Land as Information. A Multidimensional Valuation Approach for Slow Mobility Planning

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Abstract. One of the most sustainable ways of improving the landscape value is the valorisation of the countryside dirt road network with the purpose of creating a greenweb, a communication system able to improve the territory attractiveness. The study assumes an axiological approach to land planning, including a qualitative valuation model and an interactive multicriteria tool based on the combination of WebGIS and DRSA tools. The valuation model is based on an axiological pattern taking into account four groups of valorisations according to a semiotic marketing approach. A hierarchic three explains each of them, so that every land object or rail performance can be assessed into a general frame oriented to provide the aggregate value of the path that which they relate, as composed by the GIS network pattern aiming to meet the users' preference profile. The DRSA tool allows generating the preferences structure of the target segments users.

Keywords: Greenways, WebGIS, DRSA, Axiological approach, Qualitative land assessment, Land planning.

1 Introduction

The general trend of the economy dematerialization and the increasing role played by the "experience goods" compared by the "search goods" (Huang et al., 2009) in the customer demand, the enhance and spread of the environmental sensitivity and of the curiosity for the local identities, have nowadays increased the interest in the greenways.

Several initiatives and organizations all over the world arrange tools and provide database aimed at spreading information about the characteristics of the existing greenways in order to attract users and improve the availability of sustainable experiences for recreation.

Actually, a system of GreenWeb can be considered one a way of transferring and sharing land information.

Proceedings of the 7th International Conference on Information and Communication Technologies in Agriculture, Food and Environment (HAICTA 2015), Kavala, Greece, 17-20 September, 2015.

Landscape can be assumed the shape of a territory, and its multiple and dynamic perspectives accord to the idea of its continuous changing. Furthermore, information is the raw material of communication.

A land improvement policy needs the evaluative knowledge, that is signification activity.

Signification, information and communication are the three main point of a government process aimed at create and maintain a new value system for sustainability (Rizzo, 1999).

The landscape, as a concept, is connected to sustainability perspective of the enhancement of the local anthropic identity (Stephenson 2008), thus confirming its natural and cultural unity. Stephenson remarks the need for assuming "value-as-a-whole", recognising the importance of assessment in land policies.

Greenways, as both a physical infrastructure and a cultural approach to landscape, improved due to a planning international movement (Fabos, 1995), specifically based on assessment to support decisions aimed at combining natural and cultural features, as well as rational and creative approaches (Ahern, 1995; Ribeiro and Bardo, 2006).

A greenways network can connect different anthropic land districts, promote cultural and economic upgrade of rural land, develope sustainability awareness, renovate the scale of values and preferences (Toccolini et al., 2006).

The land social value, because of the impossibility of comparing costs with externalities (Dasgupta, 2000) claims the need of *creating networks* and an interactive assessment model, involving planners and users.

Greenways can be assumed as the physical communicative network of land, through which the users push and spread land information.

This study proposes an assessment and communication WebGIS-DSRA pattern able to create the information the user needs to increase it into the *GreenWeb*.

2 Materials

2.1 Greenways: General Issues and the Case Study

Many different experiences of greenways networks recently developed, and a vast literature exists on the subject, concerning: "multiple-scales; networks for land preservation at the community scale; historical and theoretical greenway issues (Fabos and Ryan, 2006).

Greenways have been made In Italy for about 1500 km, mostly in the northern regions. Most of them follow the path of abandoned railways and allow biking (Dal Sasso and Ottolino, 2011).

The increasing attention around the greenways shows that they are actualized as effective land marketing systems which are helpful to the local economy.

A network of greenways can be considered the land facility by means of which it is possible to realize the most unitary landscape experience, so that it should be assumed in its informational, no more physical, dimension and function.

A green-web is the matrix of multiple and mobile points of view of the landscape, that capitalizes the individual and changeable experiences as a general and social substance of value.

This substance is the core of the reasons and motivations of the land (re)production and use.

Individual perspectives and social values can be connected by an information and decision system in which data are collected and by means of which it is possible to reveal users' preferences.

