TeMA

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Land Use, Mobility and Environment

This special issue collects a selection of peer-review papers presented at the 8th International Conference INPUT 2014 titled "Smart City: planning for energy, transportation and sustainability of urban systems", held on 4-6 June in Naples, Italy. The issue includes recent developments on the theme of relationship between innovation and city management and planning.

Tema is the Journal of Land use, Mobility and Environment and offers papers with a unified approach to planning and mobility. TeMA Journal has also received the Sparc Europe Seal of Open Access Journals released by Scholarly Publishing and Academic Resources Coalition (SPARC Europe) and the Directory of Open Access Journals (DOAJ).

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SMART CITY

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TeMA. Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science, and complex systems.

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Journal of
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This special issue of TeMA collects the papers presented at the 8th International Conference INPUT 2014 which will take place in Naples from 4th to 6th June. The Conference focuses on one of the central topics within the urban studies debate and combines, in a new perspective, researches concerning the relationship between innovation and management of city changing.

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EIGHTH INTERNATIONAL CONFERENCE INPUT 2014

SMART CITY. PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

This special issue of TeMA collects the papers presented at the Eighth International Conference INPUT, 2014, titled "Smart City. Planning for energy, transportation and sustainability of the urban system" that takes place in Naples from 4 to 6 of June 2014.

INPUT (Innovation in Urban Planning and Territorial) consists of an informal group/network of academic researchers Italians and foreigners working in several areas related to urban and territorial planning. Starting from the first conference, held in Venice in 1999, INPUT has represented an opportunity to reflect on the use of Information and Communication Technologies (ICTs) as key planning support tools. The theme of the eighth conference focuses on one of the most topical debate of urban studies that combines , in a new perspective, researches concerning the relationship between innovation (technological, methodological, of process etc..) and the management of the changes of the city. The Smart City is also currently the most investigated subject by TeMA that with this number is intended to provide a broad overview of the research activities currently in place in Italy and a number of European countries. Naples, with its tradition of studies in this particular research field, represents the best place to review progress on what is being done and try to identify some structural elements of a planning approach.

Furthermore the conference has represented the ideal space of mind comparison and ideas exchanging about a number of topics like: planning support systems, models to geo-design, qualitative cognitive models and formal ontologies, smart mobility and urban transport, Visualization and spatial perception in urban planning innovative processes for urban regeneration, smart city and smart citizen, the Smart Energy Master project, urban entropy and evaluation in urban planning, etc..

The conference INPUT Naples 2014 were sent 84 papers, through a computerized procedure using the website www.input2014.it . The papers were subjected to a series of monitoring and control operations. The first fundamental phase saw the submission of the papers to reviewers. To enable a blind procedure the papers have been checked in advance, in order to eliminate any reference to the authors. The review was carried out on a form set up by the local scientific committee. The review forms received were sent to the authors who have adapted the papers, in a more or less extensive way, on the base of the received comments. At this point (third stage), the new version of the paper was subjected to control for to standardize the content to the layout required for the publication within TeMA. In parallel, the Local Scientific Committee, along with the Editorial Board of the magazine, has provided to the technical operation on the site TeMA (insertion of data for the indexing and insertion of pdf version of the papers). In the light of the time's shortness and of the high number of contributions the Local Scientific Committee decided to publish the papers by applying some simplifies compared with the normal procedures used by TeMA. Specifically:

- Each paper was equipped with cover, TeMA Editorial Advisory Board, INPUT Scientific Committee, introductory page of INPUT 2014 and summary;
- Summary and sorting of the papers are in alphabetical order, based on the surname of the first author;
- Each paper is indexed with own DOI codex which can be found in the electronic version on TeMA website (www.tema.unina.it). The codex is not present on the pdf version of the papers.

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LANDSCAPE PLANNING AND ECOLOGICAL NETWORKS

PART B

A RURAL SYSTEM IN NUORO, SARDINIA

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ABSTRACT

This paper represents the continuation, i.e. Part B, of an homonymous paper aiming at designing an ecological network for the periurban area on the town of Nuoro in central Sardinia. While in Part A we illustrate the methodological premises and introduce a spatial network analysis-based study of a pilot ecological network, in this paper we apply a complex network analysis approach to the construction and characterization of the dynamics of the ecological network of Nuoro.
We are interested in monitoring the performance of the ecological network evolving from a real to a hypothetical scenario, where the two target vegetal species (holm oak and cultivated or wild olive) are present in each patch. We focus on global network properties and on three different centrality measures: degree, clustering coefficient, and betweenness centrality. We also take into account the influence of the intensity of the connection (i.e. the weight) by introducing the corresponding weighted centrality measures. Through thematic mapping we illustrate the pattern of each centrality indicator throughout the entire pilot set of patches. In this way, we demonstrate how spatial network analysis is useful to monitor the performance of the network and to support decision-making, management, and planning.

KEYWORDS
Spatial network analysis, dynamics, centrality, monitoring system

1 INTRODUCTION

This paper represents the continuation of another paper titled "Landscape planning and ecological networks. Part A. A rural system in Nuoro, Sardinia", where we have presented the premises of a study on the ecological network in Nuoro (ENN), Sardinia. In this paper, we illustrate the applied methodology to build the ENN. We analyze the ENN and comment on the obtained results.

2 BUILDING THE ENN

The study has regarded the northern part of Nuoro where we have sampled a set of 100 patches (nodes in the ENN). Each patch has been characterized according to the classification proposed in Table 1, where we report the classification for ten characteristic patches.

