Integration of Cultural and Natural Heritage Information in Future Mobile Guides

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ABSTRACT

This paper presents a visualization model supporting the map-based presentation of environmental data about geographic areas. Our model is based on the evaluation of the ecological aspects of a landscape and on the dynamic generation of a layer that shows the levels of naturality, the land use, and other similar characteristics, of the area in focus. We propose this model as an extension of the information that can be provided by a mobile guide with the aim to support the exploration of Natural Heritage by making users aware of the richness and weaknesses of the places they visit and raising the attention towards biodiversity and environment preservation, which are key to green tourism.

CCS CONCEPTS

• **Information systems → Web searching and information discovery**; Geographic information systems; • **Human-centered computing** → Visualization.

KEYWORDS

Natural Heritage exploration, adaptive web, GIS

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1 INTRODUCTION

With the increasing attention to biodiversity and the preservation of the environment, general and scholarly tourism have broadened their focus to cover both the exploration of Cultural Heritage sites and the organization of itineraries aimed at increasing people's awareness of the richness of geographic areas in terms of natural monuments and resources. Both Cultural and Natural Heritage are thus becoming very important to promote the territory, especially in Italy, where most historical places are within, or nearby, natural reserves.

As most mobile guides support the exploration of specific Points of Interest [4, 5, 8, 10, 19, 20], or collections within museums [13, 17, 23, 27], they fail to provide the user with a broad view of the places surrounding Cultural Heritage items. With the aim of extending the scope of mobile guides, we investigate the presentation of the "environment side" of geographic areas. This is key to inform people about the richness and weaknesses of the places they visit. Specifically, the awareness of the natural features of the territory is important to value and preserve it and to understand the role that different landscapes have in biodiversity preservation.

The research about Ecological Networks [6] studies the environmental characteristics of landscapes to describe the structure of existing ecosystems and help planning their conservation and expansion. It summarizes the status of a geographic area that can help visitors understand the naturality and biodiversity of places. However, as Ecological Networks target specialists, they provide data that lay users can hardly understand. We thus aim to develop a visualization model to present information that is at the same time relevant and understandable to a broad audience. In this paper we describe a model for the dynamic presentation of environmental data about geographic areas. We aim to extend mobile guides with this information to promote sustainable tourism.

In the following, Section 2 describes the main concepts the Ecological Networks in a non-technical way. Section 3 presents the visualization model we propose. Section 4 outlines our vision of how to personalize the presentation of an Ecological Network within a mobile guide and Section 5 closes the paper.

2 ECOLOGICAL NETWORKS

The Ecological Networks (ENs) have been introduced to preserve biodiversity and enhance ecosystem services [15] by reducing the process of nature and landscape fragmentation and vulnerability caused by the development of new urbanizations, infrastructural networks and intensive agriculture [16].

An Ecological Network is an interconnected system consisting of areas that include natural and semi-natural habitats. The typical representation is a network of core areas describing natural habitats

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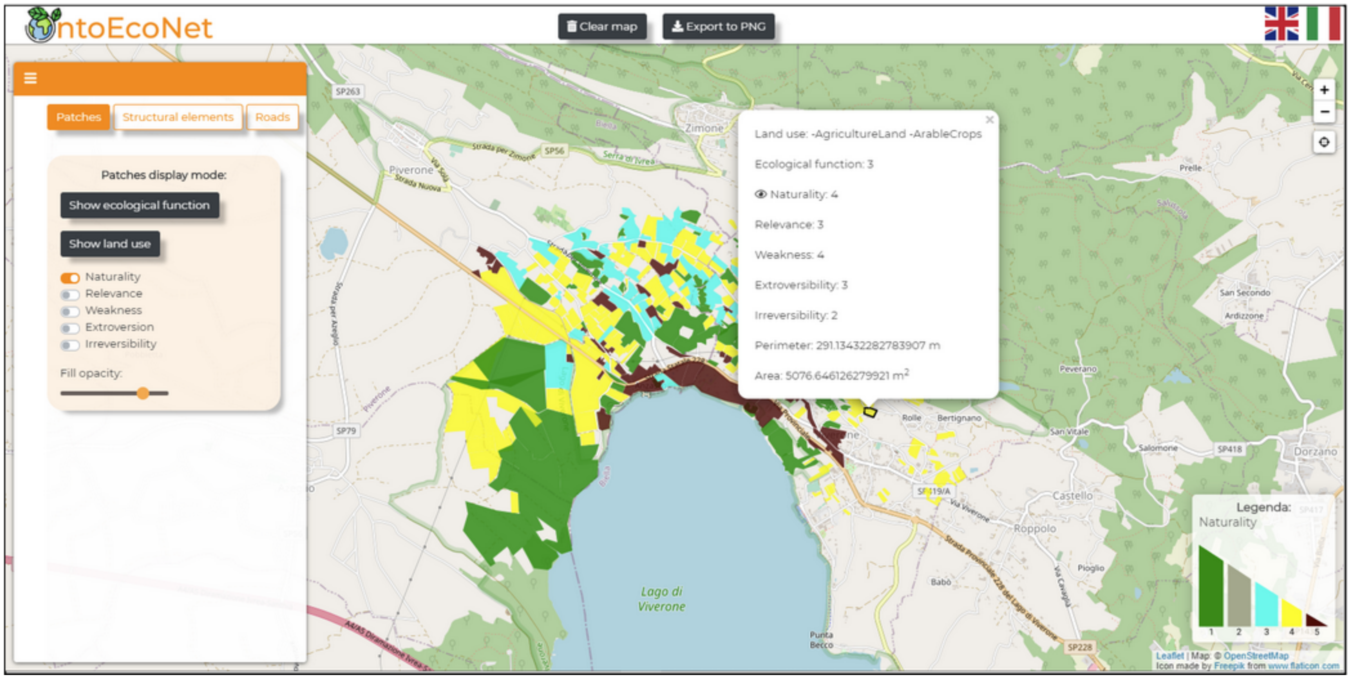

