Land Suitability Evaluation for Agro-forestry: Definition of a Web-Based Multi-Criteria Spatial Decision Support System (MC-SDSS): Preliminary Results

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Abstract. Land suitability evaluation (LSE) is a widespread methodology that supports environmental managers and planners in analysing the interactions between location, development actions, and environmental elements. In the present paper, we discuss on a web-based multi-criteria spatial decision support system (MC-SDSS) implemented to accomplish LSE for agro-forestry. We propose a MC-SDSS developed on a free open source software for geospatial (FOSS4G) environment, accessible through a user-friendly geographical user interface (GUI) that allows to perform geospatial analyses. To this end, the MC-SDSS has been conceived as a multi-tier architecture, able to manage processes executable via OGC (Open Geospatial Consortium) web processing services (WPSs) and produce output maps and data available via the largely used OGC services: web feature service (WFS), web coverage service (WCS) and web map service (WMS). In this first application, we chose the weighted linear combination (WLC) as decision rule to aggregate data, weighted by judgements provided by experts following the analytical hierarchy process (AHP).

Keywords: Free open source software for geospatial (FOSS4G) · Webgis platforms · Web-based Multi-Criteria spatial decision support system (MC-SDSS) · Land suitability evaluation (LSE) · Analytical hierarchy process (AHP)

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1 Introduction

Today, landscape planning and management involve the identification of consensus-based solutions that address multiple societal needs and demands [1]. To manage agro-forestry resources according to the economic, environmental, and social dimensions of sustainability, Decision-Making (DM) approaches and procedures that examine trade-offs between often competing/conflicting objectives/alternatives should be implemented. Considering that soil can be fairly recognisable as an ecosystem structure and a non-renewable resource, studies for the assessment of land take phenomenon and actions for its mitigation have been encouraged at European level [2, 3].

GIS-based technologies and approaches can play a fundamental role both in suitability assessment and in complex DM, in the course of environmental impact analysis [4]. Recently, geo-scientific community has been focusing on the use of GIS technologies and techniques for supporting DM in numerous fields of application. The need for related standard and effective spatial interfaces, geo-visual analytic tools, integrated geographic platforms (SDIs, Spatial Data Infrastructures) has been recognised by several researchers as shown by their research works [5–10]. It is universally recognised the capacity of maps to offer an overview of and insight into spatial patterns and relations [11–15].

Land suitability evaluation (LSE) can effectively support environmental managers and planners in analysing the interactions between location, development actions and environmental elements [16]. The LSE, today widespread, can be defined as a method for identifying and assessing the suitability of an area for a specific land use and is based on the explicit identification of constraints and opportunities either for conservation of present land uses or for planning and location of new ones [17–19]. In implementing a LSE two different components can be distinguished: the so-called physical LSE (suitability is an intrinsic characteristic of the examined area); a subsequent usability evaluation (usability is the current and actual possibility to use the available resources).

Today, in a LSE procedure the principles of sustainable development should explicitly be taken into account when choosing and weighting criteria and/or alternatives. In this direction, multi-criteria decision analysis (MCDA), that can be synthesised as a complex and dynamic technique supporting DM in combining several criteria to make an optimal decision, can support Decision Makers (DMs) in taking into account multiple criteria explicitly [20]. Coupling MCDA techniques with geographical information systems (GIS) in GIS-MCDA procedures [21] represents a key element in the implementation of a multi-criteria spatial decision support system (MC-SDSS) [22]. As a matter of fact, the introduction of GIS-MCDA in physical LSE, which was concomitant with the scientific and technological advance of such tools, has enabled to see the whole spatial planning approach from a new perspective [5].