N	CLASSIFICATION	OLEA EUROPEA	QUERCUS ILEX
1	Olive orchard	Dominant cultivated	Absent, possible colonization
2	Green area	Present cultivated	Absent, possible colonization
3	Green area	Absent, possible colonization	Present as young plants
4	Green area	Present cultivated	Absent, possible colonization
5	Green area	Present cultivated	Established
6	Green area	Present cultivated	Established
7	Green area	Absent, possible colonization	Established
8	Green area	Absent, possible colonization	Established
9	Green area	Absent, possible colonization	Established
10	Natural area	Initial colonization	Absent, possible colonization

Tab. 1 General characterization and classification of the first ten patches of the sample.

The information was collected through analysis of orthophotos, validated on site and has been then processed in an integrated GIS-network modelling environment. The ENN is composed of a set of nodes N - each one corresponding to the centroid of a patch - and a set of edges E representing the dispersal relational connections between patches. Two patches are connected if their centroids lay within a certain dispersal distance. Centroids correspond to the geometric barycentre of each patch thus two patches are connected in the ENN depending on the geometry of their areas: small patches are much more likely to be interconnected than larger ones.

We use time-varying analysis of the ENN to monitor its characteristics over time. In this case, we study the dynamics of the ENN in order to build a monitoring system of that network.

Relevant benchmarks in the ENN's dynamic analysis consist of an initial and a final scenario. The initial scenario is represented by the network configuration ENN_{2014}, where patches are included as nodes, only if they currently host target species. The final scenario corresponds to a network configuration ENN_{FIN} which is the composition of two ecological networks ENN_{FIN_OLEA} and $ENN_{FIN\_QUERCUS}$, where the two target species are present in all the patches. We assume that the final scenario corresponds to the configuration requested by citizens and public administration interested in boosting policies against the loss of biodiversity and vegetal biomass (carbon sink). In addition, we consider that the final scenario is the result of a process where exogenous (human) actions intervene in the network development with programs, plans, policies, etc., in order to implement urban and peri-urban green infrastructures.

We are interested to model an ecological urban systems as a network of relational properties between nodes. We mathematically formalize our model through the adjacency matrix A, where diagonal elements a_{ii} are equal to zero (no self-loops are admitted: a patch can not be connected to itself) and off-diagonal elements a_{ij} are equal to 1, if nodes i and j are connected, and 0 otherwise. In addition, we represent the ENN as weighted directed spatial networks in order to take into account: i) the pattern of seed dispersal from colonized to first neighbour nodes, and ii) the intensity of the relation between each pair of nodes. In this respect, we consider that the intensity of interaction (i.e. the weight) varies depending on the probability that the seeds are dispersed and the impedance to movement. According to the ethologic studies reported in section 3.2 of Part A, olive seeds are dispersed with a probability that is 200 times higher than the corresponding measure for Holm oak seeds. In this first application, we model impedance as the inverse of the distance between patches' centroids. Thus, we model the level of interaction between patches (link weights) colonized by both the two target species according to the following equation:

$$w_{ij} = (p_o + p_q) * \frac{1}{d_{ij}} \tag{1}$$

Where p_o is equal to 0.05 and p_q to 1 representing the dispersal level of Olea Europea (p_o) and Quercus Ilex (p_q); d_{ij} is the Euclidian distance between the centroids of patches.

In Figure 1, we illustrate the ENNs corresponding to the initial (on the top) and final (on the bottom) scenarios. Spatial weighted networks overlay the orthophoto of Nuoro. Nodes are identified by the red dots; weights are thematically represented in different colour and thickness.

In the next section, we scrutinize the two network scenarios.

3 ANALYZING THE ENN

This section presents the network analyses developed for the two scenarios of the ENN. We divide the illustration in two parts; the first part is dedicated to the analysis of the topology of the EN, while in the second one we focus on the weighted network study. In table 2, we report the main topological measures calculated for the two scenarios.

The first five columns of Table 2 describe simple network characteristics, such as number of nodes (N) and edges (E), edge density (E/N), average shortest path length ($<l>$), and diameter or maximum path length (l_{max}). While the number of nodes is constant, the number of edges reaches more than the double of the original value. The same behaviour holds for the density. The average shortest path length, a measure of cohesiveness among the nodes, is low signalling high interconnectivity in the ENN. We observe a decrease of 2% of the average shortest path, while the diameter decreases of 20%.

The last three measures of Table 2 represent a synthetic indication of different aspects of network centrality. Nodes with a high centrality play a crucial role in the entire architecture of the system, whose overall vulnerability depends on the those fundamental elements. In detail, the different centrality measures unfold as follows. The degree k represents the number of connection of a node with the first neighbours.

The ENN is a directed network where we can account for incoming connections (in-degree, Kin) and, outgoing connections (out-degree, Kout) from a given node. In an ecological network, the degree represents the probability of a patch to be colonized (in-degree) and colonize (out-degree) other patches.

