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# Spatial decision support for strategic environmental assessment of land use plans. A case study in southern Italy

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**Abstract**

This paper presents and discusses the construction of a spatial decision-support tool for the Strategic Environmental Assessment (SEA) of a land use plan: the spatial coordination plan of the Province of Naples, in southern Italy. The decision-support tool organises the relevant information, spatially resolves the actions of the plan, predicts their environmental impacts, and generates overall performance maps. Its final goal is to provide a suitable technical support to a formal SEA procedure. The expected implications of the plan, such as changes in land use and traffic flows and urban expansion, were modelled and assessed against a set of environmental criteria using SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis and mapping. It was found that the SWOT analysis provided a good basis for assessment and strategy formulation. The paper also intends to contribute to the topic of data and scale issues in SEA, by exemplifying the role played by spatial data and spatial analyses to support informative SEA.
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*Keywords:* Spatial indicators; SWOT mapping and analysis; Land use change; SEA; Data; Landscape scale

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[1] Paola Napolitano is expressing her personal views, which do not necessarily reflect that of the Province of Naples.

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## 1. Introduction

The procedure of Strategic Environmental Assessment (SEA) is inextricably linked to decision-making (Sadler and Verheem, 1996). The SEA report is a decision-support instrument aimed at providing as detailed a picture as possible of the environmental impacts related to the implementation of a plan, policy or programme. In the case of plans, the SEA report must contain sufficient information to assess the acceptability of the impacts, and consequently to propose suitable modifications and mitigations. It can be argued that most of this information has a spatial component because geographical distribution of impacts plays a relevant role in determining how they are perceived by decision-makers, as well as by the affected stakeholders and the general public. Although this applies to all kinds of plans, it is particularly evident for land use plans, whose implications have an explicit spatial nature.

The SEA Directive has not yet been implemented in Italy, even though provisions to perform SEA have been introduced by several regional governments, and integrated into their existing Environmental Impact Assessment (EIA) or territorial planning legislation. Consequently, interest is rising and pioneer studies have been blooming (Daini, 2002; Bagnati, 2003; Bollini et al., 2003; Bagnati, 2004; Baldizzone, 2004; Giordano, 2005). However, there is not a consolidated approach widely accepted at a national level, and technical support (e.g., guidelines, best-practice handbooks) is lacking.

Most of the pioneer experiences referred to the European Commission guidelines for the SEA of structural funds (EC, 1998). Although methodologically sound, the guidelines present limitations that hamper their application to land use plans. In particular, they do not specifically provide for the use of spatial data, relying entirely on matrix-based assessments. In other words, the performances of a plan are generalised over the whole territory, and assessed by aggregated indicator values, rather than by their geographical distributions. Even though there are examples of Italian SEAs in which spatial analyses and maps were extensively used (Provincia di Milano, 2003; Bollini et al., 2003), the lack of technical guidance caused most studies not to account for the spatial representation of impact predictions. Consequently, key issues were disregarded (e.g., cumulative effects), reducing the effectiveness of SEA reports (Diamantini and Geneletti, 2004).

The purpose of this study is to improve current SEA practice by constructing a spatial decision-support tool for the SEA of a land use plan. The paper intends to contribute to the topic of data and scale issues by discussing, through a real-life case, the role played by spatial data and spatial analyses in SEA. The decision-support tool aims at organising the relevant information, spatially resolving the actions of the plan, predicting their environmental impacts, and generating overall performance maps. Its final goal is to provide a suitable technical support to a formal SEA procedure. The latter obviously requires also other types of inputs, such as public consultation and setting of environmental targets, which are not addressed by this paper. The case study is represented by the spatial coordination plan of the Province of Naples, in southern Italy.

The paper is structured as follows. Section 2 provides a description of the study region and of the spatial plan selected for the analysis. The methodology and its application to the case study are presented in Section 3, whereas Section 4 briefly discusses the results. Finally, Section 5 provides some conclusions and ideas for future applications and improvements.

## 2. The spatial coordination plan of the Province of Naples

The Province of Naples covers an area of 1171 $km^2$ and has a population of 3.1 million distributed over 92 municipalities (Fig. 1). It is a very complex region in terms of both environmental and socio-economic aspects, and it is characterised by an often strikingly uneven distribution of assets and services. The population density is the highest of Italian provinces with an average of 2570 people/km$^2$, peaking at over 8000 people/km$^2$ in and around the city of Naples. The territory is dotted with worldwide famous historical, cultural and archaeological sites (e.g., Naples city centre, excavations of Pompeii), but also with overcrowded and poorly serviced suburbs. The areas of outstanding natural beauty and scenery (e.g., Vesuvius Natural Park, Capri and Ischia Islands, Sorrento Peninsula, Amalfi Coast) coexist with vast industrial wastelands and severe pollution (e.g., Sarno River).

Population density and real-estate speculation have been applying a steady pressure on agricultural land and natural resources, contributing to environmental degradation. Furthermore, the region is heavily affected by natural hazards, often exacerbated by uncontrolled urban sprawl. Landslides and floods affect large tracts of urbanised areas, and as many as 18 municipalities located around the Vesuvius cone are considered as highly exposed to volcanic risk.