For this case study, some our elaboration (Fig. 1-2) from the database of the Sicilian Hydrographical Office (1950-2000) and Sicilian Department for Agriculture and Forests (2004) allow to represent the most important terms of this preference pattern.

The Province of Syracuse belongs to the 17th Ambit of Guidelines of the Regional Territorial Landscape Plan, including the geological support named *Tavolato Ibleo*.

The area has a tabular structure composed by terraces overlooking the sea; the altitude range goes from 200 up to 600 m above sea level area.

Two different areas can be distinguished: the high Iblean landscape and the waterfront the description of which can be found in qualified literature (DCEH, Sicilian Region, 1996).

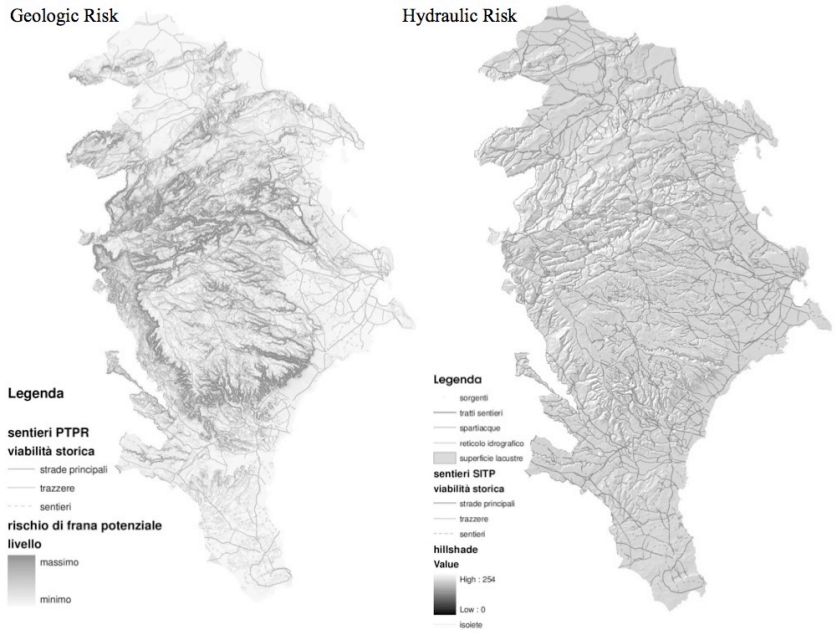


Fig. 1. Practical features: land "discontinuity" (our elaboration from: Sicilian Region, 1950-2000; Sicilian Region, 2004).

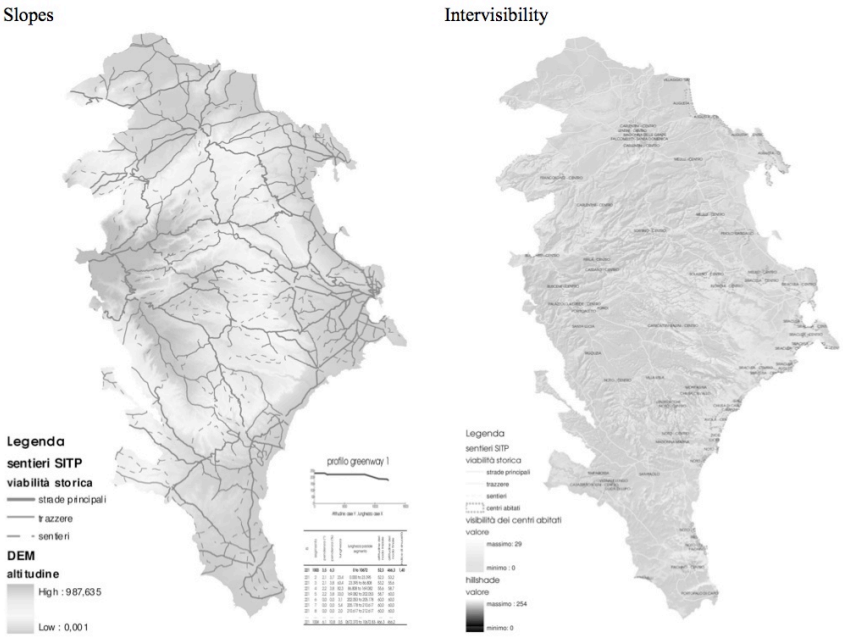


Fig. 2. Critical and playful features. Path "non discontinuity" and "non continuity" (ib.).