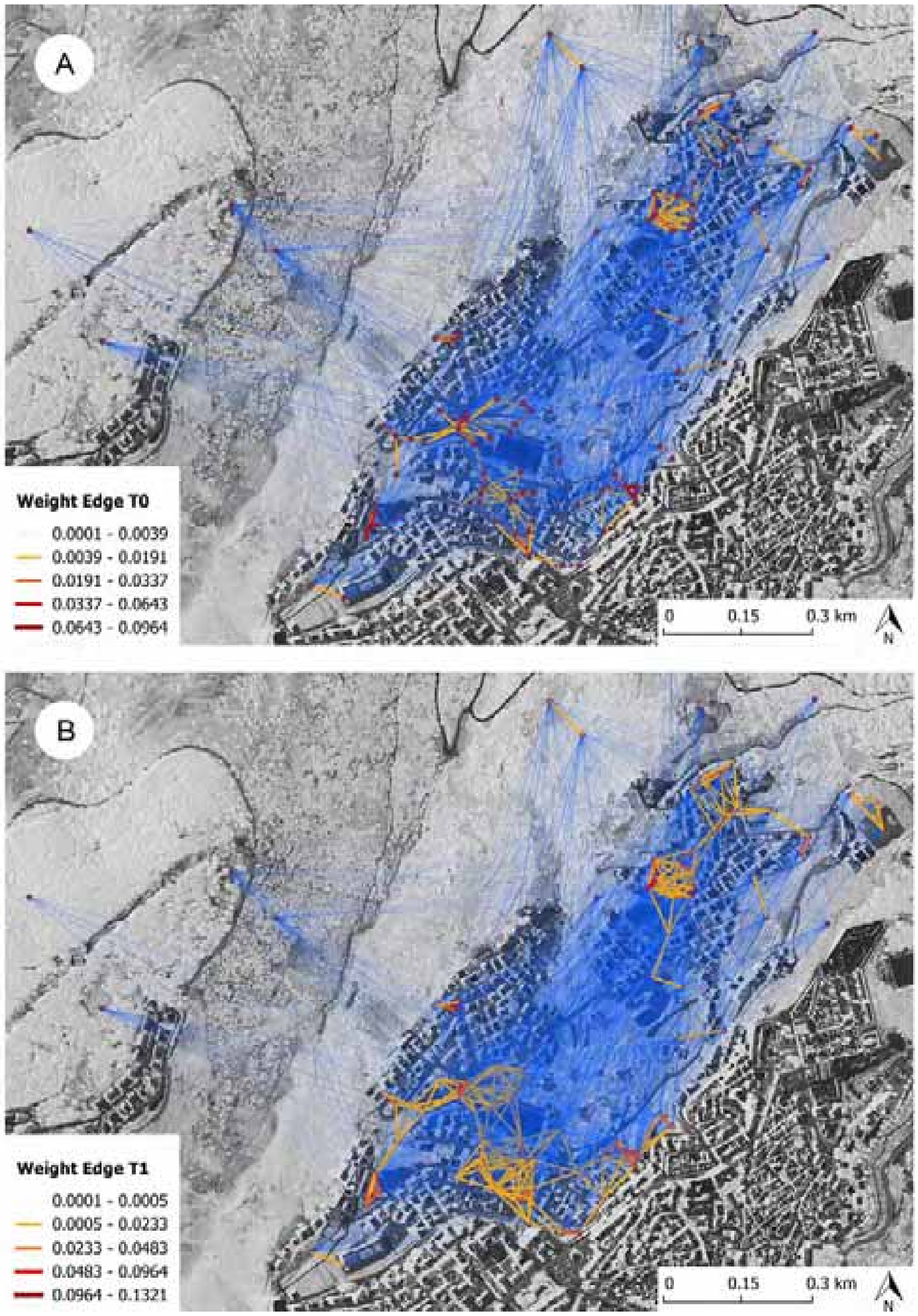

Fig. 1 The Ecological Network of Nuoro (ENN): spatial weighted network representation of initial (A) and final (B) scenarios.

SCENARIO	N	E	E/N	<l>	l_{max}	<Kin>	<Kout>	<C>	<BC>
Initial	100	3677	36,77	1,35	5	37,14	61,28	0,648	0,0019
Final	100	7948	79,48	1,32	4	79,84	79,84	0,934	0,0034

Tab. 2 Topological analysis of the ENN: initial and final scenarios.