To manage such a complex environmental and territorial context, the public authorities have been working on a Provincial spatial coordination plan. Italy's planning tiered system provides for national acts for direction and coordination, regional spatial coordination plans, provincial spatial coordination plans, and general policy and land use plans at both municipal and inter-municipal level (Gazzola et al., 2004). Provincial spatial coordination plans set out general strategies for spatial development and for the use of natural resources.

The spatial coordination plan of the Province of Naples, hereafter referred to as the Naples Plan, provides indications on land capability and land allocation at a broad scale, on main infrastructure corridors, and on protected area boundaries. Additionally, it contains regulations concerning water and soil management, as well as natural hazard prevention. The Province Council adopted a preliminary version of the Naples Plan in July 2003. A broad revision process was then initiated, which is still in progress. In 2004, a new regional law on territorial governance was approved, that added new contents and values to spatial planning, and introduced an obligation to perform SEA. Consistently with the provisions of this law, the Naples Plan is to undergo a formal SEA procedure before its approval. For this purpose, the Provincial administration decided to build-up a preliminary spatial decision-support tool, which is described in the following section.

## 3. Methods

The method adopted to develop the spatial decision-support tool consisted of three main stages:

1. Identifying the main environmental concerns and indicators;
2. Spatially resolving the main effects of the Naples Plan;
3. Assessing the effects using suitable environmental indicators.

### *3.1. Identification of concerns and indicators*

A strategic assessment makes sense only after having defined a strategy by means of a holistic and long-term vision (Diamantini and Geneletti, 2004). In operational terms, this typically consists in setting performance targets for a set of relevant environmental parameters. The plan is then appraised against the compliance with such targets. This work aimed at building a decision-support tool, in a stage in which a formal SEA procedure was not yet undertaken, and targets and

Table 1
Key issues and elements to be considered during the SEA of the Spatial coordination plan of the Province of Naples

| Area of concern (value) | Legislation | Criteria and indicators | Data to characterise environmental state | Pressure elements controlled by the Plan | Response tools |
|---|---|---|---|---|---|
| Sustainable use of energy and reduction of greenhouse emissions | Italian national energy plan (law n.10/1991); Kyoto Protocol. | Potential for energy efficiency; potential for solar energy. | Energy consumption; buildings stock; solar potential. | Changes in energy consumption related to urban development. | Regulation of housing plans; promotion of solar energy; regulation of good agricultural practice. |
| Protection and rational use of water | EC Water Framework Directive (2000/60/EC) and national implementation. | Pollutant loads to sensitive water bodies; settlement distribution with respect to existing water infrastructures. | Water quality; water supply; land use; population; soil hydrology. | Changes in pollution loads from agricultural practice and urban development. | Regulation of housing and infrastructure development plans; good agricultural practice. |
| Protection and rational use of soil | Italian national soil-protection law (n. 183/1989); EC communication toward a thematic strategy for soil protection COM(2002)179. | Soil erosion; mass movements; soil sealing. | Soil texture; erosion factors; land use. | Increased soil sealing; erosion and mass movements due to urban and agricultural land uses. | Regulation of good agricultural practice; introduction of soil sealing mitigation measures in urban development. |
| Reduction of natural hazards | Italian national soil-protection law (n. 183/1989). | Urban areas and sensitive elements exposed to natural hazards. | Hazard and risk areas. | Land use. | Land use constraints for urban development; resettlement plans. |
| Conservation of biodiversity and natural ecosystems | EC Habitats Directive (1992/43/EC); EC communication on a European community biodiversity strategy COM (98)42. | Connectivity; fragmentation; diversity. | Protected areas; land use. | Green areas; land use. | Planning of green and protected areas. |
| Protection of landscape and rational use of space | European landscape convention; European spatial development perspective. | Urban sprawl (residential density, land use mix, centeredness); visual landscape quality. | Elements of visual disturbance; land use and distribution of settlements. | Urban development. | Regulations for housing outside the urban fabric; promotion of landscape visual quality. |
| Quality of the urban environment | Charter of European cities and towns toward sustainability; | Noise; air pollution; electromagnetic fields; | Green areas; accessibility by public transport, | Traffic; Location of industrial activities; | Transport plans; green areas. |

(continued on next page)

Table 1 (*continued*)

| Area of concern (value) | Legislation | Criteria and indicators | Data to characterise environmental state | Pressure elements controlled by the Plan | Response tools |
|---|---|---|---|---|---|
| | closing declaration of Urban 21, Berlin; EC communication toward a thematic strategy on the urban environment COM(2004)60. | green areas mobility and accessibility; public transport; cycle paths. | sources of pollution. | green areas planning. | |

objectives were not yet set. Therefore, first it was required to identify the main environmental areas of concern. This is normally done by fostering political debate, public participation and stakeholder consultation, as well as by referring to the existing legal framework (directives, protocols, conventions, etc.). Given the technical nature of this study, only the latter approach was pursued. In particular, the analysis focuses on the provisions of Italian and European Union documents related to environmental management and spatial development. The range of potential impacts of a plan is very wide, and therefore it is crucial to identify key issues, upon which to base the assessment.

Seven main areas of concerns emerged: sustainable use of energy and reduction of greenhouse emissions, protection and rational use of soil, protection and rational use of water resources, reduction of natural hazards, conservation of biodiversity and natural ecosystems, protection of landscape and rational use of space, and quality of the urban environment (see Table 1). Concerns were linked to suitable criteria and indicators related to the state of the environment, as well as to pressure elements and response tools, according to the widely used DPSIR model. DPSIR (driving force, pressure, state, impact, response) is the causal framework for describing the interactions between society and the environment adopted by the European Environment Agency (EEA, 1999). Criteria and indicators were used to measure and give a spatial representation to the performance of the Naples Plan. Pressure elements and response tools referred to the Plan's role respectively in determining environmental impacts, and in proposing measures to reduce them.