3 Methods

3.1 An axiological approach

An axiological approach is a value-centred and value-oriented vision that assumes land as a bundle of combined potential and current social values: the first one is based on objects and performances, the second one depends on the appreciation of them by the users according to the axiological profile their choices are due to.

In order to measure and to map this social value, a specific tool allows the users expressing their preferences and communicate the satisfaction degree of the experiences, so that the evaluator can adjust the tool: the users input their preferences into a form on the Web-GIS interface.

The system proposes a group of paths, which the users can further reduce in order to select the best one, by inserting more specific information about their wishes and expectations.

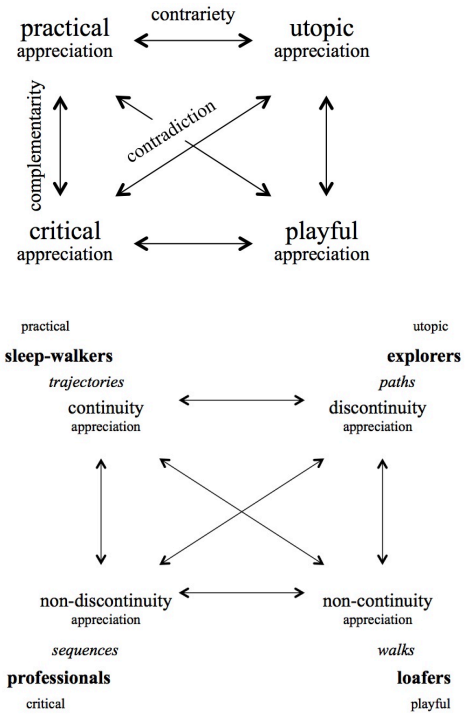
The input form and the related preference pattern are inserted into three different sections each of them each of them referred to one of three different approaches.

Object approach: "value is considered an intrinsic characteristic of an object" or goods, so that the object is required (or rejected) itself. The form to be filled for

selecting the path provides a list including the local landscape attractions. The user selects the ones he wants to come across; the system makes a query and composes all the paths containing the kinds of object indicated in the form.

Performance approach: "an object is relevant by the effect of its performances", which are functional or utility characteristics, so that the same group of performances can be provided by diverse objects. The performances section includes: 1. *measurable performances* (maximum length, slope, car road crosses, …); 2. *valuable performances* (smoothness, hardness, riskiness, …), calculated by using the space analysis Web-GIS functions; the pattern reduces the previous selection so that the user can refine the query up to select the best path.

Axiological approach: "objects and their performances are relevant only in order to achieve a purpose, if traced to a value". The value is attributed to the capability of the path to satisfy some general instances when crossed; objects and performances have no value in themselves; the user assigns to them a value once connected by the path whose configuration is defined by assembling a certain number of path units, so that the value function is optimized.



Appreciations	I level Criteria	II level Criteria
practical	safety	towns proximity
		roads proximity
		path continuity
		geological risk
	comfort	orography
		roadbed
		continuity
		weather conditions
	accessibility	street and towns proximity
		trip roundness
	facilities	facilities proximity
		towns proximity
	transportation options	coaches
		train
critical	duration	time
	length	distance
	efficiency	efficiency
		cultural
	range	naturalistic
		cultural
		recreation
	intervisibility	visible surface
utopic	wildness	traffic distance
		bound areas
	adventure	town distance
		ways of use
		orography
		vegetation
playful	perceptual landscape	quantitative features
		qualitative features
		attractors/detractors
	recreation	facilities

Fig. 3. The axiological square (Floch, 1995) and its adaptation to the study case (left). Appreciations and criteria (I and II level) of the valuation pattern (right; indicators omitted).

