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# Spatial planning and Natura 2000 – approaches, tools and techniques and their potential benefits for the planning and management of Natura 2000

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**Abstract:** Geo-spatial information technologies (GIS) play an important role in spatial planning processes as they provide a reliable information basis for decision making processes. Over the past two decades geo-information technologies have quickly developed and are widely used in the field of spatial planning. The reason is on the one hand the geospatial character of the spatial planning and the need for spatially referred quantitative and qualitative information, and, on the other hand, the large amounts of data and specialized spatial data infrastructures and platforms on European, national, regional and local levels. In this regard, Natura 2000 sites are no exception, as they are, on the one hand, subject to the implementation of procedures for spatial planning, and ,on the other hand, they are an important integral part of development spatial plans for various administrative-territorial units in national and European context. The article presents the state of the art on geo-spatial information technologies (GIS) used in spatial planning processes that can be beneficial to Natura 2000.

**Key words:** geo-spatial information technologies (GIS), spatial planning, Natura 2000

Natura 2000 is the largest coordinated network of protected areas in the world binding together some 29 countries in a common environmental aim. However, the practical implementation of the network, it's monitoring and management in a sustainable manner presents quite a challenge for the spatial planning and territorial development across the Member states. This is particularly because the network is not restricted only to nature reserves, but also covers large areas where socio-economic activities take place. The key underlying element for unfolding the challenges during the actual planning processes lies in resolving the increasing conflicts about land use and the degradation of the land resources, while meeting the expanding demand for preserving the European natural capital and biodiversity. The legal basis of the Natura 2000 are the EU Habitat and Birds Directives (79/409/EEC) where Special Projection Areas (SPAs) and Special areas of conservation (SACs) are designated which have had a far-reaching consequences for the spatial planning polices of the Member States. The implementation of these directives through the spatial planning process appeared to be a rather challenging process for many governments.

In the academic literature and policy documents there is no common definition on the term spatial planning. Across the EU member states it is a challenge to translate the term because usually it includes different processes, procedures, tools and even actors. In some member states spatial planning relate to coordination and / or integration of the spatial dimension of sectoral policies through targeted territorial strategies that makes it rather closer to the classic strategic planning of regional development than planning of the territory (UN, 2008). Moreover, the term express more complex processes in a strategic sense for aggregative political actions aimed at different governmental tiers for optimization of the social processes in a spatial aspect (Faludi, 2002). In this context, the term spatial development refers directly to the processes of evolution/development of the territory and all their dimensions, the concept of spatial planning is interpreted as an organized set of methods and the concept of spatial policy - as structured set of planned activities and interventions that influence on the spatial development of the people and activities in various categories such as production, marketing and communication systems realized in an environment with natural, urban and social character (CEMAT, 2006). One of the most cited definition for spatial planning is provided by the Compendium of European Spatial Planning - "spatial planning refers to methods used largely by the public sector to influence the future distribution of activities in spaces. It is undertaken with the aims of creating a more rational territorial organisation of land uses and the linkages between them, to balance demands for development with the need to protect the environment and to achieve social and economic objectives" (European Commission, 1997). In this regard, the spatial planning policy is an interdisciplinary and cross-cutting policy which instruments and tools can provide solutions and methods to meet the challenges of protecting, maintaining and diminishing negative impacts on Natura 2000.

Nowadays geo-spatial information technologies (GIS) play an important role in spatial planning processes as they provide a reliable information basis for decision making processes. However, a major challenge has been the harmonisation of data and the development of common standards for information from different data sources. Furthermore, the type of data required for spatial planning processes related to Natura 2000 varies considerably depending on whether the information is needed to assess the impact of plans and projects or if they concern setting up a long term strategic perspective on the development of a region. More recently special participate platforms have been established as a new tool for public participation to allow soliciting different opinions from broad audience of experts and public. These tools have showed to deliver potential benefits for the planning and management of Natura 2000, where multiple groups stakeholders are involved.

The article presents the state of the art on geo-spatial information technologies (GIS) used in spatial planning processes that can be beneficial to Natura 2000. Over the past two decades geo-information technologies have quickly developed and are widely used in the field of spatial planning. The reason is on the one hand the geospatial character of the spatial planning and the need for spatially referred quantitative and qualitative information, and, on the other hand, the large amounts of data and specialized spatial data infrastructures and platforms on European, national, regional and local levels. In this regard, Natura 2000 sites are no

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exception, as they are, on the one hand, subject to the implementation of procedures for spatial planning, and ,on the other hand, they are an important integral part of development spatial plans for various administrative-territorial units in national and European context.