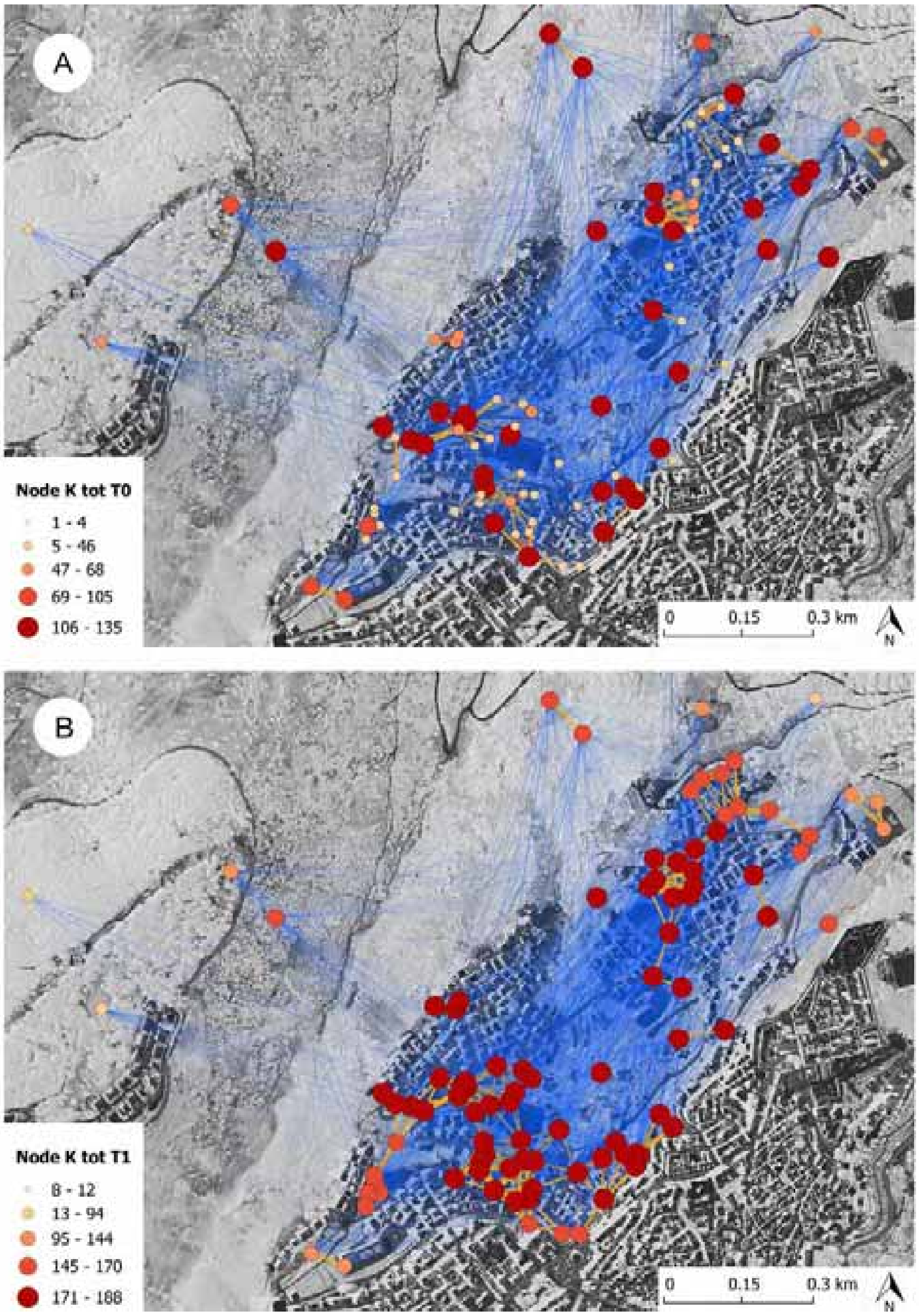

Fig. 2 Thematic mapping of total degree (K tot) for initial (A) and final (B) scenario.

The average values of Kin and Kout increases between the two scenarios although Kin roughly doubles. In Figure 2, we map the sum of Kin and Kout, the total degree (K tot): this analysis points out immediately the most and less connected patches of the ENN.

The node clustering coefficient (CC) is another network measure able to represent the level of interconnection between nodes that are connected to a given node. This coefficient ranges between 0 - completely disconnected- to 1 for completely connected neighbours.