As an example, with respect to the protection and rational use of water, the following criteria and indicators were selected (see Table 1):

- Pollutant loads in sensitive water bodies;
- Efficiency of settlement distribution with respect to existing water infrastructures. This was expressed by comparing the maximum water supply provided by the existing water distribution network with the distribution of economic activities and settlements (Sami et al., in press).

The data required to map these indicators included water quality, soil hydrology, land use, industry and population at both the present state, and the expected plan implementation scenario. Among the pressure elements that can be controlled by the plan, there are the increase in pollution loads from agriculture and urban uses, and the location of new urban areas irrespective of existing infrastructures. The response tools that can be implemented by the plan include policies for efficient water use and drainage management practice in agriculture, housing, and infrastructure development plans.

A spatial resolution of 25 m was adopted for the analysis. Data with a 25-m cell size (or smaller) are now to be considered as a standard in Italy, as well as in many western European countries (e.g. Nunes de Lima, 2005). Digital elevation models of similar or better resolution cover most Italian provinces and municipalities. Most regions carried out specific land cover mapping projects that also achieved at least a 25-m resolution. Data related to soil remain a matter of less detailed knowledge. Nevertheless, a parameterisation of soil properties based on coarser information can be implemented and combined with land cover data to achieve a reasonable representation of land hydrologic responses (Beven, 2000).

It was found that a grid cell of 25 to 50 m reasonably represented environmental and land use processes and patterns at the landscape scale. This corresponds to the scale of the spatial database that is normally used to support provincial planning. Coarser resolutions hamper a suitable geographic representation of patterns and phenomena that play a key role in planning at the Province level, such as flooded areas, ecologically relevant patches, and settlements. A finer resolution, that can represent processes that are relevant for the design and implementation phase, is generally not of interest when attempting to assess the impacts of plans and strategies.

### 3.2. Spatial effects of the Naples Plan

SEA is affected by a greater level of uncertainty than project EIA (von Seht, 1999). Even though a spatial plan sometimes provides indications whose effects are unequivocal (e.g., sitting of main infrastructures), most issues are addressed in more general terms (e.g., policies to control soil erosion). In order to set the basis for an effective SEA procedure, it is crucial to try to identify, and spatially resolve, the outcomes of implementing the plan proposal. The second stage of the method consisted in predicting the expected changes caused by the implementation of the spatial strategy devised by the Naples Plan. The analysis focused on the changes that are most instrumental in causing environmental impacts, and that have a spatial representation, given that some SEA impacts are by nature not spatially fixed (Therivel, 2004). To test the approach, three main effects were addressed: urban expansion, land use changes, and passengers and freight

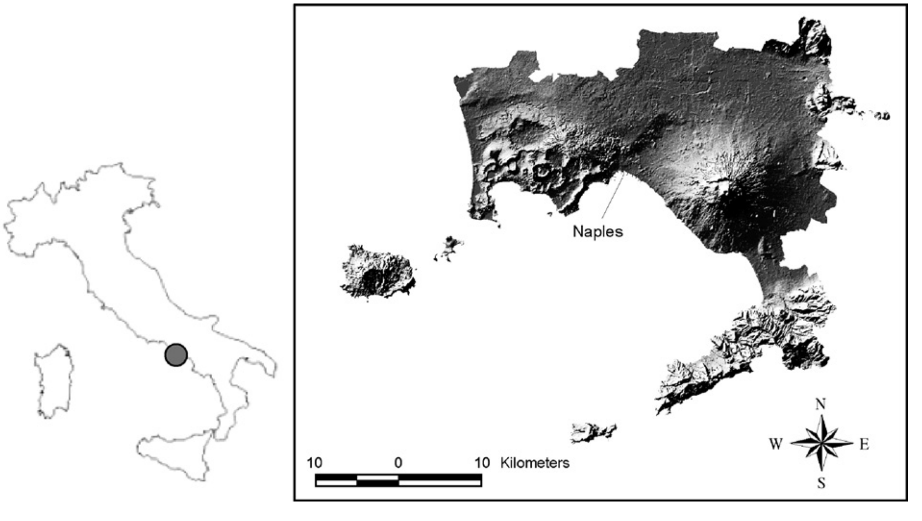



Fig. 1. Location and Digital Elevation Model of the Province of Naples.

flows. The analyses were carried out using the Geographical Information Systems (GIS) Arc-GIS 9 and ILWIS.

#### 3.2.1. Urban expansion

The Naples Plan provides for a maximum allowable increase in residential areas, and for a set of constraints (natural hazards, population density, etc.) that restrict the location of new settlements. Furthermore, in order to halt urban sprawl, the Naples Plan sets size and compactness thresholds for the new residential sites. First, the constraints were mapped and overlaid to identify developable areas. The analysis was conducted using raster maps with a cell size of 25 m. Subsequently, each cell was assigned an index that expresses its suitability to host residential use. The index was computed through favourability functions (Chung and Fabbri, 1993), by assuming that future developments will occur in areas similar to existing residential areas, according to characteristics such as slope, distance form roads, distance from city centre, etc.