Referring to the issue of the present paper and as highlighted in other researches [23], GIS-MCDA procedures are widespread in spatial planning and DM processes, since they allow to consider, at the same time, the objectives and the different criteria influencing a specific land suitability analysis. The integration of web-based GIS and MCDA techniques allows to obtain a MC-SDSS which provides appropriate analytical tools for direct involvement of people in a collaborative spatial planning process [24]. Thanks to the use of web applications, MC-SDSSs, traditionally developed for stand-alone users, can be implemented on a web server (WebGIS), in order to allow, through the internet, the interaction with thematic maps and data associated with it. WebGIS platforms [25] are exploitable by common browsers (Mozilla Firefox, Google Chrome, Internet Explorer, etc.), thus they extent and improve the utilisation of these systems, that can be referred as web-based MC-SDSSs. The main benefits of using WebGIS technology are: (i) global sharing of geographic information and geospatial data, (ii) ease usability by the client, (iii) data network dissemination and ability to reach a wider community of users [7]. The WebGIS tool can be used, therefore, as an information consultation tool enriched by the geospatial component, for querying and analysing geographic data and thematic maps. In this way, it is possible to exploit all the advantages of being able to display and manage data in a spatial way, adding greater new significance on environmental analyses, jointly with the possibility to combine this information with other types of data characterizing an area of interest by different aspects (territorial, geo-morphological, socio-economic, etc.). Using the mapping power, a GIS-based environment allows visualizing, querying and analysing data to understand relationships, patterns and trends in order to improve communication and DM processes [26]: this implies the adoption of specific and suitable GIS and SDI architectures, that in the framework of the study here described have been developed using free/open source (FOSS) packages.

Moreover, while originally MC-SDSSs were proposed as systems that accomplish single-user evaluations, today an increasing number of applications in different research and operational fields propose MC-SDSS within a framework of group (e.g., collaborative) DM.

Over the last 50 years, a wide literature has proposed several multi-criteria methods and techniques dealing with theoretical and practical issues on DM [27]. Among these, one of the more widespread methods to derive the relative criteria weights according to an appropriate hierarchical system is the analytic hierarchy process (AHP) proposed by Saaty [28].

The main goal of our research is the implementation of a web-based MC-SDSS, capable to provide a user-friendly geographical user interface (GUI) for perform spatial analyses (geoprocessing): in particular, via a specific WebGIS application, users are allowed to set and tune MCDA parameters according to their preferences (based on their knowledge), in order to produce scenarios and identify most suitability locations according to a specific use. To this end, the MC-SDSS has been conceived as a server-side architecture, able to manage processes executable via OGC (Open Geospatial Consortium, www.opengeospatial.org) web processing service (WPS) and to produce output maps and data available via the largely used OGC services: web feature service (WFS), web coverage service (WCS) and web map service (WMS). In this first application, we propose a web-based MC-SDSS implemented as a general schema to perform LSE for agro-forestry in which geo-processes implemented as WPS are those related to criteria weighting and aggregation.

2 Materials and Methods

To implement the MC-SDDS and provide users with an effective MCDA accessible online, a suitable architecture has been designed and implemented. The logical and physical components of such architecture, as well as the data workflow, are depicted in the general schema reported in Fig. 1. A detailed description of each component (and of the related functionalities/capabilities) is provided in the following sub-paragraphs.