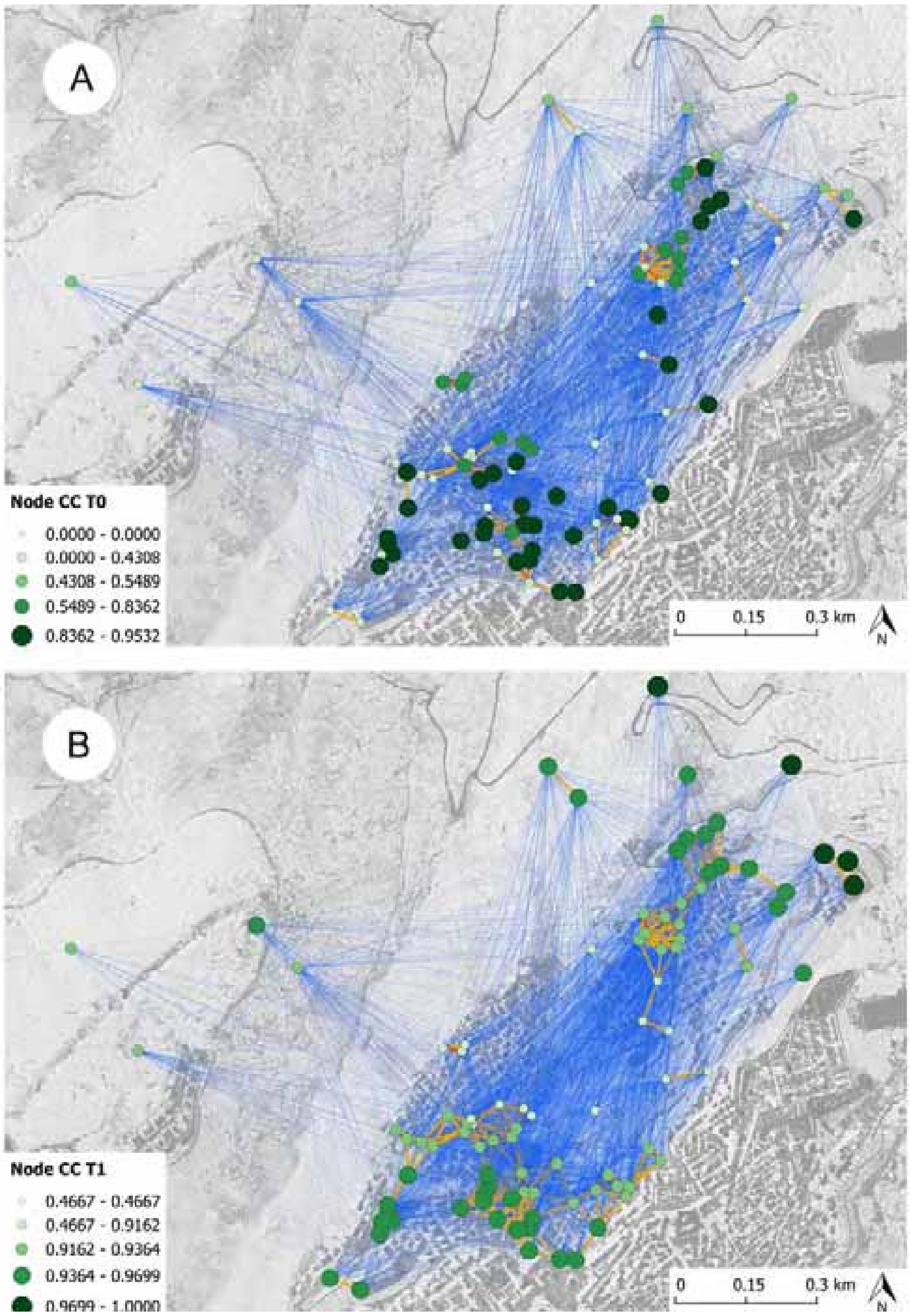

Fig. 3 Thematic mapping of the Node Clustering Coefficient (CC) for initial (A) and final (B) scenario.

In our case, this measure shows a remarkable growth and is close to 1 in scenario B. In Figure 3, we map the node CC for the ENN in the initial (T0) and final scenario (T1). Finally, the node betweenness centrality (BC) is another indicator of inter-centrality, as it measures the number of shortest paths connecting two nodes whatsoever and passing through a given node. Thus, BC is able to detect the patches that act as bridges and provide the shortcuts in the ENN. The average BC nearly doubles the initial in the final scenario. In Figure 4, we map the BC in the initial (T0) and final scenario (T1).

The second part of the analysis is based on a weighted network study of the centrality. In table 3, we report the main measures obtained in this analysis.

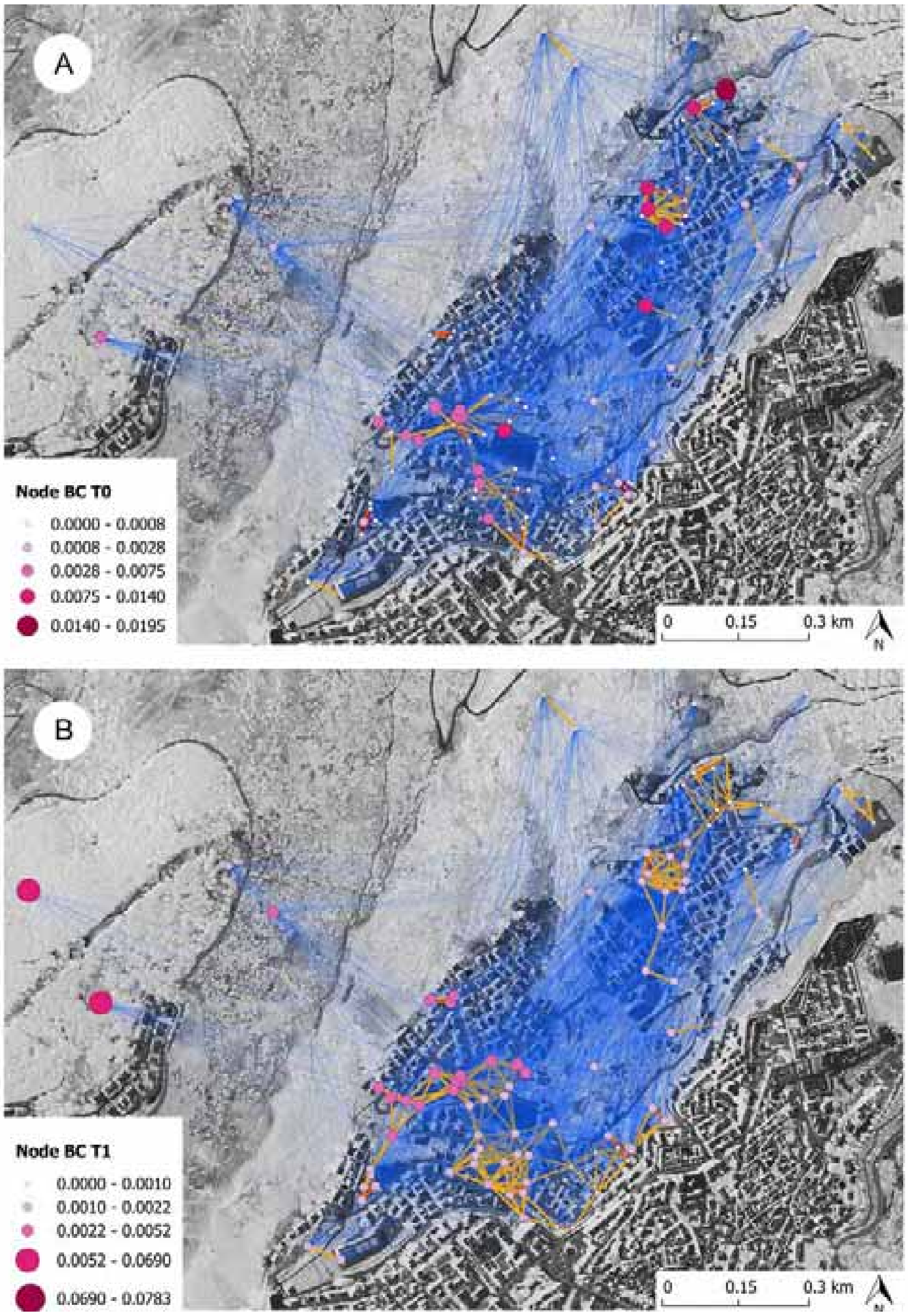

Fig. 4 Thematic mapping of node Betweenness Centrality (BC) for initial (A) and final (B) scenario.

