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Geocomputation, Sustainability and Environmental Planning

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Contents

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Sustainable Development: Concepts and Methods for Its Application in Urban and Environmental Planning

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1 Sustainability: From Principles to Evaluation Methods

The idea of *sustainable development* may appear quite vague, fuzzy and evasive (Pearce et al. 1989). In fact, whereas sustainability is related to a status of maintenance and conservation of the existing conditions, both in space and time and is referred to the capacity to guarantee a support without causing decay, the concept of development implies, instead, an alteration and a transformation of actual status, then a condition of instability.

This semantic conflict induces to an idea of both improvement and preservation: in substance, the effective aim of a sustainable development is the possibility to guarantee a better life quality for an enduring period of time.

The Bruntland report (1987) systematized the definition of environmental sustainability even on a political level:

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs".

The definition above reported implies a series of concepts connected to that of Sustainable development. Two key elements in particular are highlighted, these being intergenerational and intragenerational equity. The first one refers to the need to manage present resources in order to allow future generations to meet their needs, while the second one aims at reducing differences in resources allocation between people in a same timeframe, thus recalling the need to tackle issues

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referred to differences in development between industrialized and developing countries. A third element is time, as sustainability involves a care of the future and therefore to plan an evolutionary path of development, that therefore should be inserted in models.

Without recalling the overall evolution that brought to implement the concept of sustainable development, it is worth recalling the work carried on by Meadows et al (1972), reporting to The Club of Rome to investigate major trends of global concern at the beginning of '70s of the past century. The matter is not trivial, as we can notice a series of key points still important in to-date research. One key point is referred to modeling, as the work carried out was one of the first to model different variable connected to natural and human resources, although in a simplified manner. A second point referred to evolution over time, therefore considering the time dimension as important in designing scenarios. A third element is related to the critiques that such model brought over itself, that in a sense recalled the general criticism in the following years on quantitative measures as elements to provide discrete solutions to real problems.

'The limits to growth' was focused on a set of trends as accelerating industrialization, rapid population growth, widespread malnutrition, depletion of nonrenewable resources and a deteriorating environment. Authors used World3 model to simulate interactions between Earth humans as systems and tried to focus on possibilities to implement 'sustainable' – although this term was not used - actions that would alter growth trends among the variables considered. Although the major aim of the work carried out was to analyze the interactions of exponential growth with a finite set of resources and not to predict actual evolutions, criticism arose since the beginning from different domains.

Criticism focused on different aspects of the work, namely on the base of data used, considered weak, as well as a not clear procedure, as the details about the model World3 and assumption were made clear in 1974. Also, critiques were put on the lack of consideration of technological changes in the evolutionary model, although the same authors stated that the aim of the simplified model was to study possible interactions using a limited set of variables and that technology was not considered, and on the mainly Malthusian assumption of the different paces in growth of population and resources.

The work was re-elaborated in 1992 and 2004 – respectively 20 and 30 years after the original research – in order to consider in a more refined way the growing importance of concepts related to sustainable development, and particularity income distribution and intergenerational exchange, offering also alternatives, originally not considered in the model, as human creativity for improving quality of life and elements as energetic efficiency, recycling and rise in average endurance of human life.

In any case the importance of the research carried out lies on the attention it brought over the finiteness of resources and on environmental issues. The debate started in the years '70s of Twentieth century leads to the definition of Sustainable Development as well as to events as the Rio Conference and can be also rooted in such research on global and models of interactions, than at least in this sense played an important role. Also, 'Limits to growth' can be read to-date as a call both for a use of quantitative modeling to elaborate complex and interactive amount of data and for a wider debate on one side between different disciplines and on the other side between quantitative and qualitative research and decision making processes. The Bruntland report, above all, then the Rio Conference and the Instambul Habitat II Conference definitely underlined the importance of social and economical dimension of environmental sustainability (O.N.U. 1993 1996). Since then the concept of sustainable development goes transversely across all scientific, social and economic disciplines and becomes the main objective of modern market economies. The necessity to include, in decision-making process, all the concerns connected with *environmental resources exploitation* emerges in all different sectors of public policies.

