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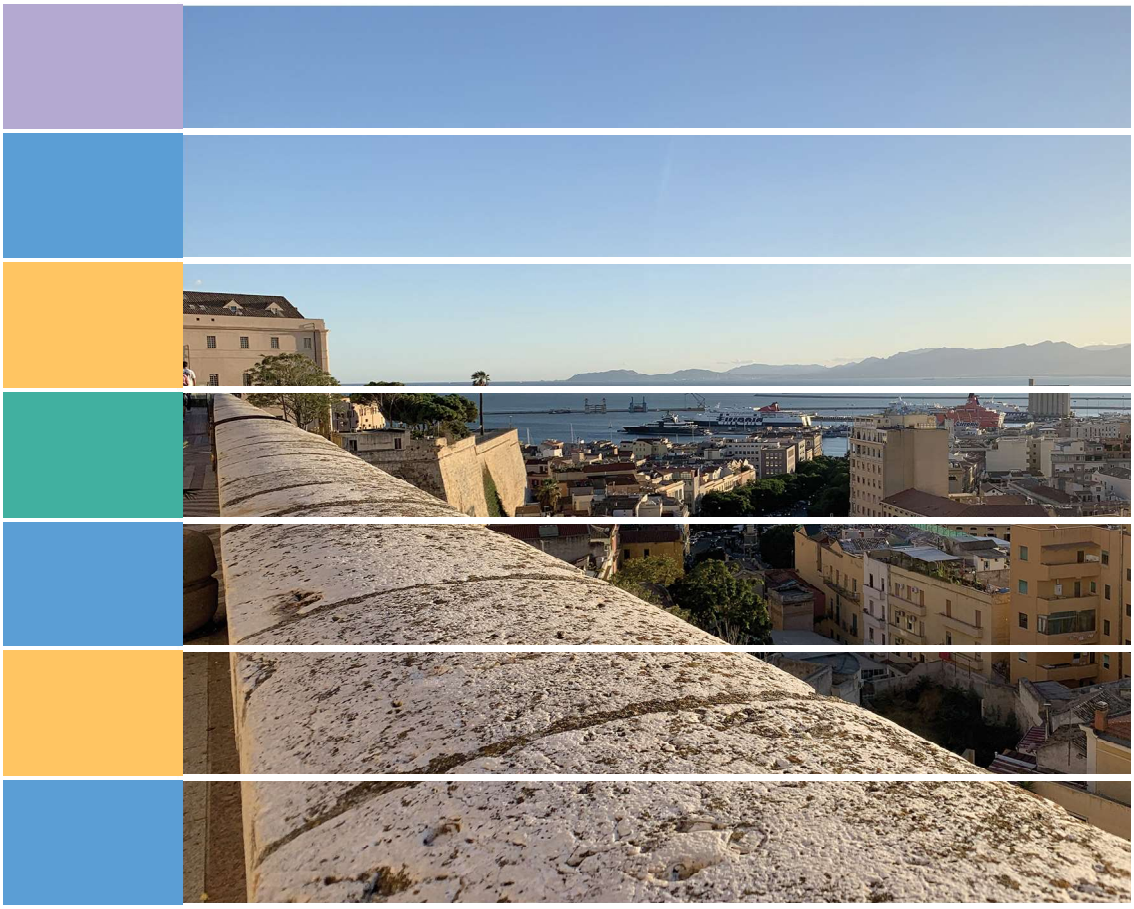
Editors

Planning, Nature and Ecosystem Services



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Smart City, Urban Planning for a Sustainable Future

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Carmela Gargiulo Corrado Zoppi

Editors

Planning, Nature and Ecosystem Services

INPUT aCAdemy 2019

Conference proceedings

Federico II Open Access University Press

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La cooperazione al cuore del Mediterraneo

Planning, nature and ecosystem services / editors Carmela Gargiulo, Corrado Zoppi - Napoli: FedOAPress. 2019 - (Smart City, Urban Planning for a Sustainable Future. 5).