The weight holds the intensity of the connection between patches. The average values increases, a sign that overall connections become more reliable and colonization possible.

The strength (S) can be interpreted as weighted total degree, as it measures the sum of the weights associated to the edges of a given node.

This indicator is able to appreciate the centrality of a node with respect also to the "traffic" implied. In our case, the quantity transported is the number of seeds dispersed in the ENN from or to a given patch. On average, the strength displays a relevant growth reaching a figure that is by far more than the double of its original value.

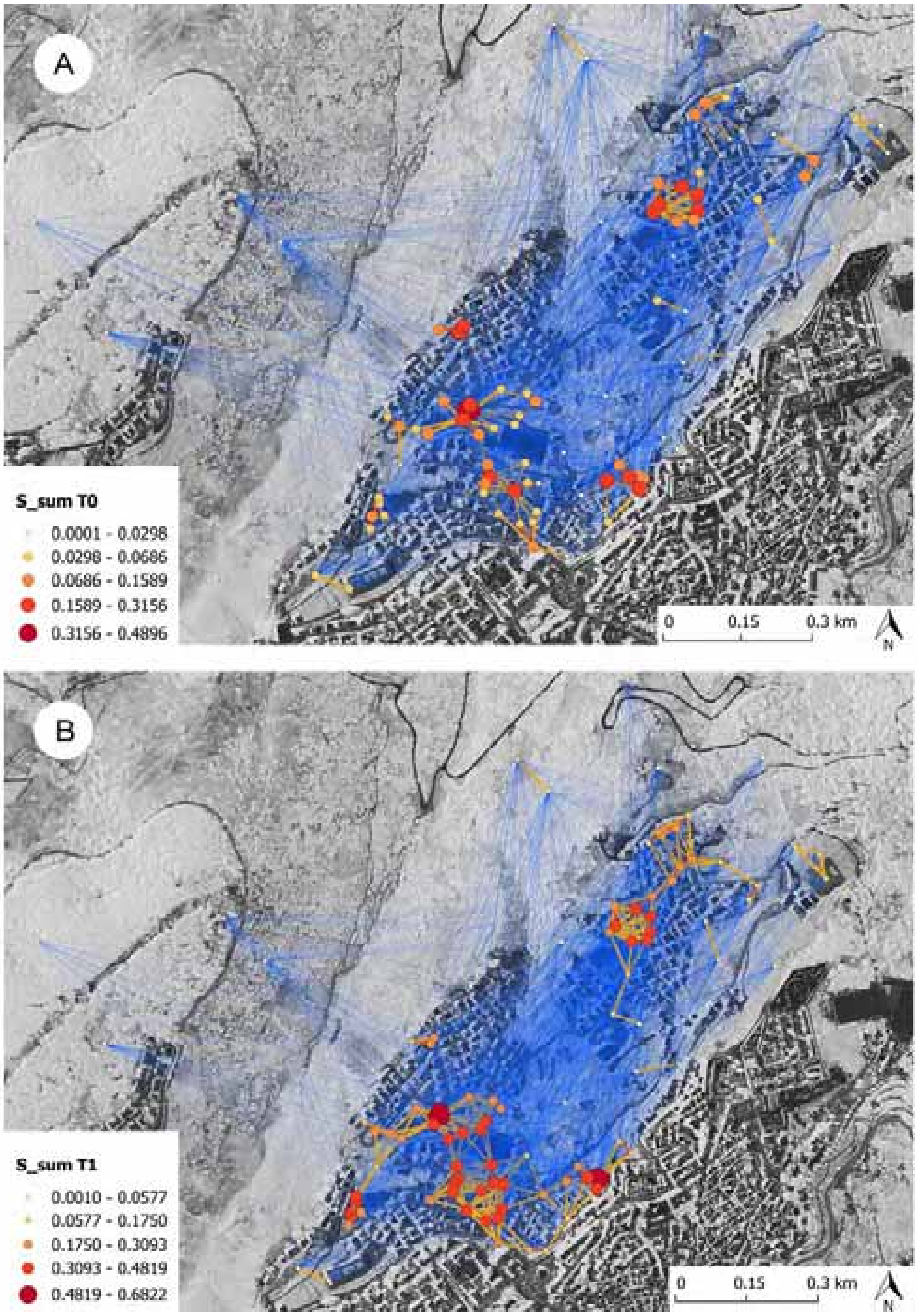

Fig. 5 Thematic mapping of the strength (S_sum) for initial (A) and final (B) scenario.

SCENARIO	<w>	<s>	$\langle C_w \rangle$	$\langle BC_w \rangle$
Initial	0.0010	0.08	0.002	0.004
Final	0.0014	0.22	0.002	0.011

Tab. 3 Weighted network analysis of the ENN: initial and final scenarios.

In Figure 5, we map the strength throughout the whole ENN (S_sum) in the initial (T0) and final scenario (T1). The node weighted clustering coefficient (CCweight) yields an appreciation of the level of connectedness between neighbour nodes taking into account the intensity of the connections.