With respect to *ecological protection* demands, the conditions of sustainability are at first connected with the requirement that natural resources stock does not decrease in time (Odum 1989, Pearce 1990). Subsequently, a new concept of sustainability comes forward which underlines the importance of inserting environmental criteria in territorial development choices, rather than supporting specific protection policies, indicating boundary thresholds to resources use and consumption. In accordance with this idea, all decisions about new government interventions are taken with the respect of environment "carrying capacity" (Costanza 1991, Daly and Cobb 1990, Nijkamp 1990 1994, Nijkamp and Archibugi 1989, Pearce 1991).

The *economic efficiency* criterion in resources exploitation, as well as the *social dimension* of sustainability, become relevant issues at the same time and a special emphasis is given to social justness, even extended to an intergenerational perspective; low-income classes' protection and care represent the core of sustainable development subjects. (Sen 1992, Serageldin et al. 1995, Zamagni 1994).

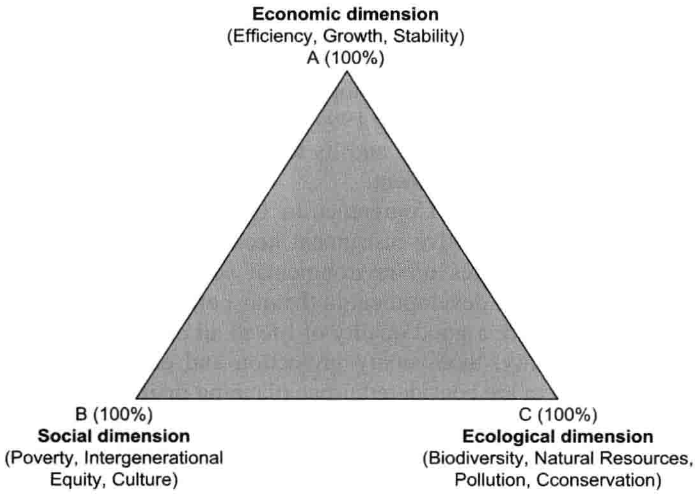

Fig. 1. Symbolic representation of environmental sustainibility (Giaoutzi and Nijkamp 1993)

Therefore a systemic approach stands out with clarity, reinforcing von Bertalanffy's theories (1967) focused on systems as realities more complex than the simple collection of their parts and characterized by openness and interactions: connections among economic, social and environmental systems have always to be considered; a sustainable development is in fact capable to integrate, settle and balance these three factors: social justice, economic utility and environmental integrity (Figure1) (Giaoutzi and Nijkamp 1993).

An effective sustainable development is then impossible without finding out integration among the above-mentioned dimensions; promoting sustainability means to pursue a balance among these different components (Munasinghe and Mc Neely 1995).

The combination of environmental sustainability fundamental values as well as their complete application in territorial context implies the identification of "what" a certain city and its territory aim to become, i.e. the *strategic vision of sustainable development* (Fusco Girard and Nijkamp 2000).

Such strategic vision has to be shared by public and private subjects and becomes the expression of an intergenerational social contract, which requires a debate among all stakeholders in order to find out a set of objective and shareable *values*. The value-oriented approach to sustainability (Keeney 1992) enables to evaluate the desirability of a development perspective and to focus on those strategic objectives that do not change day by day, but remain somehow stable in time.

In this context, a sustainable development becomes also a participative development: *sustainability and participation* result as two much correlated activities which allow identifying a long term development vision, the only one able to pursue and achieve the entire community general interest.

Long-period logic, proper to sustainability, imposes decision makers to *plan* temporal evolution of urban and territiorial systems that appear too complex to be interpreted by articulated deterministic models. As a consequence, urban and territorial *evolution scenarios* have to be implemented: they represent "possible futures" that enable to focus on specific topics selected to better characterize a certain development hypothesis (Nijkamp 1994). Building a scenario means to single out a strategic vision of what a city and its territory might become, then to plan their effective sustainable development.

Since the Rio United Nation Conference in 1992, *urban and territorial planning* is considered as the effective instrument necessary to promote and put into practice the general principles of environmental sustainability, combining and weighing conservation with development in the most efficient way.

The possibility to assure a good quality of life to all citizens and the capability to guarantee social equity, biodiversity protection and environmental resources carrying capacity respect are considered urban planning main tasks.

