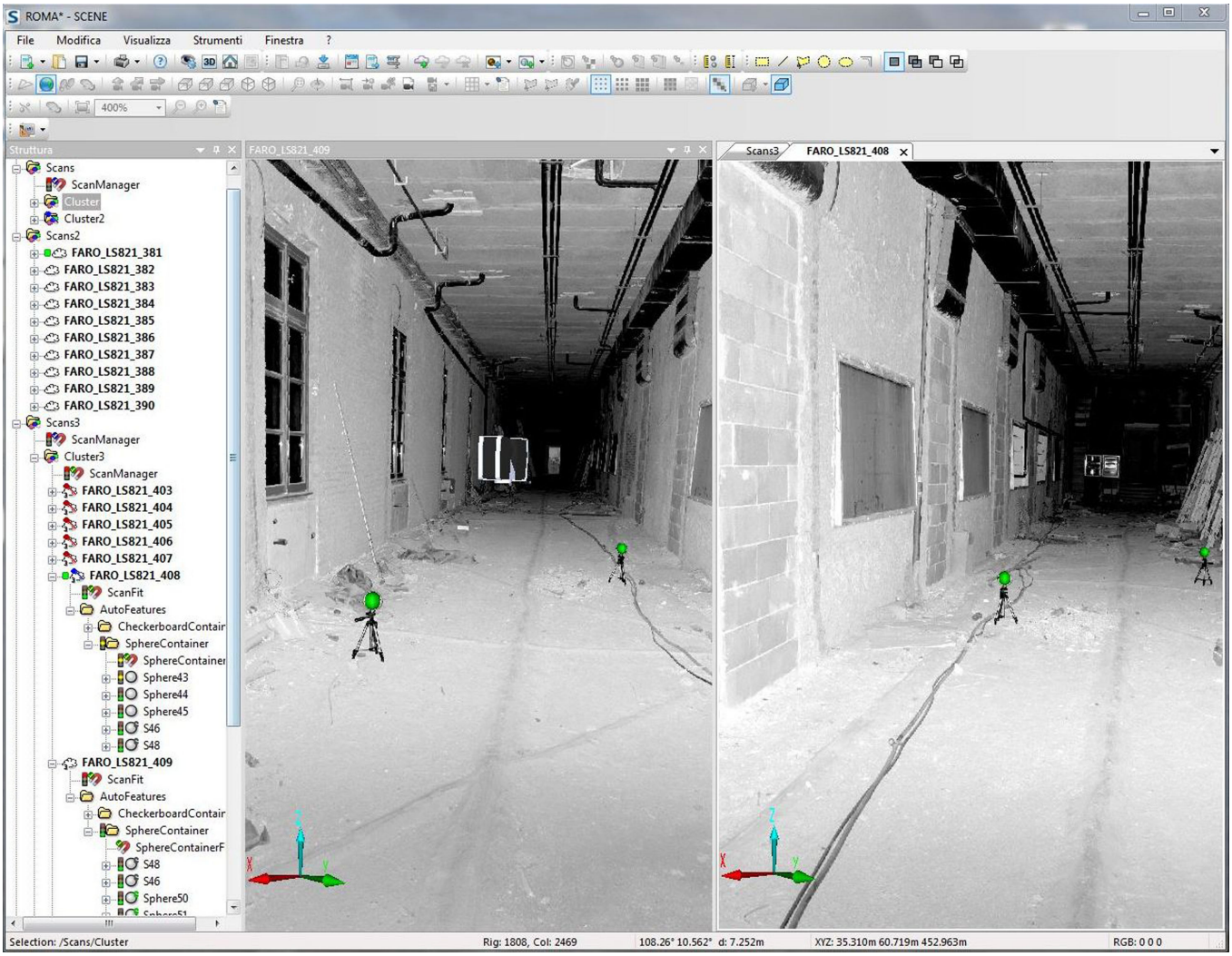

Figure 4 – Scans alignment with spherical target on the extension first floor of the *Manica Lunga*.

Figure 5 – Point cloud model of the *Piazzale Maggiore* obtained by laser scanning.

survey of the roof we used the Aibotix X6V2, an UAV equipped with a GPS receiver, accelerometer and ultrasonic sensors. It has a weight of 3.4 kilograms, a reaching distance of 50 km/h, and a reaching altitude, in optimal conditions, of 3,000 meters. The digital camera mounted on the command post is a 17.2 mega-pixel, mirror-less Olympus E-PL5 with an approximate weight of 450 grams. Once we projected the plane of flight within the AiPro Flight software (figure 6), we took 278 photo shoots using the highest resolution, with an area of overlap

Table 2 – Digital camera settings.

	Ambienti	
	Roofs + gardens	External facade
Resolution (Mpx)	16,1	2,0
Involved surface (mq)	16.000	3.200
Flight speed (m/sec.)	1	0,5
Flight duration (min.)	12	42
Number of pictures	278	2.200

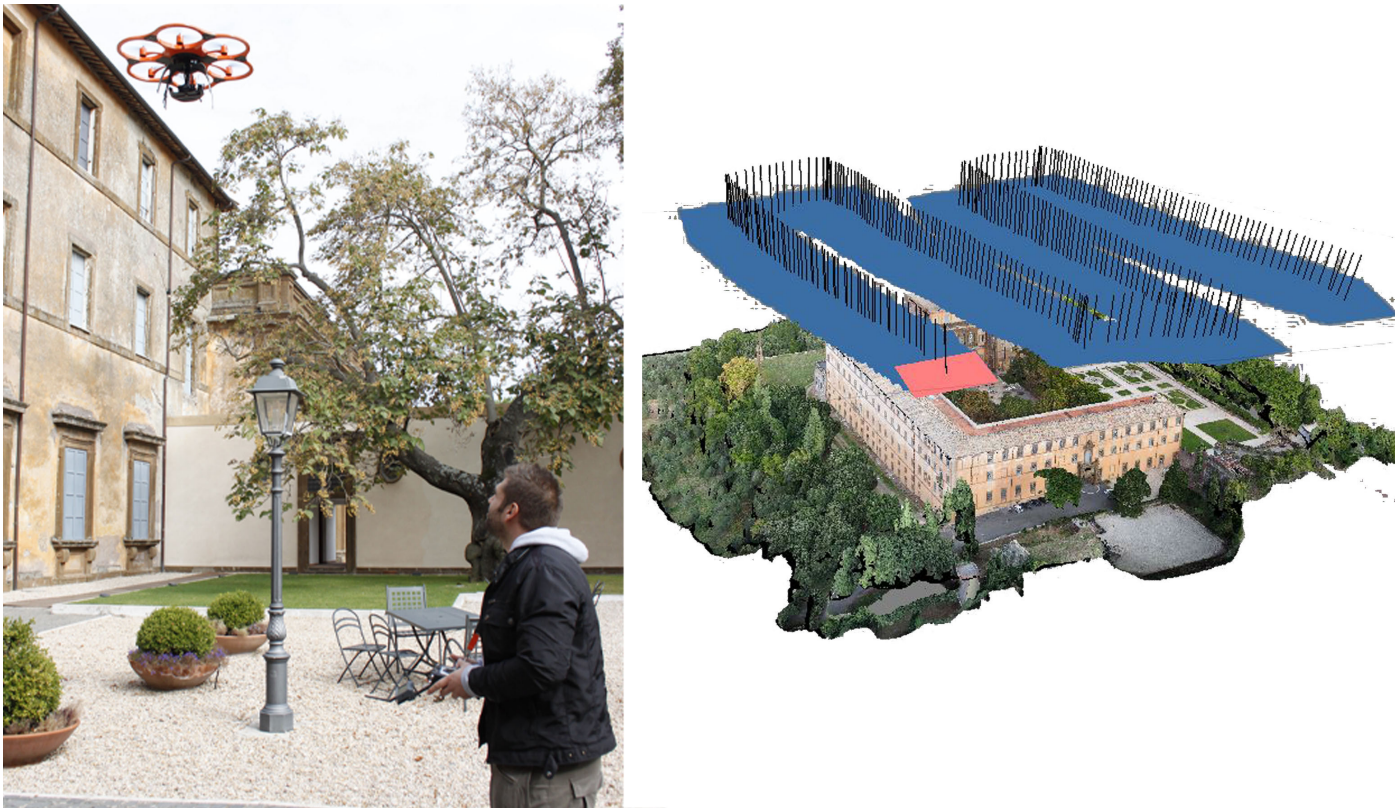

Figure 6 – Drone Aibotix X6 V2 in flight equipped with digital camera Olympus E-PL5 (left) and layout frame on the roof (right).

between shoots of more than 80% at a maximum altitude of about 60 meters above the ground, encompassing an area, aside from the roof, which included the *Terrazzone*, the *Giardino della Girandola*, the *Piazzale Maggiore* and the upstream embankment with a total surveying extension of about 1.6 hectares.

For the survey of the *Manica Lunga's* external facade, however, we had experimented the handmade prototype of an "esacottero"(weighing 2.4 kilograms) equipped with an electronic DJI A2 and with GoPro Hero 3+ digital video camera, weighing only 80 grams, which, is used for sports activities. From this video, in full HD quality, we extracted about 2,200 frames at a resolution of 2 megapixels, divided into 6 flights that framed the entire external prospect, which covers almost 3,200 square meters (table 2). With this instrumentation most of the flight operations, like the speed and course, are manual and cannot be set in advance (figure 7).

The three-dimensional model of the point clouds was obtained from the developing of hundreds of photo shots with the Agisoft PhotoScan software. The most significant operations were those involving the importation of data, automatic pre-alignment, and the frame by frame manual corrections, of at least two pairs of homologous points, and the insertion of the 'support point' coordinates, which were surveyed with the total station and GPS (figure 8). This last operation permits us to correct the measuring errors and to generate a true to form 3D model (figure 9), considerably reducing the distortions directly linked to the photogrammetry operations.

The philological reconstruction of the lost facies of the *Manica Lunga*.

Analysing the historical documentation (surveys, drawings,

Figure 7 – Drone DJI A2 in flight equipped with digital video camera GoPro Hero 3+ (top-left) and flight project on the eastern external facade of the *Manica Lunga* (top-right and down).

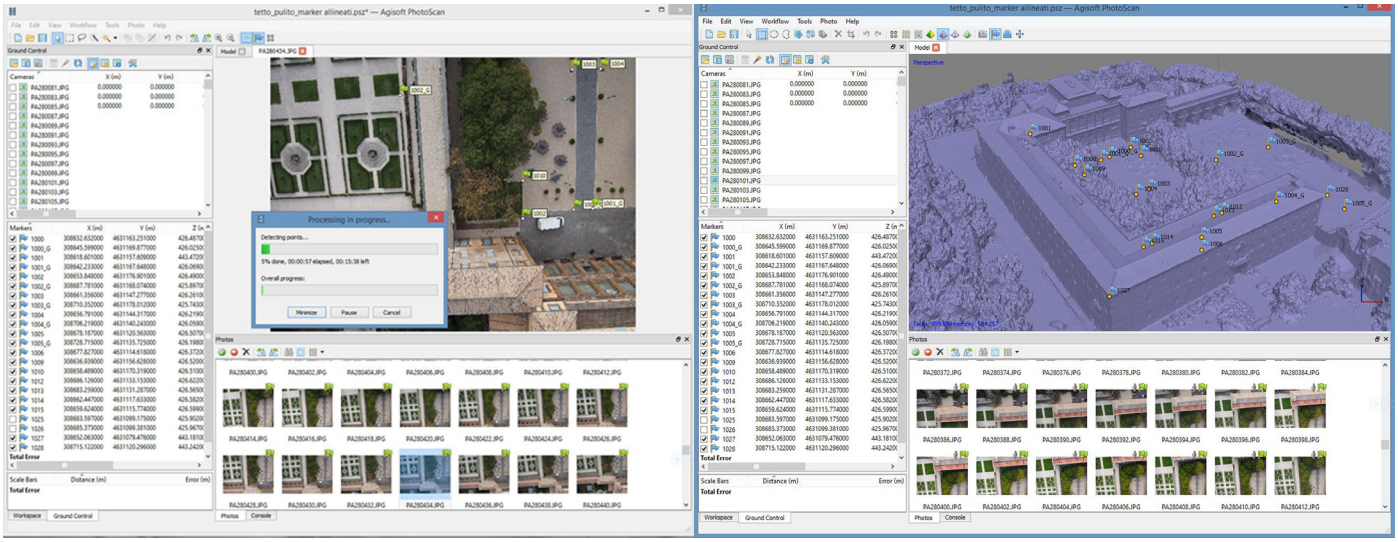

Figure 8 – Import and pre-alignment of the frames, with support points from the total station (left); 3D mesh model of the *Villa Mongradone* (right).

projects, photographs, files, etc.), studying the literature of reference, and especially by the processing and interpretation of the surveyed models obtained using modern technology of acquisition (laser scanning and photogrammetry), we have been able to graphically reconstruct models of the original *facies* of the front of the *Villa* overlooking the *Piazzale Maggiore* as they were before 1929 – more precisely dating back to 1865.

In-fact, once the infographic three-dimensional point cloud model of the enlargement of the *Manica Lunga* and the *braccio meridionale* was obtained, it was possible to realize also the longitudinal sections of the buildings. These sections, located in the added corridors and facing towards the original fronts on the *Corte* (and they were the subject, in 1929, of substantial functional modifications) have been, as will be seen shortly, a great support for the hypothetical recon-

Figure 9 – Point cloud model of the *Villa Mondragone* obtained by photogrammetry.

structions. Also of great importance for these studies, was the photogrammetric survey of the *Manica Lunga's* external façade. It was not restorated by Busiri Vici and for this reason it still shows signs of the 1853 attempted restoration, not visible in the span corresponding to *Piazzale Maggiore*. The orthophoto in true form was used to obtain information about the original compositional proportions of the corresponding 'lost' internal prospect of 1929 (figure 10). Another important contribution to this study was also the three-dimensional modeling (using 3D Studio Max software) of the philological reconstruction of all the internal prospects of the *Piazzale Maggiore* realized with the support of the point clouds obtained by the laser-scanner surveys.

During the first analysis, the construction of the new volumes of the *Piazzale Maggiore* generated the disappearing of the only curvilinear shaped window of the Villa; the vertical lines of the opening of the *Manica Lunga* were reduced from 14 to 13 and from 16 to 12 on the *braccio meridionale,* with the loss of the ancient visible compositional blueprint, in part and with due care, as seen in the section shown in figure 10. The majority of the windows dating back to the situation 'before 1929' were transformed, of course, into linking doors leading to the new volume, the others, instead, were sealed (above-all on the first floor). Busiri Vici also created an axis of symmetry in the facade absent in the year 1865, this axis was emphasized by the displacement, in the central position, of one of the twin doors originally present in the south western angle of the *Corte,* and by the placement of the two new doors through to the extremities of the façade (figure 11).

The small interventions, realized by Busiri Vici in 1929, have misled even some authors who have generally alluded to modernization (Franck), or have attributed the volumes of 1929 to other eras (Belli Barsali-Branchetti) or have not understood the slightest distortion of the layout of the openings defined by the roman architect-engineer (Marucci-Torresi). This allows us to say, that the latest transformations of *Villa Mondragone,* showed little respect for the original historical architecture. In this document, we focused on only one of the many upheavals suffered by the Villa less than a century ago: analyzing even one of these, we can say that one of the most valid philological and critical method to study the transformations of a factory was represented by the reconstruction using the scientific methods of disciplines of architectural survey.

Conclusions

The interpretation of the reconstructive models and drawings proposed in this paper, were obtained, as seen, by accurate surveys taken by using integrated and advanced technologies, this should allow us, thanks to the fundamental support of the study and interpretation of iconographic testimonies and archival documents, to have a better understanding of

Figure 10 – Analysis of the *Manica Lunga*. From top to bottom: orthophoto of the external front obtained by photogrammetry (blue); longitudinal section, obtained from the 3D point cloud model, in correspondence to the hallway with a view to the old front (green); philological reconstruction of lost facies overlooking the *Piazzale Maggiore* modeled in 3D (red); current interior facade obtained from laser scanning (orange). Highlighted by red frame spans of the attempted restoration of 1853.

some of the transformations of *Villa Mondragone.*

This methodology can easily been used for other monumental facilities or in other contexts, becoming a valuable (and perhaps necessary) tool for the correct understanding of the historical layers. There are, in fact, many advantages of digital reproduction, including the acquisition of full 3D geometric objects; its digital reproduction, preserving the information over time; the display of the model on different software platform, etc.

The utilization of the new devices for the indirect survey and the new possibilities offered by the software, which manages the data from the mentioned hardware, in fact, has profoundly altered the method of surveying historical artifacts, and more. That is why, the incessant progress of scientific and industrial research in this field generates continuous technological improvements, and for this reason it is essential to be updated for a responsible and conscious understanding of this type of experimentation.

Acknowledgements

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Although the paper is the result of a joint research, the authors report in agreement that the paragraph 'The complex of the *Ville Tuscolane*...' is attribute to R. M.Strollo, the paragraph 'Laser scanning and photogrammetric survey...' is attribute to S. D'Auria and the paragraphs 'The philological reconstruction...' and 'Conclusions' are attribute to G. Sini.

Figure 11 – Analysis of the southern part of the building. Philological reconstruction of lost *facies* overlooking by the *Piazzale Maggiore* modeled in 3D (top/blue); current facade obtained by laser scanning (down/green).

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Survey, documentary research and stratigraphic analyses of the gothic church of S. Eligio al Mercato in Naples

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Keywords: laser-scanning, survey, restauration, Angevin

Abstract

Digital techniques of survey are an essential tool in the field of the architectural restoration, for investigation of the stratigraphy of the structures, aiming at their chronological collocation in the right historical period. Their spread has been driven mainly by the reduction of the time needed for the survey step, the better reliability of the representation of the historicized artifacts, whose constituents do not have serial characteristics, and by the development of three-dimensional models, queried, which significantly reduce the level of discretization of the survey.

The study proposed in this paper is part of a larger research whose main aim is the construction and testing of a methodological research process that allows easy reading of the medieval buildings in Naples, particularly late medieval religious architecture in Naples. This procedure utilizes the drawing, the survey and the contribution from archival data in order to complete the work with historical information. In particular, the survey, conducted scientifically, allowed to bring out information (alignments, even the smallest variations, differences in wall thickness, anomalies and inaccuracies existing or fake, relations between the various parts of the building) otherwise not deductible.

We summarize here some of the findings related to the interesting case-study of the proto-Angevin church of S. Eligio al mercato, the first religious construction in Naples after the Angevin conquest of the kingdom. Once the artifact was surveyed with laser scanner, the data obtained were used as a database for the extrapolation of significant graphic restitution such as the materical survey of the buildings and the statistic elaboration of metrological data. In the end , these data were compared with the information that emerged from the documentary research, conducted at the Historical Archive of the Banco di Napoli and the Current Archive of the Superintendent of Architectural Heritage of Naples.

In this way it was possible to investigate the stratigraphic complexity of the artifact, confirming, once again, that the layers are not occasional and rare circumstances but instead a reality itself in the architecture and that the analysis of material consistency is essential for their identification and interpretation [1].

The research has led to significant acquisitions related to to historiographical construction phases (modernization, adaptation, restoration) of the church, with significant advances in knowledge.

The Church of S. Eligio al Mercato

The church of S. Eligio is located on the southwestern edge of the Market Square, the scene of memorable events in the history of Naples. The building has walls mainly made of Neapolitan yellow tuff.

The main entrance is located on the right side and is identified by the presence of a Gothic portal, one of the few surviving elements of the Angevin construction.

The interior is characterized by a longitudinal body with three aisles, which is followed by a quadrangular transect. The central nave, higher than the side aisles, has wooden trusses roofing while the aisles, each one made of four bays, are topped with groin vaults, with irregular plan.

During the transformations of the late sixteenth century, it was joined to the church, through the opening of round arches of piperno, and through another aisle, called in the literature "hospital aisle" probably an environment pertaining to the attached fourteenth hospital added to the religious foundation.

All is terminating in a central polygonal apse, on which side there are two-span rectangular chapels , ended by pointed ogival vaults (figure 1).

Historical profile

S. Eligio al mercato is the first Neapolitan religious foundation of the Angevin dynasty, after Naples was made capital of the kingdom. It was built at the initiative of a brotherhood of laymen as charitable work intended to accommodate, in a first stage, poor and the sick people, mostly foreigners, which, especially if poor, came in town without assistance and a burial place.