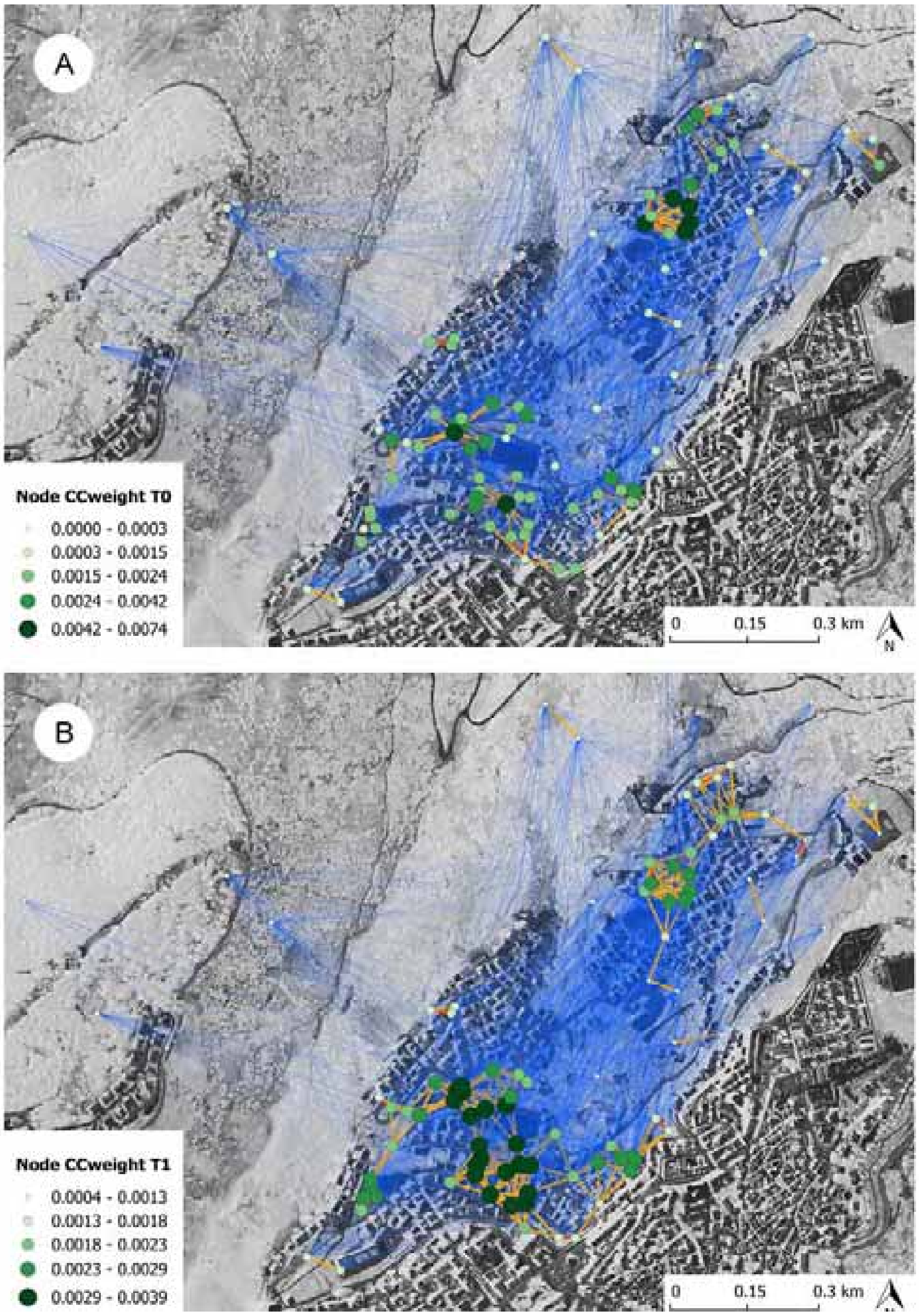

Fig. 6 Thematic mapping of the node weighted clustering coefficient (CCweight) for initial (A) and final (B) scenario.

This measure on average does not show appreciable variations. In Figure 6, we map CCweight throughout the whole ENN in the initial (T0) and final scenario (T1). The node weighted betweenness centrality (BCweight) is a measure able to describe the level of inter-centrality taking into account the influence of the intensity of the connections. On average this indicator displays a significant increase. In Figure 7, we map BCweight throughout the whole ENN in the initial (T0) and final scenario (T1).