The Natura 2000 network is not only the cornerstones of the European policy related to environmental protection, but also one of the largest organized, and to a great extent standardized, initiatives within the EU for collecting and processing geospatial information and data. The main challenge for this initiative relates to the large territorial extent of the network (including the total of 27393 sites in EU28), and the unique character of each area. The wide range of territorial extent and specific character suggest different approaches for data collection and processing of geospatial information. Because of this the harmonization of data volumes is challenging. Last but not least, each site of the Natura 2000 network has a different context in terms of spatial and socio-economic development, which in turn causes different genesis, intensity and scope of pressures on habitats and species subject to protection.

All these problems and limitations influence directly the quality and usability of the information basis on spatial planning of the Natura 2000 sites. This on its turn requires the application of adequate spatial-analytical procedures and models on the basis of which appropriate and informed decisions for the purpose of future development to be taken.

Based on the common European initiatives for collecting, editing, analysing and publishing of geospatial information for Natura 2000 sites, the following three aspects are presented in the current article:

• Requirements for geospatial data and data infrastructure for the Natura 2000 network;

• Available methods for spatial analysis and modelling of data and their applications for the purposes of spatial planning within the zones in the Natura 2000 network;

• The opportunities that state of the art geo-information technologies provide to improve public information accessibility, strengthening and empowerment of the various categories of stakeholders in the processes and procedures of spatial planning - Public Participation GIS (PPGIS).

**Geospatial data and data infrastructure for the Natura 2000 network**

Geographic data and information play a strategic role in defining and applying all European policies, including those referring to spatial planning and sustainable governance of the Natura 2000 sites. The geographic data, its quality, quantity and accessibility have become subject of a number of major initiatives concerning the application of GIS, promoting the scientific research in the field and monitoring of the effects in the usage of GIS technologies by European governmental and non-governmental organizations (such as GSDI, GINIE, EUROGI). The majority of these organizations are related and actively communicating with the European Environmental Agency (EEA) and the European Commission, that organize their own initiatives in regard to the development of infrastructures for spatial data and information networks, concerning directly the environment and the zones within the Natura 2000 network of protected areas.

One of the biggest challenges in the spatial planning of Natura 2000 sites, however, relates to the high diversity of data necessary to conduct an effective planning process. Because of the specific problems in the different EU countries and unequally developed spatial data infrastructures, the harmonization of the spatial data is extremely difficult task. There are specific problems regarding spatial information faced by the decision makers, influencing the efficiency and quality of the decisions. These problems are related to the availability of the data, its quality, organization, accessibility and sharing. These are common to a large policy and information themes and are experienced across the various levels of public authority, as well in the field of nature conservation. Regarding the spatial information, there are initiatives taken to collect, harmonize or organize the dissemination or use of spatial information, where INSPIRE Directive is playing the central role.

The INSPIRE Directive, entered in force in 2007, is one of the fundamental documents addressing the issue on spatial information on various fields, including the environment. The main aim of the Directive is the establishment of an Infrastructure for Spatial Information in the European Community (INSPIRE) for environmental policies, or policies and activities that have an impact on the environment. The INSPIRE Directive complements the existing initiatives at the Community level concerning spatial information for the environmental sector, such as the implementation of the EPER (European pollutant emission register), the Forest focus (the monitoring of forests and environmental interactions), established by Councils legislation or programmes funded by the Commission (CORINE, European Transport Policy Information System) and ensure their interoperability.

Therefore, it is a big step towards overcoming the challenges regarding the lack of availability, accessibility, and sharing of spatial information across the various levels of public authority in Europe. It defines common standards for 34 spatial data themes and Natura 2000 is one of the explicitly mentioned classification - designation schemes in INSPIRE Protected sites data specifications. INSPIRE is based on the infrastructures for spatial information established and operated by every Member States of the EU. Thus, each Member State regularly submits data to the European Commission for the European database on Natura 2000. The data is submitted in a standard data form and is validated by the EEA and its supporting bodies. However, it is responsibility of the Member state to regularly update the data. The specific spatial data, namely the borders of the sites are validated by the EEA and if any discrepancies are found it is reported to the MS which should take it in consideration. Afterwards, the spatial data is generalized to a scale of 1/100 000 and it is integrated in the common database.