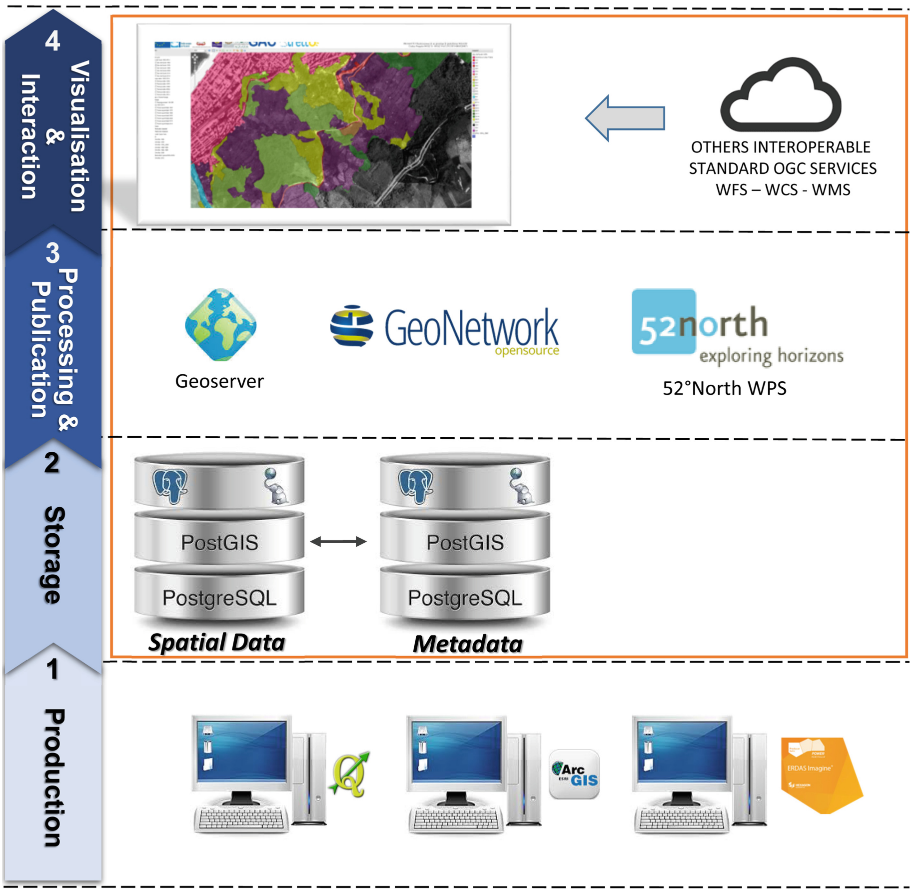

Fig. 1. Data workflow and general schema of the Web-based Multi-Criteria Spatial Decision Support System (MC-SDSS)

2.1 Spatial Data Infrastructure (SDI)

In order to facilitate the access to all the geospatial data and analysis produced, and to share them with stakeholders and decision makers (DMs), so as to support the planning process, a spatial data infrastructure (SDI) was developed in a FOSS4G (Free and Open Source Software for Geospatial) environment [29].

In general terms, SDIs can be referred as common platforms for management, discovery, publication and use of geospatial data and metadata. A SDI provides an ideal environment to connect applications to data, at the same time influencing the creation of data and the development of applications based on standards and appropriate procedures. Various and widespread are the solutions commonly adopted to design and implement SDI architectures [30]: in particular, the implementation of applications in FOSS4G environment is actually supported by the large availability of software suites and packages [31], which make possible - among other things - to effectively share and publish the resulting maps and data by means of suitable (and customisable) web interfaces. The architecture here adopted has been properly designed to allow the interchange of geospatial data over the Web and to provide the beneficiaries with a user-friendly application, characterised by accessibility and versatility. Following that, we implemented the SDI with a multi-tier architecture composed by three layers with different functions:

1. Data repository stratum to store data and metadata in a geospatial database implemented in PostgreSQL with PostGIS extension (http://postgis.net);
2. Server stratum, composed by GeoServer (http://geoserver.org) and GeoNetwork Opensource (http://geonetwork-opensource.org), to manage stored data and metadata and publish them on the web using OGC standard interfaces, 52° North WPS (http://52north.org/communities/geoprocessing/wps/) to enable the infrastructure to the deployment of geo-processes using OGC WPS standard interface;
3. Client front end stratum (i.e., the WebGIS client).

All above components are implemented in a virtual environment, (i.e., a virtual machine), based on the Ubuntu operating system, and managed by a VMware® vCenter server.

The Data Repository identifies the storage area containing the data-set and metadata used. The access is allowed only to devices physically defined at the level of the storage area network (SAN), in order to ensure the complete integrity and consistency of the data themselves.

The Server stratum represents the software environment that allows to organise information making it accessible from the network. Moreover, it provides maps, data and geo-process, from a variety of formats, to standard-OGC interfaces, so they are available to clients such as web browsers and Desktop-like GIS suites that manages OGC standards. This makes it possible to store spatial data in almost any format that users prefer. In our case, we adopted the GeoServer suite, a widespread used open source application server, which plays a key-role within the SDI as server for sharing geospatial data. It allows sharing and managing (by means of different access privileges) the information layers stored in the repository and is also interoperable (e.g., the capability of two or more systems to exchange data and information among them meaningfully and accurately, and then be able to use them independently from the operating system or the software used).

