Habitat Degradation: A Comparative Study Between Tomar (PT) and Potenza (IT)

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Abstract. The increasing impacts of climate and land use change directly impact habitat quality and biodiversity. Monitoring the habitats quality can be a valuable tool for the conservation of biodiversity, as it is an indicator of biodiversity. This research work aims to ap-ply the InVEST Habitat Quality model to compare two different cases study from Portugal (Tomar) and Southern Italy (Potenza). Threats to biodiversity were considered taking into account the substantial territorial differences of the two areas considered: Tomar, an area particularly affected by forest fires-driven degradation phenomena; Potenza is, instead, an area particularly affected by the installation of wind farms. Results highlight how these tools can be considered a valuable support tool for spatial planning decisions for biodiversity conservation.

Keywords: Habitat quality · Tomar (Portugal) · Potenza (Italy)

1 Introduction

Intensive human activities can lead to a widespread loss of species, habitat fragmentation and habitat degradation [1, 2]. Habitat loss and degradation is a key cause of declining biodiversity [3, 4]. Biodiversity means biological wealth and therefore environmental quality: decision-makers and conservation organizations should learn about spatial changes in biodiversity and habitat and identify potential impact factors [5]. Consequently, the greater the diversity of the system, the less its vulnerability. Sometimes biodiversity is closely related to human activities. Therefore its quantification can be useful in order to better guide the decisions in territorial planning and in order to better understand the interaction and the consequent effect between territorial components and anthropogenic activities [6]. This new approach allows to better design sustainable and environmental policies and deeply understand the interaction among territorial components and relative processes and dynamics [7, 8].

The purpose of this work is to test InVEST-Habitat Quality (Integrated Valuation of Ecosystem Services and Tradeoffs) model [9] in order to compare the spatial distribution of biodiversity threats between Tomar (Portugal) and Potenza (Italy). As highlighted from many authors [10–12], this tool reveals to be useful in assessing the impact

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of changing in land use/land cover (LULC) or, equally, in appreciating benefits from conservation policies [13, 14]. As a result, we aimed to (1) identify habitat suitability and threats to biodiversity for different land uses; (2) apply the InVEST-Habitat Quality model to assess and map habitat quality from 2007 to 2015 for Tomar and from 2014 to 2018 for Potenza; and (3) to analyze and compare the potential impact factors of habitat quality.

2 Study Area

The study areas both belong to Southern Europe (Portugal and Southern Italy) and have similar characteristics: both areas are characterized by a low density of settlement and a high landscape value of the territory [15–17], articulated in a high naturalness environment (woods and forests) and valuable agroforestry mosaics (see Fig. 1 and Fig. 2). Although the important similarities, they have a fundamental difference: the main threat to biodiversity is represented for Tomar by the forest fires [18, 19] and for Potenza, as the rest of the Basilicata region [20–23], by the transformations due to the installation of wind farms [24].