Subsequently, an urban growth scenario was constructed, taking into account the Naples Plan's guidelines for size and compactness. In this scenario, the cells with the highest suitability values were progressively allocated to residential use until the "satisfaction of the demand" (Eastman et al., 1998) was achieved. The demand was considered tantamount to the maximum urban growth allowed by the Plan, i.e. to the condition of maximum environmental impact. This was consistent with the precautionary principle, which should be applied under uncertainty conditions. The results are presented in Figure 2. Figure 2a shows the location of developable (i.e., unconstrained) areas, whereas Figure 2b depicts the expected residential expansion.

#### 3.2.2. Land use change

As previously mentioned, provincial spatial coordination plans do not specify the range of permitted uses for each parcel, this being the role of municipal land use plans. The Naples Plan only contains some indications on land capabilities and on the general allocation of uses. However, the evolution of land uses is of paramount importance for SEA, because it influences several of the indicators listed in Table 1. For example, land use changes in a watershed affect physical processes like erosion, as well as biological processes like animal flows. By combining the information contained in the Naples Plan's cartography and regulations with the current land use and land cover, a scenario of the expected evolution of main land use types was generated (Fig. 3). For this purpose, a new legend was adopted that represented a compromise between the detailed legend of existing land use maps, and the broad zoning provided by the Naples Plan.

Three main land use types, namely urban, agriculture, and natural areas, were considered, further divided in sub-classes (see full legend in Table 2). This legend aimed at capturing the factors that play a relevant role in determining environmental impacts, such as the location of direct and indirect pollution sources (landfill, commercial districts, etc.), as well as pollution receptors (residential areas, natural parks, etc.). Obviously, the selected classes are general and do not provide indications on a number of conditions, such as house density, industrial process, and cultivation type. However, these detailed factors are more suited to be used during project EIA rather than SEA.

#### 3.2.3. Demography, passengers, and freight transport

Forecasted demographic changes, relocation of industrial and productive areas, and modifications to the transport network are among the most important elements of a spatial plan. This information can be rapidly processed to extract the main patterns of traffic increase/ decrease due to different phenomena (e.g., relocation of industrial sites, centralisation of public

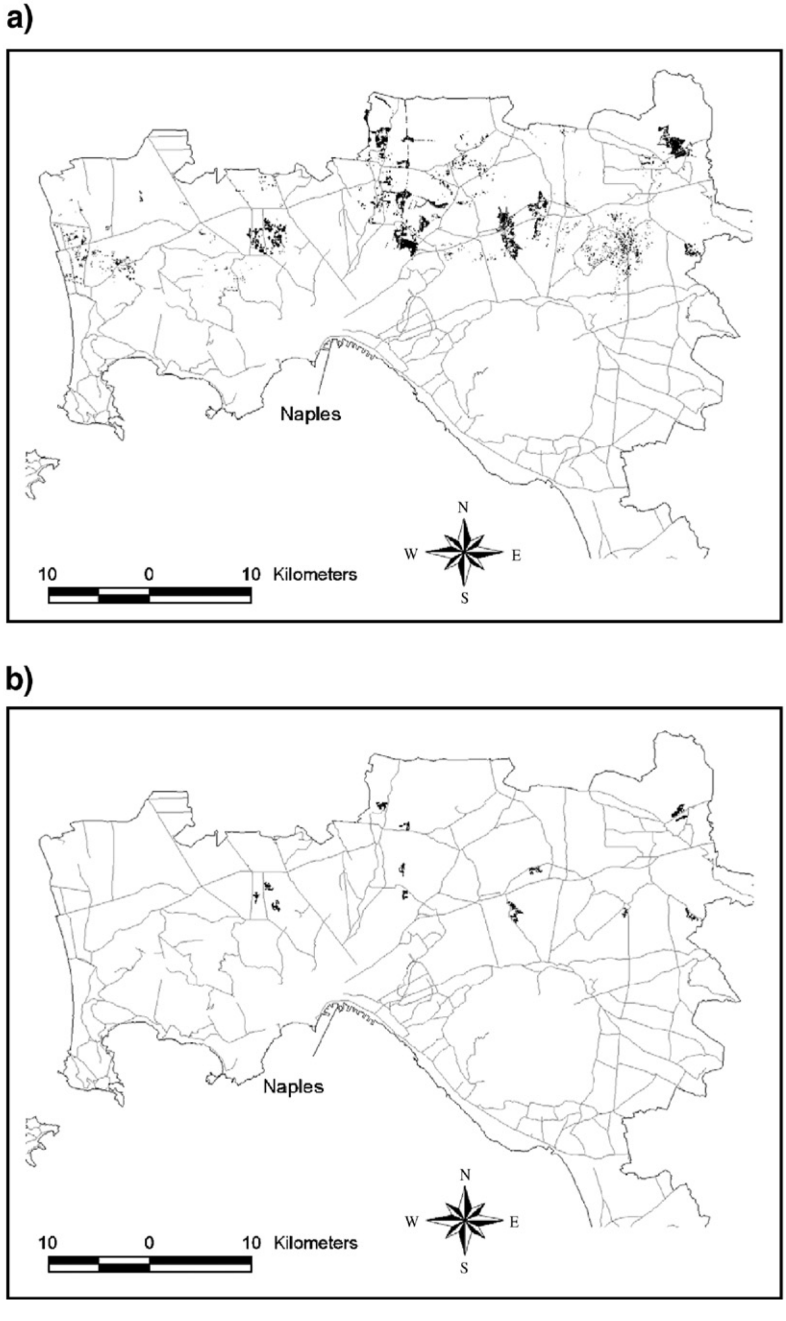



Fig. 2. Location of developable areas within the Province of Naples (a) and expected residential expansion (b). Transport network is shown as a reference.