From the technical point of view, GeoServer is the reference implementation of the W * S standards defined by OGC. In this way, for instance, users are allowed to access geospatial data using any client (Desktop GIS software and/or web application) enabled to manage W * S connections. Concerning the front-end stratum, by accessing the WebGIS interface through its own web browser, the user (not necessarily with specific GIS skills) can gather and view thematic maps, charts and other results available (e.g., scenarios). In particular, to visualise the data available, the WMS standard is commonly and widely exploited, by means of a map-server approach that allows producing thematic maps of geo-referenced data and responding to queries about the content of the maps themselves. Other than the OGC standards related to geospatial data access and sharing, it is also possible to exploit another type of service specifically devoted to the processing task: the web processing service (WPS, www.opengeospatial.org/standards/wps), that we implemented by means of the 52° North WPS software. Such standard provides rules in order to define how inputs (requests) and outputs (responses) can be processed in the frame of a Web service. The WPS standard also defines how the client can request the execution of a process, and how to manage the output resulting from the process. To this end, a specific interface is defined in order to support the publishing of geospatial processes and clients' discovery of and binding to those processes. The data required by the WPS during the processing can be provided via Web or, alternatively, can remain available at the server. By using the WPS, it is possible to implement any calculation (including all its inputs and outputs) and trigger the execution as a Web service. Such standard is able to support simultaneous processes (via HTTP and SOAP), allowing the client to choose the most appropriate interface mechanism. The WPS processes execution is invoked by submitting a request (in XML or URL-encoded) to a specific URL (identifying the inputs, the type of process to be executed and the output format to be provided). A WPS is usually not invoked directly, but generally it is requested by a client application (preferably, web-based), which provides the user with interactive controls.

2.2 WebGIS Platform Implementation

The publication of geographic data through the web has stimulated the development of tools for the implementation of WebGIS platform and applications. The WebGIS is not a simple extension of a GIS Desktop suite, but it is part of the larger category of web-oriented software [32]. The network is the way for the interchange of data through the Web browser and the communication is based on client-server architecture in which two independent modules interact to perform a task. In such a way, it is possible to build geographic web-oriented tools for publishing, consulting and analyse data, useful for planning purposes. The main the advantages of using a WebGIS client are:

- the effective usability (WebGIS applications are accessible and exploitable through common internet browsers);
- the spread on the network and the capability to reach a wider audience of users.

Fundamental, therefore, is the role of a similar approach/architecture as a support tool in DM and planning, as part of a more articulated and complex system like the MC-SDSS subsequently described. The WebGIS client was developed in heron mapping client MC (http://heron-mc.org), a free and open source framework based on

GeoExt (http://geoext.org). GeoExt is a JavaScript powerful toolkit that combines the web mapping library OpenLayers with the user interface of Ext JS to help build powerful desktop-style GIS apps on the web based on JavaScript language. Heron MC provides to developers prebuild widgets to view, query, print, as well as advanced tools to data editing and filtering. Also Heron MC developers are generating new functions continuously, so it is possible to add new functions and menus to the web interface. OpenLayers is an open source JavaScript library, used to visualise interactive maps in web browsers: it provides the so-called application programming interface (API) allowing the access to various sources of cartographic information on the Web, such as OGC protocols, commercial maps (i.e., Google and Bing Maps, etc.), different GIS formats, maps from the OpenStreetMap (OSM) project, etc. Ext JS is a JavaScript framework for building feature-rich, cross-platform web applications for desktops, tablets, and smartphones. Ext JS leverages HTML5 features on modern browsers while maintaining compatibility and functionality for legacy browsers. It features hundreds of high-performance UI widgets that are designed to fit the needs of the most complex web applications.