Web link:
http://www.tema.unina.it/index.php/tema/Monographs

ISBN: 978-88-6887-054-6
DOI: 10.6093/978-88-6887-054-6

Università degli Studi di Napoli Federico II
Centro di Ateneo per le Biblioteche "Roberto Pettorino"
Piazza Bellini 59-60 - 80138 Napoli, Italy
http://www.fedoapress.unina.it

Published in Italy

Cover and graphic project: TeMA*Lab*

INPUT aCAdemy 2019

This book collects the papers presented at INPUT aCAdemy 2019, a special edition of the INPUT Conference hosted by the Department of Civil and Environmental Engineering, and Architecture (DICAAR) of the University of Cagliari.

INPUT aCAdemy Conference will focus on contemporary planning issues with particular attention to ecosystem services, green and blue infrastructure and governance and management of Natura 2000 sites and coastal marine areas.

INPUT aCAdemy 2019 is organized within the GIREPAM Project (Integrated Management of Ecological Networks through Parks and Marine Areas), co-funded by the European Regional Development Fund (ERDF) in relation to the 2014-2020 Interreg Italy – France (Maritime) Programme.

INPUT aCAdemy 2019 is supported by Società Italiana degli Urbanisti (SIU, the Italian Society of Spatial Planners), Istituto Nazionale di Urbanistica (INU, the Italian National Institute of Urban Planning), UrbIng Ricerca Scientifica (the Association of Spatial Planning Scholars of the Italian Schools of Engineering) and Ordine degli Ingegneri di Cagliari (OIC, Professional Association of Engineers of Cagliari).

This book is the most recent scientific contribution of the "Smart City, Urban Planning for a Sustainable Future" Book Series, dedicated to the collection of research e-books, published by FedOAPress - Federico II Open Access University Press. The volume contains the scientific contributions presented at the INPUT aCAdemy 2019 Conference. In detail, this publication, including 92 papers grouped in 11 sessions, for a total of 1056 pages, has been edited by some members of the Editorial Staff of "TeMA Journal", here listed in alphabetical order:

- Rosaria Battarra;
- Gerardo Carpentieri;
- Federica Gaglione;
- Carmen Guida;
- Rosa Morosini;
- Floriana Zucaro.

The most heartfelt thanks go to these young and more experienced colleagues for the hard work done in these months. A final word of thanks goes to Professor Roberto Delle Donne, Director of the CAB - Center for Libraries "Roberto Pettorino" of the University of Naples Federico II, for his active availability and the constant support also shown in this last publication.

Rocco Papa
Editor of the Smart City, Urban Planning for a Sustainable Future" Book Series
Published by FedOAPress - Federico II Open Access University Press

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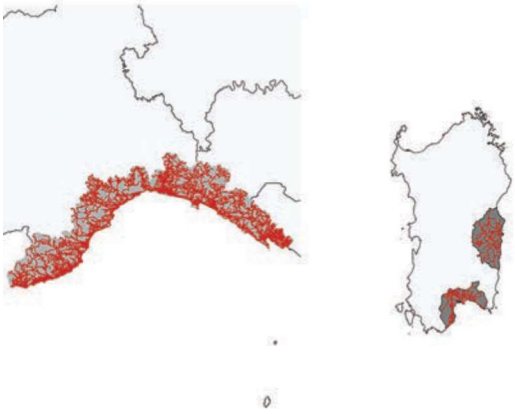

THE IMPACT OF URBANIZATION PROCESSES IN LANDSCAPE FRAGMENTATION

A COMPARISON BETWEEN COASTAL ZONES OF SARDINIA AND LIGURIA

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How to cite item in APA format:
Lombardini, G., De Montis, A. & Serra, V. (2019). The impact of urbanization processes in landscape fragmentation: A comparison between coastal zones of Sardinia and Liguria. In C. Gargiulo & C. Zoppi (Eds.), *Planning, nature and ecosystem services* (pp. 80-85). Naples: FedOAPress. ISBN: 978-88-6887-054-6, doi: 10.6093/978-88-6887-054.6

ABSTRACT

Landscape fragmentation (LF) is the process, according to which landscape parts (patches) become smaller and more isolated. LF is partly due to human activity and has always accompanied man since prehistoric times. In recent decades, the increase of human population, the exponential growth of human needs and the construction of settlements and transport and mobility infrastructures have accentuated the effects of LF. These situations result in a reduction of connectivity of habitats, due mainly to a barrier effect that hinders the movement of animal species. In literature, numerous indices have been proposed for the quantification of LF. In this paper, we apply the Urban Fragmentation Index (UFI), that evaluates the fragmentation caused by urbanized areas, and the Infrastructural Fragmentation Index (IFI), that evaluates the LF caused by road infrastructure. In addition, we aim at comparing LF in the Italian regions of Liguria and Sardinia, with a typical focus on coastal and inner areas. We demonstrate how LF is always higher in coastal landscape units, where there is a higher impact of human development.