services), by resorting to a technique based on gravitational models (Isard et al., 1998), which is described in detail in Pistocchi and Preger (2003). In this study, the expected evolution of land uses and demographic trends were used to generate a population distribution scenario, which was

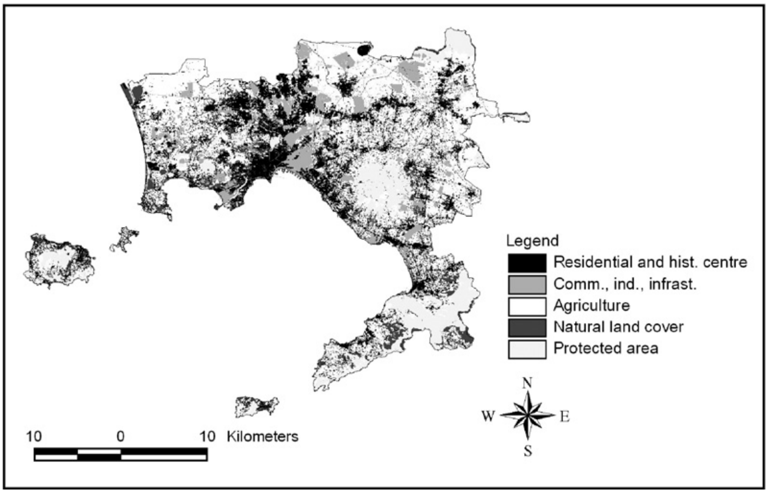



Fig. 3. Expected evolution of land use (simplified legend for b/w representation).

compared with the present state. Subsequently, key land use changes were identified, such as the location of economic activities, which influences both home/workplace traffic and freight flows.

Using the distribution of population change, economic activities, and infrastructures, traffic patterns were generated for the present state, as well as the Naples Plan's scenario. This resulted in many patterns of traffic (see example in Fig. 4), which were used for subsequent specific evaluations. This approach allowed representing in a consistent and simple way how the Naples Plan might modify the distribution of traffic flows. The obtained patterns can be validated by

Table 2
Strength and weakness analysis of land use at different distance ranges from protected areas

| | 0–250 m | 250–500 m | 500–1000 m |
|---|---|---|---|
| Residential areas | −− | −− | − |
| Industrial areas | −− | −− | −− |
| Green areas | − | 0 | 0 |
| Historical centres and archaeological areas | − | − | − |
| Commercial and services | −− | − | 0 |
| Degraded land | −− | −− | −− |
| Transport infrastructures | −− | −− | −− |
| Agricultural land with high ecological or landscape value | 0 | 0 | + |
| Prime farmland | − | 0 | + |
| Marginal farmland | − | 0 | 0 |
| Protected areas | + | ++ | ++ |
| Ecologically-relevant areas | ++ | ++ | ++ |
| Other natural areas | + | + | ++ |
| Water bodies | + | ++ | ++ |

Legend:
++ remarkable strength factor.
+ strength factor.
0 neutral condition.
− weakness factor.
−− remarkable weakness factor.

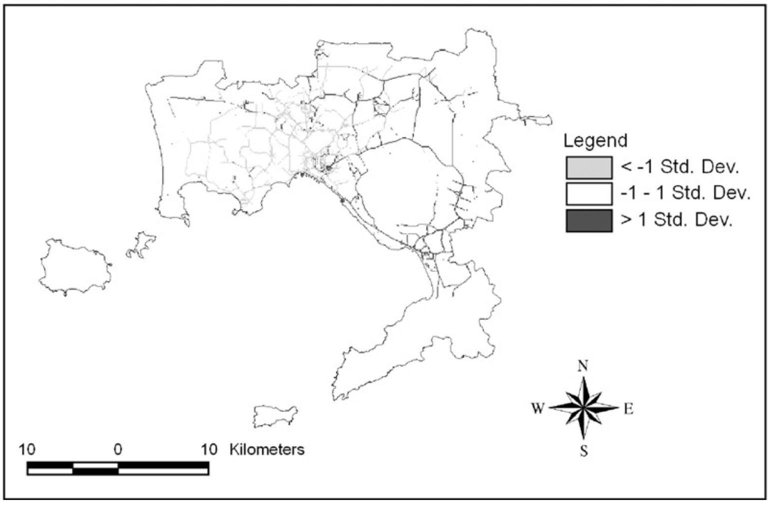



Fig. 4. Expected changes in home-to-work traffic expressed through a standard deviation scale to emphasise patterns, rather than absolute values.

collecting evidences of present state flows, and provide a causal relationship between land use, infrastructures, economic activities and population.

### *3.3. Environmental impacts of the Naples Plan*

This stage aimed at providing a framework for the assessment of the changes likely to be brought about by the Naples Plan's proposals. Impacts should be assessed against explicit environmental criteria, and with respect to a baseline environment (Jones et al., 2005). Characterising impacts of planning tools requires a substantially different approach with respect to the impacts of projects. A plan can be regarded as a project at the landscape scale, whose features, and hence predictable impacts, are defined to an extent that does not allow anything more than identifying opportunities and threats, to be associated to possible implementation scenarios.