To gather a good degree of interactivity, the WebGIS application allows user to get the maps and work with them, according to different functions. The set of functions available encompasses, first of all, the basic ones: the classic pan and zoom on a map, which involve not only the scaling of the image, but also the identification of geographic objects in the archive and related to the specific request. Another capability resides, then, in the selection mode, which can be graphical and spatial. In such WebGIS environment, in fact, the selection is made on a set of geographical objects characterised by mutual spatial relationship (such as, for example, contiguity, adjacency, intersection, etc.) and by specific descriptive attributes (qualitative/quantitative). Objects (also named as “features”) can be selected on the basis of a request made in WFS standard.

As stated in the previous section, one of the common ways to invoke a WPS process is to exploit a web-based application: this is another specific capability of the current WebGIS implementation. The WebGIS, thus, provides an interface mechanism to: (i) identify/select the geo-referenced data required by the process, (ii) launch the calculation and (iii) manage the output obtained by means of the calculation in order to make it available to the client.

2.3 The Multi-Criteria Spatial Decision Support System (MC-SDSS) Module

The MC-SDSS module of our platform has been implemented according to four main phases, as reported in the following flow-chart (Fig. 2) and subsequently described.

Phase 1 - Criteria Definition and Selection. As in previous activities of the research group [23], and following the approach proposed by Eastman et al. [33], we consider evaluation criteria as factors and constraints. In more details, factors are the measured decisional variables on the basis of which the suitability of an area for a specific use can be assessed, while constraints represent the limitation or, as in our case, the exclusion