The objective to carry out the so called "*strong*" sustainability is typical of strategic planning process, which aims to analyze potential territorial transformations and to identify those resources to be protected and exploited compatibly with cultural, historical and environmental values of a certain territory.

The idea of this type of sustainibility requires the identification of limit thresholds (Fusco Girard 1987, Nijkamp 1995) by means of appropriate *indicators* able to measure quantitative and qualitative characteristics of territorial resources.

Such analyses are almost accepted in planning practice, but the systemic feature of environmental phenomena calls for the construction of complex indices, which makes the specification of territorial transformation limits more difficult (Fusco Girard and Nijkamp 2000).

Sustainability defined as "weak" presents instead a different approach: not all forms of capital (natural, human, social, economical) are replaceable each other, therefore it is necessary to introduce some limits to their replaceability (Pearce and Turner 1990).

The application of weak sustainability principles within territorial planning belongs to the operative dimension of the plan that defines effective ambits of territorial interventions, previously established at a strategic level, and specifies functional contents of those transformations (Stanghellini 1999).

Urban planning is required to meet, above all, strong sustainibility principles in order to guarantee the conservation of unique and irreplaceable environmental resources, and, in second place, to observe weak sustainibility criteria according to which, in every urban and territorial transformation, the consumption of some environmental resources can be compensated by the increase of others (Lombardi and Micelli 1999).

Within urban and territorial planning process, *evaluation* is regarded as a core activity: it enables to face environmental sustainability complexity and permits to find out, for each specific territory, those solutions capable to best integrate environmental, social, cultural and economical objectives.

A *strategic and integrated assessment* is, in fact, the instrument by which it is possible to pass from theoretical *sustainable development* principles to their effective *application* in territorial space.

The complexity of a decision making process, involving territorial trasformations, reveals the necessity to carry out evaluations not only related to the feasibility (technical, economical, financial, etc.) of the proposed interventions, but also able to analyze their impacts on environmental, social, economical, cultural and political systems: this requires the devising and the construction of *multidimensional evaluation methods* (Las Casas 1992, Lombardo 1995).

Urban planning process can adopt a first type of evaluation which employs specific indicators, built "ad hoc" for the intervention under study, and aims to analyze the effects on the territory directly affected by the *project/plan impacts*: this type of evaluation can be called "*local*". On the other side, a model of *integrated assessment* focuses its attention on the study of systemic effects that an intervention may have on a vaste area.

In this context, the European debate relative to the definition of *territorial impact assessment* procedures, connected with national and EU policies, becomes very significant (CEC 2002, 2004, 2005). This discussion highlights the necessity to adopt integrated evaluation approaches able to overcome the sectoral valence of assessment techniques adopted since the second half of the nineties (cost benefit analysis, cost effectiveness methods, environmental auditing, etc.) in order to improve the completeness and applicability level of the assessment process, as well as to indicate government action sustainability (Pearce and Secconbe-Hett 2000).

The evaluation process cannot be reduced to the function of audit, but it should aim to develop territorial sustainable development scenarios both adopting scientific methods and stimulating stakeholders' participation actions.

In this sense, territory has not to be strictly considered in physical terms, but as a place where economical, social and environmental changes converge and occur; such transformation characterizes development dynamics (Camagni 2006).

The analysis of European regulations, related to sustainable environmental assessment, highlights that, notwithstanding the EU efforts to widen objectives and significance of evaluation instruments, in particular by Strategic Environmental Assessment (Therivel et al. 1992), results obtained are still quite modest in comparison with the whole objectives established by regulation themselves.

This can be due to two main reasons (Camagni and Schizzerrotto 2004):

- complexity of evaluation process, sometimes considered as a limit for its complete application and, consequently, a potential pretext to start up ultra-simplified procedures;
- multidimensional and integrated nature of decision making process, connected to territorial transformations, in comparison with the sectoral character of adopted evaluation techniques.

Actually, some of the most used evaluation methods present a lack of balance in the direction of environmental variables or alternatively they have simply added or juxtaposed social and economical indicators to traditional and consolidated ecological and natural indices, without finding out a link among all the variables connected with the three dimensions (fig. 1) of sustainable development.