Opportunities and threats can be evaluated with reference to the strength and weakness factors of the region under consideration. All these elements should be specifically assessed in relation to previously set values, and associated criteria (see Table 1). Structuring the assessment in this way is consistent to a well-known technique referred to as Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis. SWOT analysis is a commonly used tool to study the external and internal factors that affect a decision situation (Wheelen and Hunger, 1995). SWOT analysis can provide a good basis for assessment and strategy formulation, even though it is often left only at the level of pinpointing the issues, and describing them in general terms (Kangas et al., 2003). In this study, SWOT analysis was adapted to provide a more comprehensive decision-support tool, by spatially resolving the factors, and linking them to specific values and objectives.

Strengths and weaknesses represent the *internal* factors, and were assessed by considering the state of the environment, with particular reference to the values pursued by national and European policies (Table 1). Opportunities and threats, i.e., the *external* factors, were associated to the Plan's zoning and regulations. In particular, opportunities represent expected appropriate actions to the current state and pressures on the environment, whereas threats refer to inappropriate or negative actions. For instance, mapping areas affected by geomorphologic risk means identifying a weakness factor. In those areas, planning infrastructures or urban renewal interventions represents an inappropriate plan action, i.e. a threat. On the contrary, expanding leisure areas can be considered as an opportunity for the plan to adopt suitable management practices. To better describe the approach, the results of the SWOT analysis of one of the areas of concern are illustrated in detail in the next section.

## 4. Results of the SWOT analysis

Consistent with the objective of the study, the results are represented by a framework to support a forthcoming formal SEA, as well as the concomitantly Naples Plan's revision. In particular, the results consisted in thematic maps of the different elements of the SWOT analysis, as well as in overall maps for each of the areas of concern. As an example, the SWOT analysis results for the area of concern related to ecosystem protection are described next.

In order to provide the basis for the assessment of the Naples Plan's effect on natural ecosystems and biodiversity, three main criteria were considered: land use around protected areas, the presence of ecologically relevant elements (corridors, ecotones, etc.), and the fragmentation of remnant woodlands and forests. The first criterion – land use around protected areas – is a proxy to express disturbances that affect nature-conservation sites. Current land uses surrounding such sites were considered as strength or weakness factors, according to the qualitative scheme of Table 2. For example, settlements within 250 m of protected areas were considered as a remarkable weakness factor, whereas the presence of farmland with high ecological value as a neutral condition, i.e., neither a strength nor a weakness. Subsequently, opportunities and threats were identified by assessing the expected evolution of land uses around conservation sites. For instance, urban expansion was considered as a serious threat, whereas new urban parks as a potential opportunity. The resulting map is shown in Fig. 5.

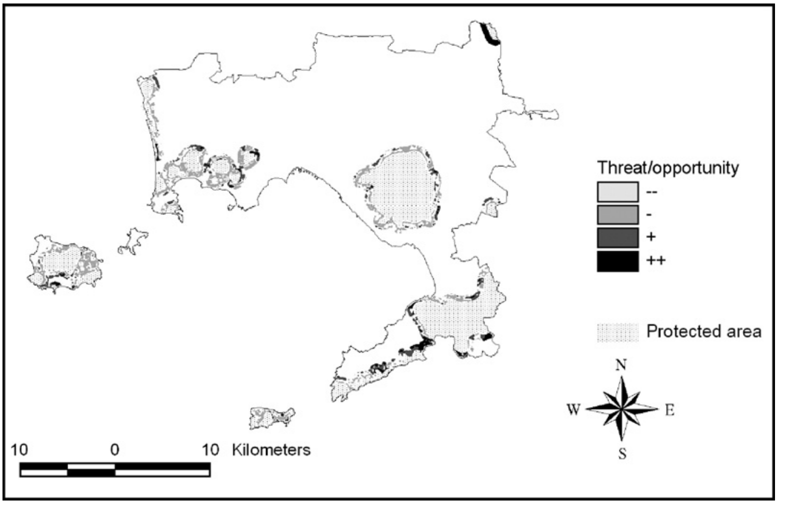



Fig. 5. Opportunities and threats of the Naples Plan's provisions around protected areas.

In relation to ecologically relevant elements, they were first mapped and then assessed in terms of weaknesses or strengths, according to the suitability of current land use (Fig. 6a). Opportunities and threats were then mapped where the Naples Plan provides for an evolution toward a land use with respectively a higher or a lower compatibility with the conservation of these elements (Fig. 6b). Analogously, the fragmentation indicator was used to identify strengths (large and compact forest patches) and weaknesses (small and dispersed patches). Opportunities referred to situations in which