INSPIRE has its coherence ensured at the European level by its strong connections with other related European and global initiatives, such as: GALILEO (the European satellite navigation system) and GMES (Global Monitoring for Environment and Security), completing them and making them interoperable and has the support and assistance of the European Environmental Agency (and its information and observation network: EIONET) and the GSDI Association (Global Spatial Data Infrastructure). INSPIRE is also linked to the Directives of the European Parliament and of the Council 2003/4/EC on the public access to

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environmental information and Directive 2003/98/EC on the re-use of public sector information by their complementary objectives regarding the efficient public data use, the transparency in decision making and the free access to public information.

One of the biggest challenges in the spatial planning of Natura 2000 sites relates to the high diversity of data necessary to conduct an effective planning process. The type of data needed depends on the spatial planning approach as well as the species and habitats for which the sites has been designated. Given the challenges of spatial data harmonization, data quality, sharing and access for spatial planning and Natura 2000 purposes, several projects have been initiated to explore these, focusing on different aspects of problems:

- **NatureSDI Plus Project**

NatureSDI Plus project is one of the first projects developed to directly contribute to the Annexes I and III of the INSPIRE Directive focusing on the nature conservation issues by establishing a Best Practice Network on geographical information for nature conservation in the MS. The project is addressing the need for interoperable, accessible and harmonized datasets for geo-information provided in the field of environmental protection. The aims of the project are achieved through state of the art methodologies and best practice examples, to improve harmonization of national datasets and make them more accessible and exploitable. As the first step towards the harmonization process, the project analyses the data usability and accessibility within a wide European context. The conclusions are that the heterogeneity of the data among the different countries is very high. Best Practices on interoperable datasets for nature conservation is collected and available for the users on the website of the project. The final objective of the project is to provide NATURA-SDIplus Geoportal that has aggregated datasets and metadata from different partners.

- **Humboldt Project**

Humboldt is another project that is designed to facilitate the integration and harmonization of different datasets into a common European structure. Thus, it contributes to the implementation of a European Spatial Data Infrastructure (ESDI) that integrates the diversity of spatial data available for a multitude of European organizations. The ESDI is directly related to the implementation of the INSPIRE directive. The mail objective of the project is to facilitate organizations to document, publish and harmonize their spatial information in the field of nature protection. A key feature of the Humboldt project is the development of scenario applications that provide specific examples of the use of the Humboldt framework to address the challenges of the interoperability of geospatial data in a variety of application settings. The main aim of the Protected Areas Scenario is to embed geo-information managed by park authorities in a seamless flow gathering data from diverse sources at different level, European, national, regional, enabling its exploitation for planning, management and tourism promotion. The website of the project gives access to the open source software which is an output of the activities aimed at achieving the objectives.

- **Plan4All Project**

Plan4all is yet another project focused at the harmonization of spatial planning data according to the INSPIRE Directive based on the existing best practices in EU regions and municipalities and the results of current research projects. It is an eContentplus "Best Practices Network" project started in May 2009 with durability of 30 months. The eContentplus programme is a European Commission multiannual programme and its main aim is to make digital content in Europe more accessible, usable and exploitable. The main objective of Plan4all was to build a network of local, regional and national public bodies, stakeholders, ICT industry organizations; organizations dealing with planning issues and regional development; universities; and international organizations. Thus it is not restricted only to spatial planning issues in the field of nature conservation. The partnership has consisted of data holders, software and planning organizations, SMEs, consultancy, research organizations and academia in European countries and international organizations. The results of the project are European forums for SDI in spatial planning, a database of best practices and analysis of best practices in terms of organization, sharing, harmonization and SDI building recommendations for spatial planning.

Over the last years, various GIS tools and technologies were introduced concerning the gathering, maintenance and accessibility of the spatial data on Natura 200 network. The European Commission with the support of the EEA has developed a public viewer for all Natura 2000 sites based on state of the art GIS technology. The tool provides a number of functions for the users to view spatial information for the network and also allows the turning off and on of several layers such as nationally designated areas (CDDA), CORINE land cover, biogeographical regions, etc. The tool is a successful example of the incorporation of the GIS technologies for environmental protection for the largest coordinated network of conservation areas in the world. The viewer, due to the aggregated information for all member states, proves to be a useful tool for practitioners in the field of spatial planning, developers, governmental authorities on all levels, NGOs and researchers. It is also a good instrument to be used for raising the awareness on the environmental protection in the EU, in education or for the general public and landowners in relation to projects concerning or affecting protected sites. The EC has also launched the Web Map Services which is a standard protocol allowing users to acquire geo-referenced maps online. Another service concerning the Natura 2000 network is the Web Feature Service (to be published) which allows users to request geographical features that can be used for spatial analysis or mapping. Also available for all stakeholders and the general public are various exported maps for Natura 2000 by Member states due to state of art spatial technologies.