This fact is possibly due to the strictly "environmental" origin of most evaluation procedures: overlay mapping (Mc Harg 1969, Krauskopf and Bunde 1972), matrices and networks (Leopold 1971, Bereano 1972), weighting-scaling checklist such as the EES (Environmental Evaluation System) system (Dee et al. 1973) and the WRAM (Water Resource Assessment Methodology) method (Solomon et al. 1977).

The necessity to dispose of innovative evaluation methods (Camagni and Musolino 2004) able to consistently consider the three sides of sustainable development emerges. Social justice, economic utility and environmental integrity can be summarized in the *territorial dimension* that merges geographical and physical elements with environmental and natural features, with cultural social and economical characters.

Modeling and quantitative analysis in general suffered criticism after the enthusiasm of the years '50s and '60s of the past century, particularly for providing quite deterministic conclusions following the elaboration of data. The same models implemented by Meadows et al (1972) suffered such criticism, partially tackled in the following studies (1992 and 2004), although their effort played an important role in feeding the debate over environmental issues. To date, scholars involved in quantitative research, and particularly those interested in space, are aware of the issues raised by their object of study and of the limitations of the models and tools available. Particularly, scholars and researchers to-date do not limit the analysis to quantitative aspects but even more make efforts both to test their conclusion on the real space and also to take into consideration qualitative aspects in the modeling, allowing the latter approach a renewed 'dignity' once neglected in favor of exact sciences.

Still, issues remain at stake when dealing with integration into models of the different elements that build the concept of sustainability. In fact, urban and economical models on one side and environmental ones on the other one have generally evolved in separate domains of knowledge, although maintaining a strong link with the relations between Earth and its inhabitants (Guhathakurta 2003). Urban models generally rely on elements as economic and spatial interaction with little attention on ecological dynamics, while environmental models focused mainly on non-urban - and therefore non-artificial subsets of the environment.

One of the common elements between the two 'families of models' lays on the limited capacity to follow rules of testing and accuracy that on the contrary characterize physical models; therefore social scientists rely on models that produce first insights to the studied object and focusing on some of its attributes.

Recently, these two aims have become closer and the debate over sustainability has probably helped in forcing these two sides to meet. Also, this convergence has helped in understanding social and environmental relationships and spillover effects can be observed in research in the different domains. This is particularly evident in the more recent advances and publications in geocomputational issues that, involving scholars from different research areas, have often made unsearched similarities to emerge. In fact, scholars interested on spatial issues, and sustainability heavily rely on space, generally need advanced geographical information instruments and tools and spatial analytical techniques to carry on their research. This involves them to improve knowledge on different theories and techniques, often not originally present in their 'home' research domain and therefore a contamination between disciplines arises. As a result, interdisciplinary areas as workshops and books play an important role in helping theories, ideas, methods, models and techniques to be exchanged and to understand different aspects and points of view of spatial issues, often noticing both a use of similar instruments to model different human or ecological characteristics or, still, the rising of common conclusions from different starting points and research agendas.

2 Geo-computational Approaches to Sustainability

The experience developed by Ian McHarg (1969) represents the first attempt to base environmental planning with more objective methods. More particularly he supposed that the real world can be considered as a layer cake and each layer represents a sectoral analysis (e.g. hydrology, geology, vegetation, transports, etc.). This metaphor represents the fundamental of overlay mapping. At the beginning, these principle applied only by hand, just considering the degree of darkness, produced by layer transparency, as a negative impact. In the following years, this craftmade approach, has been adopted for data organization in Geographical Information Systems producing analyses with a high level of quality and rigour.

Nowadays, great part of studies in environmental planning field have been developed using GIS. Campagna (2005) realized a complete survey of research topics and applications of GIScience methods to sustainable spatial planning. The next step than the simple use of geographic information in supporting environmental planning is the adoption of spatial simulation models which can predict the evolution of phenomena. As the use of spatial information has definitely improved the quality of data set on which to base the decision-making process, the use of Geostatistics, spatial simulation and more generally geocomputation methods allows the possibility of basing the decision-making process on predicted future scenarios. The aim of this book is to provide an overview of the main methods and techniques adopted in the field of environmental geocomputation in order to produce a more sustainable development. The authors have deliberately avoided to have a complete dissertation on geocomputation topics, because a complete illustration of the main concepts and the different approaches to geocomputation have been presented in a previous book Geocomputation and Urban Planning (Murgante at al. 2009).