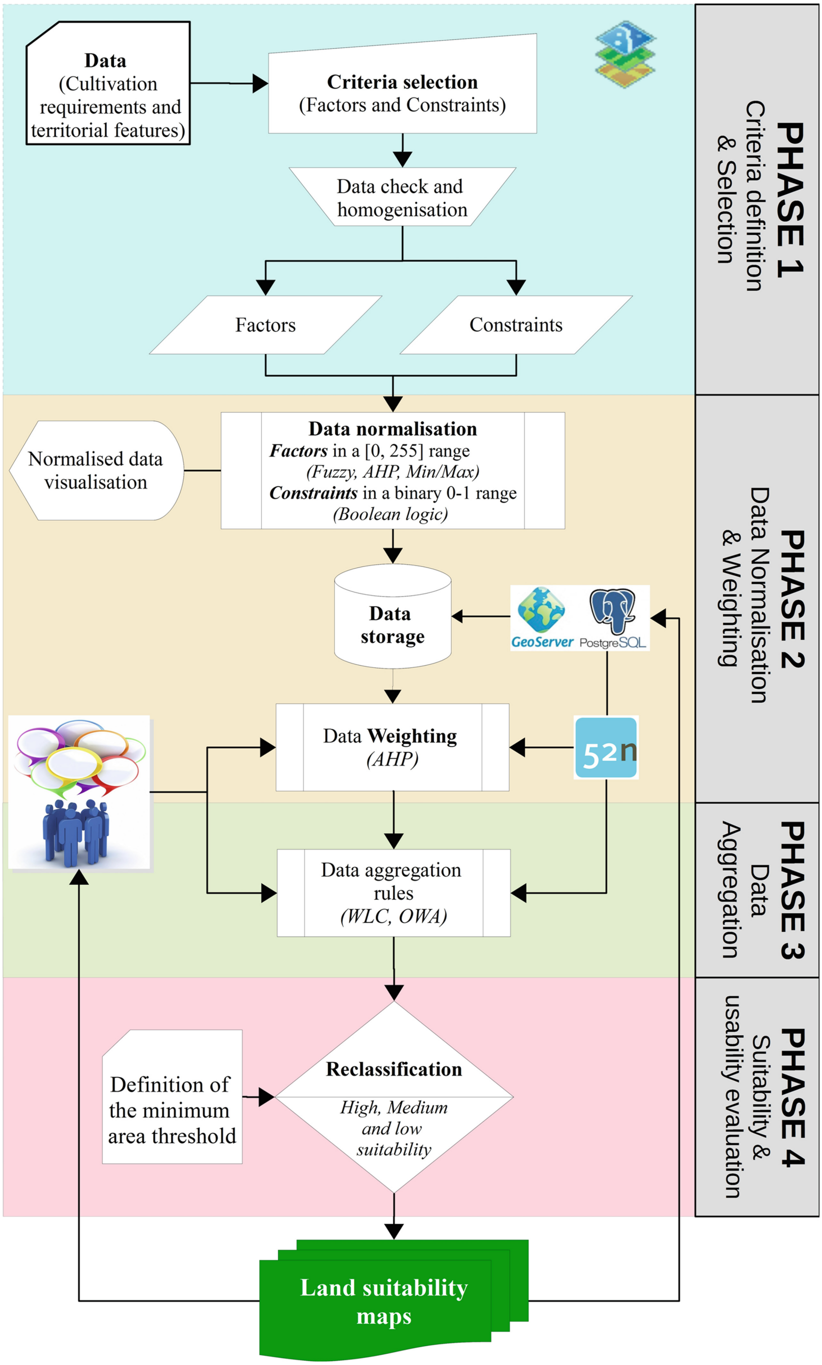

Fig. 2. Flow-chart showing the main four phases of the multi-criteria spatial decision support system (MC-SDSS) module

of an area for that use. In general terms, the criteria reported in Table 1 should be considered in implementing a LSE for agroforestry.

Phase 2 - Data Normalisation and Weighting. Criteria are physical variables measured in different scales. A procedure of normalisation, i.e. a standardisation procedure to refer all criteria in a common range, must be performed. Factors are normalised in a closed [0, 255] 8 bit interval, through Min/Max, AHP and fuzzy logic approaches;

Table 1. Criteria (Factors and constraints) to be considered in implementing a land suitability evaluation (LSE) for agroforestry

Factors		Constraints	
Name	**Description**	**Name**	**Description**
Land Use/Land Cover (LU/LC)	Referring to the considered agro-forestry use of the LSE, judgement is expressed on the productive suitability of the considered kinds of vegetation	***Core areas of Natural parks***	In Italy, in accordance with the general policy law on protected areas (Framework law 394/1991), every kind of human activity is forbidden in the integral reserves (so-called Zone A)
Elevation	Micro-climate variations depending on this parameter (air temperature gradient in particular), significantly influencing the phenology of vegetation	***Urbanized areas***	A technical constraint to exclude urban areas from the evaluation
Slope	Slope directly influences soil loss, thus the limits of practicability of agro-forestry activities, especially referred to the mechanisation of operations	***Areas with steep slopes***	Areas whose use for agro-forestry would lead to a high risk of erosion. Chosen limits depend on the considered agro-forestry use
Aspect	This factor directly influences the amount of solar radiation to the soil surface during the growing season	***Landslide and earth-flow areas***	Constraint based on the hydrogeological hazard & risk assessment plan (in Italian known as PAI, *Piano di AssettoIdro-geologico*) that defines the areas of the territory where the risk of damage to people and environmental heritage is relevant
Pedology	Pedological factors category includes the chemical and physical characteristics of soils that directly influence the definition of the optimum growing conditions of vegetation	***Flood expansion fields***	Riverbed of the so-called *fiumare* (typical Calabrian torrents) serving as flood expansion fields
Climate	Climate factorsmainly accomplish for temperature and precipitations. Depending on the considered agro-forestry use, they are normalised as single parameters as well as specific climate indices	***Archaeological areas and Sea coastline***	Pursuant to the ICCLH (Italian Code of the Cultural and Landscape Heritage, Italian Legislative Decree n° 42 of 22/01/2004) these areas are not suitable for crop production

these last, in order to best fit the physical quantities examined, by choosing membership functions with two (monotonic) or four (symmetric) control points. Constraints are normalised trough Boolean algebra in a binary [0-1] map: 0 for the areas excluded from the evaluation and 1 for those included.

Among MCDA techniques and procedures, to obtain the factors' weights basing on judgments provided by experts and DMs, we implemented an AHP-based sub-module. Despite relevant criticism highlighted by scholars, the AHP procedure remains widely applied in many research and operational fields [27, 34, 35] for several reasons. Among others, (i) the possibility to allow relationships between factors and to overcome the human difficulty in simultaneously judging the importance with regard to all the factors inserted in the model; (ii) a relative simplicity compared to other MCDA techniques; (iii) the possibility, through a specific index (i.e., the consistency ratio, CR), to check the inconsistencies in judgments provided by experts [35].