ISBN: 978-619-90446-1-2

**Use of remote sensing for Natura 2000**

Remote sensing data is increasingly becoming important for spatial planning of Natura 2000. In recent years, a number of Remote Sensing (RS) data and techniques have become available to spatial planners and natural resource managers, supporting not only the planning procedures, but the whole process of managing and monitoring the status of the ecosystems, landscapes and the human-nature interaction. Satellites and aircrafts collect the majority of base map data and imagery used in GIS. The sensors typically used include film and digital cameras, light-detection and ranging (LIDAR) systems, synthetic aperture radar (SAR) systems, multispectral and hyperspectral scanners. Today these geoformation technologies, together with GIS and GPS are becoming part of the planning process for implementation of nature conservation measures as well as for the assessment and mapping of natural habitats and their land uses within Natura 2000 ecological network. This is because remote sensing has the potential to provide a broad range of non-subjective data and information for habitats and landscapes, as well as, it offers the opportunity to acquire necessary data in a systematic, repeatable, and spatially explicit manner. A major advantage of remote sensing compared to traditional field data base gathering is its complete spatial coverage including the acquisition of data in remote and inaccessible areas. Remote sensing can provide indicators for different spatial and temporal scales ranging from the individual habitat level to entire landscapes and involving varying temporal revisit frequencies up to daily observations. Habitat mapping is developing at a fast rate within the two basic approaches of field mapping and remote sensing. The latest technologies are quickly incorporated into habitat monitoring (Lengyel et al. 2008; Turner et al. 2003). Field mapping, for instance, is facilitated by the use of object-oriented methods or wireless sensor systems (Bock et al. 2005). Additionally, advances in remote sensing methods have resulted in the widespread production and use of spatial information on biodiversity (Duro et al. 2007; Papastergiadou et al. 2007; Forster et al. 2008). In fact, earth observation data is becoming more and more accepted as an appropriate data source to supplement, and in some cases even replace, field-based surveys in biodiversity science and conservation, as well as in ecology. Objectivity and transparency in the process of integrity assessments of Natura 2000 sites can be supported by quantitative methods, if applied cautiously (Lang and Langanke 2005). However, it should be kept in mind that there are various sources of uncertainty in remote sensing-based monitoring of vegetation (Rocchini et al. 2013).

Remote sensing can be done from space (using satellite platforms), from the air (using aircrafts), and from the ground (using static and vehicle-based systems). The same type of sensor, such as a multispectral digital frame camera, may be deployed on all three types of platforms for different applications. Each type of platform has unique advantages and disadvantages in terms of spatial coverage, access, and flexibility.

Recently, one of the newest and very fast growing sectors of remote sensing, with huge potential for spatial planning of Natura 2000 sites is the Unmanned Aircraft Systems for Earth observation. This new geoinformation technology emerged from the convergence between robotic, computer vision and geomatic technologies. Integrated, these technologies have established a new paradigm (Colomina et al., 2008) of aerial remote sensing and mapping that, for some years now, has been serving the needs of large-scale low-altitude imaging and geospatial information users and is developing an industry of its own (Cho et al., 2013, Mayr, 2013 and Petrie, 2013). The topic has become so important that the European national mapping agencies have organized working groups and begun to establish a common position (Cramer et al., 2013). Today more and more service and technology providers give the opportunity for acquisition in fast and financially effective way valuable RS data, which is very important for spatial planning, management and monitoring of Natura 2000 sites.

**Methods for spatial analysis and modelling of data and their applications for the purposes of spatial planning within the zones in the Natura 2000 network**

Due to the complex character of the Natura 2000 sites a wide range of spatial and analytic approaches, methods and models is required for spatial planning process of Natura 2000 sites. At the same time in order to ensure adequate ‘harmonization’ and integration with the overall models of spatial and regional development the extraction and generation of specific spatially-referred information is required. This includes data on economic, ecological, and social processes and structures (Goodchild, Janelle, 2004). That makes mapping, geographic information systems (GIS), spatial analysis and modelling valuable (and necessary) planning tools when balancing multiple land use claims on natural resources (Vries & Goossen, 2002). Within this context, the geospatial analysis could be defined as a compilation of variable approaches, procedures, techniques and models for the transformation of spatial and attributive data into useful information facilitating the decision-making in regard to the planning and management of sites within the European network Natura 2000, as well as the integration of those decisions in the overall spatial development.