In recent times, there is a growing attention to climate change, particularly due to the increasing awareness of this phenomenon. It is also more evident that coastal zones could be the more damaged by these changes, Starting from the assumption that climate changes are taking place, it is clear that coastal areas, with huge urbanization pressures, are most vulnerable to these changes. Unfortunately, planning documents, at regional and local level, do not take into account this phenomenon.

In the same way it is very strange that a discipline such as planning which programs the territory for the future years in great part of cases is not based on simulation models. Sectoral analyses, often based on surveys, are not enough to highlight the dynamics of the area. Better knowing urban and environmental changes occurred in the past, it is possible to provide better simulations predicting future scenarios.

The contribution of *Hansen* tries to solve both this issues adopting the model LUCIA - Land Use Change Impact Analysis (Hansen, 2007) - coupled with climate change scenarios. The integration of LUCIA, based on cellular automata land use simulation model, with climate change scenarios, produced detailed model of spatial dynamics identifying possible vulnerable zones and improving the decision making process.

The paper by *Vanegas et al.* presents a comparison between a mathematical formulation and a heuristic solution method with the ultimate objective to develop an high performance heuristic solution able to locate near to optimal sites, composed by a given number of cells (raster structure): these sites must be compact and maximize cells' intrinsic multiple criteria suitability.

The problem of location of optimal sites for afforestation of agricultural land considers levels of importance (weights) for the criteria involved in the analysis, therefore a MADM (Multi Attribute Decision Making) approach is applied. Since the paper focuses its attention on general formulations for site location, it does not adopt alternative methods for the computation of criterion weights, as they are considered as mathematical parameters from the optimization point of view.

The Integer Programming (IP) method for Multiple-Criteria Site Location develops linear programming formulation for acquiring optimal sites composed by a set of pixels forming a compact and contiguous site: this result is obtained maximizing its performance according to one or more weighted Normalized Criteria (NC). Then, an alternative solution is devised in order to locate feasible (near to optimal) sites that fulfill multiple criteria requirements: this method is a Heuristic Multiple-Criteria solution for Site Location (HMSL), which is divided in 3 stages: seeds generation, region growing and region ranking. The final goal of the entire algorithm is to construct a compact site maximizing the intrinsic multiple criteria suitability of the cells.

To validate the heuristic approach, a comparison with a mathematical formulation is performed with afforestation data of reduced areas within The Netherlands, Denmark, and Flanders, but the authors believe that the proposed approaches for site location can be applied on grids of cells with attribute data generated by any other application field. This experimentation reveals that heuristic method is considerably faster than the mathematical one, that objective values obtained with the two approaches are substantially similar and that the heuristic solutions are also spatially nearer to the optimal patch location. Whereas the HMSL has a higher performance, each whole territory is processed with this method and a sensitivity analysis is carried out to determine its behavior for different parameter values. This analysis shows that regions' homogeneity plays an important role for identifying the most suitable sites, but the obtained results show that HMSL is entirely applicable for real sized problems, even considering a high number of candidate solutions.

The research carried out by *Lombardo and Petri* implements a methodology able to evaluate both the opportunity to use wind energy and, in the affirmative case, the producibility (productivity?) and location of a wind farm. An evaluation framework is developed, which can be used both for wind energy and for other renewable energy sources exploitation.

As systematic planning and programming for renewable energy plants siting are still at embryonic stage, the present role of local authorities is not to develop new strategies, but it is mainly limited to the approval or the denial of private proposals. However, in Italy, none of the current procedures, norms or laws attempts to put into relation the different aspects involved in the exploitation of renewable energy sources and their environmental and visual impact, so that a reliable assessment is not possible (even not required) and rational planning of installation locations is quite impossible.