The value of a path is the weighed average score calculated going up the WBS from indicators, through subcriteria up to the root-criteria (values) coming from the axiological square by Floch (1995).

It's a general scheme in which four kinds of appreciations are connected by relationships of complementarity, contrariety and contradiction.

They are *practical* (functionality), *critical* (convenience), *utopic* (existential), *playful* (diversity, surprise) appreciations, describing the traveller's profiles.

These values are specified in progressively detailed levels, forming a WBS valuation pattern (Fig. 3), comprising 145 indicators (omitted).

For each of the indicators addressing the last level of the criteria, one or more indices have been identified in order to turn different performances into the same value scale (0 to 2 scores). Some value functions are shown as follows (Fig. 4).

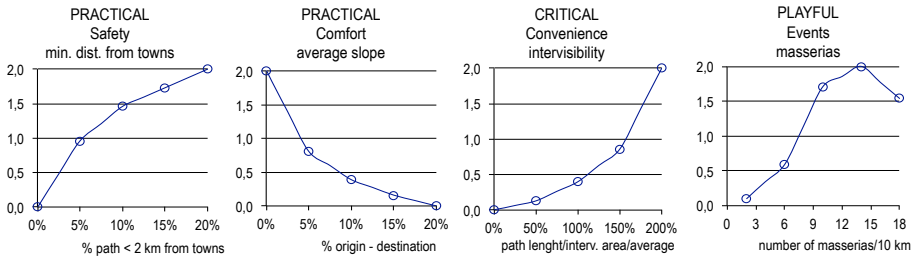


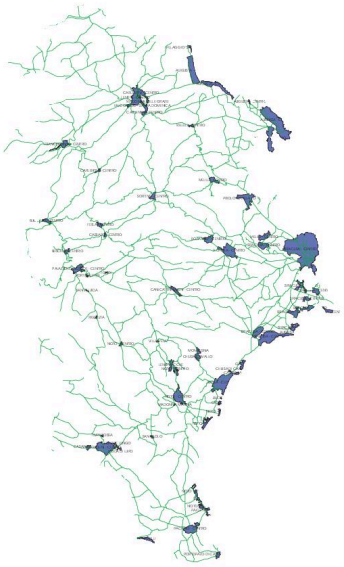
Fig. 4. Sample of transformation of observations into valuations: Practical valorisation (other valorisations omitted).

3.3 Spatial Analysis GIS Tools for Path Arrangement

A *GreenWeb* should be considered, from a topologic point of view, as a set of arcs and nodes linked into a reticular framework connecting the social-land fabric. Each node is usually associated to a value function (Correnti, 2003), but in this experience the value is traced to the path as a whole.

Network Analyst extension is the tool which aggregates the path maximizing this value function. The databank includes the ancient road network (fig. 8) as shown in IGM 1:50.000 maps started in 1965; some groups have been distinguished: main (consular) roads, herds' roads, lanes; 2. ancient railways and baronial shippers along the waterfront (abolished in 1812); all of them have been geo-referenced and featured according to the database coming from the Guidelines of the Territorial Landscape Regional Plan (Department of Cultural and Environmental Heritage and Public Education – Sicilian Region, 1996) and from the Landscape Territorial Plan of the Province of Syracuse (Superintendence of Cultural Heritage of the Province of Syracuse, 2012). By means of the Spatial Join extension and the geoprocessing functions (Biallo, 2005), a new viability database has been implemented by dividing each road into 250 m long segment, so that a continuous greenway can be assembled by joining the arcs which maximize the value function. *Spatial join* and *Range query* are the two geometric operations more frequently used in the geographic data management. The *spatial join* is a relational join in which geometric attribute and space relations are used and imposed instead of alphanumeric ones. There are: *topologic join* that is more speed if the storage structure is based on a set of layers;

there are also *join* based on *direction* and *distance*. The general diagram of the information management is shown in fig. 5 (right).