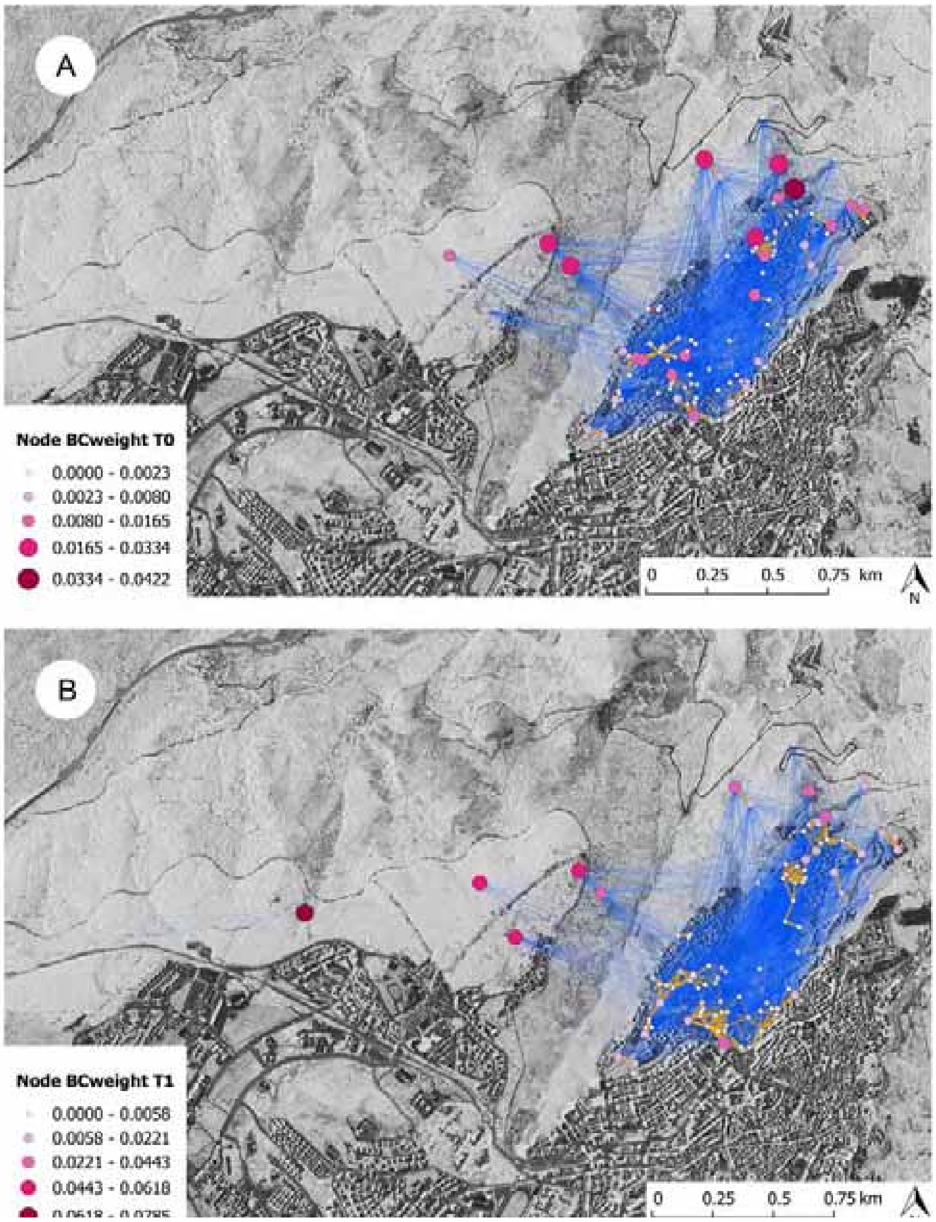

Fig. 7 Thematic mapping of the node weighted betweenness centrality (BCweight) for initial (A) and final (B) scenario.

4 CONCLUSION AND OUTLOOK

In this section, we summarize the argument developed in the two papers (Part A and B) regarding the study of an ecological network of Nuoro, Sardinia, and propose possible courses of future research. In these essays, we start by recalling the major research streams attaining biodiversity conservation, which includes, inter alia, the design, construction, and maintenance of ecological networks. We have presented the approach to ecological network in landscape planning and recalled fundamental concepts, such as target species and dispersal distance, that have allowed us to describe the main determinants of the dynamics of an ecological network, i.e. the colonization of new green areas or patches. We have connected the analysis of these issues with research on spatial networks, in order to interpret the ecological network as a system. Green areas (i.e. nodes) represented by the patches' centroids (barycenters) are interlaced by connections describing the probability of mutual colonization. We have built the ecological network on a pilot set of 100 patches connected according to the spatial distribution and dispersal pattern of two target species: the Olea Europea and Quercus Ilex. We have applied spatial network analysis to monitor the dynamics of the ecological network evolving from an initial to a final scenario. The initial scenario corresponds to the current situation, while the final scenario to an ideal network, where all the patches host both the target species. This analysis focuses on global characteristics and on the centrality of the patches assessed through three measures: degree, clustering coefficient, and betweenness centrality. These indicators are able to locate the most critical patches providing the whole system with informational resistance and shortcuts.

This study presents robust premises that merge biodiversity conservation issues, ecological network management and planning, and spatial networks analysis, while reports on an application to the case of Nuoro which is still on a pilot stage. Thus our research needs further work on some questions we now argue on as follows. The extension of the pilot system currently covers the northern sector of the town of Nuoro including just one hundred patches. We are going to extend our analysis to the whole municipality comprehending both urban and periurban areas. We have included patches by detecting the presence of target species through mainly two instruments: field survey and orthophoto interpretation. As the first is always the most reliable assessment of current status of the patches, we would like to verify every patch colonization status through direct field work. Another set of questions attain the ecological network construction and analysis. We have established the connection's intensity by imposing, in first approximation, that the weight is proportional to the inverse of the distance between two patches. In this way, we take into account that the dispersal through short distances is easier than through longer distances. We feel further investigation is needed to better specify how distance, as well as other elements, such as the extension of the patches, affect seeds' dispersal and to construct a finer model to describe the weights. In addition, we have adopted network centrality measures to describe the criticality of some patches with respect to others. Further research is needed to clarify the meaning of these measures with respect to the underlying ecological principles. Finally, spatial network tools have been developed in the perspective to build an efficient decision and planning support system. Many planning tools affect the development and performance of the ecological network of Nuoro: the main tool is the Municipal Master Plan, which regulates land use. Further work is in need to study the characteristics of planning tools, the most critical parts, and the transformations implied in perspective to ascertain how a municipal ecological network evolves.

IMAGES SOURCES

Figg. 1-7: All the pictures have been realized by Amedeo Ganciu and post-processed by Antonio Ledda.

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