Figure 1: Visualization of the naturality level of a landscape.

joined by corridors. Corridors are links to maintain vital ecological or environmental connections by forming physical linkages between the core areas. See [6] for details.

Most studies about Ecological Networks are carried out by manually analyzing the ecological features of landscapes and reconstructing the networks. For instance, Land Cover Piemonte (LCP) cartography [22] defines five aspects of land patches. Each aspect represents an *evaluation criterion* and, as specified in [26], its value ranges from 1 to 5, where 1 is the maximum value:

(1) *naturality* describes how close the land patch is to a natural environment;
(2) *relevance* specifies how relevant it is for the conservation of the habitat;
(3) *fragility* denotes how fragile the land patch is with respect to anthropogenic pressure;
(4) *extroversion* describes how much pressure it can exert on the neighboring patches;
(5) *irreversibility* specifies how difficult it would be to change the use of the land patch.

Some recent work automates the specification of Ecological Networks by defining formal representations of the constraints that define their elements and other aspects of naturality. Specifically, [24, 25] use the mapping of land patches according to the evaluation criteria of LCP cartography to identify core areas, corridors, etc., in a landscape. Core areas are defined by jointly considering these criteria and the fact that the area is not urbanized, or traversed by main roads and other architectural barriers.

3 VISUALIZATION MODEL

Automatic classification tools to specify Ecological Networks support the development of visualization models for their dynamic representation, based on the data about land patches. Starting from the work described in [25], we defined a visual model that exploits color coding on a geographic map to represent the Ecological Network. We selected the colors of the layers showing the elements of the Ecological Network in collaboration with a group of urban planners who specified which ones are conventionally used to represent the various types of information. Moreover, we differentiated the color scales as much as possible to support an easy identification of land patches in the map.

Figures 1 and 2 show two layers of the user interface we developed. They display data concerning a geographic area near Ivrea (Piedmont, Italy). As each land patch is separately represented and classified, the user can click on it to view the values of all the LCP evaluation criteria. The visualized ones are marked with an "eye" icon; see the tooltip in figure 1. Specifically:

- Figure 1 shows the level of naturality of the represented landscape in a color scale mapped to [1, 5], where 1 is the best value.
- Figure 2 shows the fragility level of the represented geographic area. In this case, LCP uses a scale in [1, 4] and highest level, in red, is the worst one from the environmental viewpoint.

The legend in the right bottom portion of the user interface maps colors to values and the height of the bars denotes the direction of the scale. The left side bar makes it possible to view the land use of the area and shows the list of evaluation criteria that can be

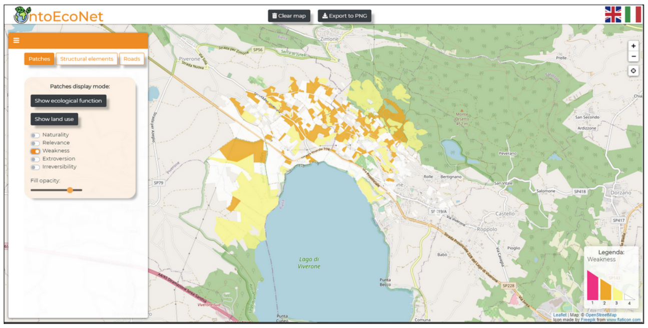

Figure 2: Visualization of the fragility level of a landscape.

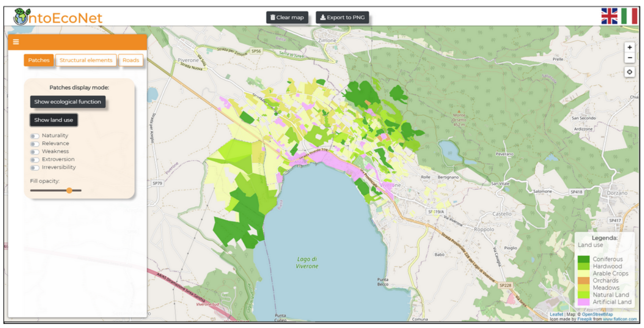

Figure 3: Visualization of the land use of a landscape.

visualized in the map; see Section 2. Criteria can be combined to obtain aggregated data (not relevant here). Below the list of criteria, a slidebar makes it possible to tune the opacity of colors to make the lower layer of the map more or less visible.