id	Shape	Categoria	Lunghezza m
1	polyline	Sentieri	3850
2	polyline	strade principali	500
3	polyline	Trazzere	1456
4	polyline	Trazzere	457
.....	.....	.....	.....
377	polyline	Sentieri	678

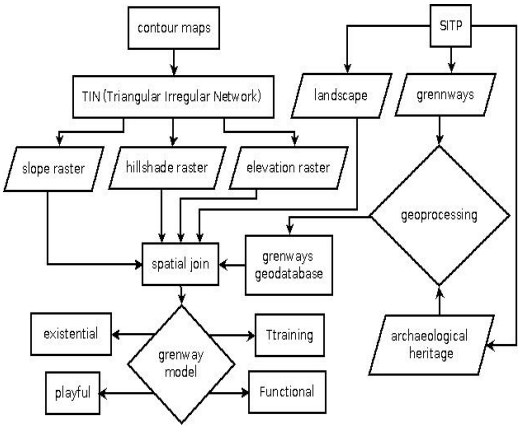
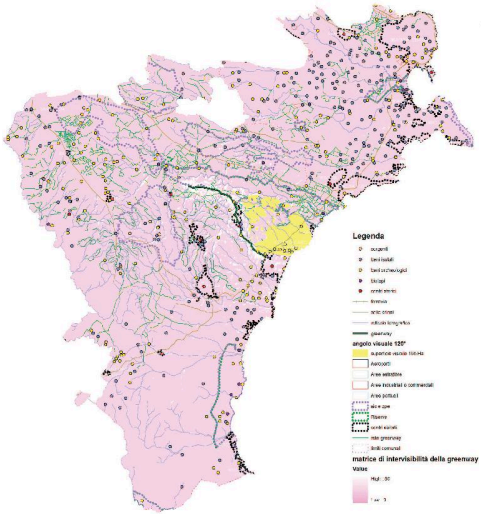


Fig. 5. GIS database sample and dirt road-net.



shape	lunghezza	id sub archi	distanza dal bene archeologico	codice del bene	ambito	numero	comune del bene archeogico	località del bene archeologico	...
polyline	250	1	1003,108	SR206d	17	245	Avola	Tracciato FF.SS.	...
polyline	250	2	860,701	SR206d	17	245	Avola	Tracciato FF.SS.	...
polyline	250,000	3	804,374	SR206d	17	245	Avola	Tracciato FF.SS.	...
polyline	250,000	4	846,315	SR206d	17	245	Avola	Tracciato FF.SS.	...
polyline	250,000	5	981,234	SR206d	17	245	Avola	Tracciato FF.SS.	...
polyline	250,000	6	1054,544	SR196	17	232	Avola	Monte d'Oro	...
polyline	250,000	7	1083,267	SR196	17	232	Avola	Monte d'Oro	...
polyline	39,953	8	1097,625	SR196	17	232	Avola	Monte d'Oro	...
polyline	250,000	9	1310,806	SR206d	17	245	Avola	Tracciato FF.SS.	...
polyline	223,877	10	1160,066	SR206d	17	245	Avola	Tracciato FF.SS.	...
polyline	250,000	11	1272,709	SR300	17	341	Noto	Cava S. Anna	...
polyline	28,153	12	1362,649	SR300	17	341	Noto	Cava S. Anna	...
polyline	56,635	13	1256,909	SR300	17	341	Noto	Cava S. Anna	...
polyline	189,045	14	1172,716	SR300	17	341	Noto	Cava S. Anna	...
polyline	110,976	15	1220,494	SR300	17	341	Noto	Cava S. Anna	...
polyline	250,000	16	913,500	SR206d	17	245	Avola	Tracciato FF.SS.	...
polyline	250,000	17	666,140	SR206d	17	245	Avola	Tracciato FF.SS.	...
polyline	250,000	18	487,484	SR206d	17	245	Avola	Tracciato FF.SS.	...
polyline	250,000	19	469,352	SR206d	17	245	Avola	Tracciato FF.SS.	...
polyline	250,000	20	393,072	SR206d	17	245	Avola	Tracciato FF.SS.	...
...	...	...	...	...	...	...	...	...	...
polyline	250,000	3598	503,072	SR206d	17	245	Avola	Tracciato FF.SS.	...