The general objective of the proposed research is to develop methods and techniques aimed to produce systematic and integrated knowledge on the possibility of production and sustainable use of renewable energy sources. The specific objective is to build a planning support system where sectoral modelling and evaluations can be integrated with advanced spatial analysis techniques in order to assess the possibilities of production and sustainable use of renewable energy on the base of natural vocations/potentiality of territorial systems. The conceived methodology is composed of two parts: the first concerns the analysis at the wide scale of the area probably affected by the wind blade impacts and the second part implements local impact assessment of each possible wind farm locations.

The entire methodology and its application on an Italian case study (S. Luce, Livorno) is an attempt to elaborate a procedural framework to evaluate the landscape impact of every new type of territorial element (wind farms, dumps, incinerators, etc.). So, landscape quality measure (an element clearly difficult to schematize) and its assessment are included into a process that starts from the impacted area characterization and ends with local impacts mitigation.

The paper by *Danese et al.* is also based on the analysis for wind farms location. More particularly, visual impact assessment has been enriched with a new type of viewshed analysis. Single, multiple and cumulative viewshed do not collect information concerning visibility of single objects distinguished in an evident way from the others. The Identifying Viewshed (Danese et al 2009) implemented in GRASS environment overcomes this limits allowing more accurate analyses and producing more detailed assessments.

The paper by *Mauro* tackles an issue related to sustainable development, particularly from the point of view of the safeguard and recovery of terraced landscape. In light of the pursuit for a sustainable development, the main aim of this study is to identify the recent evolution of terraced areas, representing the first step to plan their recovery. Actions taken to identify areas and to monitor changes are carried on using GIS analytical functions and an application to the province of Trieste (North-eastern Italy) is presented.

The research brought to the realization of different maps related to different timescales. In particular, four rural land-cover classes were realized, these being derived from MOLAND geographical database, realized for urban areas at European level and extended to the overall regional territory in Friuli Venezia Giulia Region. Maps of land cover likely to host terraced formation for the four considered periods (1955, 1975, 1985 and 2000) were crossed with a map of morphology derived from a DEM, selecting 5-45% slope areas. The combination of such intermediate maps, as rural maps with slopes for each considered year – were used to estimate past or current presence of terraced landscapes.

The contribution of *Novack et al.* is to construct and compare potential models for the estimation of population density for 212 census sectors of brasialian São Paulo city (10.886.513 inhabitants, living in an area of 1.523 km^2) using, as independent variables, landscape metrics calculated on a classified image from the QuickBird II sensor. As the traditional approaches to estimate population density are mainly based on field surveys, they become, specially for big cities, labor-intensive, time-consuming, costly and difficult to update: in this context the combination of high resolution remote sensing data and spatial regression techniques represents a very powerful tool. To this end the authors devised and implemented a new methodology structured through several consequential steps.

First of all, the QuickBird image is classified by the Maximum-Likelihood method and all independent variables are generated by FragStats software over this satellite image. Independent variables considered on each census sector are only four: number of polygons classified as ceramics roofs, percentage of class with dark roof, aggregation index of the streets class and the patch density of the vegetation class. As some of the selected variables could well explain population density, two ordinary linear regression models (called M1 and M2) are selected and formal statistical tests are applied. For the analysis of the spatial dependency of residuals, a distance-based neighborhood matrix is created: for spatial dependency detection Global Moran index is used, nevertheless the strongest evidence on the existence of spatial dependency of residuals for both models is the visual inspection of LISA maps. The next step is to test which spatial regression model would be the most suitable for each model and to this aim Lagrange Multiplier test statistics are used. Finally, the running of spatial regression models is conducted as well as the inclusion of dummy variables in order to compare them in terms of spatial dependency elimination. With the purpose to create a simple but accurate enough model, which could be applied onto other areas and validated in other conditions, the most appropriate model for the test area's population density estimation is model M1, with the introduction of Spatial Lag parameter. Results of this experimentation prove that population density can be relatively well estimated by the use of spatial metrics calculated over a classified high resolution image when using the population density itself as independent variable in spatial regression models.

The concept of spatial autocorrelation has been applied using different techniques in the paper by *Lucia et al.*. The integration of chemical and physical parameters and geostatistical techniques has found many applications in recent years that have allowed the estimation of background values for contaminants in the investigated matrices. More particularly this paper investigates the distribution of some heavy metals on the geochemical characterization of the polluted site of national interest Tito (PZ) through the application of geostatistical techniques. All geostatistical analysis were carried out using the "geoR" spatial extension of the statistical software "R".