Following the AHP method, to obtain a ratio scale of measurement (i.e., the factors' weights), judgments provided by the experts through iterative pairwise comparisons (PCs) are organised as numeric data in a positive reciprocal matrix (the pairwise comparison matrix, PCM). Therefore, in a PCM if the priority of element *i* compared to element *j* is w_{ij} (relative weights), the priority of element *j* compared to element *i* is 1/ w_{ij}. To obtain factors' weights, each expert makes a judgment w_{ij} of all pairs of the *n* elements that include in the PCM as a number (a_{ij}) according to the Saaty's fundamental scale of absolute numbers [28]. Values range from 1 (indifference) to 9 (extreme importance, preference or likelihood); when compromise is needed, the following intermediate values 2, 4, 6, 8 must be used [28].

The AHP is also useful when many interests are involved and a number of people participate in the judgement process. Following our previous experiences [35], we provided the possibility to supports group-DM by aggregating the individual PCMs. To do that, we adopted the aggregating individual judgment (AIJ) approach suggested by Forman and Peniwati [36], in which each individual preference/judgment provided by experts is aggregated by means of a geometric mean. Following what suggested by Saaty [28], only PCMs with CR < 0.1 are considered consistent, thus can be considered in following phase 3 (data aggregation), while PCMs with CR > 0.1 should be omitted.

Phase 3 - Data Aggregation: Decision Rules. In this first conceiving, aggregation of results is performed by means of weighted linear combination (WLC). Once obtained, the results of the WLC are masked with the normalised constraints by Boolean intersection (AND type operator). In mathematical terms, the implemented decision rule to derive the land suitability index (LSI) of the j-th area can be expressed as reported in the following formula (Eq. 1).

$$LSI_{\mathrm{j}} = \left(\sum_{i=1}^{n} w_{ji} \cdot x_i \right) \cdot \prod_{k=1}^{m} c_{jk} \tag{1}$$

where: *n* is the total number of considered factors $\mathrm{x_i}$; w_i is the weight of the i-th factor; *m* is the total number of constraints; c_{jk} are the k constraints present in the j-th area (i.e., the raster cell).

Phase 4 - Data Reclassification, Suitability and Usability Evaluation. Results coming from the aggregation phase, are reclassified in three suitability classes: High, Medium and Low suitability. A class with zero suitability is also included in the reclassification of the results to include those areas having no specific constraints but which prove completely unsuitable for the considered agro-forestry use. Furthermore, the selection and localisation of best areas in terms of suitability and minimum area thresholds is provided.

3 Results and Discussion

In accordance with Zhao [37], we implemented a SDI that uses web services to manage, analyse, and distribute geospatial data connecting electronic devices (desktop and mobile) through the web, therefore it shares the so-called geoservices or geospatial web services (GWS). The data workflow includes the following steps: data and metadata obtained in GIS and remote sensing software environments (1), are uploaded and stored into the PostgreSQL-PostGis geospatial Database (2), managed by GeoServer (data), GeonetWork OpenSource (metadata) and 52° North WPS (geo-process) servers (3), then provided as GWSs to thick clients (i.e. QGIS, www.qgis.org), thin clients and also integrated in the implemented WebGIS that allows for browsing, zooming, identifying, querying the data, maps and execute geo-process (4). All produced geospatial data (orthophoto mosaics, Land Use/Land Cover maps, etc.) as well as reference base data (orthophotos, cadastral maps, road networks, etc.) are exposed as OGC standard interfaces (WMS, WFS, WCS) and in a GUI of the implemented WebGIS platform.

Data can reside locally or in different remote servers (accessible via the above mentioned OGC-compliant services). The use of such standards allows to provide heterogeneous geospatial data as geospatial services. Thus, the WebGIS platform interface efficiently allows to retrieve data in geospatial format from GeoServer (e.g., via WMS service) and to display them as map layers.