Charles I of Anjou, on the request of the confraternity, donated the land intended to accommodate the new church on July 2th in 1270. In 1279 a second donation, made by the

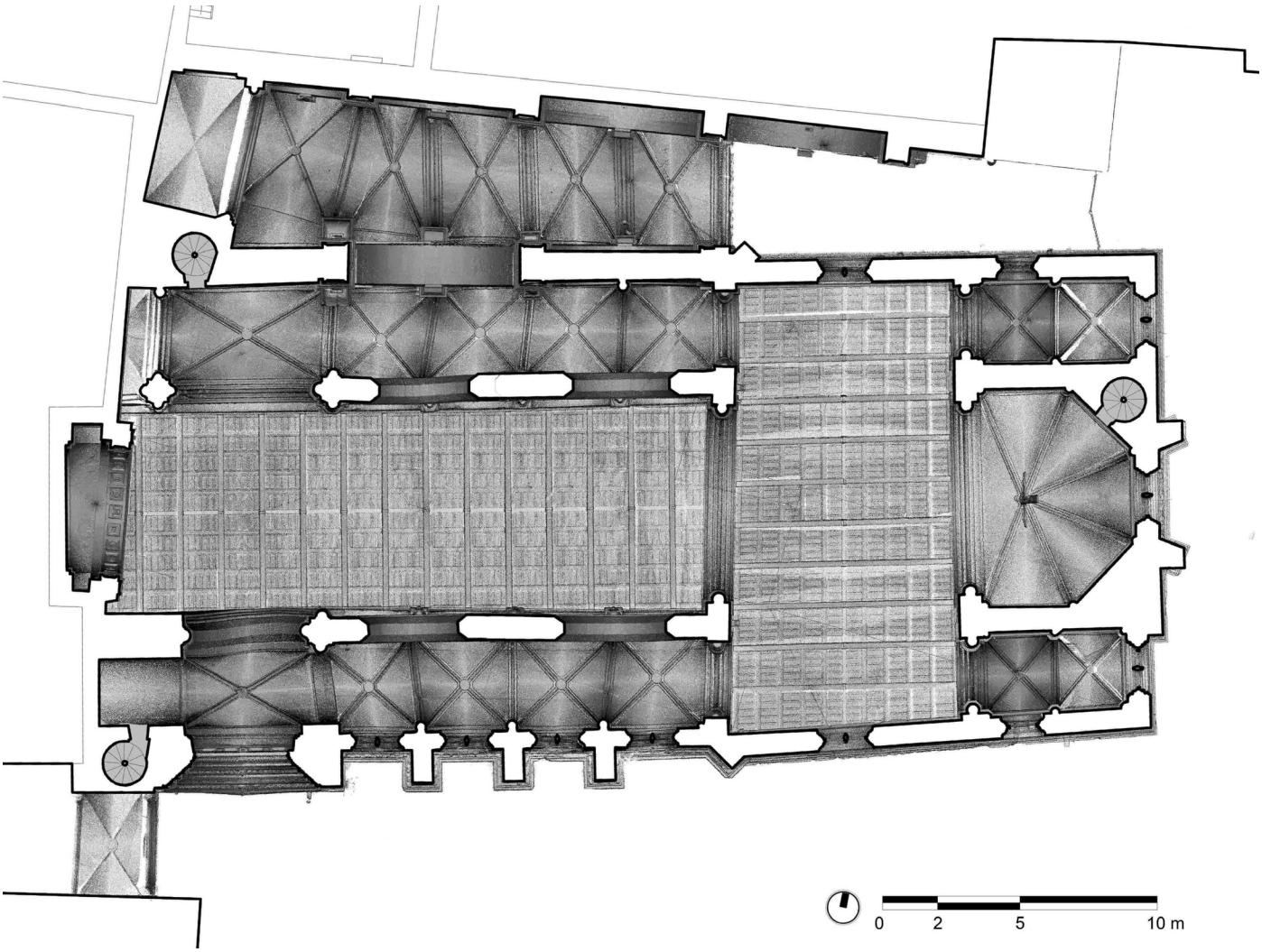

Figure 1 – Naples, church of S. Eligio, plan obtained by the post-processing of the point cloud.

same sovereign, approximately 861 m^2 of land (a band/strip wide 3 and long 41 canes) was placed in order to broaden the church and hospital.

The erection of the care complex underwent several interruptions, due, primarily, to the outbreak, in 1282, of the War of the Vespers, and also to many changes, funded by two donations of Charles II (one of 1302, the other 1304), for the expansion determined by the rapid growth of the hospital, and to the occurrence of instability and, finally, to repair the damage inflicted by the earthquakes of 1349 and 1456 [2].

Until 1546, the church and the hospital were managed exclusively by the brotherhood of laymen. From that date on, for the disposal of the Viceroy Pedro de Toledo, the administration of the church and the hospital was entrusted to three governors, then become five, one of royal appointment, the other elected by the people [3]. From the same year on in the hospital were also accepted women.

In 1592, as private donations (the main economic source the structure) were no longer sufficient to meet the changing needs of the building always in expansion, the governors of S. Eligio opened a public pawnshop.

In the early seventeenth century, the church was subject to further changes; in particular, it dates back to 1602 the payment of ten ducats for the design of a 'nova ecclesia facienda' by architect Francesco Grimaldi. Other works date back to the years 1619-20 by the master architect of the wall Giovanni Cola di Franco [4]. The fragmentary information related to these works, founded in the Historical Archive of the Bank of Naples, do not allow to reconstruct the work in detail, also because of the disappearance of the structures in the seventeenth century during the stylistic restoration.

Conspicuous and systematic are instead the news related to the restoration done in the eighteenth century. As part of the housing and urban renewal (promoted by the Bourbons from the mid-eighteenth century) of Naples, that in 1734 became the capital of the kingdom carolino, the Banco di S. Eligio commissioned, first to Luigi Vanvitelli, in 1766 to Ferdinando Fuga, the renewal of the complex and, in particular, of the church [5]. Archive documents show that in 1769 was opened a transaction account for the 'restoration' of the church. From the registers examined was deducted that several workers were under the supervision of Bartolomeo Vec-

chione. Just to name a few: the chief master Marino D'Acierno, the plasterer Pasquale Fucino, the marble worker Antonio Di Lucca, the carpenter Giovan Battista De Rosa, the smith Francesco Antonio Pellegrino, the gilder Giuseppe Porta and many more. The involvement of so many workers and the considerable amounts of money invested in the transaction (only for the works of marble were spent 5500 ducats) show that the renewals of the church in late eighteenth century, completed in 1774, were extended and systematic.
During the French decade, the pawnshop of S. Eligio was closed; in 1809, a commission was established for the management of the charity institutes in the city, disbanded six years later by Ferdinand IV.
After the Restoration, the literature of reference reports that the architect Orazio Angelini, in 1836-43, transformed the interior of the church, covering it entirely with stucco in classicist style [6]. However, the information founded in the State Archive of Naples attests the repair works in church, dating back to the period between 1842-43, were made under the direction of the architects Raffaele Cappelli, Domenico Mazzamauro and Giuseppe de Leva.
An air raid on March 1, 1943 caused extensive damage to the building. The documents and images related to the works made after the catastrophic event, kept in the Archives of the current Superintendent of the Architectural Heritage of Naples, in part already described in the literature [7], show that the repair of war damage, even for S. Eligio was an opportunity to conduct an extensive reconstruction, with the consequent elimination of baroque looking renewals.

Research objectives

The research aim to formalize the most appropriate working methods (in terms of equipment and technical specifications for data processing) for the survey of the Angevin monuments in order to derive stratigraphic data useful for the investigation of these construction. The survey, in fact, like the restoration, can not be considered a true science because it does not satisfy the Galilean method, cause for different solutions there are different situations and different results; however, the methodology implemented here can be considered scientific.
Before going on to describe this method it should be noted that the survey drawings used in the early stages of preliminary investigation were provided by the Regional Directorate for Cultural and Landscape Heritage of Campania, which are those made in 1992 on the occasion of the "Plan aimed at recovery and restoration of public monuments of the historical center of Naples" cured by the General Superintendent of the time, nominated after the earthquake in Campania and Basilicata.
The comparison between the surveys made in 1992 and those carried out with the use of laser scanners and those who exploit photogrammetry was not a simple exercise of metrics comparison for the search of precision (even if not less interesting) but an important opportunity to see in what ways the measurements produce information useful for the interpretations of the specific restorative practices and, finally, to understand when and how to make use of the two different methods, either separately or in combination, for the extrapolation of data useful for the next phase of preparation of the elaborate of stratigraphic investigation and reconstructive hypothesis.

Description of Methodology

The methodology used for this research consists of three basic steps: the preparation of the draft of the survey project, the acquisition of the metric data, the elaboration and interpretation of the data. In this method, based on laser scanner and photogrammetric survey, the planning phase of the operation, the preparatory moment before measurements in situ, is of particular importance. The use of these techniques in fact requires a specific survey project that indicates the location of the bases and of the target for the network of support and compensation, the definition of the steps of scanning and the resolution of each single range scan, the correct choice of the points of the station, in order to limit as much as possible shadow areas, the choice of passive sensors to be used and, above all, deciding which parts are better to be scanned with one or the other technology or with both. In the case presented here, it was decided to use laser scanner for all surfaces, both internal and external, in order to have a three-dimensional model of the entire structure from which it was easy to extract all the two-dimensional deliverables required for the next interpretation phase, and use the photogrammetric method only for the survey of the facades. The latter, in fact, provides a higher colorimetric quality, essential for the drawing of the survey of the materials. In the next phase of laser scanner survey, the instrument used was the FARO Focus 3D (figure 2) that guarantees, with the highest powerful setting and optimal environmental conditions, a range of about 120 meters, a speed of measure of 122,000 points per second, a maximum error of 2 mm at 25 linear meters of distance and an accuracy of a tenth of a millimeter. Moreover, it is able to take, thanks to an integrated CCD sensor, a number of pictures equal to 84 for each scan with a maximum resolution of 2 megapixels for single photo. They were carried out, in all, 49 scans, of which 28 external and 21 internal (figure 3), with varying resolutions between 1/8 and 1/2 of the maximum resolution (average distance of the scanning step 6 mm to 10 m), for an average span of 6

minutes each, including the acquisition of colorimetric data. (table 1).

Figure 2 – Data acquisition of external facades with laser scanner using spherical target.

Figure 3 – Plan of all scanning stations.

During the acquisition step we made use of both checkerboard target, applied to the vertical surfaces, and spherical target as well, in order to facilitate the subsequent phase of post-processing of the data. In this way, they were included in each scan also the elements of reference useful to the union of the scans themselves: fifty paper plan targets (mark checkerboard) combined with six calibrated balls with a magnetic base (mark registration spheres) arranged at different heights above or near the building and in spots visible from several stations. The pre-alignment and registration of the scans were carried out with the FARO Scene 5.2 software. The results obtained gave acceptable values of error: an average error of overlap of individual scans of 3.4 mm and a standard deviation of 3.0 mm.

In order to compensate for the low resolution of the orthophotos obtained from laser scanner survey, photogrammetric shots have been taken using the Nikon D3100 and Nikon D3200 previously calibrated, and different lenses (18-55 mm, 18-105 mm, 10-20 mm shiftable and a 28 mm). In the shooting step, in addition to the usual parameters (focal plane, focal distance, aperture, average scale of the frame), was chosen the configuration of every single shot. In this specific case both a stereo and a multi-converging images configuration have been used. the first with axis parallel to each other and the latter when the surface to be surveyed is located at a very close distance from the shooting point.

After capturing, the frames have been processed with the software Photoscan of Agisoft to obtain a ortho images of the different facades. The software uses algorithms that allow to direct the frame even if acquired in a configuration not corresponding to the photogrammetric principles. The operations on the set and not through a web server, are completely automatic and the operator can set only certain parameters related to the quality of the final products (orientation and construction of the model). It does not provide explicit indication on the result or the orientation of the construction of the model, therefore the verification tests are based on comparison between reference models (in this case the survey obtained with the laser) or through qualitative observation. Every single facade was scaled using not a known measure, but instead using points acquired by laser scanner. In this way, the obtained cloud of points of the sigle facade by photogrammetry was both scaled and georeferenced according to the data obtained with the laser. In the end, by comparison between the graphics obtained from the three-dimensional survey and those obtained in 1992, it was possible to identify the major inconsistencies and integrate the data with new, more

Table 1 – Laser scanner settings.

	Setting	Resolution	Quality	Speed (pt./sec.)	Time	Number of scans
INTERNAL	Setting A	1/8	1 pt. each 12.3 mm a 10 m	122.000 (4X)	3’ 44”	19
	Setting B	1/5	1 pt. each 7.7 mm a 10 m	122.000 (4X)	6’ 31”	2
EXTERNAL	Setting A	1/8	1 pt. each 12.3 mm a 10 m	122.000 (4X)	3’ 44”	6
	Setting B	1/5	1 pt. each 7.7 mm a 10 m	122.000 (4X)	6’ 31”	12
	Setting C	1/4	1 pt. each 6.1 mm a 10 m	122.000 (4X)	9’ 06”	4
	Setting D	1/2	1 pt. each 3.0 mm a 10 m	122.000 (4X)	30’34”	5

comprehensive and more accurate measurements.

Results

A careful analysis of the related literature showed that the most significant gap in the study of medieval architecture in Naples is constituted by the lack of scientific surveys conducted according to the protocols of the restoration, that can't give information about the complex and stratified materials, and can't represent it and interpret it in different scales of detail like in our case.
Therefore a first result is the creation of a 'scientific' survey conducted using laser scanner technology and photogrammetry. By combining the two different methods of acquisition it was possible to realize a more rapid and accurate representation of the metric data and give specific data about the colors that has a quality suitable for the recognition of the stratigraphic units (figure 4).
As for our case study, the research carried out resulted in significant advances in the knowledge about the construction.

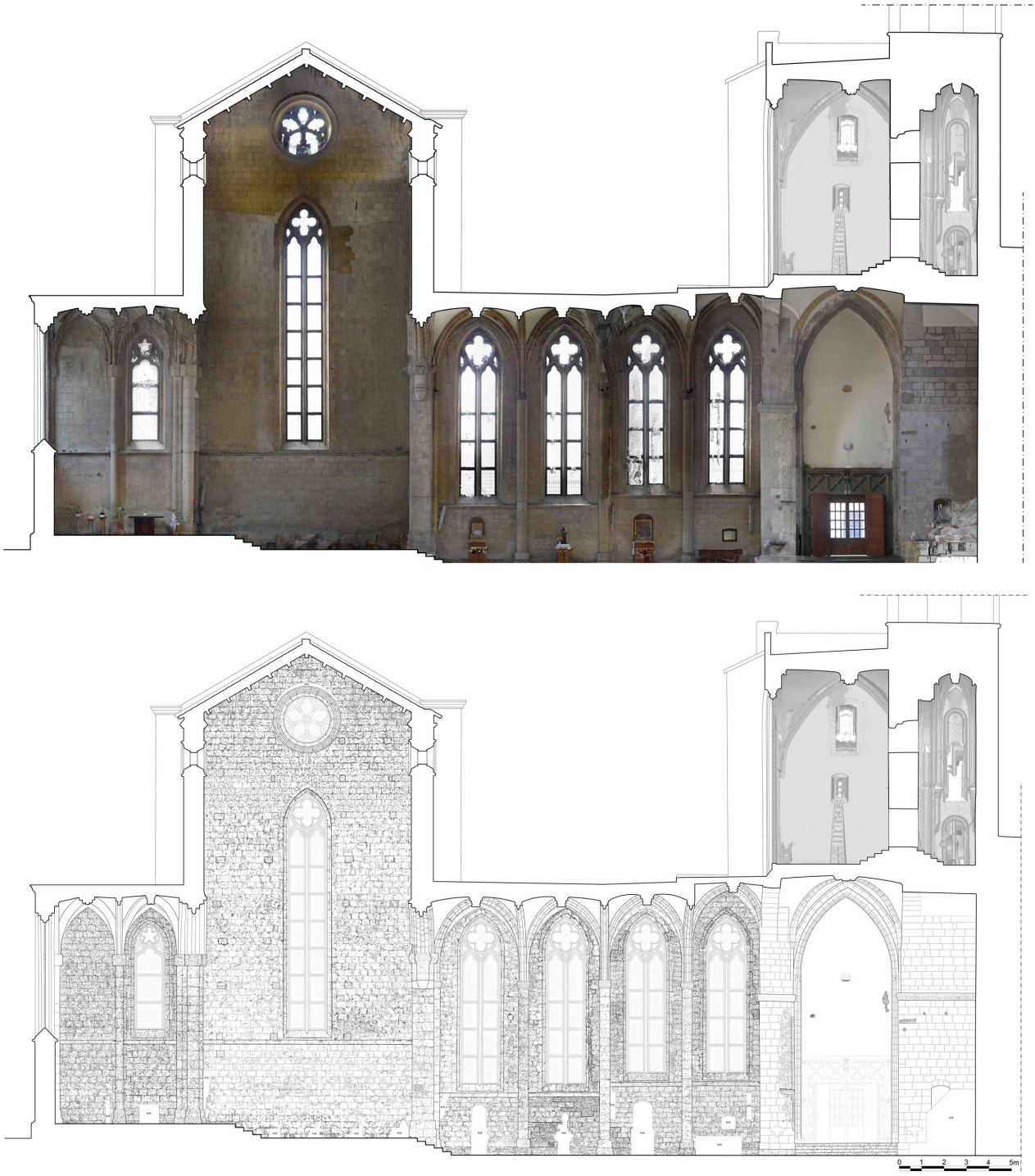

Figure 4 – Naples, church of S. Eligio, longitudinal section, ortophoto (top figure), materic survey (figure below).

In short, through the documentary research it was possible to provide a number of new data relating to the operations of restoration on the building from the eighteenth century. In particular, the information about the operations of the years 1769 to 1774, found in the Historical Archive of the Banco di Napoli, are the testimony of an extensive renovation commissioned by the Banco di S. Eligio to Ferdinando Fuga but directed by Bartolomeo Vecchione. Information on nineteenth-century restorations that regards mainly roofing, found at the State Archive of Naples, seem to deny the attribution of the operations of those years to Orazio Angelini, as reported by most of the relevant literature on the subject; in the end, the new information on the restoration work that affected the building since the war, are the result of research conducted in the Current and Photo archives of the Superintendence for Architectural Heritage of Naples. They made it possible to define, through the study of the drawings, the images and documents of those years, the extended works that interested the building after the work carried out to repair the damage caused by the catastrophic bombing of World War II. Works that have erased centuries of stratification (figures 5 and 6).
The data obtained from the documentary research, compared with the information that emerged from the surveys of materials and drawing plans, allowed to define an accurate set of information about the stratigraphic and a reliable dating. The interpretation of these data, made particularly difficult by the extensive post-war reconstruction, confirms the isolated survival of masonry attributable to the phase of Anjou, of pseudoisodomic type with blocks of yellow tuff, the presence in some parts of the eighteenth-century walls in *bozzette* masonry; almost everywhere it is possible to see the replacement or the reconstruction with blocks put in the first half of the twentieth century (figure 7).

Conclusions

Analyzing the first results achieved it was possible to identify, among the major advantages of digital reproduction, the acquisition of the complete three-dimensional geometry of the object, the storage of the model on digital media, the possibility to preserve the information in the time, the availability of a vast digital archive to be investigated at any time and the possibility to perform analysis directly on the three-dimensional replication. The upgrade compared with the traditional method of study (based on the availability of simple photos of the object or, at most, on wireframe three-dimensional models obtained by direct survey) is remarkable for the final accuracy and quantity of available information (figure 8).

Figures 5 and 6 – Naples, church of S. Eligio, extensive damage to the building after air raid on March 1, 1943 (picture right), repair of war damage (picture left).

Figure 7 – Naples, church of S. Eligio, chronology of structures.

Figure 8 – Point cloud 3D model.

The work here presented also opens the door to several possible developments and, at the same time, identifies a number of issues that require further study. We aim to extend the stratigraphic investigation to all other religious complexes of the Angevin period for which an important database is under realization. Moreover we aim to use the same methodological procedures to investigate even civil architecture of the same period. Through the materic survey of the buildings of different churches it will be possible to distinguish and recognize the few material evidence of the Angevin period for which future research could be directed to their metrological analysis, never performed in a systematic way, so as to achieve a better knowledge of medieval building techniques in Naples.

Aknowledgment

Part of this work is the result of a collaborative scientific work between the laboratories of Architectural Restoration of the Second University of Naples and of the University of Salerno, under the guidance of Prof. Luigi Guerriero, and laboratories of Architectural Survey of the University of Salerno, held by Prof. Salvatore Barba. Special thanks to the Laboratorio Modelli of the University of Salerno that had provided the laser scanner and software for the data processing and to the staff of the Historical Archive of the Banco di Napoli and of the Current and Photographic Archives of the Superintendent of Architectural Heritage of Naples for assistance in locating the relevant material.