Fig. 6. Information system and spatial query in a specified area.

4 An Interactive Value Adjustment Pattern Based on DRSA

The greenway can be considered a product-service for the users to improve which an appropriate marketing strategy needs to be identified by coordinating the recreational demand with the local supply, in relation to the target segments of the users.

According to the Floch's four appreciations, that properly describe the users' (tourists') demand typically in a Web 2.0 era, an interactive strategic pattern aimed at identifying and managing the users' behaviour has been drew up, envisaging a recreational context characterized as the transition to Tourism 2.0.

Nowadays Tourism 2.0 can be defined as a way of tourism promotion, which is closely related to the development of Web 2.0.

The development of such a new ICTs helps to coordinate the supply to demand, which is ever changing and more globalized.

Even today, the researchers are working in order to allow an evolution of the use of the web, to support the transition from Web 2.0 to Web 3.0. In this regard, one could speak of a tourism 3.0.

The Web 3.0 fosters the interaction between some different possible paths, allowing a new level of the integration and the interoperability to some applications.

In the case of Web 3.0, there are some fundamental elements creating a Web database which would facilitate the access to the contents of some applications which are not individuated by the browsers, making the most of the technologies which are based on the artificial intelligence (*AI*): the semantic web, the Geospatial Web, etc..

The web GIS is a ICTs tool that, if properly structured, is able to support the development of a Web 2.0 type, and therefore the tourism 2.0.

This tool shows some potentials, which, if exploited, would allow to support a new era of web 3.0 type.

The tools to support the development of a web GIS which is able to meet these requirements are: a data mining and an artificial intelligence tool that produces an output of the informational type for the product or service requested by the user.

To support the extraction and the processing data, we propose the *DRSA* (*Dominance-based Rough Set Approach*) (Greco, Masahiro and Slowinski, 2006).

The DRSA tool is used to generate the preferences structure of the target segments users.

It is used as a basis for the extraction and the processing of the data. It allows to identify the preferences structure to support the GIS tool and the Web GIS tool, to generate the best green way at meeting the user's preferences.

DRSA belongs to the algorithms family called rough sets that are developed by the Operations Research.

In particular, in DRSA the relationship of discernibility (Greco, Matarazzo and Slowinski , 2004a) that is typical for the rough set (*CRSA – Classic Rough Set Approach*) is replaced by a relationship of dominance that makes this tool more flexible and suitable for the analysis of some multi criteria decision problems.

The DRSA enables to generate a minimal set of decision rules in a neutral way. By means of this minimal set it is possible to generate a preferences structure or perceptual-value (Sturiale and Trovato, 2010) structure for the user.

This algorithm also has the advantage of detecting the inconsistencies and the ambiguities of the input data, and helps to converge towards the minimum information structure on which the choice of the user depends.

In this regard, it is considered advantageous to process the information of a data base which is achieved on the basis of some questionnaires to support the feedback for the institutional web that uses the proposed web GIS tool.

The revised information will form the basis for the structuring of the segments of the green way for the different target segments that are considered in the Floch's approach.

5 Results and Discussions

5.1 Valuation model results

The value of a single greenway is given by the four appreciations vectors of scores calculated by aggregating the scores of the relevant characteristics of the land area crossed by the greenway.

In particular, each appreciation corresponding to the more aggregate criterion level is weighed by the user inserting his or her request about the characteristics of the path, thus declaring his or her axiological profile, whereas the weights of the sub criteria are assigned as an hypothesis by the appraiser.

The combined application of the object, performance and axiological approaches is synthesized in fig. 10.