Thanks to the architecture previously pictured for the WebGIS, the user (not necessarily endowed with specific GIS skills), through a normal web browser, can display basic geospatial data and maps, execute geo-processes and all the scenarios representing the results produced within the MC-SDSS module. In particular, to display the data of interest, the WMS standard is exploited: such a type of map-server interface provides a simple HTTP interface, allowing the client to request and get a map from one or more distributed spatial databases. In response to that request, one or more map images (i.e., JPEG, PNG, etc., formats) are returned, so that they can be displayed within the browser (or, alternatively, by a desktop application client).

The MC-SDSS here described has been conceived and designed to offer an effective solution, accessible also to non-experts, and based on specific online tools (e.g. web-based processing and multi-criteria assessment). While in this first application, aggregation rules are conceived only by means of a WLC procedure, in a next development ordered weighted averaging (OWA) operators [38] will be implemented to better manage trade-off among evaluation factors.

To this end, the WPS has been configured to offer GIS geoprocessing capabilities to clients via web, including access to pre-programmed calculations and/or computation models, operating on geo-referenced data. The WPS, thus, allows to execute simple calculations, such as adding one or more sets of spatially referenced layers (raster maps representing territorial features or environmental characteristics), or as multiplying a single layer by a scalar (values representing indices and/or a weights). In such a way, it is possible to perform the WLC, which assigns weights for each criterion considered (Land Cover, Elevation, Slope, Aspect, etc.) and sums these to an overall score for searching suitable locations.

The data required by the WPS are delivered via web, and the service is targeted at processing both vector and raster data: for the specific purposes of this work, raster data (in GeoTIFF format) have been selected and used as input for the processing tasks implemented. Considering the general framework described and the processing steps outlined, the WebGIS application represent the front-end interface of the MC-SDSS, through which the user is able to access data, perform calculation and assess the results obtained (land suitability maps).

The final product consists of maps of land suitability for each specific agro-forestry use under consideration, giving a current picture of the areas suitable for that use. In that way, the implemented Web-based MC-SDSS can represent a powerful tool to support sustainable planning and management actions.

4 Conclusion and Final Remarks

Digital mapping and WebGIS, jointly with spatial analysis, are largely considered as effective tools in providing a comprehensive overview of environmental phenomena [39]. Through appropriate descriptions and thematic maps, it is easier to understand environmental features and characteristics, and to point out patterns and interactions. The geo-referencing of information is always a basic element for planning and management of resources and often this process puts various subjects around the same table in order to contribute, each in their skills and their missions, an immersive common or otherwise taking advantage of the mutual collaboration and cooperation [40]. Moreover, it must be highlighted their potentiality in informing people, promoting transparency in choices, thus providing local authorities with the possibility to collect and use valuable knowledge [41].

In this paper we have described the design of a Web-based MC-SDSS, relying on a specific SDI architecture, having the target to perform spatial and environmental analyses, supporting DM processes related to the agro-forestry LSE [42, 43].

Thanks to WebGIS interface and tools specifically implemented, information sharing is able to improve the effectiveness of analyses carried out, in order to support the DM, and of the scenario evaluation tasks (e.g., what-if analysis). Moreover, in perspective, WebGIS coupled with Web 2.0 technologies will allow to overcome most of the limitations and critical aspects of traditional methods of public participation inherent to their synchronous and place-based nature [42].

From the practical point of view, the web-based MC-SDSS has been pictured using FOSS4G environments, which encompass a set of application solutions suitable for our purposes and implementable in a well-integrated and easy-to-use platform. This solution, by providing on-line tools in order to perform multi-criteria spatial analyses via WPS protocols, allows to publish on the Web geospatial information following the standard required by the OGC (through a series of specific features for viewing and consulting of thematic maps in an advanced framework), and consequently to share the results with DMs, in order to support LSE processes.

While in this first application we implemented our web-based MC-SDSS platform without any limitation to potential users, in next development we are planning to manage three different type of users that can access the system via the WebGIS client: guest, expert, DM. To each of them, corresponds a different level of privileges in using the MC-SDSS platform.

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