Figure 3 shows the visualization of land use: land patches are classified in Artificial Land, Natural Land, Meadows, Hardwood and other types, depending on the fact that the area has been urbanized or not. In case of a natural area, the land use specifies the type of trees it contains. Figure 4 shows the core areas, which aggregate multiple land patches and are worth visualizing because they are key to safeguard biodiversity.

We dynamically generate the maps shown in the figures by exploiting OpenStreetMap [21] data and tiles. The Ecological Network layers are obtained by applying the work described in [25] to the data provided by project "Experimental activity of participatory elaboration of ecological network" [11].[1] For the management of layers, we employ the Leaflet JS library [1].

This user interface is suitable for an expert who analyzes a landscape; however, it does not fit the needs of lay users because it exposes them to too much data. We thus plan to develop a model supporting the adaptation of the user interface to diverse users.

[1]The "Experimental activity of participatory elaboration of ecological network" project [11] was conducted in 2014-15 by the Metropolitan City of Torino (Italy) (www.cittametropolitana.torino.it/) in collaboration with Politecnico di Torino (www.polito.it) and ENEA (www.enea.it) [11].

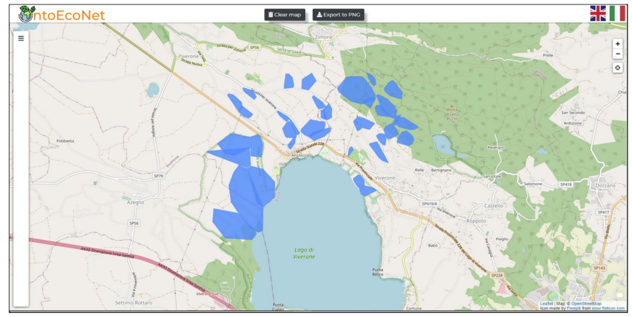

Figure 4: Visualization of the core areas of a landscape.

4 EXTENDING MOBILE GUIDES WITH ECOLOGICAL DATA ABOUT LANDSCAPES

Mobile guides typically steer the exploration of Cultural Heritage sites by showing the relevant items on a geographic map; for instance, see [7, 8, 10, 14]. Our idea is that of extending the map with an environmental data layer to present both ecological information and Points of Interest. The main issue is the prevention of information overload; therefore, ecological data should be filtered in a context-dependent way, taking both the user's interests and the characteristics of the areas (s)he inspects into account. Moreover, the user interface should be simpler than the examples presented in Section 3, where the user can decide which type of information has to be shown, or how to combine data to obtain aggregated views of landscapes.

In this respect, we have to investigate whether tourists are interested in viewing environmental data or not. In the positive case, the map annotated with this data might represent the default visualization mode, or we might apply personalization strategies to present specific contents of interest. In alternative, explicit widgets might support the selection of the preferred layout. In our future work, we plan to study these aspects. Our first intuitions are the following:

- To promote tourism, and the respect for nature, a mobile guide should show positive information about landscapes with an implicit message to protect them. This means that the map might display the core areas to highlight the presence of naturalistic zones, making the user aware of their existence. In contrast, unless the user is explicitly interested, it is not worth representing the existence of poorly natural land patches.
- Different levels of detail in the presentation of ecological data might be offered, depending on the user's interests. For instance, core areas might be regularly used to aggregate land patches, as in Figure 4. However, if users are particularly interested in ecological networks, the user interface might show the values of the evaluation criteria for each individual land patch, as in Figures 1-3. Moreover, it might present the information regarding biodiversity related to land use to highlight the value of natural reserves.
- Multi-stakeholder goals might be supported by promoting in the mobile guide the areas that excel from the naturalistic

viewpoint, or by raising awareness about their weaknesses and need to support public policies for their repair.

Some works discuss the risk to overload users with too much information when presenting detailed geographic maps [3, 9, 12] and associate this situation to users' spatial abilities [2, 18]. To avoid this risk, we plan to promote environmental layers through widgets that notify the user when there is something relevant to inspect. This can be done by exploiting geo-fencing and geo-localization to detect that the user is visiting a core area or a high-naturality patch. In that case, the mobile guide might suggest to add the relevant layers for the visualization of the environmental data. If the user switches on the layers, her/his action might be considered as an evidence of interest. Therefore, it might be exploited to bootstrap her/his user profile for a subsequent adaptation of the user interface.

5 CONCLUSIONS

We described a visualization model supporting the presentation of environmental data about landscapes in geographic maps. We plan to integrate this model into a mobile guide so that the user can receive rich information about places, including the naturality of the area in the focus of attention. We believe that this type of information can be very useful to increase people's awareness about the conservation of the environment, its fragility, and to promote green tourism by highlighting the ecological value of natural reserves. However, enriching mobile guides with environmental data might challenge users with too much information. We will thus assess the suitability of our approach (that is largely applied in work contexts) to the tourism domain in a user test.

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