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Energy Efficiency in Buildings and Districts

Assessing risk and opportunities in a high-renewables scenario: local planning and new energy landscapes

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Keywords: landscape, renewable energy, local planning

Abstract

With the significant exception of hydroelectric power plants and traditional biomass burning, renewable energy (RE) have so far represented a limited share of global primary energy. However, renewable power generation technologies, with specific reference to wind and solar plants, have consistently followed a steep price-experience learning curve: new solar photovoltaic power plants cost today 80 per cent less than those built ten years ago and since 2013 the world is annually adding more capacity for renewable power than coal, natural gas, and oil combined. The impressive and largely unforeseen reduction of total RE generation costs, together with emerging options for energy storage, is empowering new distributed power generation models and some analysts suggest that electricity produced from large-scale solar plants will be soon cheaper than power produced from any conventional technology, in many European countries.

The perspective of a power generation system strongly based on renewable sources represents a thrilling opportunity for climate change mitigation, but also raise concerns about potential risks. In this context, a first analysis of the Italian scenario is proposed, and the relevance of a possible transition to a power generation system based on renewables in terms of soil consumption and potential competition with agriculture is discussed.

Renewable power plants have generally low environmental impacts, particularly in terms of pollutants emissions, but due to the need of harvesting diluted forms of energy (solar radiation and wind) have a different spatial scale with respect to traditional thermal power plants. The adoption of a distributed power generation model based on renewable sources can produce positive social, environmental and economic effects, but implies relevant transformations at landscape level and hence needs to be properly managed. Local authorities and communities should be aware of the transition scale and importance, being involved and empowered in designing future energy landscapes.

Fostering the adoption of renewable energy, the Italian legislation has introduced the concept of 'not suitable areas' for RE plants, but the approach adopted so far in the authorization process appears insufficient for achieving high quality results at local scale. In this perspective, pro-active planning tools should be adopted to orient the deployment of renewable power plants at district level, filling the gap between building efficiency policies and large-scale energy plans, toward the definition of collectively shared renewable energy landscapes.

Introduction: tracking an unexpected paradigm shift

The global energy scenario is crossing an extremely complex transitional phase: technological, geopolitical, and economic factors are putting pressure on a model – involving power generation, distribution, and energy consumption – that has been structurally stable for decades.

A comprehensive analysis of the global energy system, including the vast debate of Climate Change mitigation heading toward the Conference of Paris 2015 (Colombo, 2014), represents a gruelling task and goes far beyond the means and the aim of this paper. In order to briefly address the sudden evolution of renewable power generation, a phenomenon that has relevant consequences at landscape level and needs to be carefully addressed by urban planners, we have analysed two series of the most renowned reports on the matter at global scale, produced by the International Energy Agency (IEA) and by the Intergovernmental Panel on Climate Change (IPCC).

Until very recently, renewable energy technologies have been considered theoretically promising, but not adequate to represent a substantial contribution to global energy systems. With few exceptions, both technical and economic analysts have been caught off guard by the unexpected reduction of renewable power generation costs, and looking backward at predictions and scenarios proposed few years ago it is possible to appreciate both of the speed of the on-going transition and the dire difficulty of making today even short-term assumptions in the energy field.

The International Energy Agency has published since 2006 the bi-annual report *Energy Technology Perspectives* (IEA, 2006, 2008, 2010, 2012 and 2014), based on a model developed to study global energy efficiency and CO_2 emission reduction potentials, including the role of renewable power generation in tackling climate change. This approach makes the series easily comparable with the IPCC reports on climate change mitigation prepared by the Working Group III (IPCC 2001,

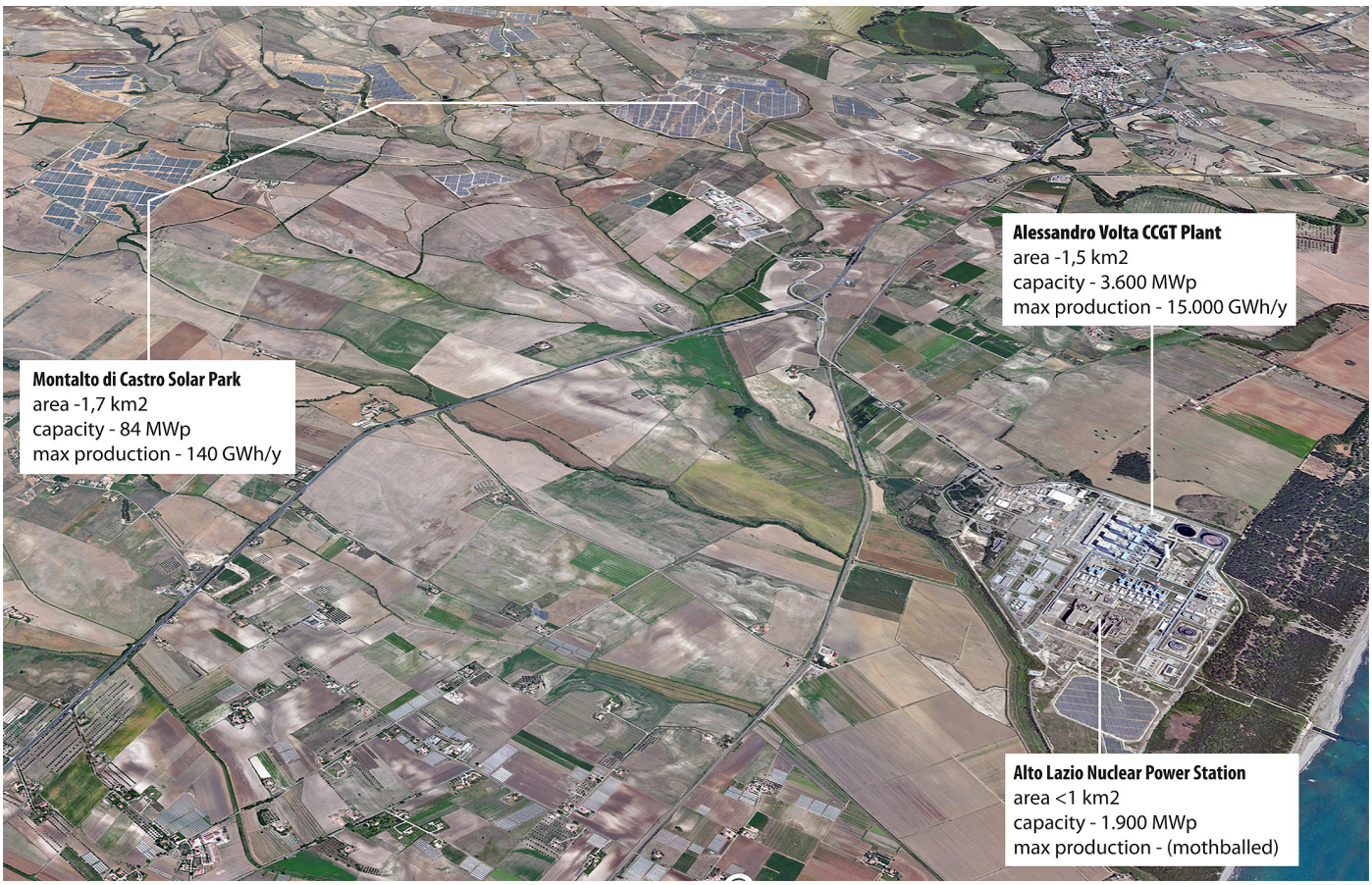


Figure 1 – Power generation technologies and land use. Comparing different magnitude scales in the emblematic context of Montalto di Castro (Italy).

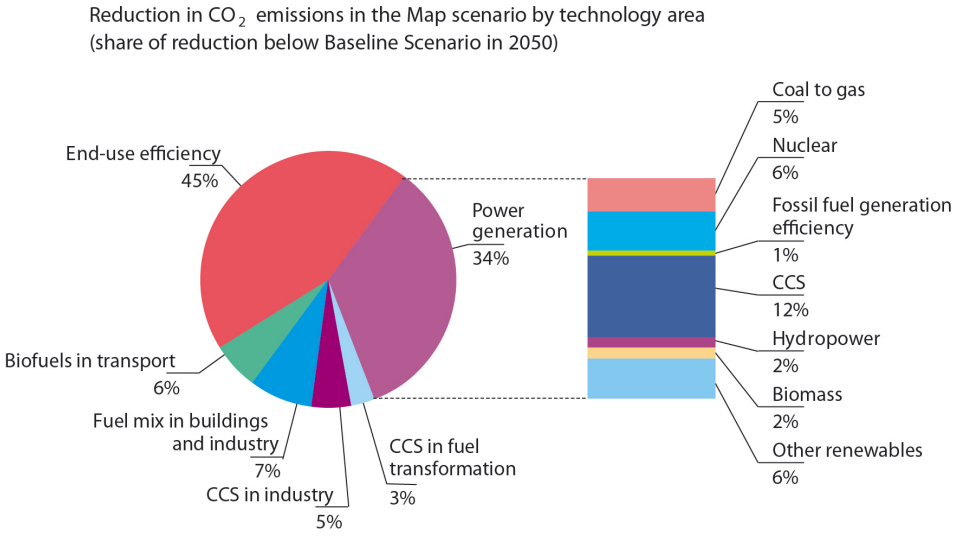


Figure 2 – Potential contribution of technologies in reducing CO_2 emissions by 2050 in the IEA 2006 Energy Technology Perspectives (IEA, 2006).

2007 and 2014), considered here as suitable benchmark[1].

In 1990, renewable energies were barely mentioned by the IPCC among the technical options for tackling climate

1. Indeed, earlier IPCC studies (IPCC, 1990 and 1995) appear today as sights from another world: it was in 1990 when the third energy crisis, after the 1973 and 1979-80 crises, caused by the Iraqi invasion of Kuwait, was quickly resolved by the US led intervention, hence confirming an apparently undisputable energetic status-quo. Not surprisingly, the main strategies proposed at that time for reducing greenhouse gas emissions were efficiency improvements, fuel substitution, gas removal or fixation, and behavioural change (e.g. increased work in homes through information technology, modal shift in transport, etc.).

change. More interestingly, the attitude toward renewable energy still wasn't changed 15 years later.
In the 2006 issue of Energy Technology Perspectives, the EIA still considered renewable power capable of a mere 10% contribution, including hydropower and biomass, in reducing emissions by 2050, against the baseline scenario.
The hopes for emission reductions were still mainly put in end-use efficiency (45%) and in the application of Carbon Capture and Storage technologies (CCS, 20%), with nuclear power accounting for a limited 6% value. In this context photovoltaic power generation (PV) was pitilessly judged: unless a technological break-through it was not expected to become ready for mass deployment before 2030, and the investments required considered in the order of USD 100 billion: much larger than for any other renewable technology (IEA, 2006).

The rise of high-renewables scenarios

When considering the potential of a technology in reducing carbon emissions, deployment rate is an essential parameter. Many models used to build mid-term predictions, including IEAs, have considered linear growth rates for RE technologies, while wind and PV have grown exponentially: during 2014, cumulative PV capacity reached 177 GWp, sufficient to supply 1% of global electricity demands (IEA_2, 2014).
In a context where the world is annually adding more capacity of solar and wind than coal, natural gas and oil combined, several studies has gone far beyond IEA and IPCC positions, advising a drastic reconsideration of the role of solar power in future energy systems.
This is the case of the AGORA report published by the Fraunhofer Institute for Solar Energy Systems (Fraunhofer ISE, 2015) that have analysed current and future cost of PV for large-scale power generation, urging a fundamental review of cost-optimal power system pathways[2].

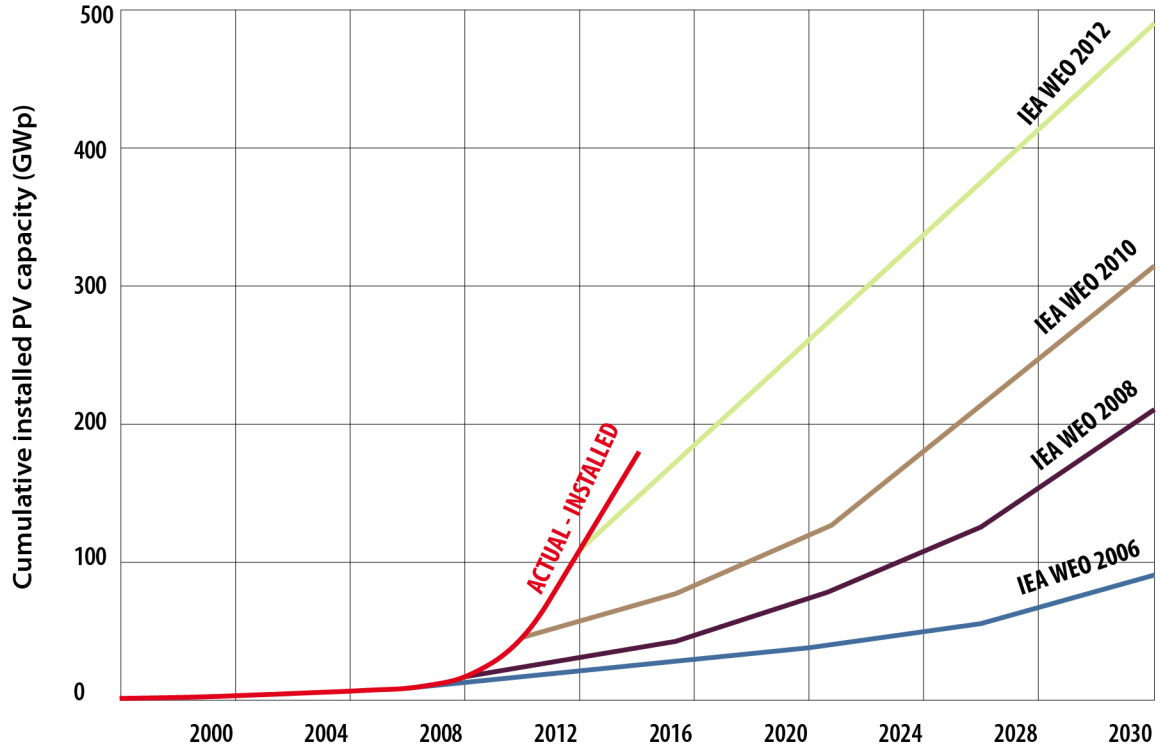


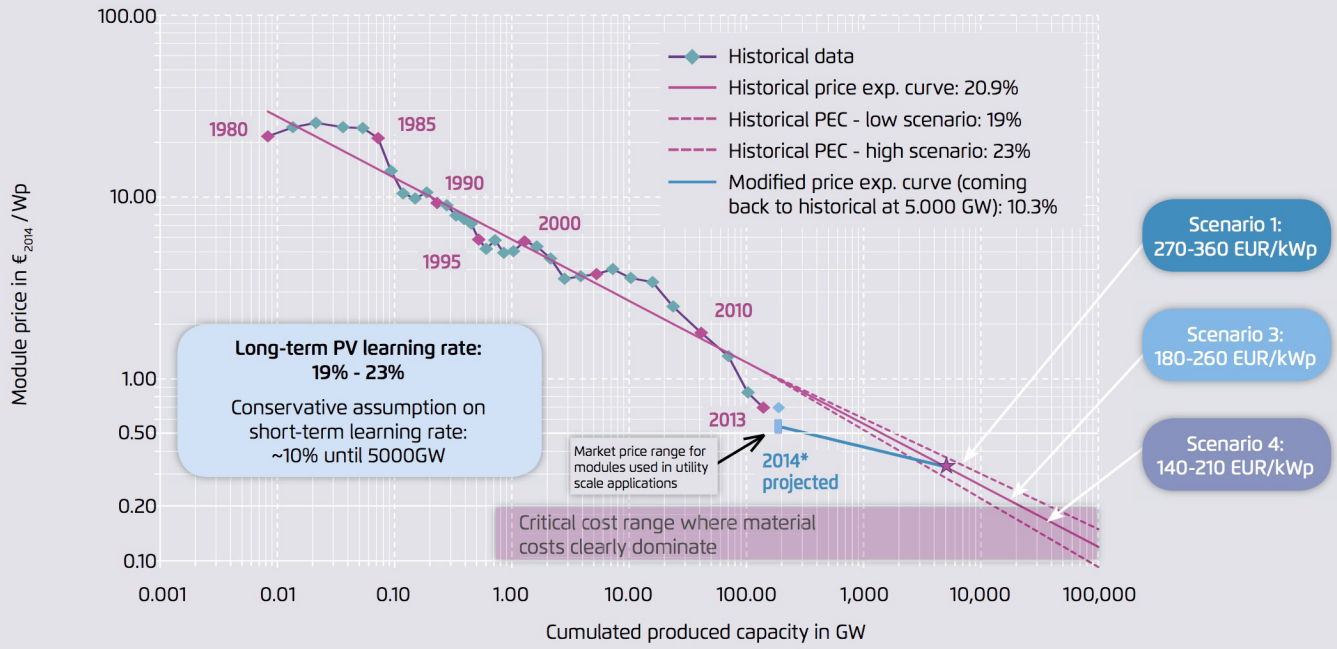
Figure 3 – Actual growth of installed PV capacity confronted with IEA World Energy Outlook scenarios.

IEA and the IPCC have analysed in depth solar PV and wind power – the two technologies of our greater concern due to their potential impact at landscape scale – in specific studies (IPCC, 2011 and IEA, 2014). However, only in 2014 the IPCC Work Group III recognized that, in the seven years after the previous assessment report, renewable energy had become a fast growing category in energy supply, with many RE technologies having advanced substantially and achieved technical and economic maturity (IPCC, 2014 – TS3.2.2).
In 2014 IEA has similarly shown a new attitude toward renewable power generation, in contrast to the former very cautious position: the Agency has actually been forced by the facts at continuously adjusting its forecasts, increasing the highest expected contribution of PV to the global electricity by 2050 from 7% (IEA, 2010), to 12% (IEA, 2012) and finally to 16% (IEA, 2014).

2. Fraunhofer expects LCOE (Levelised Cost Of Energy: the price at which electricity must be generated from a specific source to break even) to decline to 2-4 $€_{cent}$ per KWh (compared to IEA's 4-16 $US\$_{cent}$) and worldwide installed PV capacity to reach as much as 30.700 GW_p

The analysis takes into account all costs related to large-scale PV generation, and indicates that power produced from large-scale solar photovoltaic plants could be soon become cheaper than power produced from any conventional technology in large parts of Europe.
In the context of the present study, it is important to underline that a large scale deployment of PV does not necessarily imply the adoption of ground-mounted power plants, which can determine "large scale" impacts on the landscape.

Future module prices in different scenarios based on the historical "learning rate" Figure E2



Fraunhofer ISE, own illustration

Figure 4 – In logarithmic scale: historical learning rates in PV module prices and future price scenarios (Fraunhofer ISE, 2015).

Regional and even local conditions definitely do matter in determining the economic convenience of RE: in many contexts competitiveness has already been reached[3]. According to IRENA, in 2014 new European onshore or mainland wind projects have provided energy at a lower cost than conventional systems (IRENA, 2015). As a consequence, the theme of regional and local convenience of RE sources has become extremely relevant for planners, although it is not clear if intermittent RE sources will be predominantly integrated at local and regional scale, or over long ranges.[4]
As already mentioned, it is almost impossible today take robust assumptions about the mid-term evolution of the global energy system: meanwhile, from a planner's perspective, it is important to consider renewable power generation as a single 'technology package', together with transmission and energy storage technologies. Indeed, the relative efficiency of these factors can affect economic and environmental equilibrium, hence producing different solutions on the ground, and therefore different cities and different landscapes.

Assessing risks for land use and landscape of renewable energy technologies in Italy

After a short period of European supremacy, large industrial states like China or US are rapidly surpassing European nations in terms of absolute installed RE power. For general comparison, in 2013 only China has installed 51 GW of RE,

(compared to IEA's 4.600 GW_p) by 2050.

3. In January 2015, the tender for the second phase of Mohammed bin Rashid Solar Park in Dubai was awarded to the lowest bidder for a value close to 5 $\$_{cents}$ per KWh for a 25-year fixed contract: the lowest solar price ever achieved worldwide, already competitive even in an oil producing country like UAE. According to IEA 2014 projections, the proposed price should have been reached only in 2050.