In accordance with the specifics of each individual territory, the established models of land-use and the planned directions of spatial and/or functional development on the one hand, and, the availability of quality geospatial data, platforms and technological solutions on the other hand, require different spatial and analytic operations or a combination of them. In practice a number of recurrent steps occur during the spatial planning procedures, some of which cyclical (iterative) in nature. The derived results could be used for the analysis of a following phase until the desired final result is reached. The majority of spatial and analytic procedures require the application of different methods for the geo-editing of input data (including format, coordinate, projection and other transformations), queries within the database, statistical analysis and analytic modeling. A specific characteristic of the geospatial analysis is the wide range of application of qualitative and logic models as well as specific cartographic techniques for visualization. Widely used methods among others are also the agent-based modeling, fractal and cluster analysis.

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GIS allows the realization of a number of spatial and analytic operations, which are to a great extent applicable within the sites of the Natura 2000 protection network. These operations, in a generalized manner, could be summarized in the following basic categories (Fig. 1):

1) Functions and methods for data extracting from the database for defining the geometric and other specific characteristics of the spatial objects. Within this category of methods the following could be included:

- Filtering of the data base with queries, aiming to select a subcategory of spatial (geometric and topological) and attributive criteria;
- Grouping and characterization of spatial objects on the basis of predefined classification criteria within the attributive values of the objects (including reclassification on the basis of statistical division of attribute values with a variety of methods – quantitative, equal intervals, standard deviation, natural breaks, etc.);
- Calculation of morphological indexes in the geometry of polygonal features (solidity, indentations and clipping of the polygons);
- Definition of geographic center (centroid) and center of gravitation within the polygon;
- Geometric and semantic generalization of data;
- Statistical analysis (including spatial statistics and geo-statistics) based on the attributive values of different objects within the various measurement scales (nominal – in category and dichotomy, sequential – 'weak' convergent sequence and range, interval, cyclical and relations scale).

2) Functions for combination of spatial and attributive data extracted from two or more layers through overlay operations (no restriction in the number of layers, which could participate in such operations). This group of methods is in the basis of integration of different categories of information resources in the spatial planning procedures. Within this group are defined the following basic methods, techniques and approaches:

- Application of different logical and arithmetic operations for union, erase, intersect, identity etc., as well as, other methods for geoprocessing (e.g. Dissolve, Clip, Merge, Buffering etc.);
- Construction of topologies for the newly created points, linear and polygonal objects and performance of analytical operations with the newly defined attributes (e.g. selection of a preferable location for certain economic activity, risk management, assessment of the potential of the territory);
- Application of overlay operations for the purposes of visualization (e.g. visualization of landscape elevation with hillshade);
- Possible combinations of features within different layers, representing Descartes relations, without the necessity for a theoretical maximum number of combinations to be reached;
- Often it is necessary to additionally edit the results of the analysis due to the accumulation of small 'sliver' polygons, which result from the intersection of the input polygons in the initial phase;
- When working with raster layers the most widely applied analytical function is Map Algebra, which allows the results of the analysis to be formed in three different variations – via transformation of data within a singular layer with scalar values, transformation of data within a singular layer with mathematical function (formula representing regression or other function) and with the usage of mathematical combination of values in two or more layers in a defined sequence. The analysis is performed cell by cell. For the purposes of the analysis grids could be used, with different types of values within the pixels (binary, categorical or floating-point values).

Map Algebra allows reclassification procedures for the purpose of recoding of input values with new values, scaling of attributes of the features from one interval scale to another, 'masking' of data in order to exclude a part of the irrelevant information from the raster layer for further analysis. The raster data is used for local, focal, zonal and global analytical operations. When performing raster analysis full-resolution data is necessary, instead of compressed images (so called 'pyramids'), which are only applicable for visualization purposes.

3) Neighborhood functions are used for:

- Identification of objects localized within a search window;
- Topological overlay ('point within a polygon', 'polyline within a polygon' or 'polygon within a polygon') for the purpose of defining whether a point, polyline or polygon object is situated within the bounds of another spatial object, which is a part of a different layer;
- Geomorphological analysis – slope, exposition, vertical and horizontal curvatures of a landscape surfaces (linear, convexed, conclaved, convergent and divergent) based on data from output digital elevation model (DEM), including for the purposed of hydrological and hydraulic analysis;
- Interpolation functions with the use of different spatial interpolation methods (IDW, Kringing, Spline) including areal interpolation and functions for generation of isocline representations (in 2D and 2.5D);
- Filtering of raster data with sliding windows (kernels) with various proportions (3 x 3.5 and other pixels) and extraction of data with maximal, minimal, average, meridional, standard deviation, contrasting of highest and smallest pixel values within sliding window.