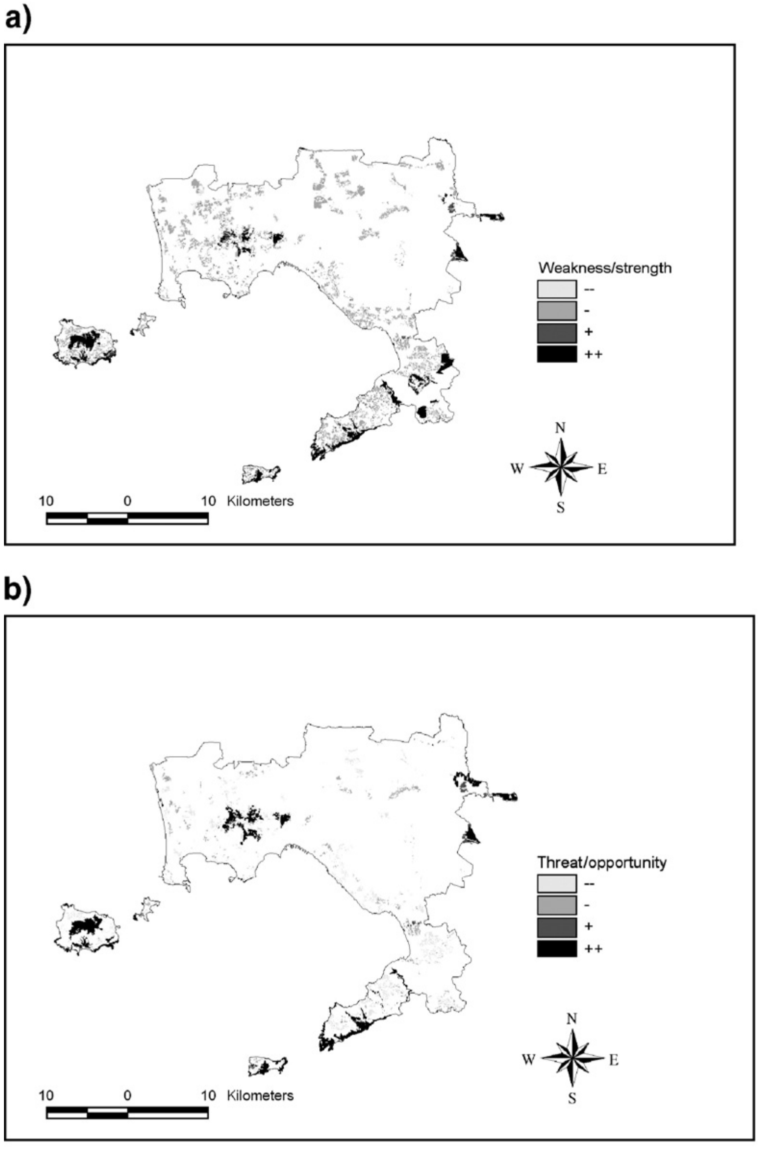
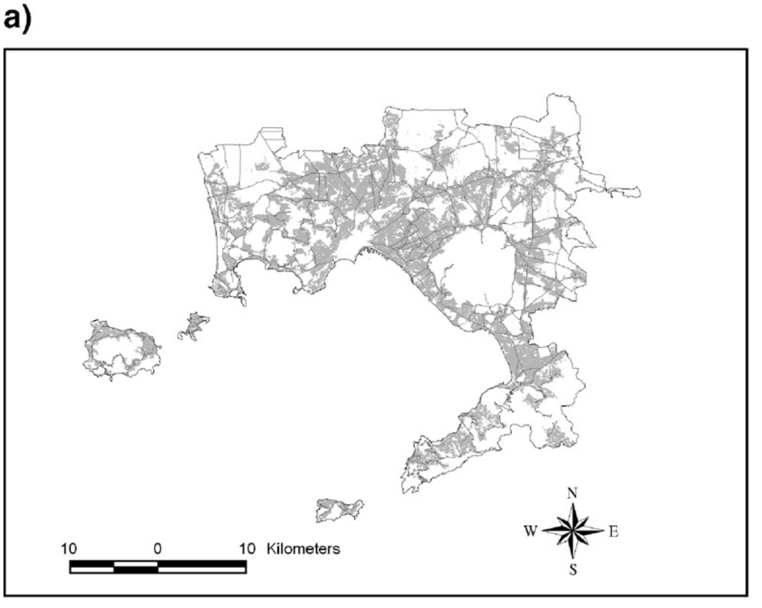



Fig. 6. SWOT analysis related to ecologically-relevant landscape elements. (a) Strengths and weaknesses. (b) Opportunities and threats.



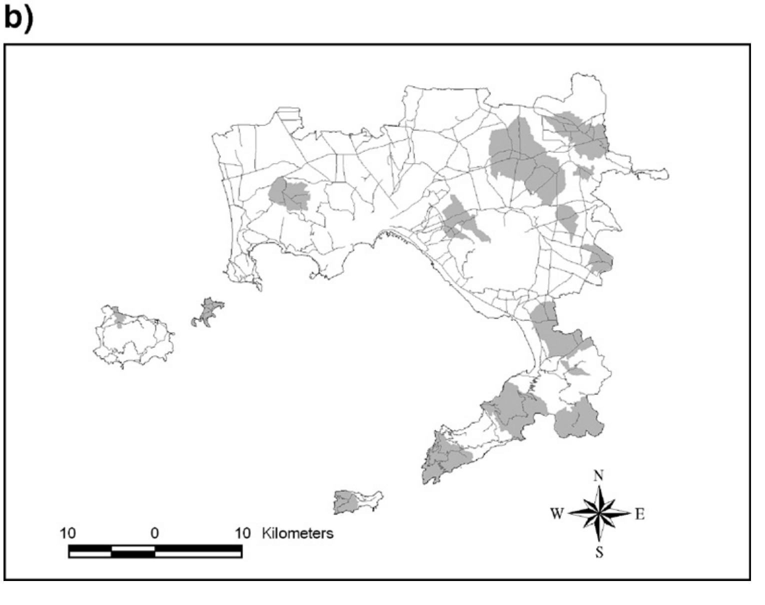




Fig. 7. Map of the critical areas with respect to soil conservation (a) and urban sprawl (b). Transport network is shown as a reference.

the Plan's provisions are bound to alleviate fragmentation (e.g., conservation of farmland) and threats when the opposite occurs (e.g., urban encroachment, new infrastructures).