4. An international study group (Breyer C., et al., 2014) have recently proposed the economic convenience of a 100% renewable generation mix in the whole North-Eastern Asian region, from the Gobi desert to Japan, achieved connecting wind, hydro and PV solar plants in a high voltage direct current transmission (HVDC) supergrid, deployed at continental scale with the support of a power-to-gas storage system.

which roughly corresponds to the total Italian renewable power capacity. In some sectors, however, European nations are still in the frontline, being the firsts experiencing intermittent renewable power as an essential part of their electricity supply: during 2014, Italy has actually been in the first place worldwide for PV generation, with a share close to 8%, (44% of renewable electricity), followed by solar (21%), bioenergy (16%), wind (14%) and geothermal energy (6%).

Considering renewable technologies risk in terms of land use and landscape, it can be observed that hydroelectric and geothermal installed capacity is basically unchanged since decades, and residual potentials can be considered negligible[5].

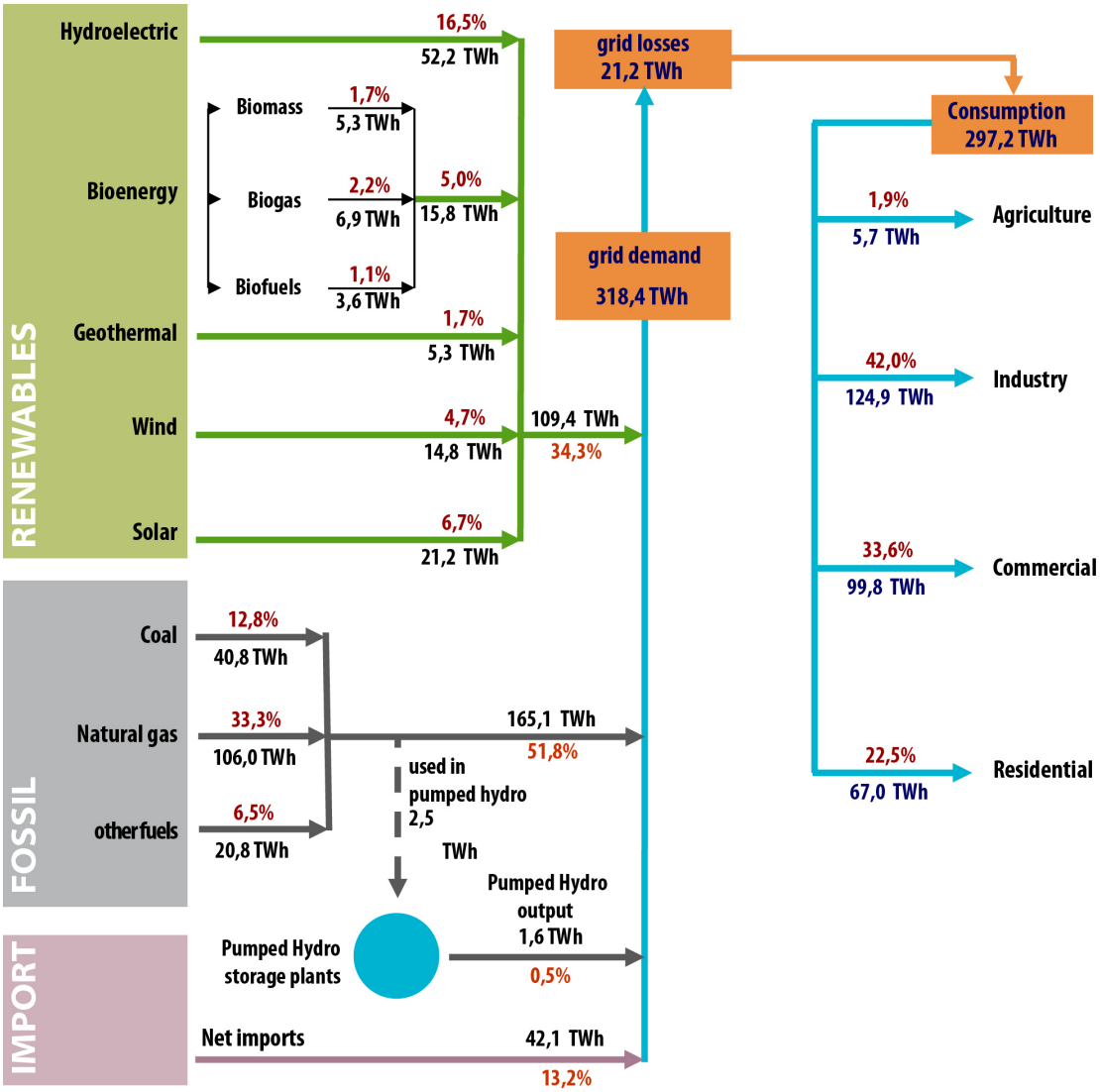


Figure 5 – Contribution of RE sources in Italian electric power generation, year 2013. Data GSE (2015).

followed by Greece and Germany (IEA, 2014).

Taking into account the electric, thermal, and transportation sectors, in 2013 Italy has consumed 20,7 Mtep of renewable energy, corresponding to 16,7% of total primary energy demand (124 Mtep): a value already close to the target assigned to Italy by the 2009/28/CE Directive for 2020 (17%) and in line with the National Energetic Strategy – SEN, that foresees a 19-20% renewable share for 2020 (GSE, 2015).

In the electric sector 600.000 renewable power plants are operational in Italy, for an installed capacity of 50 GWp, which have produced 112 TWh of electric power (9,6 Mtep) in 2013. The main renewable source has been hydroelectric energy

Conversely, biomass production represents the first renewable source in terms of share of Italian primary energy[6], and

5. Geothermal plants are presently concentrated in the provinces of Pisa (53,7%), Siena (24,3%) and Grosseto (22%), and although some minor plants have been recently installed, a relevant deployment of this technology is unlikely. Many mini and micro-hydro projects have been introduced in the last years, and the environmental assessment of new projects can represent a relevant theme at local level. However, all the Italian mini-hydro power plants have a combined capacity of 3 GW, and cannot represent a viable solution for the structural needs of the Italian energy system, nor a significant overall potential threat in terms of land use.

6. In 2013, biomass provided 7,5 Mtep in the thermal sector, 1,25 Mtep (biofuels) in the transport sector and 1,5 Mtep in the electric sector (GSE, 2015).

potentially involves a great part of national ecosystems.

In the context of the present study it is worth noting that an exhaustive analysis of the risks of a substantially higher use of biomass in the national energy mix should consider a challenging number of factors, including forestry and agricultural policies, as well as air pollution regulations at European and national level. Moreover, these implications put biomass production for energy uses partially beyond the range of effectiveness of urban planning instruments. Linkages between biomass, energy and land use represent a peculiar subject that needs to be analysed with the support of specific studies that cannot be exhaustively treated here.

As a general remark it can be said that agricultural waste and by-products will indubitably play an important role in sustainably integrating the Italian energy system, while feedstock production dedicated solely at producing electric power or fuels should never be considered a viable option. Conversion of sunlight into power through photosynthesis is 100 times less efficient in comparison with PV plants (World Resources Institute, 2015), therefore the use of bio-energy must always be conceived in terms of co-production of goods and in synergy with ecosystem services empowerment. In this perspective, forestry and co-generation power plants, as well as biogas plants combined with agriculture and livestock, can constitute integrated value chains, capable of positively contributing at environmental and landscape level, and pondered as such, with all the complexities indicated above, within local planning instruments.

Considering wind, Italy does not have a potential comparable with European states like Germany, Nederland, and Great Britain. Installed wind capacity is above 8.5 GW, which is surely significant, but already represents more than half of total inland potential for large generators, which has been consistently esteemed at 12-13 GW (RSE, 2012)[7].

The complex relationship between large wind power plants and landscape, including environmental issues and social acceptability, has been acutely debated during the last ten years (Puttilli, 2014), and the main assessment references have been well summarized in the already cited RSE monographic study on wind power (RSE, 2012). In the context of this brief review it is sufficient to underline that maximum wind power generation for Italy is inherently limited, and although significant in the national electric mix, wind power cannot be radically increased. Wind plants presently operating in Italy are 6.400, with an average power of 1,3 MW each; their number can be increased up to 10.000, but not much further. Therefore, the maximum theoretical impact of wind power in terms of land use, considering a soil footprint[8] of 3 hectares for each generator, corresponds to a total of 300 km^2, which roughly corresponds to 0,1% of the Italian total area (300.000 km^2 circa).

Small wind plants are not deemed capable of significantly contributing to renewable power generation due to reduced efficiency, which is substantially dependent to the physical dimension of the generator, and higher costs. However, the reduced impact on environment and landscape, with respect to larger plants, can make micro-wind plants attractive and worth of consideration for local planning in specific contexts.

All renewable technologies analysed above are inherently resource-constrained[9]: biomass is limited by competition with food production in agricultural land, high-temperature geothermal, hydro, and wind energy by local availability of potentials.

Therefore, all this technologies can be further developed and deployed in the Italian context, but cannot represent a game-changing option for our energy system and for the Italian landscape.

This is not the case for solar energy. As summarized above, solar power presently represents 8% of Italian electric power production (21,5 TWh/year, corresponding to 2 Mtep) and only 1,6% of primary energy demand. However, solar power is not resource constrained and other factors have to be considered, in order to quantify the potential impact of a large-scale deployment of this technology.

The integration of high shares of not-programmable RE in the electricity system is challenging, although the Italian grid appears already able to manage larger shares of intermittent power without structural problems. The considerable storage capacity represented by Italian pumped-hydro reserves, able to provide 8 GW of power and 8 TWh of storage[10], is basically underutilized and the national transmission system operator has recently been capable of flawlessly managing a solar eclipse[11], demonstrating the Italian grid resilience to PV-induced unbalances. In the longer term, the promising trends in the development of energy management and

7.This figure also corresponds to the target defined by the PAN (National Action Plan for renewable energy), which is of 12,68 GW wind capacity in Italy by 2020, with a production of 20 TWh/year.

8. The indicative, precautionary value of 3 ha of non exclusive land use is suggested assuming the diameter of a 4MW generator (120m), which corresponds to the maximum diameter presently adopted for inland plants, taking into account the minimal distances between generators within a wind farm.

9. Due to their negligible relevance at landscape level heat pumps are not mentioned here. Heat pumps remarkably contribute (2,5Mtep in 2013) to the thermal energy sector needs, taking advantage of the unlimited thermal potential of soil, water and air.

10. The feasibility of further 3 GW – 9 TWh of pumped-hydro storage has been investigated (RSE, 2012).

11. According to Terna (Italian transmission system operator) the recent solar eclipse event occurred on March, 3rd 2015, has strayed only ±25 millihertz, which is about the half of normal variability in Europe's grid frequency.

storage solutions, from short period regulation to long-term storage, including power-to-gas conversion, do not permit foreseeing an *a priori* absolute limit to the deployment of solar power plants.

In conclusion, although the Italian PV market is presently stabilized at very low levels (the market is presently esteemed at 1 GWp of installed PV power per year, circa), is important for local planners to pay special attention to solar technology, because due to rapidly declining costs, in combination with the lack of evident physical or technological constraints, it can become the main element of transformation of the Italian energy system, in a relatively short period of time. The remaining part of the article is therefore focused on PV technology, while other renewable sources are consciously kept in the background, due to their site-specific relevance and their overall limited role in the transformation of the national context.

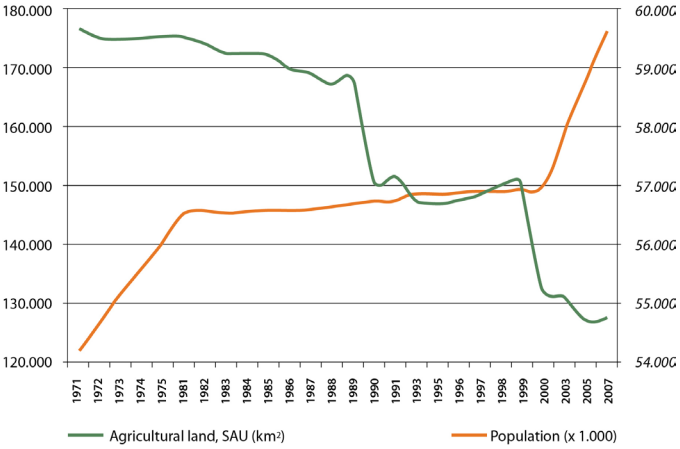
Land use and landscape risk of photovoltaic: a comparison with agriculture and soil consumption dynamics

In order to quantify the potential impact of a large-scale deployment of solar photovoltaic plants in Italy the complete substitution of imported (42 TWh/y) and fossil fuel generated electricity (165 TWh/y) can be hypothesized. It is worth noting that this is not proposed here as an operational scenario, but a figure of 200 TWh/y of added PV electricity will be cautiously supposed in order to explore the maximum potential impact[12].

We propose as relevant background for the assessment two main dynamics of Italian land use: the loss of agricultural land and soil consumption (soil sealing).

In 1970 total agricultural land (Superficie Agricola Utile, SAU) was km^2 180.000 circa, corresponding to 60% of total Italian national area. In the '90s, due to abandonment of less productive areas and soil consumption, used agricultural land was reduced to km^2 150.000 circa (50%), and became km^2 130.000 (43%) in 2010 (ISTAT, 2012).

This land use change is potentially reversible, but its scale is impressive, especially if compared with population trends, and implies not only negative consequences in terms of food production capacity, but also affects landscape and ecological factors, mostly in a negative fashion. Loss of organic soil content and landscape simplification are only partially balanced by the reduced anthropogenic pressure (use of fertilizers, etc.), and the slow reverse path toward stable natural ecosystems of abandoned arable land is not linear, nor certain.



Picture 6 – Agricultural soil (SAU) loss and population trends in Italy, 1970-2007 (INEA graphics on ISTAT, 2012).

Agricultural soil loss is partially overlapped with irreversible soil sealing determined by urban dynamics. Before 1960 urbanized soil was 8.700 km^2, involving 2,9% of total Italian area. In 1989 16.220 km^2 had been occupied (5,4%), and 21.890 km^2, corresponding to 7,3% of the total national area, resulted irreversibly consumed in 2012 (ISPRA, 2014).

Residential, commercial and industrial buildings represent 30% of total soil consumption (6.567 km^2), railways and paved roads 6.129 km^2 (28%), other roads 4.159 km^2 (19%), while service areas, parking, quarries, and landfills correspond to 14% of soil consumption (3.065 km^2, the remaining 9% being classified as other consumed area).

If the ecological effects of agricultural land abandonment are partially reversible, and not only negative, soil sealing produced by urbanization is almost completely irreversible, and in general represents a severe ecological loss. At the same time, urbanization should be considered the greatest energetic, economic, and social investment made so far by the Italian people, and considered as the most relevant background when assessing the new energy perspectives.

For a first comparison between the different magnitude orders implied, it's worth noting that all operational ground mounted PV plants in Italy, representing 41% of existing capacity, corresponding to 7,3 GWp, interest a gross area of 138,4 km^2 (GSE, 2013) which corresponds to the 0,05% circa of total national area.

In order to provide, as proposed above, enough PV capacity to completely substitute imports and fossil fuels used today in power generation, assuming a mean production of 1.300 kWh for installed kWp, a total 160 GWp capacity would be necessary.

12. The most extreme scenario, i.e. the complete substitution of primary energy production, would imply a three fold-increase of proposed values, but also a radical technological transformation that is deemed too theoretical for being considered here.

Considering an intermediate density value between on ground and on roof plants (GSE, 2013) a footprint value of 15 m^2/kWp could be assumed, therefore implying a total needed surface of 2.400 km2, which corresponds to the 0,8% of the Italian territory.

This maximum value represent less than 1/9 of already sealed soil, which makes evident the opportunity, and the need of appropriate tools for managing the "landing" of solar energy generation capacity in relationship with the built environment and with local energy demand.

aluminium, copper and steel. However, in the Italian context, the landscape should be considered as the real key element in the evaluation of renewable energy plants.

If the maximum total deployment of wind and PV plants does not represent in absolute terms a dangerous contribution to soil sealing, a badly allocated renewable energy capacity can indeed represent a lost opportunity for the Italian landscape.

Energy and food production have always been connected, and have played a fundamental role in generating the Italian

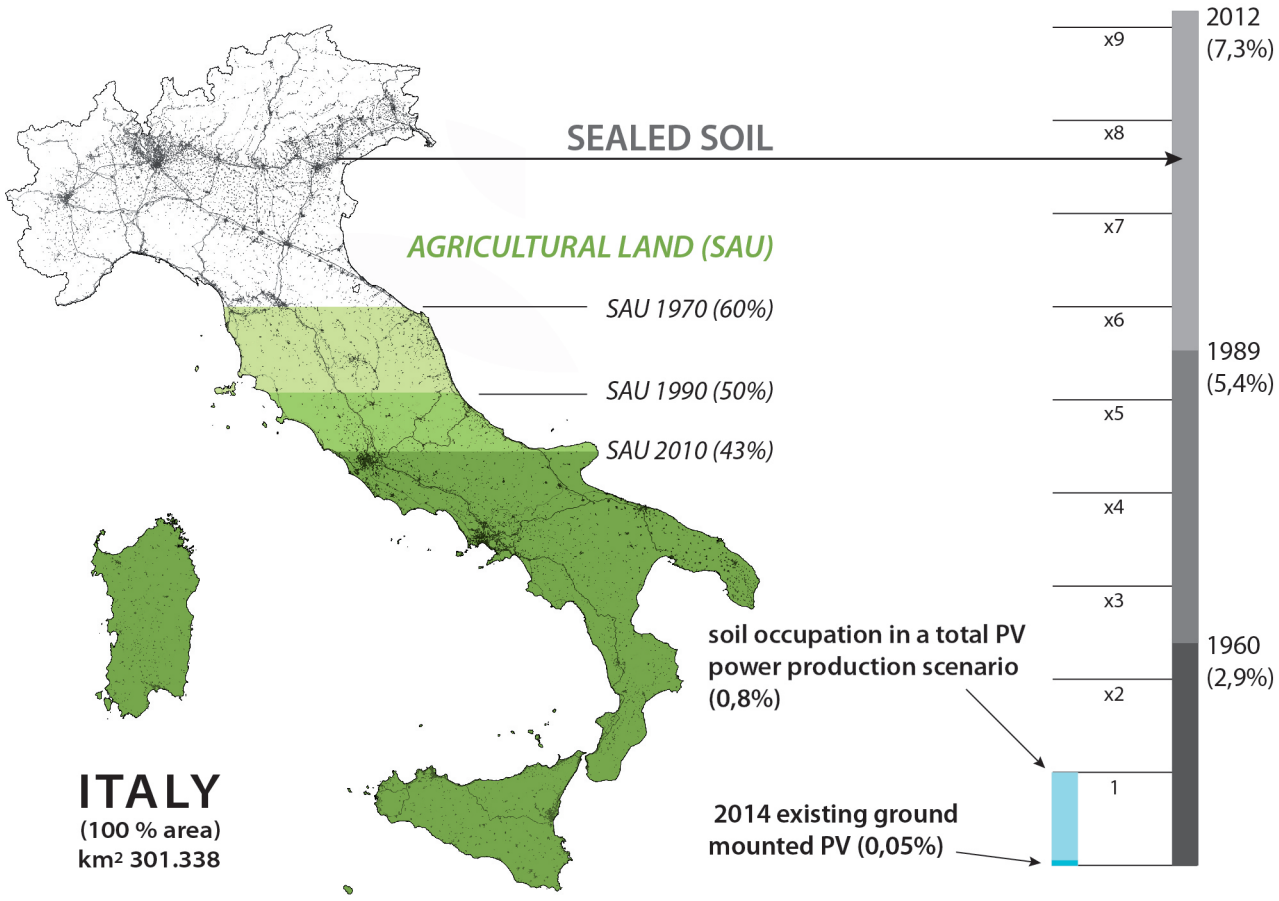


Figure 7 – Actual soil occupation determined by PV power plants, in comparison with agricultural land loss, and soil consumption dynamics. The maximum impact of PV plants (up to a complete substitution of imports and fossil fuel generated power) is compared with irreversibly sealed soil.

Opportunities from a decentralized power production model: a pro-active approach for local renewable energy plans

Integrated life-cycle assessment of electricity-supply scenarios seems to confirm global environmental benefit of low-carbon technologies (Hertwich et al., 2014). At global scale wind and PV power, besides obvious advantages in terms of emissions, show lower soil consumption with respect to coal, or even to large hydro power plants, their main impact being linked to the production and use of cement (foundations),

landscape (Sereni, 1961), through the incessant activity of local communities.

Renewable power plants, including biomass, micro wind and solar, can represent an important opportunity for re-binding local communities and landscape, but placement options, quality and dimensioning should be responsibly planned and managed.