4) Functions for analysis of connectivity and proximity of spatial objects with regard to:

- Distance (Euclidean, network, Manhattan, linear, Decardean distance and distance within the 'big' circle - ordodroma) and travel time – by using buffer (different buffers around points, linear and polygonal features, raster cells and raster zones – buffers with fixed and floating distances, singular or multiple – with or without open boundaries, symmetric or asymmetric)
- For identification of nearest neighbors for a pre-defined spatial object, for network analysis or analysis of transport accessibility (topological – vector or continuous – with raster layers);
- Analysis of visibility, based on digital elevation models (DEMs);
- Application of algorithms from graph theory within network analysis, based on strict conditions with regard to the topology of vector data.

The effectiveness of the applicable spatial and analytic functions to a great extent depends on the quality of the input data model. As a whole vector data is more appropriate for analytical purposes related to connectivity and network analysis, topological overlay operations and when combining layers with a number of attributes; raster data is more appropriate for the purposes of arithmetic and Boolean overlay operations, buffering, proximity analysis and transport accessibility analysis, creation of continuous surfaces and analysis of images, acquired via distance sensing technology (satellite, aerial –photo, Lidar, interferometric imagery).

Inseparable from geospatial analysis is the modelling function of GIS technologies. The term 'model' in the GIS scientific field has several definitions – geometric data model (topological, vector – point, linear, polygonal, network, TIN; or raster – pixels or zones), in the context of various logic models of data base structures (hierarchy, relational, object-oriented, hybrid etc.) and analytical models, applicable in geospatial analysis (for example: assessment of soil erosion spread, transport accessibility, selection of most desirable location for situating a factory base, retail store or waste processing plant). The majority of models are mathematical and logical, based on mathematic formulae and/or logical expression.

Often the analytical models are developed in a logical scheme for automatic performance of spatial-analytical operations. For instance, the module Model Builder in ArcGIS structures logical schemes in a sequence: input data -> spatial editing function -> result, together with the information flow for combination within the model. The gathered results could be used for input information for a following spatial analytical operation. The chain of operations for data processing could include structuring of information within a hierarchy for analytical modelling. For different purposes different analytical models are applicable – static (for a fixed moment or a time period in the timeline), dynamic (defining changes in the condition of objects resulting from temporal occurrences) or spatial-temporal (defining changes within a time-space frame).