KEYWORDS
Landscape Fragmentation; Fragmentation Index; Coastal Zones; Urbanization

1 INTRODUCTION

Landscape fragmentation (LF) can be defined as a dynamic process, where larger landscape fragments, or patches, tend to become smaller and more insulated than in their original condition (EEA, 2011). This process can be caused by linear and mobility infrastructures, such as railways and roads and urbanised surfaces, which reduce the range of movement of animal species and the connectivity of the landscape (Bissonette & Adair, 2008). An important consequence of an increase in LF is a decrease in landscape connectivity (LC), i.e. a higher impedance to movement for mainly animal species, depending on land cover pattern (Scolozzi & Geneletti, 2012).

LF is measurable through indices, such as the Infrastructural Fragmentation Index (IFI), that measures LF caused by roads, motorways and railways, and the UFI, that quantifies LF caused by urbanized areas. In this paper, we aim at measuring LF through the IFI and UFI in two Italian regions: Liguria and Sardinia. We direct our application to the assessment of LF in the four provinces of the Liguria and of the metropolitan area of Cagliari and the historic region of Ogliastra in Sardinia. This essay unfolds as follows. In the next section, we describe the selected methods. In section 3, LF indexes are applied and results presented and discussed with some short concluding remarks.

2 METHODOLOGY

IFI and UFI are LF measures that allow the assessment of the overall level of disturbance caused by transport and mobility infrastructures, such as roads and railway traits, and human settlements (Biondi et al., 2003; Bruschi et al., 2015; Romano, 2002; Romano & Tamburini, 2001). IFI can be expressed with the following equation

$$IFI = \frac{\left(\sum_{i=1}^{i=n} L_i \cdot O_i\right) \cdot N \cdot P}{A} \quad (1)$$

where Li stands for the length in meters of the road or railway trait with the exclusion of discontinuities (viaducts, bridges, tunnels), Oi for a (dimension less) occlusion coefficient, A for the extension in squared meters of the landscape unit (LU) area; P for the perimeter in meters of the LU, and N for the number of patches. We consider patches larger than 0.20 ha to eliminate the distortion due to fictitious parts (Bruschi et al., 2015; De Montis et al 2017; Lega, 2004;). Oi varies, according to the difficulty that the fauna has in crossing the transportation infrastructure (Bruschi et al., 2015): it is equal to: 0.30, for municipal and

ISBN: 978-88-6887-054-6
DOI: 10.6093/978-88-6887-054-6

local roads, 0.50, for national and provincial roads, and 1.00, for national four (or more) lane roads and railways. UFI obeys to the following equation

$$UFI = \frac{\sum_{i=1}^{i=n} S_i}{A} \cdot \frac{\sum_{i=1}^{i=n} p_i}{2\sqrt{\pi \sum_{i=1}^{i=n} S_i}} \quad (2)$$

where *Si* stands for the extension in squared meters of the urban area, *pi* for the perimeter in meters of the urban area, and *A* for the extension in squared meters of the LU area. The first term of equation 2 quantifies the incidence of urbanized areas on the *LU* surface; the second term is the ratio between the perimeter of the urban area and the circumference of the equivalent circle (Battisti & Romano, 2007; De Montis et al., 2017; Romano & Zullo, 2013). These indicators have been used in various contexts, quantifying fragmentation in natural parks (Bruschi et al., 2015) and in rural Spain and Italy (De Montis et al., 2017).

3 APPLICATION TO A CASE STUDY AND RESULTS

We use the GIS to perform our study, because it has been proved useful in spatial analysis and in measuring landscape (habitat) fragmentation (De Montis et al., 2017; De Montis et al., 2018). We use data freely available online (RAS, 2003, 2008; Geoportale Regione Liguria, 2003, 2009, 2010, 2015). In order to apply the IFI, we implement a GIS and use data in shapefile format.

Roads and railways layers have been imported in GIS environment as shapefile in polyline format and measured excluding discontinuity traits, namely tunnels and bridges. Reference years depend on the availability of data set for calculations.