An example of how extremely large-scale PV plants can literally flood a landscape in a very short period of time is depicted above. The Topaz Solar Farm in Central California, one of the largest in the U.S., is a 550 MW power station that

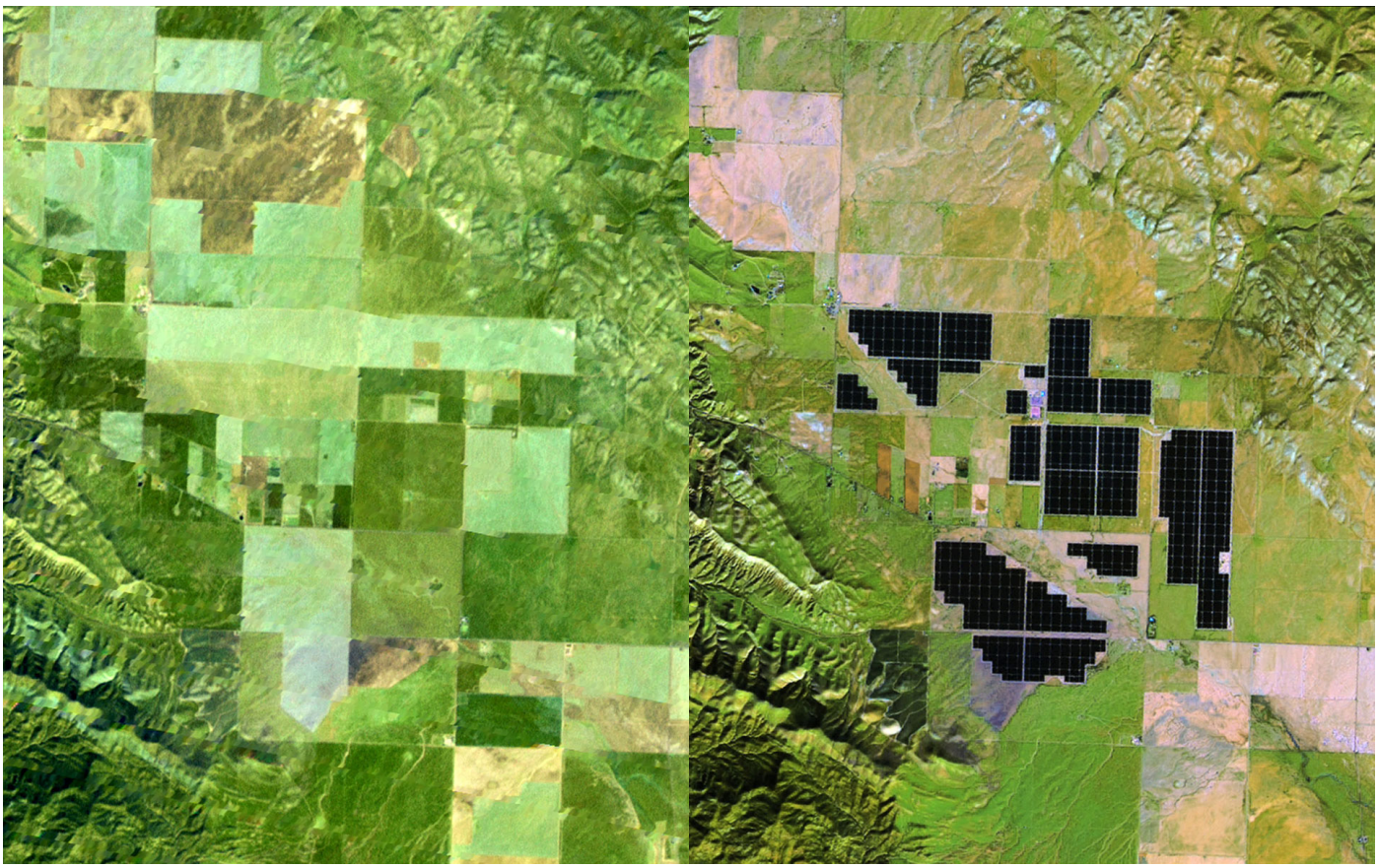


Figure 8 – Abrupt landscape transformation induced by large scale PV plants. The Topaz solar Farm in Central California: Landsat images 2011 - 2014. Source: U.S. Geological Survey (USGS) Landsat Mission Gallery "Topaz Solar Farm, California," U.S. Department of the Interior / USGS and NASA.

consists of 9 million solar panels; construction began in 2012 and was completed in late 2014. Similarly, not much more than 2 years have been necessary for the deployment of the Montalto di Castro photovoltaic power station[13].

Although very large ground mounted PV installations permit economies of scale that would represent an advantage for base-load generation, this approach cannot represent a viable, or a smart solution in the Italian scenario. As depicted above, all PV capacity could, and should, be mostly allocated in proximity with energy demand and integrated within already urbanized areas, including public urban spaces (Foglia & Valente, 2014), reactivating the co-evolutionary link between energy production and landscape that has been broken by the advent of imported fossil fuels.

In present market conditions the realization of large plants for base-load energy generation is absolutely not convenient, and, by the end of the Italian "Conto Energia" feed-in tariff, PV plants are realized only where self-consumption of energy is possible. Residential installations are incentivized with tax reductions and industrial SEU (Sistemi Efficienti di Utenza) contracts can be reasonably adopted only where an almost total local consumption of produced energy is possible.

As a consequence, a large-scale proliferation of solar plants is at the moment unlikely and new plants do "spontaneously" correspond with demand and built environment on the basis of present market conditions and fiscal policies. However, the speed and the extent of on-going global dynamics in renewable power generation should not be undervalued and it is important to provide adequate instruments to coordinate individual RE initiatives in a coherent design at district level.

The national energy strategy (SEN) and regional energy plans often provide valuable background information to understand and orient the development of renewable energy at sub-regional level. Yet, general energy planning documents fail to present spatial references, and the different scale makes them unsuitable for designing the local deployment of renewables.

The Italian guidelines for the authorization of renewable energy plants, defined by the Ministry Decree 10 September 2010[14], have clarified that only Regions and Autonomous

13. Completed in December 2010, the 84 MW Montalto di Castro Solar Park is the larger Italian plant, and one of the largest in Europe.

14. Renewable energies have received a complete discipline only in 2003 by the legislative decree no. 387 (which has long remained lack-

Provinces can forbid or limit the installation of RE plants[15] within planning documents, and have introduced the concept of "unsuitable areas": a preventive indication of critical areas, where a positive result of authorization procedures must be considered highly unlikely.

Local administrations have tried in some cases to take advantage of the concept of unsuitable area to quickly "protect" their territory from the sudden advent of RE, which have been perceived with contrasting opinions during the years of faster growth, determined by national incentives. But the accelerating aim of the law has been clarified (i.e. critical conditions are pre-emptively mapped in order to prevent meaningless administrative burden and unsuccessful proposals) and restrictive misinterpretations of the norm have been judicially rejected.

Conversely, the role of local authorities in authorization processes should be exploited *in a pro-active fashion*, producing convincing *energy plans at district level* (which does not necessarily corresponds with single municipalities).

Local demand, carbon emission profiles, available resources and potentials should be analysed, and opportunities for the creation of industrial ecologies (e.g. the valorisation of waste thermal energy produced by industrial activities, the use of energetically valuable by-products, etc.) should be highlighted and encouraged.

For both citizens and entrepreneurs, the uncertainty of authorization procedures actually represents a relevant cost and a deterrent for the deployment of renewable energy: in this perspective the prefiguration of virtuous, "desired" scenarios (including spatial allocation of PV, repertoires of high-quality solutions, etc.), openly supported by local administrations, can represent a valuable contribution to action.

Decentralized power production models can be significantly supported and oriented through a simplification and linearization of procedures, making room for entrepreneurship through management and control.

In this perspective local energy plans should became the common space of convergence for the pro-sumer citizen, the self-producing enterprise and the public authority, an opportunity for reactivating the broken production of landscape by a energy-responsible community.

ing of the essential integrative element of the guidelines, arrived only in 2010, when the Ministry Decree 10 September 2010 was adopted) then replaced by the legislative decree n. 28/2011, by which Italy has transposed the directive 2009/28/EC.

15. Limitations can be introduced only within the limits and with the modalities defined in Article 17 on the Decree. Furthermore, the Annex 3 defines criteria for the definition of unsuitable areas.

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Natural ventilation and passive cooling for energy efficiency of residential buildings in Mediterranean climate

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Keywords: Natural ventilation, Passive cooling, Energy efficiency, Building simulation

Abstract

The upcoming new energy requirements for European buildings impose Nearly Zero Energy standards within few years. In order to achieve such a result, new buildings will need to combine high performance envelopes, energy-efficient active energy systems, on site renewable energy production and passive systems. The latter seem the most difficult to be widely implemented in the conventional buildings, despite their proven effectiveness. Particularly, natural and hybrid ventilation systems in Mediterranean climate have a huge potential in terms of energy savings and indoor comfort improvement. The main obstacles for a wider use of such systems lie probably in difficulties and uncertainties inherent in the design and in the predictability of actual performance. The article describes a methodology to overcome these problems and presents two case studies that illustrate the process and give an example of the possible results.

The design process is articulated through the use of analysis and simulation tools, progressively more detailed. So the general strategies are adapted to the climate and the main building features; site and general building design depend on the microclimate specific characteristics; detailed design and systems calibration are defined on the basis of internal CFD and sub hourly energy simulations. Likewise, other aspects of passive design, such as solar systems, are determined through a similar process of progressive deepening by means of specific simulation tools.

The case studies, two public housing buildings in Tuscany (Italy), are designed on a high energy standard, with passive solar systems, natural and hybrid ventilation strategies, high-efficiency systems, integrated photovoltaic modules and, in one instance, a solar cooling system. The design process and the estimated performance are illustrated with particular regard to ventilation and cooling systems. The buildings are expected to have very low energy consumption and a high quality standard for the indoor comfort, showing a good potential for these strategies in Mediterranean climate. Namely, the cooling needs are reduced by a quantity between 74 to 100%, meaning that an effective ventilation systems (combined with other strategies, can get to completely eliminate the need of mechanical cooling.

Introduction

With the global temperature rising, the progressively higher frequency of heat waves and the higher standard of environmental indoor comfort in residential and working environments, Europe countries saw a dramatic increase in the number of air conditioning systems and of the related energy consumption (Santamouris, 2007) (Kwon, 2013). In the perspective of Nearly Zero Energy Building, a major importance is assumed by the summer energy performances control by means of low energy technology, particularly those using natural ventilation.

Technologies and control systems are now available to significantly reduce the Energy demand, still maintaining excellent indoor comfort conditions. In Mediterranean climate, controlled natural or hybrid ventilation is particularly effective in the reduction of energy consumption and in the improvement of Indoor Air Quality, even in winter and in intermediate seasons (Tucci, 2012). IAQ represents a major problem, especially in new buildings with highly airtight envelopes. Also for energy efficiency purposes, beyond a certain limit, is not possible, neither convenient, to reduce consumption improving the envelope and it is necessary to use fluid dynamics (Grosso, 2011).

The obstacles to a more extensive use of natural and hybrid ventilation are posed mainly by the extreme variability of conditions, determined by climate, biophysical site characteristics and building features. For an effective design of the devices, the general building configuration and the control systems, an innovative approach is needed (Allard, 1998) (Mahdavi, 2005), one that studies in deep the building system through simulation and evaluation methods (Morbitzer, 2003) (Chen, 2009). This contribution describes the design methodology adopted to face these problems and illustrates a few case studies, built or in the construction phase.

This approach includes a series of progressive steps that move from the site and building analysis for the definition of a general strategy, up to a detailed verification of airflow in the indoor environment. In different steps, the most updated simulation instruments are used in order to obtain reliable information on both energy consumptions and environmental comfort. Case studies pertain to residential building in central Italy, featuring buried earth pipes, underground slab (or air labyrinth) ventilation towers and control systems for

wind driven cross ventilation.
All the devices are part of a more comprehensive design strategy, which includes several passive solar systems and a tight integration with HVAC systems. Several physical models were used, such as computational fluid dynamics for external ventilation and detailed analysis of main internal spaces, dynamic simulations and air node networks for internal-external and inter-zonal ventilation, overall energy performance and indoor environmental comfort on a yearly base.
Research and literature review on earth-to-air heat exchangers (that include both buried earth pipes and underground slab), can be found in (Tucci, 2012), (Grosso, 2011), (Cimillo, 2013), (Peretti, 2013). (Hughes, 2011) and (Khan, 2008) contain a general review on passive cooling and wind driven ventilation techniques. Energy saving potential of natural and hybrid ventilation, modelling and simulations reliability are addressed by (Zhai, 2011), (Schulze, 2012) and (Freire, 2013).

Methodology

Given the conditions stated above, the project of natural ventilation is approached through a process that involves several progressive steps of analysis and design, as described by the following table. The table includes existing and new buildings and not all the steps are applicable for both. Furthermore the analysis-design steps define an iterative process rather than a simple sequence, so normally each stage can be repeated more than once.

Data gathered in the first step allows to define the climate type and the overall design strategy, with particular attention to the daily thermal range that above certain thresholds (14 °C in the case studies) allows an excellent application of natural ventilation strategies based on thermal inertia (Givoni, 1998). From these input data, in the second step, solar analysis is performed by means of simulations to study the optimal placement of passive and active systems and to maximize the solar protection of passive systems glazing in summertime. The study proceeds by analysing the urban microclimate. Airflows between buildings and plant masses, thermal exchanges of heat and vapour between the soil and building facades, vegetation hygrothermal and energy exchanges and the mean radiant temperatures, are simulated and analysed through a CFD (Computational Fluid Dynamics) software providing important information for the correct positioning of envelope openings to get the most out of cross ventilation strategy. In the third step, once defined the building general structure, the building energy performance is analysed through multi-zonal network simulations that allows to tune with a greater level of detail all the passive and active systems (including for example the window to wall ratio or the real efficiency of natural ventilation). Finally, air flows within the individual apartments are simulated via CFD software to optimize the internal distribution of partitions, to improve the flow arising from cross ventilation. Other CFD simulations have been successively performed run in order to correctly position the inlets and outlets of ventilation systems and to study their interaction with natural ventilation.

Table 1 – Methodology.

Step	Analysis	Design	Tools
1	General climatic data (temperatures, wind, humidity and solar radiation) General building features (functions, occupancy, internal loads)	Selection of natural ventilation strategy and period of usability	Statistical data analysis, simple manual calculations
2	Microclimate features (air speed and pressure and solar radiation on the building envelope and around it) Building geometry, envelope, plants and thermal mass	Site design (trees and obstructions) Building position and orientation, layout and massing	Solar simulations External CFD simulation
3	Air change needs, Thermodynamics, cooling loads, energy demand and potential for natural ventilation	Building envelope (glazing, opening position and dimension)	Nodes network simulations and Thermal simulations (including effects of natural ventilation)
4	Airflow features Internal comfort	Detailed design of openings and internal air paths	Internal CFD simulations

The final adjustments are made to reduce turbulence and related discomfort areas, in favour of an optimal air washing of the room and to improve the energy performance of natural ventilation.

Case studies

The aforementioned methodology described above has been applied in the projects of two apartments buildings in Florence. Both are multi-storey public housing that will be built with wooden structures and envelopes. Both are designed on a high energy standard and aim to achieve an A+ class, the highest in the Italian Energy certification system. This objective will be pursued through the integration of several energy saving measures: a super insulated envelope, the use of passive solar systems, natural and hybrid ventilation strategies, high-efficiency heating and cooling plants.
In both cases, passive cooling strategies are based on natural/hybrid ventilation (in addition to solar control, used as a prevention system). Other cooling techniques, such as evaporative or radiant systems, indeed perform at their best in dry climates and are less effective where the atmosphere is more humid. In Florence, where both buildings are located, relative humidity range from 65% to 69% during summer months.

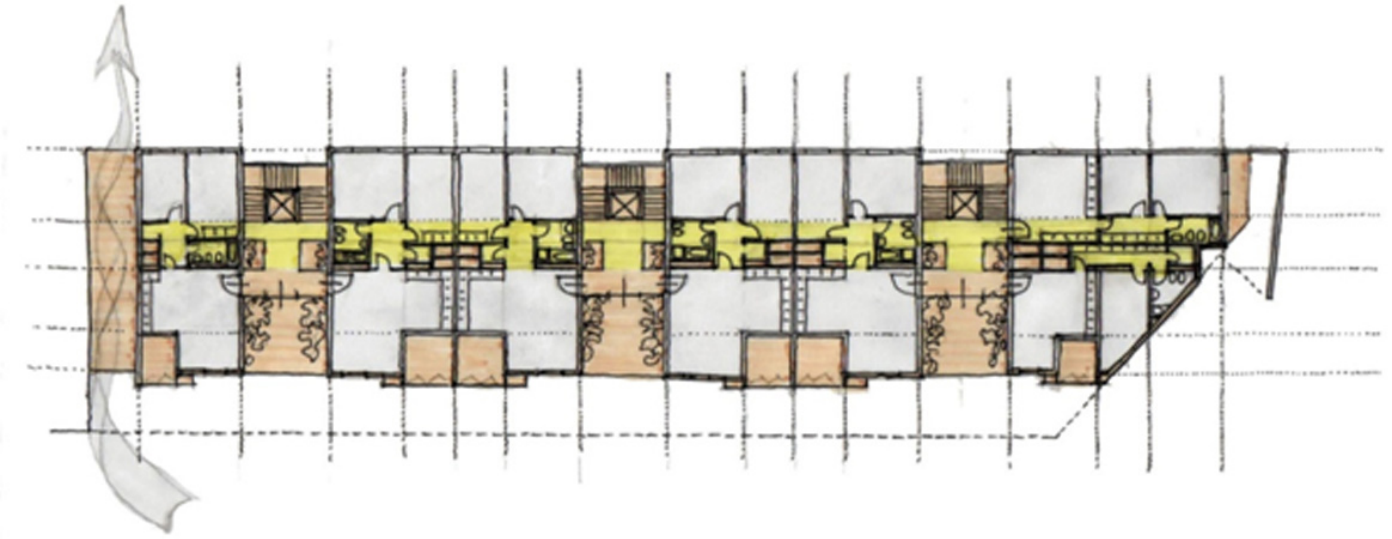

Figure 1 – Pegna ex Benelli public housing, plan with apartments in grey, distribution in yellow and bioclimatic spaces in orange.

1. Residential building in *Pegna ex Benelli* area, Florence: the project is located near the airport of Peretola and will provide non residential functions on the ground floor and 21 apartments on the other three levels (Figure 1). Each of the three staircases is coupled with a three-level sunspace and each apartment is provided with its own private sunspace and a Trombe-Michel wall, that contributes to the sunspace heating. The fresh air is provided through a system of buried earthpipes that mitigates the temperatures of external air ventilation both during the winter and the summer. The apartments are then heated by a radiant ceiling powered by an air-to-air heat pump. Besides, the plan is conceived to allow for natural cross ventilation during the intermediate seasons in all apartments. During the summer, the common sunspace, in connection with staircases, can be passively cooled, operating openings on opposite facades for cross ventilation. At the same time, the private sunspaces can turn into open loggias, as their glazing are completely operable.
Passive cooling strategies have been planned on the basis of local climate, with regular (natural) ventilation for the deactivation of solar systems and for intermediate condition in the apartments and with buried earth pipes that allow to achieve a passive cooling even in the hottest periods. In fact monthly maximum temperatures in Florence are above 26°C from June to September, and untreated outdoor air is not sufficient to ensure acceptable indoor conditions.
The overall energy performance and the buried earthpipes have been simulated through a dynamic thermal model, using EnergyPlus, while natural ventilation design has been assisted by CFD simulations for both exterior (using mainly Envi-Met software) and interior environment (with software selected on the basis of the geometry and of the conditions of each simulation). The figures 2 to 5 show the progressive deepening of simulation scope. These studies made possible to calibrate the sizes of atrium and apartments opening, to detail interior spaces configuration and to assess indoor comfort conditions.