For each area of concern, an overall map was generated to provide an overview of the distribution of critical elements, and to support the proposal of additional Plan's regulations. In particular, such new provisions should be aimed at avoiding development that increases threats, and promoting development that foster the opportunities. As an example, Fig. 7a presents a map that shows priority areas for soil-protection interventions to reduce the erosion risk posed by environmental factors and agricultural practices. The map provides operational indications about where and how to constrain land use in order to ensure sustainable use of soil. Fig. 7b shows an example related to the protection of the landscape and rationale use of space. This map shows the areas most exposed to the risk of urban sprawl, due to a combination of current conditions (i.e., weaknesses), and Plan's policies (i.e., threats). The results allow identifying the most critical areas, to guide the revision of the Naples Plan, as well as the identification of mitigation or compensation measures.

## 5. Conclusions and future developments

This paper presented an approach to construct a spatial decision-support tool aimed at providing technical guidance to SEA of land use plans. The approach was tested using as a case study the spatial coordination plan of the Province of Naples. The method allowed organising the relevant information, spatially resolving the main actions of a plan, predicting their environmental effects, and generating overall performance maps. Comprehensive territorial plans are sometimes formulated in rather fuzzy terms, and it is not always straightforward to understand and predict what the proposals will imply in practice. Even harder is to do so in geographical terms, i.e., by forecasting the location of the changes steered by a plan, as well as the distribution of the consequent environmental impacts. Through this study, an effort was made to spatially model the expected implications of a plan, and to assess them against a set of environmental criteria.

If SEA must provide timely and relevant information to decision-makers (Jones et al., 2005), then the spatial decision-support tool constructed here can ensure this through the identification of cornerstone objectives and indicators, as well as of operational ways to measure them in the light of the available data. The approach relied on data that are routinely acquired by the province administration, or that can be generated from such data with relatively little effort. These data have a spatial scale that range from 1:10,000 to 1:25,000, and are linked to metadata containing information on their quality and accuracy. This spatial scale proved adequate to SEA, allowing representing the most relevant environmental processes and land use patterns. The use of the existing GIS database of the Province of Naples allowed making the approach replicable and easily updatable. Furthermore, it reduced significantly the time and cost involved with the generation of the decision-support tool. Being based on data that are regularly collected, updated, and quality tested, the assessment framework built-up in this study represents a dynamic instrument that can be adapted to the volatile context of strategic decision-making.

The output of this study is being used by the provincial administration to guide the on-going revision of the Naples Plan, and the concomitant SEA procedure. In particular, the analyses presented here are to be run in an interactive fashion by the administration officers to assess the suitability of the proposed zoning. The SWOT mapping can contribute to the proposal of zoning modifications, as well as mitigation and compensation measures. Modifications can be targeted to specific sites, and aimed at solving locally critical conditions. They can be implemented through a revision of a plan's provisions, such as the boundaries of developable land and the size threshold for new settlements. Mitigations can be introduced by new regulations to reduce the pressure on some of the environmental areas of concern (e.g., proposal of energy efficiency standard for new residential areas). Finally, compensation measures may be adopted for the areas overburdened with environmental impacts.

Political proposals and ideas can be inputted, through technical officers, in the decision-support tool to generate and compare scenarios. The effectiveness of the procedure can be further enhanced by interacting with stakeholders, generating and assessing scenarios in an open planning process. This could be implemented with relatively little effort, at least for some well-defined analyses, such as the expected evolution of urban areas and the future pressure on nature-conservation sites. The decision-support tool allows for a high degree of interaction: transparency is guaranteed by a clear record of all evaluation stages, analyses are replicable, and the inputs that lead to composite assessments can be retrieved and modified.

The decision-support tool is also suitable to contribute to other spatial planning activities at the province level. In particular, it can represent the backbone of the SEA of future sectoral plans, such as transportation, agricultural development, and water management plans. Even though further and more specific sectoral analyses and data would need to be integrated, the system provides a reference framework to identify the areas of concern, to structure the spatial data, and to model and assess the main environmental impacts.

From a technical standpoint, future development of the approach should include uncertainty and sensitivity analyses. The assessment of the effects of a strategic proposal is characterised by an inherent high level of uncertainty (von Seht, 1999; Wood and Djeddour, 1992), and prediction models must account for it. Following the approach proposed here, several scenarios could be constructed, simulating the effect of different policies, as well as their different degrees of implementation. This can be done in an iterative way, concomitantly with a plan's revision process. The spatial decision-support tool can be used as a reference framework in order to ensure transparency, consistency between simulations, and the generation of replicable results. Finally, from a procedural standpoint, the study could be extended to other critical aspects of SEA, such as public consultation and participation. In particular, people's perceptions and value judgments could be included, spatially resolved whenever appropriate, and linked to the relevant areas of concern.

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