IFI variation has been assessed in the time period 2003-2008, for Sardinia, and 2003-2010, for Liguria. As for the UFI, the time periods selected are 2003-2008, for Sardinia, and 2009-2015 for Liguria. We obtained the absolute values and average yearly variations reported in Tab. 1.

Tab. 1 shows the results. As time periods vary for different regional spatial data sets, with reference to IFI T0 refers to the year 2003 for both the regions and T1 to 2008 for Sardinia and 2010 for Liguria; with respect to UFI, t0 means 2003 for Sardinia and 2009 for Liguria, while t1 stands for 2008 for Sardinia and 2015 for Liguria.

As for the absolute values, the area with highest IFI is recorded for Coastal Liguria municipalities (113331.5 in 2010), while the lowest one is obtained for Sardinian Coastal Ogliastra municipalities (1018.23 in 2008). The lowest UFI value was recorded in Ogliastra (0.30 in 2003), while the highest value was obtained in Coastal Liguria municipalities (12.80 in 2015).

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NAME OF THE LU	IFI_{T0}	IFI_{T1}	UFI_{t0}	UFI_{t1}	Δ IFI	Δ UFI
Imperia	938.84	7237.30	2.50	2.50	95.84%	0.00%
Savona	1862.46	13698.56	3.77	3.80	90.79%	0.13%
Genova	5483.06	17325.79	5.32	5.42	30.86%	0.31%
La Spezia	1723.29	9371.98	4.14	4.16	63.41%	0.08%
Coastal Liguria municipalities	32843.81	113331.5	12.62	12.80	35.01%	0.24%
Cagliari metro area	3005.56	3300.96	2.41	3.03	1.97%	5.15%
Coastal Cagliari metro area municipalities	2416.35	2439.87	2.12	2.64	0.19%	4.91%
Ogliastra	1201.95	1135.36	0.30	0.34	-1.11%	2.67%
Coastal Ogliastra municipalities	1104.23	1018.65	0.42	0.49	-1.55%	3.33%

Tab.1 LF in Liguria and Sardinia. IFI and UFI absolute values and average yearly change

In Fig. 1, we report a representation of the geographical data used in the analysis.

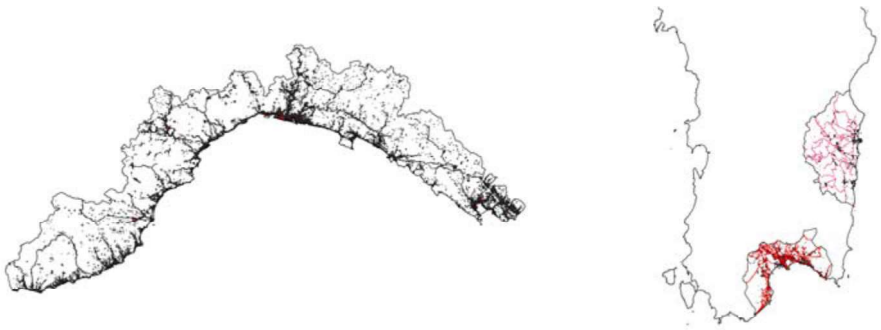

Fig. 1 On the left, urbanized areas and linear infrastructures of Liguria; on the right, fragmenting elements in two case studies of Sardinia

As for the average annual growth rates, the highest average annual increases for IFI is recorded in Imperia (95.84%), the lowest in Coastal Ogliastra municipalities (-1.55%). This decrease is in counter trend, with respect to the general inclination of Italian coastal areas, including Coastal Liguria municipalities (35.01%). As for the UFI, the highest annual increase is recorded in Coastal Cagliari metro area municipalities (5.15%), Liguria's areas display negligible values.

4 CONCLUSIONS

In this work, we have studied LF due to settlements and transport infrastructure expansion, by assessing its values and dynamics in space and time. In particular, we have applied a set

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of metrics to describe the dynamics of two LUs of Italy, in Liguria and Sardinia. We have developed a comparative approach, applying two indicators, IFI and UFI, able to give us information on the degree of fragmentation. We have found that the highest values are found in the coastal and most populated areas. The work can offer indications to planners, so that they can plan works that can limit the effects of fragmentation, the so-called defragmentation works.

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