The paper by *Vivanco et al.* "Evaluating the impact of resolution on the predictions of an air quality model over Madrid area (Spain)" compares different model results and observations obtained using traditional standard evaluation statistics with different scales of domains, noticing an improvement when observing a coarsest domain, but noticing a much lower or inexistent one for finer domains. A better behavior of pollutant predictions should be related to an improvement of meteorological predictions in terms of parameterizations involved in the meteorological model and input data, such as land use information. In particular, the research carried on is aimed at comparing a same set of analytical tools at different scales, observing a better simulation envelope when working at a more refined and detailed local scale, rather than on a coarser one, therefore observing that resolution plays a significant role in modeling, especially when trying to simulate local effects.

Pollution issues have been faced from a different point of view also in the contribution by *Di Martino et al.*. More particularly this topic has been analyzed with a spatial Data Warehouse approach. Spatial OLAP (SOLAP) systems allow multidimensional analysis of geographical data. On the other hand, they lack of geovisualization techniques to take advantage of great analysis capabilities of georeferenced data such as 3D visualization, cartographic displays personalization, etc. Then, in this paper, authors present a new spatial decision support system that integrates well-established OLAP and geovisualization tools: Mondrian/JPivot and

Google Earth. Some experiments on a simulated multidimensional dataset concerning pollution of Italian regions show the functionalities of the proposed system.

Cellura et al. deal with "Nonlinear black-box models for short-term forecasting of air temperature in the town of Palermo", where their attention is focused on the implementation of a system for obtaining short-term forecasts of air temperature and on mapping them over the monitored area of the city of Palermo (Italy), elaborating data collected hourly by a network of weather stations. The interest is, among other issues, on the Urban Heat Island (UHI) affecting metropolitan areas. The system clearly highlights temperature differences between urban and extra-urban area and average intensity of UHI of Palermo. The research is the starting point for a forecasting model with a wider time horizon in order to obtain the future evolution of the temperature with a relevant advance and to use this information to study the evolution of urban comfort conditions.

The contribution of *Kanevski et al.* is about "Automatic Mapping and Classification of Spatial Environmental Data". Authors focus on the development and consequent application of a methodology for automatic processing of environmental data for mapping and classification purposes. The attention is drawn towards spatial regression and a method called General Regression Neural Network (GRNN) is considered in detail, as well as a Probabilistic Neural Network (PNN) as an automatic tool for spatial classifications.

The idea underneath the work presented here resides on the importance of the environmental automatic decision-oriented treatment of data, from exploratory data analysis to mapping and classification, for decision-oriented purposes. In general, the problem is to develop nonlinear, robust, adaptive and data driven methods which can detect spatial patterns in noisy data and which are able to produce prediction and probabilistic/risk maps which can be used in a real decision making process. Such methods are also important, as they should be able both to model multi-scale variability in data and to detect hot-spots.

More generally some data are said to be ambiguous if they can have at least two particular interpretation. Ambiguity leads to a discordance in data classification due to a different perception of the phenomenon. Inaccuracy produces uncertainty in the case of low quality of data, due to a certain degree of error (Murgante et al 2008, Murgante and Las Casas 2004). Vagueness (Erwig and Schneider, 1997) takes into account multi-valued logic and it is based on the concept of "boundary region" which includes all elements that cannot be classified as belonging to a set or its complement (Pawlak, 1998). Three theoretical approaches to vagueness exist: the first one is based on fuzzy set theory (Zadeh, 1965) which accounts for partial membership of elements to a set; the second is Egg-Yolk Theory (Cohn and Gotts 1996, Hazarika and Cohn 2001) based on the concepts of "egg", i.e. the maximum extension of a region, and "yolk", i.e. the inner region boundary; the third approach is rough set theory. These issues have been analyzed in the paper by *Taramelli*, which analyze uncertainty in landform boundary definition. More particularly semantic and geometric approaches to landform definition have been analyzed adopting Fuzzy Logic, which allows each pixel to have a degree of membership.