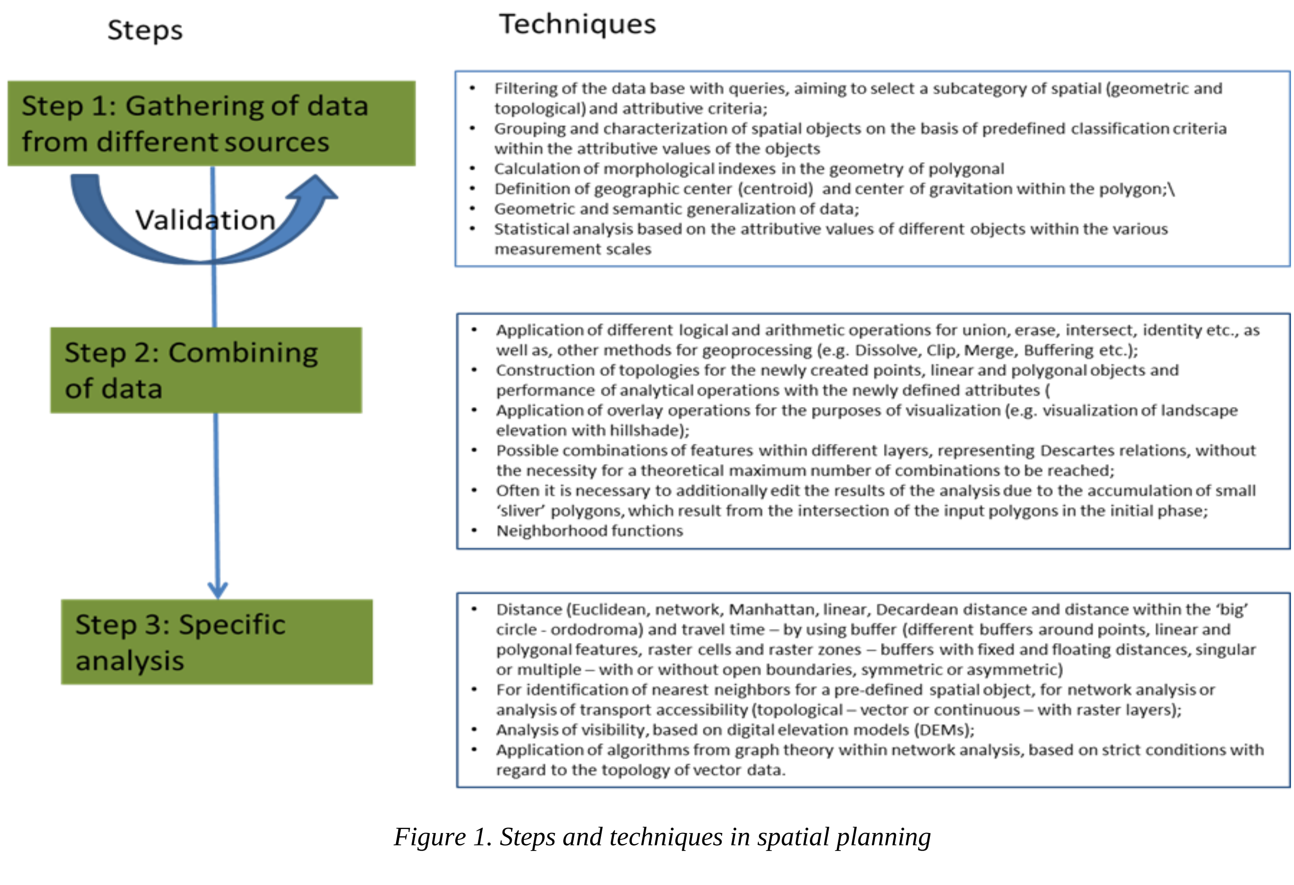


*Figure 1. Steps and techniques in spatial planning*

The quality of the original data has important consequences for the type of methods possible. As a whole vector data is more appropriate for analytical purposes related to connectivity and network analysis, topological overlay operations and when combining layers with a number of attributes; raster data is more appropriate for the purposes of arithmetic and Boolean overlay operations, buffering, proximity analysis and transport accessibility analysis, creation of continuous surfaces and analysis of images, acquired via distance sensing technology (satellite, aerial –photo, Lidar, interferometric imagery ).

**Public Participation GIS (PPGIS)**

Spatial planning is a complex public task that requires the involvement not only of experts but also a wide range of stakeholders and the local community in the decision-making process in general. The reasons are related to the regulatory requirements for implementing the principles of publicity and partnership but also the nature of the activities and the decisions that affect the territory as a whole and have a very long lasting effects over time. Moreover, the natural relation and dependence of the procedure, concerning the planning of spatial development, requires to be accompanied and supported by geospatial data and information in order to justify the proposed strategic measures and proposals related to the planning and management of the territory. Analyzed in this respect, spatial planning procedures within the Natura 2000 network may be defined as a double challenge. They are on the one hand part of the overall framework for spatial development of a territorial unit and, on the other hand, separate entity for planning, defined by specific characteristics that are often conflicting with the objectives for development of the territory. This requires achieving effective integration of development goals with the goals of environmental protection, which predetermines the definition of certain limitations of development, the need of which should be appropriately communicated and explained to the local community in a systematic way. Furthermore, in addition to the need for common spatially referred data, regarding the geographic and socio-economic elements of the space, should be 'involved' and specialized localized data for ecological status of the territory, the formed landscape configurations, biodiversity and habitats, as well as the human influence and interference in the natural ecosystems. The access and use of these specialized and geographically defined information resources are a compulsory condition not only for making expert solutions, but also for the realization of successful communication of the strategic/planning document and of the effective involvement of the different categories stakeholders and local communities in general in the procedures for development and implementation of the spatial development plan.

The necessity of geospatial information resources and the need for supporting and providing information during spatial planning, has transformed the GIS as a core inventory, analytical and visualization tool that creates a platform for consultation with multiple actors in every phase of the planning process (Peng, 2001, Batty and Xie, 1994; Harris and Batty, 1993). Over the years, however, these tools have been exploited mainly on expert level, and not so much to the stakeholders and local communities. The expert-oriented nature of GIS is one of the main reasons for the criticism from different stakeholders that the GIS is on the first place a technological tool, failing to provide an opportunity for active public participation (Aitken and Michel, 1995; Harris and Weiner, 1998). The lack of access to geo-information resources in the decision-making process and its justification often impedes reaching an understanding on future developments and conservation measures on the side of the stakeholders and the general public extremely. This may limit them to effectively participate in public consultation processes (Peng, 2001, Aitken and Michel, 1995; Curry, 1995; Obermeyer, 1995; Obermeyer and Pinto, 1994; Pickles, 1995; Rundstrom, 1995). More recently the rapid development process and innovation in geospatial technology and especially its integration with the Internet technology, facilitated putting into practice in the field of spatial planning the so called public participation geographic information system (PPGIS).