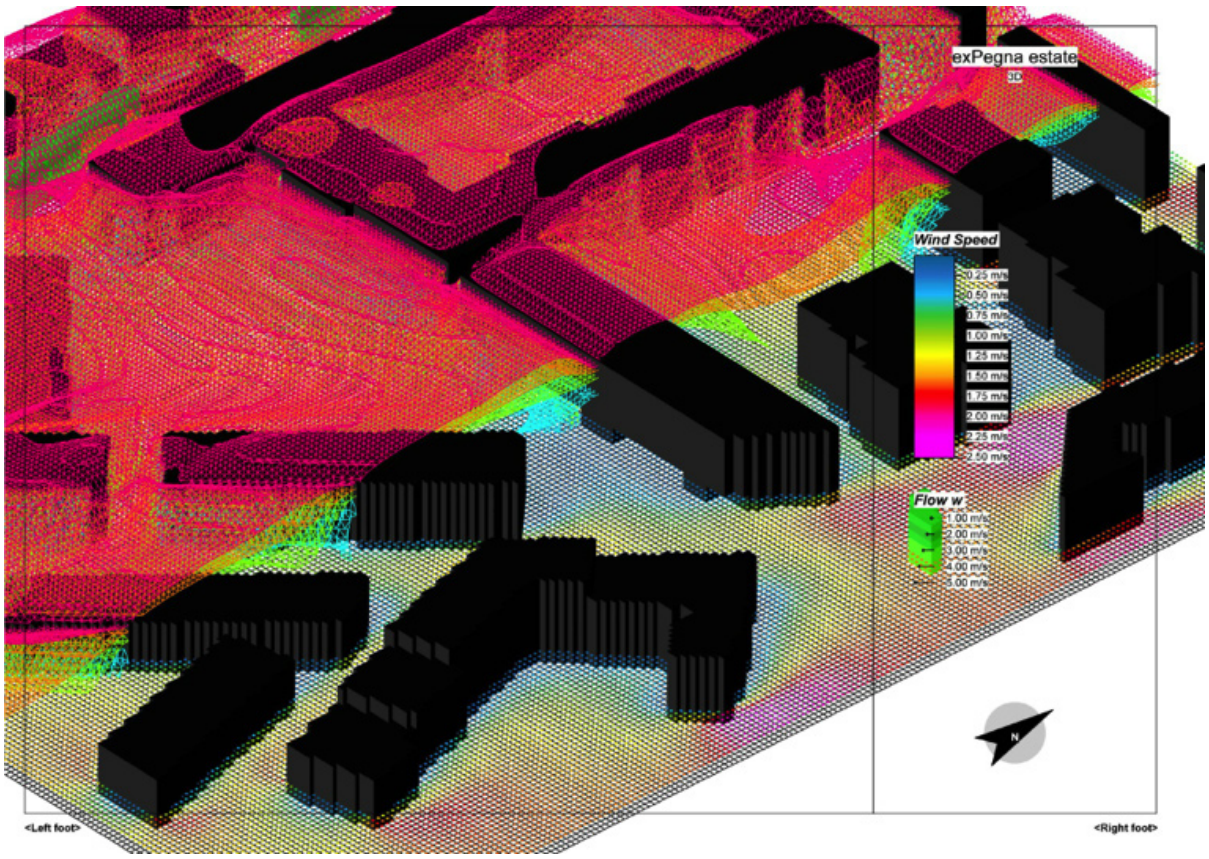

Figure 2 – External CFD simulation in typical summer conditions.

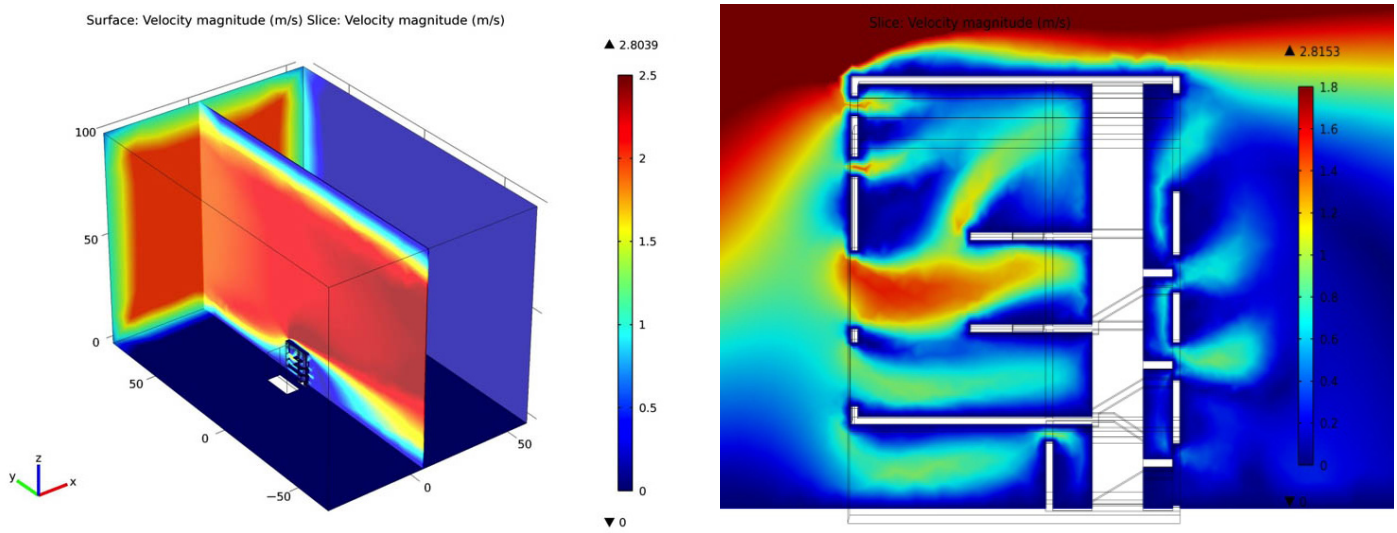

Figure 3 – CFD simulation of cross ventilation in one of the atria. External and internal environment are both included in the same model.

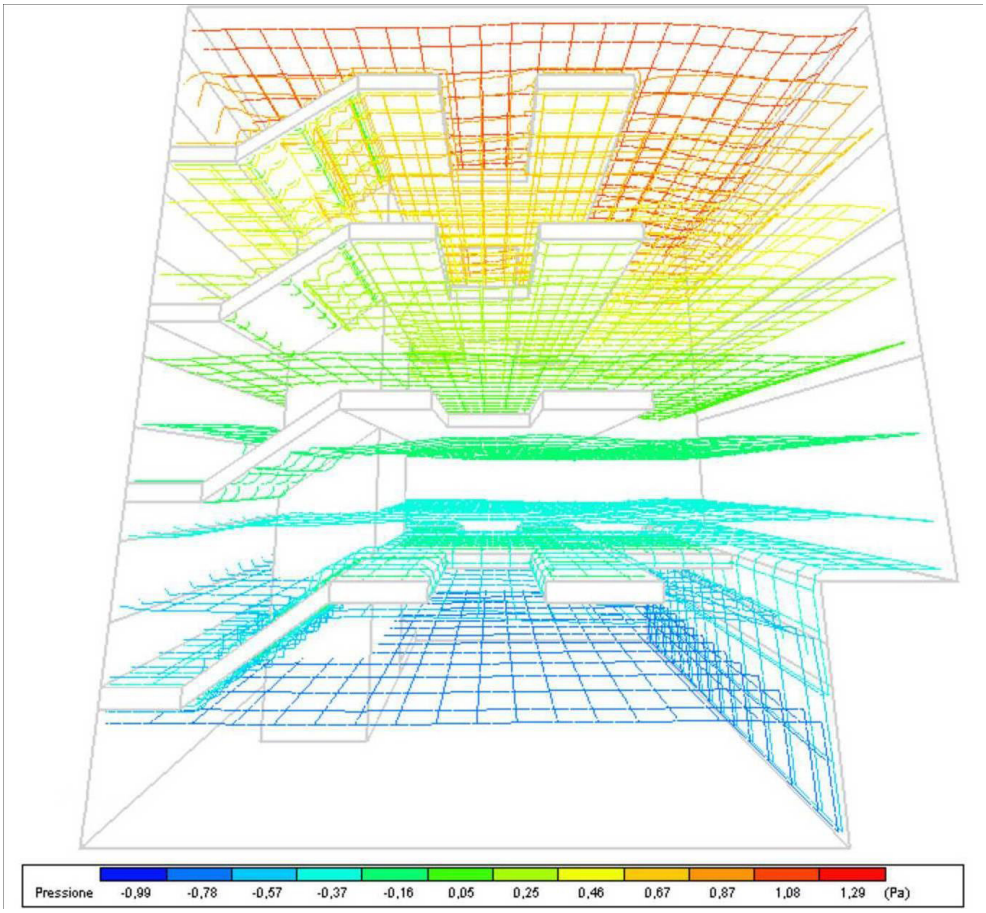

Figure 4 – Internal CFD simulation in the atrium for buoyancy effects, without wind, in summer conditions. The isosurfaces show the pressure variations due to the stratification of air layers with different temperatures.

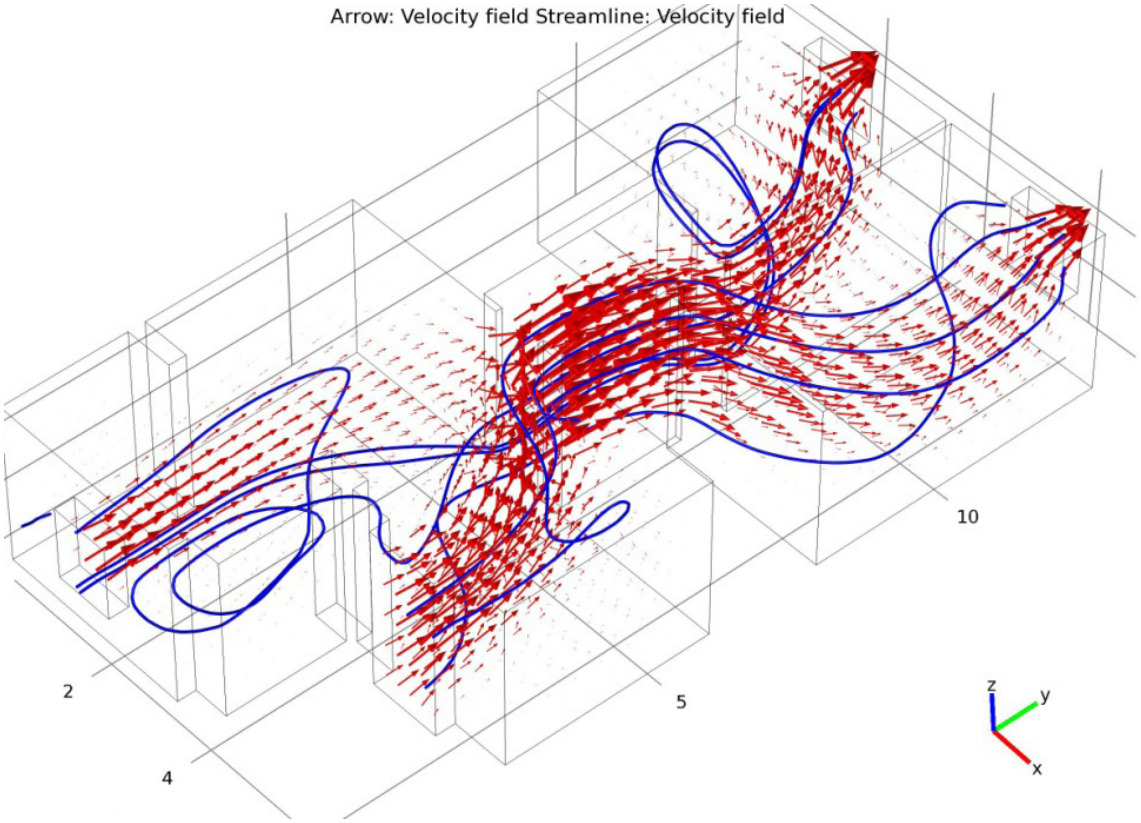

Figure 5 – CFD simulation of cross ventilation in one of the apartments. Lines and vectors show the airflow path and velocity.

Furthermore the investigations provided more reliable data for the overall energy simulation, whose main results are presented in Figures 6 to 9. More in detail the buried earth pipes, with an average length of 30 m, provide air with temperatures one to six degree lower than the exterior air, with the best performance during the hottest hours, by lowering the cooling demand by 83%. The pipes will be installed at a depth of 2 metres, and will have a net internal diameter of 35 cm. The resulting energy demand for cooling is limited to 1,5 kWh/m^2. With the additional contribution of the shading devices and the cross ventilation, the building can do without air conditioning, with few discomfort hours throughout the year. According to simulated PMV values, hours within the optimal range (-0,5 to 0,5) account for 61,96% of total time, hours within the 0,5 to 1 range and hours above 1 account respectively for 12,53% and 1,2% of total time (figure 9). Moreover, the simulated indoor comfort with passive systems in summertime is better than that of the building controlled by traditional air conditioning, due to the good performance during the hottest hours (figure 9). The influence of passive systems on indoor operative temperature in the free running (without plants) building is illustrated in figure 8.

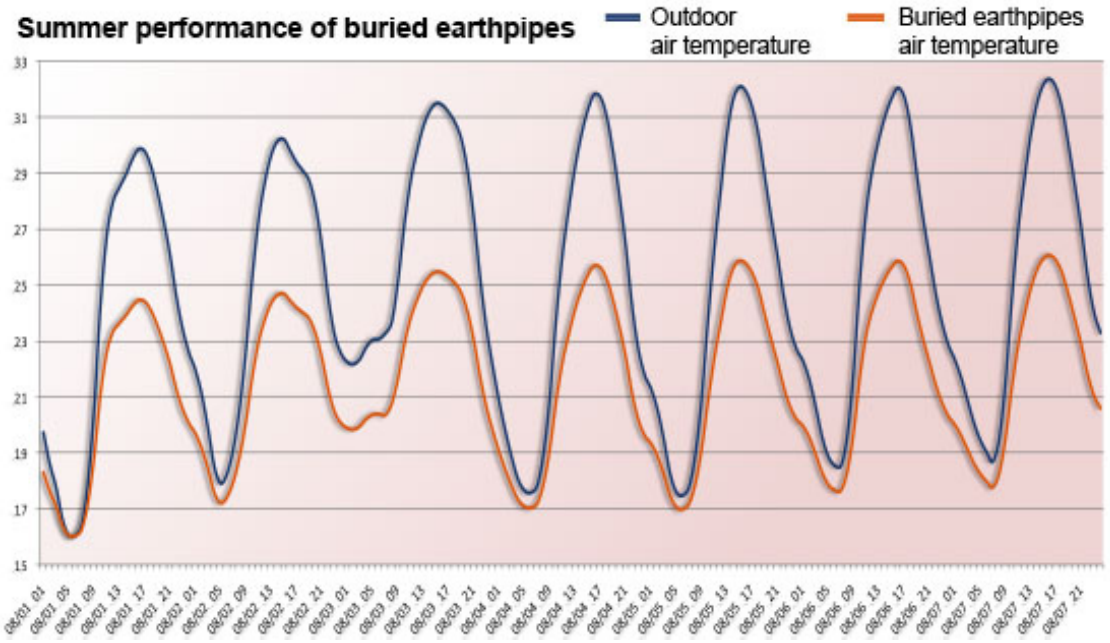

Figure 6 – Simulated temperatures of buried earth pipes compared with external air temperatures (in blue) in summer conditions.

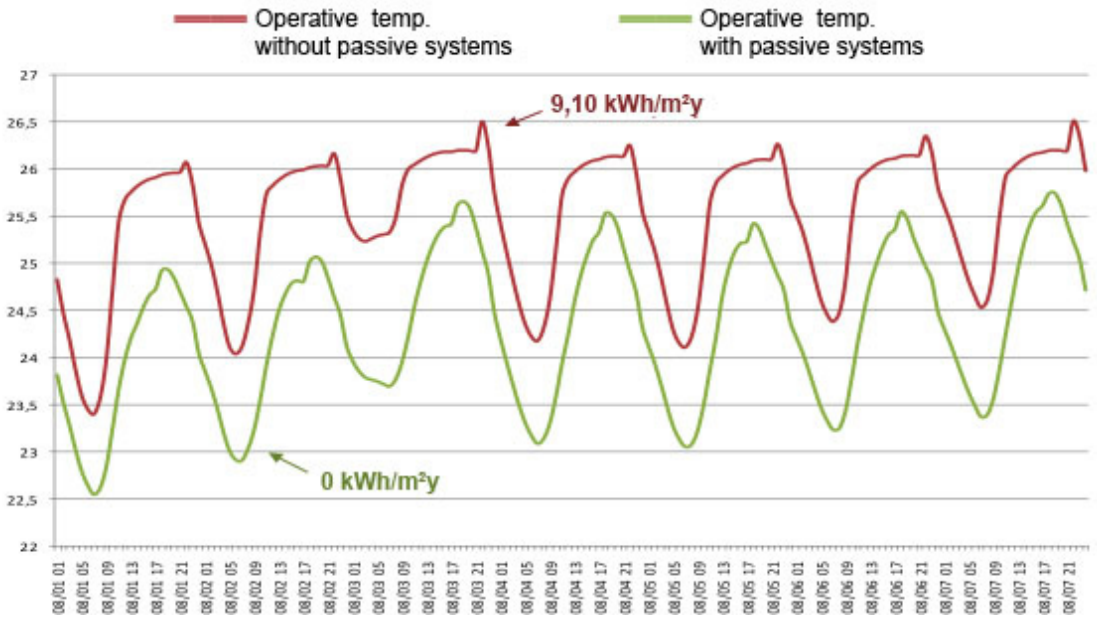

Figure 7 – Simulated indoor temperatures with buried earth pipes (and no cooling energy demand) and without them (and a cooling energy need of 9,10 kWh/m2).

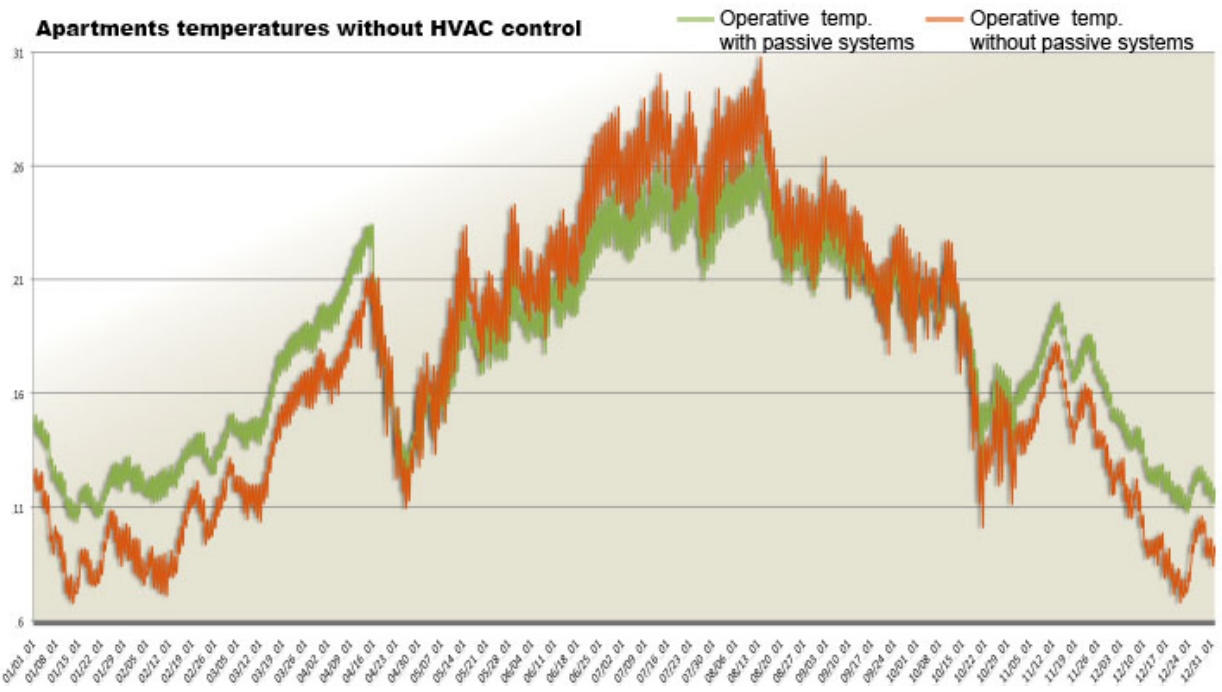

Figure 8 – Simulated hourly operative temperatures with (in green) and without (in orange) passive systems for the building without HVAC control.