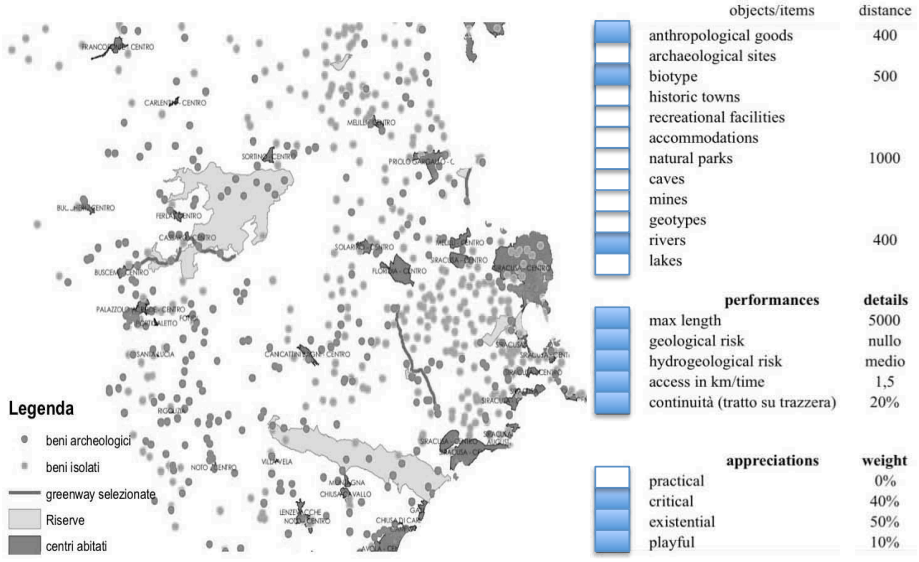


Fig. 7. Insertion of the requested object, performances and the axiological profile.

5.2 DRSA Tool Results

Some questionnaires were structured in order to identify the mode of the choice for the users and administered to a sample of users that have connected to the website that hosts the experimental project.

The questionnaires are proposed at the feedback button on the WebGIS site.

The obtained data were organized in a data base and the obtained information was processed using the DRSA tool (Greco, Matarazzo and Slowinski, 2004) in order to locate a minimal set of decision rules (tab. 1).

Table 1. Appreciations and criteria (I and II level) of the valuation pattern.

	Decision rules
1	If the perception of the landscape has a high importance, then chooses the playful profile
2	If the importance of the efficiency of the route is medium and the level of importance for the recreational facilities is high then choose the playful profile
3	If the importance of the distances is medium, the level of importance for the perceptual landscape is medium and the level of importance for the recreational facilities is high choose the playful profile
4	If the importance of the recreational facilities is high then choose the existential profile
5	If the importance of the recreational facilities is medium then choose the critical profile
6	If the importance of the density of the events is medium then choose the critical profile
7	If the importance of the adventure is medium then choose the critical profile

Subsequently, on the basis of the obtained information, it has been possible to define the preferences structure for the sample.

In particular, in this case, the preferences structure characterizes the user's profile on the basis of the four profile types. The sample was requested to declare its belonging profile.

Then the sample was requested to characterize the different profiles according to Floch's approach on the basis of the identified criteria.

The sample was also requested to declare its preferences about the level of importance of the criteria, i.e. the weight or the value that these criteria have at choosing the green way.

The quality percentage of the approximation of classification is in this case the 68%. The quality of approximation of the classification represents the relative frequency of the objects correctly classified by means of the attribute.

In particular the quality of the classification satisfies the properties of set functions called fuzzy measures.

A fuzzy measure constitutes a useful tool for modeling the importance of the coalitions.

But a fuzzy measure can be used to assess a relative value of information supplied by each attribute, and to analyze the interactions among attributes (Greco, Matarazzo and Slowinski, 2001), basing on the quality of classification calculated from the rough set approach.

Table 2. The preferences structure to support the critical, utopic and playful profile.