The concept of PPGIS emerged as part of the information society and the need to strengthen public aspect of planning and the role of local communities in it (Sheppard et al., 1999). PPGIS facilitate the integration of the opportunities provided by geospatial technology with the traditional mechanisms for the participation of stakeholders and the local communities in the planning and management of the territory (Craig et al., 2002). The main objective of PPGIS is to integrate technical and analytical capabilities of GIS to support of collaborative planning and spatially determined decision-making processes in the planning and management the territory (Onsrud and Craglia, 2003). The PPGIS can significantly improve communication and distribution of information resources both within the expert team and among the stakeholders and the general public during spatial planning and can be beneficial for supporting decisions in favor of the effective management of Natura 2000 sides. Through this type of public-based GIS platforms, the latter two groups of participants in the planning process can receive not only an effective means of access to information resources, justifying the decisions, but also accessible tools for their effectiveness participation in the procedure at every stage of its implementation.

In regard to the technological site of the PPGISs, three GIS server-based geo-technological platforms can be distinguished that are built in a three-layer architecture, including the following elements:

1. Specialized database for the respective territory, GIS server, providing opportunities for publishing and sharing of geo-information resources, and

2. A specialized interface that is used for access to the published and designed for sharing geospatial information from all users (this is provided as geoservices -Web features WFS and Web map services WMS), and

3. Integrated tools for communication and collaboration between experts, stakeholders and the local community – in the form of forums for discussion, tools for study and collection of opinions (e.g. for surveys), online feedback forms, etc.

Through the application of the PPGIS the following major benefits for spatial planning in the areas of Natura 2000 are expected:

- Increasing the public interest towards the procedures related to the planning and management of Natura 2000 by publishing on the web accessible information on the conservation and functional status, spatial parameters and possibilities for spatial development of the area;
- Low operational costs for users of these information services;
- Easy to use interface, without complicated procedures for extraction of data and information, which has the potential to seriously raise awareness among stakeholders and the general public;
- Providing information and collaborative space for transparent planning with active public participation.

Key benefits of using GIS and other related geo-information technologies for management of Natura 2000

**Concluding remarks**

As shown in the article spatial planning and the management of Natura 2000 are two interrelated processes and the application of spatial planning in nature protected is still yet to be developed. The main benefits of the use of GIS and other spatial technologies and methods in the planning and management of the sites, part of the Natura 2000 network, could be summarized in the following aspects:

- Providing tools for collecting, processing, storing, managing, analysing and visualizing of spatially referred data. The technology provides necessary framework and tools for vast amounts of information: Planners and experts can add, extract, process, update and retrieve spatial information for any related part or project in a particular Natura 2000 site;
- Powerful integrator of heterogeneous data based on its locational characteristics: throughout overlay operations;
- Large volumes of data can be easily and effectively edited, amended and updated;
- Graphical as well non-graphical (attributive data) can be collected and used simultaneous for solving complex spatially referenced problems;
- Cost savings resulting from greater efficiency. These are associated either with carrying out the mission (i.e., labor savings from automating or improving a workflow) or improvements in the mission itself. A good case for both of these is Sears, which implemented GIS in its logistics operations and has seen dramatic improvements. Sears considerably reduced the time it takes for dispatchers to create routes for their home delivery trucks (by about 75%). It also benefited enormously in reducing the costs of carrying out the mission (i.e., 12%-15% less drive time by optimizing routes). Sears also improved customer service, reduced the number of return visits to the same site, and scheduled appointments more efficiently.
- Better decision-making. This typically has to do with making better decisions about space, its structure and condition. Common examples include site selections, zoning, planning, conservation, natural resource extraction, etc. Making the correct decisions about Natura 2000 site's space is strategic to the success of the conservation and development initiatives.
- Improved communication. GIS-based maps and visualizations greatly assist in understanding situations and widening participation in the planning and management procedures. Contemporary geospatial technologies improve communication between different experts, departments, organizations, and the public.

In conclusion, spatial planning is the process through which the conflict between socio-economic development and the protection on the environment in the Natura 2000 network on the territory can be balanced. The application of the spectrum of the spatial planning tools, methods and techniques, in combination with the state-to-art GIS technologies can be beneficial for the environment and can enhance the planning process.

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