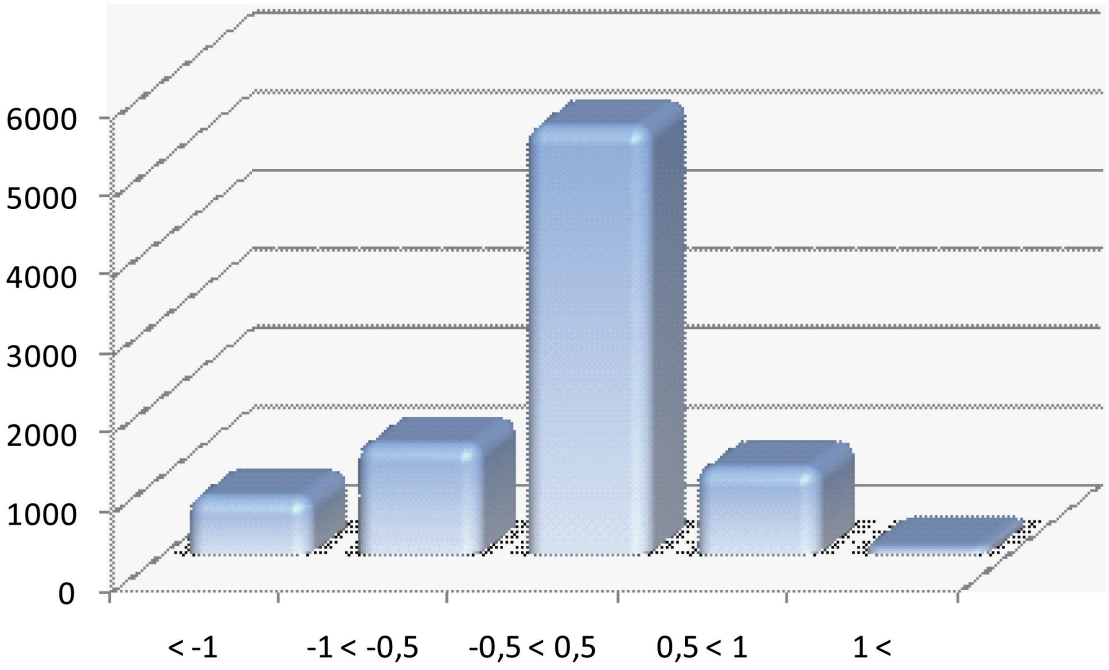

Figure 9 – Simulated hourly PMV values throughout the year.

2. Residential buildings in *Torre degli Agli* area, Florence: the project was planned to replace three obsolete public housing buildings in Florence, and will provide 84 apartments in two six-floor buildings with a common underground parking on two levels. The buildings incorporate passive systems and high-efficiency plants similarly to the Pegna Project (Figure 10). Common, large sunspaces will be built adjacent to the staircases, in order to provide pre-heated fresh air for apartments. The air will be further treaty by a heat recovery unit and then conveyed to each apartment through a distribution system that extends to all floors. In addition, each apartment has a private sunspace that completely encloses it on the south side. Furthermore, an experimental solar cooling plant will be installed on the roof. Also this project was completed

through a simulation based design process. The overall energy performance has been studied using several simulation models and natural ventilation has been designed with the support of computational fluid dynamics. Figure 3 shows one of the simulations, that include both indoor and outdoors environment in the same three-dimensional CFD model.

tion in vertical is inverted.
Compared to earthpipes (Figure 12), the performance of this system is more stable in the 24 hours, even though air temperatures tend more toward the daily average, cooing the air during the day and warming it during the night both in summertime and in wintertime. For this reason, the system will

Figure 10 – Building plan with passive solar systems: in yellow the common six-floor sunspaces that provide preheated air for apartments in winter; in orange the private single-floor sunspaces for heach apartment; in orange the Trombe-Michel walls that support the private sunspaces; in blue the ventilation tower that distribute air from sunspaces and from the underground slab.

Conversely, compared to the previous case-study, n replacement of buried earthpipes, a hollow space integrated in the underground slab under the parking will be used to cool the air during the summer. The hollow space is divided into separate portions for each distribution tower, proportionally with the volume served by each of them; each portion is configured as a maze, in order to involve in the thermal exchange

be used only during the summer, when the air is constantly under the comfort threshold in the apartments.
The complex of passive cooling measure (cross ventilation, underground slab and shading systems) is expected to reduce energy demand for cooling by 74% from 17,3 to 4,1 kWh/m^2.
During the winter, the fresh air for the apartments will be

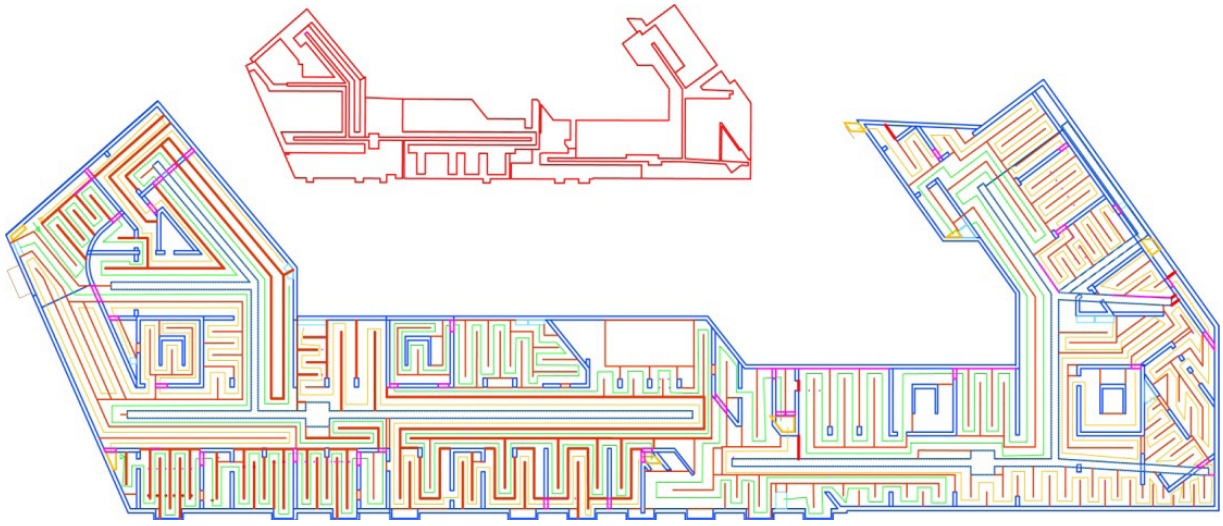

Figure 11 – Plan at the hollow space level in the underground slab.

all the available surface (figure 11). The air is taken from outside by vents integrated in the facades of the building and driven through the distribution tower by fans installed under each of them. The distribution system is the same used during winter for the air taken from sunspace, but the flow direc-

provided through the common sunspaces. In these periods, as a precautionary measure to maintain better hygiene, the hollow space in the underground slab will be used to provide fresh air to the (not conditioned) parking and storage in the underground floors.

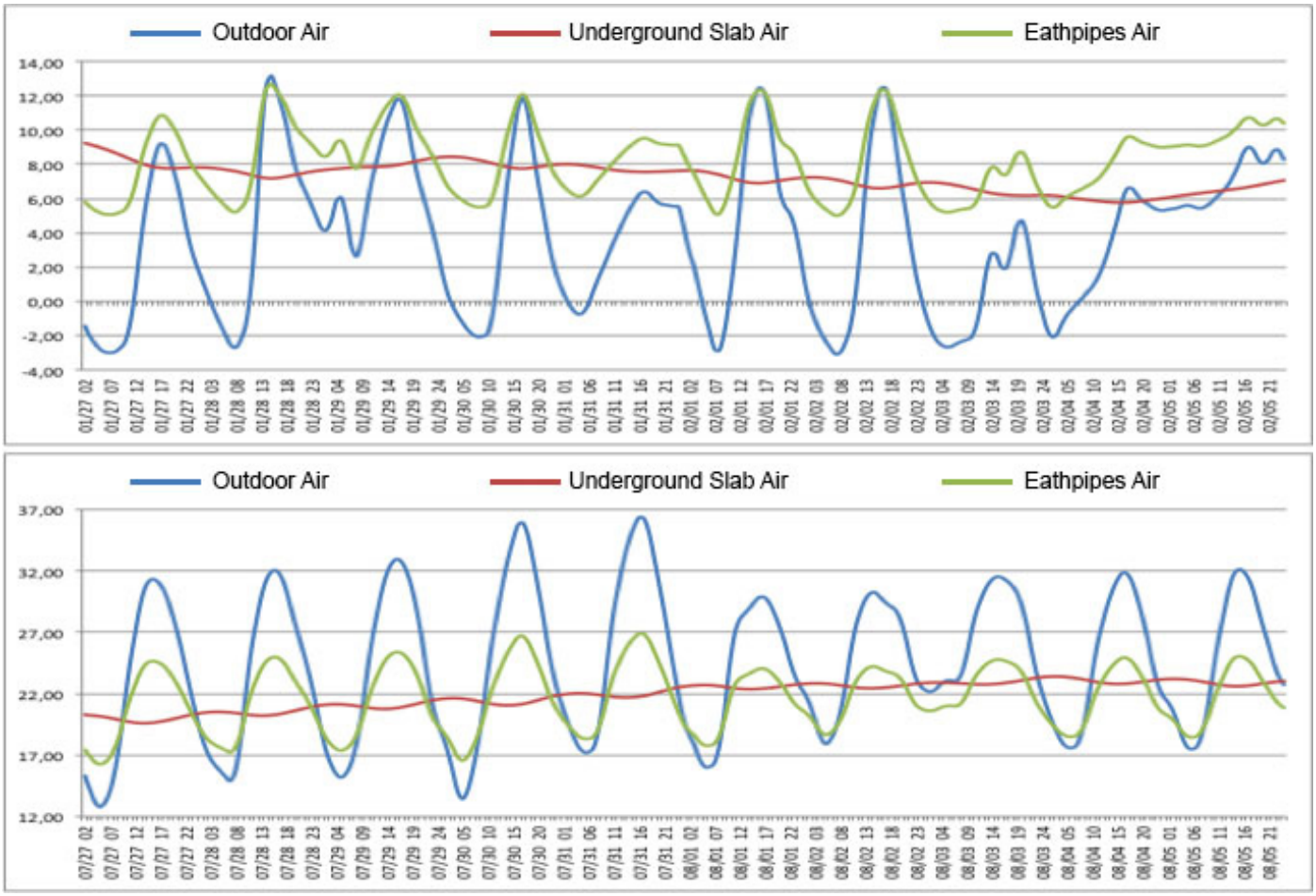

Figure 12 – Air temperatures from underground slab during the winter (above) and during the summer (below).

Conclusions

The paper deals with passive cooling and natural ventilation systems in Mediterranean climate, and describes how it is possible to design an effective natural ventilation system by integrating different analysis methods and tools for each stage of the design process. Moreover the examples treated illustrates how effective these systems can be in providing high quality internal comfort conditions while reducing energy demand in Mediterranean climate. The simulation of internal comfort conditions demonstrates that in many cases would be possible to completely eliminate the need for mechanical cooling plants, provided that occupants are willing to accept a slightly less controlled and stable condition inside the building and to tolerate few discomfort hours per year during particularly heavy climatic conditions.

In the examples analysed in the article, (i.e., two residential buildings in Florence), the estimated energy savings range from 74% to 100%. These savings have been quantified by comparing the consumption of the actual buildings to those of correspondent reference buildings. The latter were modelled identical to the actual buildings, but without natural ventilation.

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Urban regeneration as a strategic instrument for a design-based relocation of energy

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Keywords: Energy transition, urban regeneration, local energy production, stand-alone smart grids

Abstract

The article is about the issue of energy transition, and in particular the potentiality of the regenerative approach as an opportunity to implement design strategies aimed to improve energy efficiency and in general to obtain high performing local systems. The energy transition, considered as a necessary breakthrough that was for too long time procrastinated, involves a process of technological, productive, political and cultural change towards new forms of social organization, production and use. This process, which began in a critical and experimental way in the 70s and continued in the 90s of the twentieth century, is now accelerating mainly because of strong growth of developing countries that have globally increased the consumption of energy reserves. The gradual depletion of fossil energy resources pushes up the price of energy to an increasingly marked turbulence in world markets. Also without an appropriate technological/scientific response, societies anyway have to change their production levers towards more sustainable methods able to avoid tragic human consequences, being the world population driven to count 9 billion people by 2100. The energy problem is, in fact, closely linked to the food problem, the environmental problem and to the scarcity of water resources worldwide. Whether the man will invent a new way of producing energy or not, in both environmental and economic scenarios an energy transition will however take place. What distinguishes the two scenarios are mainly the consequences of the transition on the world population. Jeffrey D. Sachs identifies three steps that are necessary to transition. The first step is linked to the improvement of energy efficiency, which means using less energy to achieve the same level of welfare. The second one is to go to solar, wind, hydro, nuclear (if we'll really find effective methods for the disposal of dregs, Ed.), geothermal and other forms of energy that do not rely on fossil fuels. Finally, as long as we continue to rely on fossil fuels, we have to capture CO2 emissions before they end up in the atmosphere (Sachs, 2014).

As happened for food and wine productions and as is now happening for the manufacturing productions, even the energy production and distribution systems are strongly reevaluating the concept of proximity. Local production methods are intended both as a way to produce close to the place of use and as sizing of the production according to the real needs of a community or in general of a specific place. We are therefore witnessing the transition from an highly centralized energy system to configurations characterized by a greater spread, networks that will be less vulnerable and more effective, all connected to small and self-sustainable smart grids, always capable to be well controlled.

1. Saturation vs regeneration

Starting from reconstructions made necessary after the devastations of World War II, the urban areas exponentially accelerated their expansion, incorporating industrial areas, small towns and rural areas in a constant process of growth. An expansion often uncontrolled, spontaneous or badly regulated that produced social dispersion and that also invaded areas previously destined for agricultural productions. This motion has produced a gradual loss of identity of the city and a new logic of polarization determined more to the functions that to a development oriented to the livability of the places. Are so born commercial districts, dormitory towns, business quarters and productive areas. Today there is no more space to invade and de-industrialization of urban areas has led to the existence of big areas than can be re-planned, regenerated. These places are located within the nucleus of the city and in areas which are strategic (no more marginal because they have been incorporated by growth). How Ezio Manzini says: "The contemporary metropolis now seems to be a saturated habitat. And since there is no more an empty "elsewhere" to colonize, we know that every idea of the future, any proposed development will only be a reorganization of what we find in it today. In other words: every image that we can get about the habitats of tomorrow is, more than ever, conditioned by what was done yesterday, by what we have defined as the "prior factors" in the definition of habitat. The idea (completely abstract, but which has strongly influenced the collective imagination) of the Enlightenment engineer who designs from scratch the ideal city must be replaced by that of the *bricoleur* who uses (in a creative way, if he is able) what is there; decontextualizing it and giving it new meanings and new features ". (Manzini, 1997)

So it is possible to state that "the space of today is full of

spaces of yesterday" (Salvemini, 2006). This means that, in a conscious or unconscious way, the territory is composed by artifacts made in the past, in different periods, and since ancient times a constant reorganization has been practiced, a layering of interventions related to the evolution of the meanings and social functions related to the place. The practices of juxtaposition of elements in the past were made according to different logics and with outcomes sometimes positive, sometimes negative. The first effort in this direction is in recognition of this heritage, in the acquisition of awareness of the built environment and the "selection" of what it is advantageous to regenerate.

tion. These are vulnerabilities that the project must protect and enhance, since their disappearance or any segregation in respect to the continuity of the urban landscape or, on the contrary, their trivialization and subsequent homogenisation to the context, could finally break the thin thread of memory that binds the past to the future and so the Man to the city "(Bosco, 2012). The interventions of regeneration are different from solutions that impoverish places, from recycling practices that negate the development and growth, but are occasions of contemporary reinterpretation of spaces and artifacts and their renewed relationship with the users and, more generally, with functions they contain. It is necessary,

Diller Scofidio+Renfro, Highline regenerated linear park, New York US, 2006-2014.

The contemporary scene is a patchwork of past scenarios; a set of historical components having different size, different symbolic weight. Elements or buildings that sometimes have been preserved in their form and function, other times they have been updated, reclaimed or distorted, or improved in their performative ability, or totally changed in function, other times they have been abandoned and left in ruins. The term regeneration so does not mean a simple restructuring operation, a soft make-up or worse a cannibalization of the existing. Regeneration is a new birth; the outcome of a research work, of a deciphering activity and a respectful taking in responsibility of the existing, an environmental recovery in cases in which we operate in polluted areas, the finding of new semantics of the place - the construction of new meanings, new symbolic contents and new features - but also a technological upgrading in the perspective of sustainable development; a philosophical reuse rather than a mere building practice. Antonio Bosco (2012) notes that, "in reference to the consolidated city (...) there exist, in its interior, spaces, buildings or elements of urban furniture that assume a paramount importance in the definition of the places. Their importance is related to their symbolic importance, but it can also result from other characteristics that affect the way of life of the people, recreational aspects or the intensity of perception that makes them signs of orientation and identifica-

therefore, a renaissance through new fertilizing acts, which produce territory again and new relationships between human settlements and environment. In these territorializing acts there is the germ of a genuine and lasting sustainability of development of a research that brings back to life the virtuous relationship, the alliances between nature and culture, between culture and history (Magnaghi, 2010).

Cox Architects, Kurilpa Bridge, Brisbane AU, 2009.

2. The evolutionary localization and the self-sustainability of the places

The achievement of local self-sustainability is closely related to the concept of independence, of self-determination of communities or otherwise to the theme of self-government of energy and food production, in accordance with the environmental needs of the place. The Russian philosopher Peter Kropotkin in the early twentieth century studied with ecological awareness the economic and social issues in relation to the physical environment and resources. He judged negatively the general abandonment of agriculture in favour of the urbanization of the peasants. According to Kropotkin in order to oppose to the abandonment it is necessary to reconsider the land as a common heritage, to put agriculture at the center of production activities, so developing organic intensive cultivations in urban and suburban areas starting from the traditional and local agricultural crops and strengthen them with modern technologies. Communities could easily get to forms of self-sustainability of food and then of energy productions with a greater spread of work, and encouraging short chains of mutual production/consumption, able to contain the brokerage market phases and therefore to contain prices. In short, he introduced many aspects that are nowadays proposed in current practices and in the modern debate about the strategic importance of short supply chains in strengthening local development. The theories of Kropotkin about mutuality in agricultural-manufacturing industry influenced many authors of the utopian culture as Morris, Huxley, Orwell, Schumacher, Ward, Chapman and a part of the history studies and theories of Anglo-Saxon urban planning (Mumford Howard, Geddes, Jack). (Scudo, 2011)

The modern problem of the environmental crisis connected to a consequential anthropological degeneration was already anticipated by the German philosopher Martin Heidegger in his essay Building Dwelling Thinking (1954) in which it is programmatically debated the theme of the relationship between places, spaces and philosophy of living. The same themes have been recently analysed by Cornelius Castoriadis. According to the turkish philosopher, that is considered one of the theoretical fathers of the movement for the happy degrowth, the price to pay for freedom is the abandonment of the economy as the central value. The contemporary choices are originating irreversible depletion of the environment and of the resources that are not replaceable and they are also arousing the anthropological destruction of human beings, turning them into producers and consumers beasts, in brutalized subjects. The goal of the durability is to build a civilization of social welfare, based on a more equal division of wealth. The durability depends to the economic allocations and in general to a more conscious management of resources. In this sense, it is growing the need of places to emancipate themselves from external constraints such as the public debt, the dissipation of financial resources among different geographical areas, the protective barriers imposed by richer countries, the restrictions on access to knowledge. It is then introduced the need to assess the cost-effectiveness in social terms rather than just through the economic criteria of profit.

The ecological durability may be made possible with the help of the following levers:

- to increase the carrying capacity of the planet by exploiting the potential of different ecosystems;
- to limit the consumption of fossil fuels and other resources and products easily exhaustible or potentially dangerous for the environment, replacing them with other renewable, safer and/or abundant ones;
- to intensify the research for clean and efficient technologies in terms of the use of natural resources for the development of urban, rural and industrial contexts;
- to define rules for adequate protection of the environment and, for this purpose, to set up the necessary institutional arrangements and proceed to the choice of the right combination of economical, legal and administrative instruments.

The spatial (or geographical) durability depends on a better balance between town and country, and on a well-planned distribution of human settlements and economic activities, with an emphasis on the following issues:

- to avoid of excessive concentration in the metropolis;
- to avoid of destruction of fragile ecosystems by Man;
- to promote a modern agriculture and regenerative cultivations to small farmers by providing them with appropriate technical means, funds and market access;
- to promote the possibility of decentralized industrialization.