Critical profile
If the importance of the recreational facilities is medium then chooses the critical profile
If the importance of the density of the events is medium then chooses the critical profile
If the level of importance for the adventure is medium then chooses the critical profile
Utopic profile
If the importance of the recreational facilities is high then chooses the existential profile
Playful profile
If the perception of the landscape has a high importance, then chooses the playful profile
If the importance of the efficiency of the route is medium and the importance of the recreational facilities is high then chooses the playful profile
If the importance of the distances is medium, the importance of the perceptual landscape is medium and of the recreational facilities is high then chooses the playful profile

Then the quality of the approximation of the classification can help to identify the weights as relative value of information supplied by each attribute (Trovato, 2013).

In the end it was possible to characterize three profiles: the critical, the existential and the playful ones.

The results showed the absence of a characterization of the practical profile for the user (Tab. 2).

The DRSA tool has allowed identifying the core approximation, i.e. the criteria that are more important for the choice of the different profiles, in this case, the perceptual landscape and the level of recreational facilities.

They are present in all profiles, so that they most influence the choice of the path. The obtained data are still partial but this test can be considered satisfactory at this first stage. The general scheme of the DSRA-WebGIS participation pattern is shown in fig. 8.

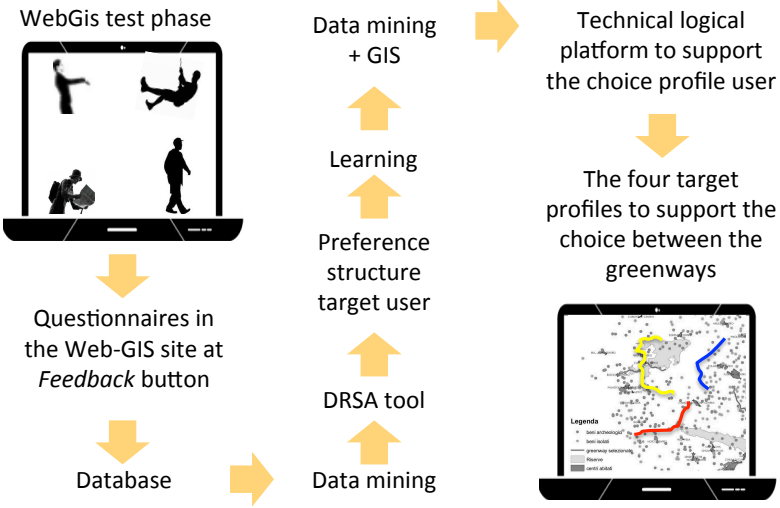


Fig. 8. The general DRSA-WebGIS participation scheme.

6 Conclusions

A green-web is an immaterial infrastructure, a phase of the information cycle – information, whose origin is the organization of the land knowledge and the access to it through of a personalized consultation system.

These three parts, between which the "value/valuation" is the most relevant one, are involved in the feedback process at the three levels of *data/information*, *value/valuation*, *planning/communication*.

1. At the first level the experience we have carried out has been an important test about the connection between data and value, so that the knowledge system has been completely redrawn; values need some specific data, and in particular an appropriate way of turning them into information;

2. At the second level, the valuation one, the value system has been assumed as the matrix of the knowledge whose wide articulation has to be reduced to some axiological relationships, in order to create a shareable communication system: an axiological approach connects the data and plan levels.

3. At the third level, the experimentation of the DRSA method has shown how it is possible to connect a valuation model to a planning approach; the interaction between user and decision-maker through the valuation model provides useful insights about what part of the land has to be enhanced and what supply chains need to be boosted for the general equalization purpose.

Acknowledgments. S. Giuffrida edited paragraphs 1, 2, 3.1, 3.2, 3.3, 5.1, 6, fig, 3, 5-8, 12, tab. 1, and drew up the MAUT valuation pattern; F. Gagliano edited paragraph 3.4 and figg. 1, 2, 9-11 and drew up the web-gis pattern; M. R. Trovato edited paragraphs 4, 5.2, fig. 13, tabb. 2-5 and drew up the DRSA valuation pattern.

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