The cultural durability seeks to promote change in cultural continuity, translating the concept of eco-development in a number of local solutions, specific to each ecosystem, cultural context and site. In this perspective, the development must be seen as a function of a limited territory and viable and relevant projects, that local communities are able to manage in autonomous and independent way. Andreas Kipar (1993) takes on five integrated objectives as a reference for the environmental remediation. These objectives concern the maintaining and the development of the ecological potential of territories, of the morphological and aesthetic quality of the landscape, of the social quality, of the quality production for environmental purposes, of the functional quality of the space for connections on a sharing grid. One of the fundamental steps made by the European Community for the definition of a common course for sustainable devel-

opment is the Aalborg Charter stipulated in Denmark on May 27 1994. European signatory cities declared "(...) that sustainable human life on this globe cannot be achieved without sustainable local communities. Local government is close to where environmental problems are perceived and closest to the citizens and shares responsibility with governments at all levels for the well-being of humankind and nature. Therefore, cities and towns are key players in the process of changing lifestyles, production, consumption and spatial patterns." (Aalborg Charter, 1994)

The so called territorialist approach underlines that the problems of sustainable development put in the foreground the territorial heritage in its environmental, urban, cultural and social aspects as fundamental elements for the long-lasting production of wealth. To counter the deterritorialization processes, the territorialist approach refers sustainability to the activation of virtuous systems of relationships between the three components of the territory: the natural environment, the built environment and the anthropic environment. The production of high-quality spaces (and not just of environments) is the precondition of sustainability, since the production of the territory is taken as the basis of the production of wealth. The concept of sustainable development is related not only to the reproducibility of natural resources (environmental sustainability), but also to complex interactions of the non-hierarchical organization of territorial and urban systems (regional sustainability), to the consistency of production systems with the enhancement of the territorial and the development of local entrepreneurship (economic sustainability) and the growth of self-government of local societies (social and political sustainability). This approach intends to pursue all these forms of sustainability and it takes the promotion of local self-sustainable development as the key element of its action, where the term 'local' aims to highlight the exploitation of land resources and the identity of the place, while 'self-sustainable' indicates the importance of a search for rules of settlement, economic and socio-political regulations able to produce local homeostasis and long-lasting balances between natural environment, built environment and anthropic environment. It is assumed therefore an autopoietic system; that is capable of self-generating, self-sustaining and so to be independent from external forces. The purpose of planning doesn't concern only with environmental protection, but with the overall quality of the territory and life activities. If the modern production considers the inhabitant as the consumer of a product (the house) the territorialist approach intends to give back to the inhabitant an active role of direct manufacturer of goods, places and meanings. Local self-sustainable development goes then understood as the development of cultures, economic subjects and techniques that can synergistically activate self-entrustment, care of basic needs and promotion of eco-development, such as the growth of local societies, respect for differences and cultural specificities, identifying ways of living based on new principles such as self-determination, the production of wealth referring to the territorial values, achieving the equilibrium of the ecosystem at the local scale. The territorialist approach differs from all other approaches to sustainable development (including the Ecological Economics) for a greater attention to local items and because it considers environmental sustainability inseparable from the cultural, social, political and economic sustainabilities. In particular it is not suggested to consider technological efficiency as the decisive factor to address the serious ongoing process of environmental degradation. The dematerialization of products and energy conservation and the development of new and more efficient techniques for the disposal and recycling of materials can only help to slow this process, but these methods are not sufficient to recreate the culture of self-sustainability and care of the land which can really produce a change of direction. "The sustainability of the territory cannot in fact be entrusted to machines and technology-directed economies, it can be obtained only through a regained environment wisdom and through the production of the territory by the inhabitants" (Magnaghi, 1997).

TNO, SolaRoad, Prefabricated PV system for urban paving, Amsterdam NL, 2014.

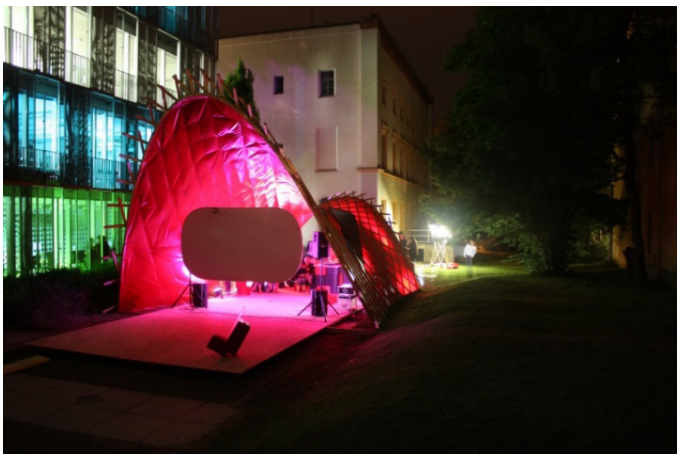
Another organizational approach in many aspects similar and anyway focused on the rediscovery of the values of the territory and sustainable development is the so-called Systemic Design. The Systemic Design is based on relationships and on a broad vision of the processes. In extreme synthesis it represents the ability to design a product (or a service) taking in consideration all of its cycle, conceiving it as part of a system that interacts with it. The system uses what is needed and what is not directly useful is no longer seen as a waste, but it becomes a resource for another system. A school of

thought that deviates from the theories of happy degrowth, of proposals of reduction, of shrinking, constriction, of generalized impoverishment and denial of progress. As stated by Herman Daly: "while growth provides quantitative expansion of the scale or the size of an economic system, the term "development" refers to the qualitative change of a system that is not dimensionally growing, but it is in balance with its environment". (Daly, 1997) The debate between sustainable development and convivial decrease, however, rather than requiring an excessive theoretical analysis, requires concentration on multidisciplinary projects, on concrete proposals, choices, solutions, ideas towards improving both the environmental, social and economic values. As the economist Pasquale Persico suggests: "It must born a resilient approach based on social base of reference, which takes care of the possible transformation. It is assumed that the difficulties of the territories and cities can be overcome abandoning the idea of the "City for Projects" and encouraging the concept of a "Regenerative City" that requires the identification of a new social base as a prerequisite of a new territorial weaving that can produce economic and social value." (Persico, 2013).

3. Towards local produced energy

As often happens, technological innovations have the possibility to pioneering progress in areas of use in which the major fundings for research are destined, and then they can be transferred to more common contexts. The off-grid energy technologies have been previously tested in aerospace engineering to supply energy to the probes, orbiting satellites and bases. Subsequently, these solutions have been adopted for military needs. One example is the K10 Solar Power Station that was developed by Italian companies Warex and CTRS Group. It is a photovoltaic stand-alone modular transportable and repositionable station. A container that can be moved using an ordinary truck and that can hold everything it's needed (photovoltaic modules, structures and components for clamping, control instruments and wiring, batteries for the accumulation) for the creation and the workability of a small power station. The system is designed to operate in extreme climatic conditions, to be easy to install and to manage and to be reliable over time. The base version produces 40,000 Wh every day. In areas of health emergency the produced energy so becomes a vital tool that can be used for purposes that elsewhere might seem basic, but in reality may be fundamental as for example extraction and purification of water, irrigation, refrigeration, communication, lighting or the possibility of setting up small centers of medical first aid.

Bauhaus University faced the theme of local production of energy in 2010 with the projects Screenhaus.SOLAR and EnergyTerminal.SOLAR. The research team coordinated by Jürgen Ruth designed a self-sufficient outdoor cinema, integrating PV flexible modules on a light and attractive hyperbolic wooden pavilion. Energy Terminals are mobile solar towers that generate electricity with the simplest means possible. As a modern campfire they are a sustainable model of energy for regions with weak infrastructures and high solar time. The three meters high towers are made of nine bamboo poles and a rigid panel that integrates a flat light source. The towers are conceived as recharge stations for every type of mobile device.



Bauhaus University, Screenhaus.SOLAR, off-grid PV outdoor cinema, 2010.

Bauhaus University, EnergyTerminal.SOLAR, solar tower, 2010.

As what happened for the agricultural food productions and for production of artefacts thanks to the latest rapid manufacturing technologies, also for energy production there is a strong reconsideration of the idea of local production, self-production, close production, and then of low-impact systems. In this case, the theme of renewable energy use concerns the study of systems that enable local production of

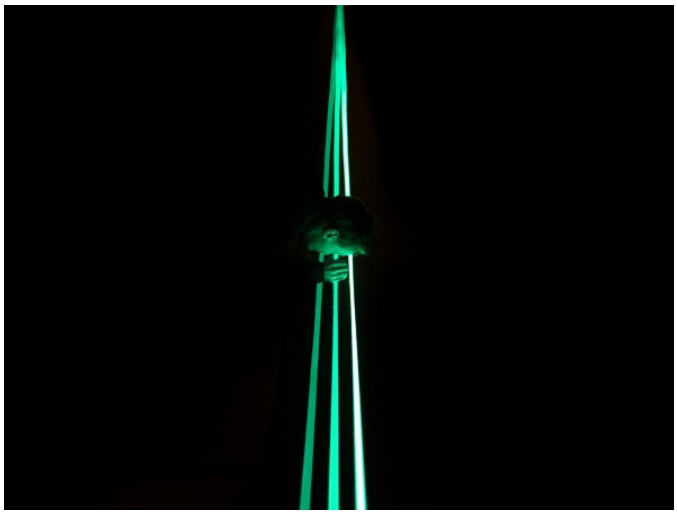
energy and the generation of well dimensioned amounts of energy in places where it is not possible or is not favorable to connect to a traditional power grid. There are in fact large areas - for example in Africa, India, in rural areas of South America, Asia and, in part, in Eastern Europe - where, due to geographical, economic, environmental or technical problems, there is no access to an electricity network or where it is too expensive so it is not practicable in a widespread way. The stand-alone systems (off-grid systems) allow communities to have electricity in remote places, where a possible connection to the national grid may be too expensive or even impossible. This option allows people to use machines and devices in contexts that are isolated or difficult to reach. There are many examples around us that can be listed: road signs, huts or mountain shelters, public lighting in areas that are few densely populated, tools for remote monitoring, irrigation systems on farms, lighting in public parks, the provision of energy for homes in rural areas. It is possible to observe that the places where systems for energy indipendence have been tested to date are places characterized by geographically and logistically criticalities. For example we could mention the project aimed to enable the provision of a mains electricity grid in the remote Scottish island of Eigg, powered by renewable sources. Previously, the island was not served by mains electricity and the individual houses had wind, hydro or (above all) diesel generators. On 1st February 2008, the Isle of Eigg switched on of the island electrification project, which now makes 24 hour power available for the first time to all residents and business activities on the island. The project is a world leader in the integration of multiple renewable energy sources into an independent grid system to supply an isolated and scattered small community.

Eigg Electric, Centre for energy storage, Isle of Eigg, Scotland, 2008.

Eigg Electric, Isle of Eigg, Scotland, 2008.

A similar example is the Italian Alpine village of Prato allo Stelvio. For its part, this small municipality, has a long tradition in the energy supply from renewable sources: the commissioning of the first hydroelectric power station and a local energy strategy dates back to 1926. The actual energy grid sees the involvement of citizens, in main part members of the cooperative that manages the local electric plants. The successful formula of Prato distinguishes itself also for the variety of technologies brought into play, which use biomass, solar source, water and wind. The winning strategy characterized by the union of different technologies not only allowed this small Italian municipality to compete at European level, to develop economic activities as tourism and commerce and to avoid the population decrease, but it also permitted its citizens substantial savings in electricity bills. The members of the Energetic Cooperative, representing 90% of the connected users, receive retail prices that are about 30% lower than regular market prices. The village's grid also proved to be less vulnerable than the national one: in 2003 in Italy a big blackout happened (the event was triggered by the falling of a tree) and all over the nation only Sardegna Region, few small islands and the municipality of Prato allo Stelvio didn't have any sort of inconvenience.

Solar Century, Blackfriars Bridge solar roof, London UK, 2014.



Daan Roosegaard, Glowing Lines, Smart Highway, 2012.

Infrabel and Enfinity, Solar tunnel, Brasschaat BE, 2011.

Daan Roosegaard, Sustainable Dancefloor, Sustainable Dance Club, Rotterdam NL, 2008.

There are some regeneration experimental projects that used the built environment to create multifunctional green energy local stations. For example we could mention the Brennero Photovoltaic Barrier, built in Italy integrating PV modules on an highway's prefab acoustic barrier, the Solar Tunnel that was realized by Infrabel in Belgium in 2011, the photovoltaic covering of the Blackfriars Bridge that was inaugurated in London in 2014 and the SolaRoad, a challenging project by TNO concerning a way to create a prefab PV urban paving system. Other interesting design proposals are the ones by Dutch architect Daan Roosengaard, who adopts dynamic paints, interactive lighting technologies (active or passive), and energy harvesting mechanisms to obtain multifunctional and poetic landscapes.

5. Conclusions

The energy question, namely the global debate about the sources of energy supply and their exploitation, is an highly complex issue that inevitably involves several disciplines and which now requires courageous choices even if they are anyway forced by the exponential global environmental depletion. It is important to note that a peculiarity of the design-oriented approach to the energy question can be the focus for the value of use of the proposed solutions. Design can face the problem from the point of view of the needs of the users, their demands, the contexts and the modes of use, rather than from the sources and logics of sale. Design has also the role to support a progressive refinement of needs with radical innovations in the world of products, systems and services that will be able to counteract a growing waste of resources. From the contemporary context also emerges the necessity of the redefinition of key concepts as "social

need", "limit" and "risk" in order to tend to an higher level of resilience of territories. If governments will not be able to recognize the different needs that different populations have and to support a national economic development research for social equity in the satisfaction of basic needs we will face increasingly harsh social crises.

In conclusion we can state that it is wrong to conceive the energy transition simply as a replacement of sources. Thanks to the exploitation of renewable resources, the concept of the spread of production of electricity is returning very current. Energy production is more and more becoming local, socially accepted and directly connected to the use and in the near future communities will need efficient, safe, tangible, simple and clever solutions that will avoid any kind of soil consumption and that will involve different disciplines (as architecture, urbanism, industrial design, civil engineering, but also the sciences of materials, ICT and political economy). We have to begin to conceive energy as something precious, something that is not taken for granted, something that we have to produce when a and where we need, something that has to be managed in a more ethical way, but also something of that we will be proud to have lovingly produced all by ourselves and to share with our neighbour, like a good homemade jam pie. Characteristics of scenarios that seemed to be overcame, or at least valid only in times before to the massive expansion of networks for global transportation of energy.

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Book Reviews

Eco-efficient Materials for Mitigating Building Cooling Needs

F. Pacheco-Torgal, J.A. Labrincha, L.F. Cabeza, C.-G. Granqvist – WP - Woodhead Publishing, 2015

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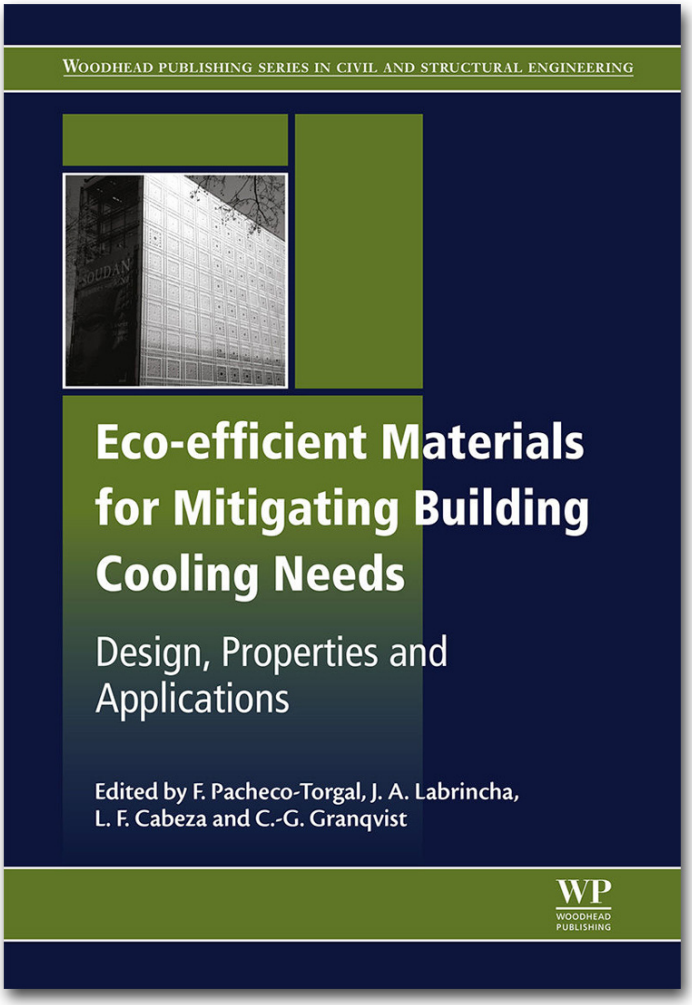

The increasingly attention to environmental issues, the need to allow a future for the planet and for the next generations, more cynical expectations concerning difficulties in energy supply and cost of energy vectors, at today, have made non-negotiable a common goal of sustainability for the coming years. In this regard, the last years have been characterized, all around the world, by new awareness and loyalty in matter of reduction of the anthropogenic impact due to the building construction, the building use and, more in general, all aspects concerning the building sector.

According to the new targets of overall sustainability, in different ways and by means of several criteria, all around the world the future construction activity is oriented toward new concepts of zero, net zero or, because of the relatively highest feasibility, nearly zero-energy buildings.

At European level, these targets have been established, for the first time in the history at a continental level, by the Recast version of the European EPBD (Energy Performance of Building Directive) 2010/31/EC and by the Directive 2010/27/EC. These documents introduce orientations and guidelines to be received by each national legislation. Only as reference, among the main defined goals, these standards established that, by 31 December 2020 - all new buildings should demand nearly zero-energy. Furthermore, a demonstrative role has been attributed to buildings occupied and/or owned by public authorities, so that the date of new nearly-zero energy buildings is anticipated, for these, at January 2018.

In the same direction, the Directive 2012/27/EC dedicated a key attention to the exemplary role of public bodies' buildings, establishing that each Member State shall provide periodical renovations of the owned building stock in order to meet at least the minimum energy performance requirements. Other prescriptions concern the necessity of long-term strategy for pushing (i) investments in the renovation of each national stock of residential and commercial buildings, (ii) policies and (iii) economical measures to stimulate cost-effective refurbishments, as well as "forward-looking perspective to guide investment decisions".

Even if only few things have been cited, it is quite clear that we are talking about very ambitious goals that, firstly, require a new approach in matter of energy efficiency in buildings. More in detail, an epochal change becomes mandatory in terms of a cultural, rather than technical, innovative point of view: the research of a synergic cooperation for an integrated work, involving different professionals, competences and stakeholders. In fact, the energy efficiency in the building industry is not only represented by some centimeters of thermal insulation panels, temperature of the gases of condensing boilers, or the energy efficiency ratio of a direct-expansion based cooling device.

It is, first of all, an enhancement of interactions between indoor and outdoor environment in the best possible way, under the perspectives of energy conservation, thermal comfort, valorization of historical heritage, livability and quality of life. In this regard, it is a matter of thermodynamics and architecture, urban planning and engineering.

Probably, these are the main motivations behind a book such as "Eco-efficient Materials for Mitigating Building Cooling Needs".

Thirty-seven scientists, of important Universities and research Institutions from all around the world, contributed by means of an up-to-date state of art in matter of materials, technologies and measures for reducing the active energy demand for the mechanical cooling of buildings. According to the large diffusion of cooling systems and by considering the more and more intensive use of these - because of the progressive phenomena of global warming and urban heat islands and the overall increase of indoor heating gains produced by the appliances - the new challenge is the reduction of the energy demand for the air-conditioning during the summer season.

This handbook presents four parts, starting from the description of materials and technologies for the mitigation of the phenomenon of the heat islands effects, and arriving to the most recent researches about phase change materials as energy efficiency strategy for allowing the latent heat storage. Of course, all most promising technologies in matter of new and refurbished walls and roofing solutions are also presented, in the parts three and four of the manual, respectively.

Because of the academic skills of the authors, the eighteen chapters are provided with exhaustive information concerning the literature state of art, with reference to the specific energy efficiency solutions and measures described in each section of the book. At the same way, after the presentation of such technologies, a discussion of the achievable performances and the thermodynamic scientific background is provided when necessary. Moreover, a proper section dealing with conclusions and future trends is also proposed in the body of chapters.

The effects of vegetation integrated in roof structures and facades, the suitability of cool materials, nanotechnologies and PCMs, high-albedo pavements and evaporative cooling walls, as well as large sets of innovative fenestration systems (i.e., electro-chromic, thermos-chromic and spectral selective glasses are widely presented) are in-deep described and explained.

Finally, the target behind this book was lofty. It is, according to us (note that we are authors of chapters, so that our opinion could be influenced by the great effort that we have spent for it), a first step toward a common work aimed at joining several complementary competences. For this reason, we prefer to finish this review with the words of one of the most important world scientist in matter of building energy efficiency, Hashem Akbari, professor at the Concordia University (Canada). He says that "*this book promotes a cool scenario by wide-scale utilization of advanced materials to recue cooling energy use in buildings...it is recommended as a good read to both academics and policy makers*".

As said, we are too much involved for subscribing completely these words. For sure, some months ago, when we accepted the commitment, just this was our aim.

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