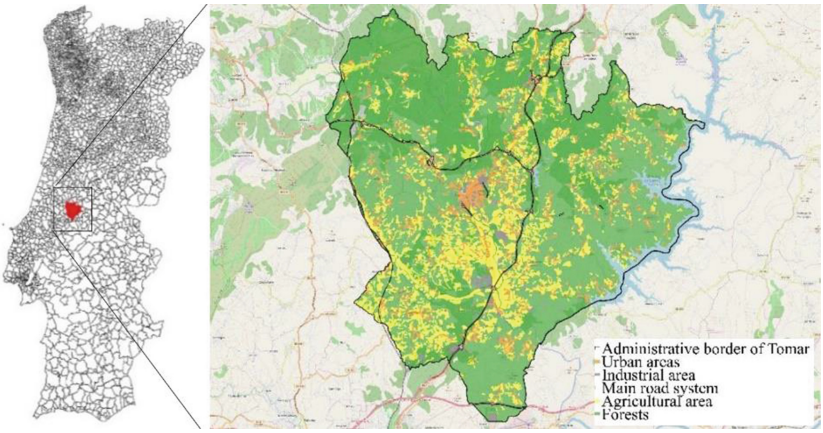


Fig. 1. Municipality of Tomar

Tomar. Tomar is a Portuguese municipality, located in the district of Santarém, in the Centro region, subregion Medio Tejo. It has an extension of 352 km^2 and has slightly more than 40,000 inhabitants. The municipal territory is mainly wooded. Forests are largely the result of policies from the 20th century [25], which have characterized changes in land use/land cover across the country. Nowadays, 97% of Portuguese woodland is privately owned, the result of this choice is that one of the most widespread tree species in Portugal is eucalyptus [18], one of the most easily flammable and fire-spreading species. The eucalyptus is a species not autochthonous but imported from Australia, starting from the 1970s to support the paper industry that began to grow in those years [26]. The eucalyptus plantations are intended solely for the cellulose industry and to

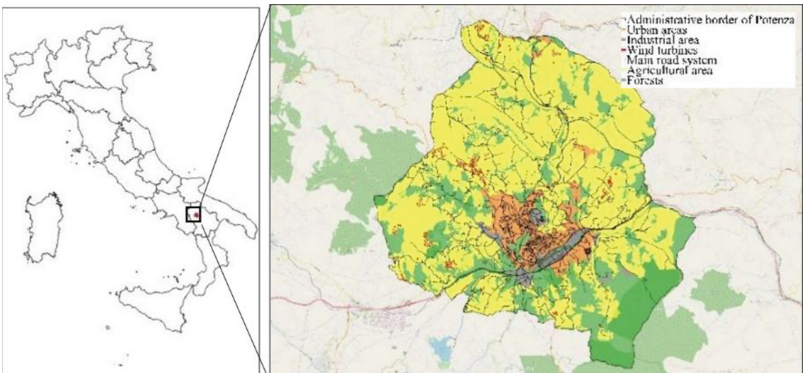


Fig. 2. Municipality of Potenza

ensure a faster financial return for the owners, as they are a rapidly growing species. The monoculture of eucalyptus, besides being highly flammable [27], also causes nutrient loss [28, 29] and other negative impacts [30], because it needs more water to grow and its structure does not allow the growth of other species in the surrounding area [31].

Potenza. Potenza is an Italian city, capital of the Basilicata region, with an extension of about 170 km^2 and counts, according to the National Institute of Statistics (ISTAT) [32], 66,391 inhabitants. It is a mostly rural environment characterized by very low population and building density [33, 34]. As the rest of the region, a significant part of the soil development process, during the last decade, is due to the expansion of urban areas, the transformation of rural areas, and the use of agricultural land for renewable energy production through the construction of ground-mounted photovoltaic systems and numerous installations of wind turbines [35]. Indeed, since 2010, a large part of the territory has been affected by the installation of RES plants, most of them with a total power output less than 1 MW which implied a relevant territorial impact not balanced by the low power output [21].

3 Methods and Materials

In order to evaluate the Habitat Quality of the two areas chosen for the comparison we applied the Habitat Quality module of InVEST (InVEST-HQ) [36]; this model generates a map of habitat quality, linking the land use maps and the threats to biodiversity considered. This approach evaluates habitat quality based on suitability and threats to biodiversity, and the hypothesis of the model is that areas with higher habitat quality support higher native species richness [37, 38]. In the model, habitat degradation by threat factors is indicated by declining habitat quality score. We have therefore selected buildings, road infrastructure, agricultural areas and quarries as the main threat factors for the habitat. The fifth source of threat to biodiversity was, instead, differentiated according to the characteristics of the two areas, considering the fires for Tomar and wind turbines

Table 1. Threats summary table of Tomar and Potenza.

Municipality	Threat	Max_Dist	Weight	Decay
Tomar and Potenza	Residential areas	10	0.8	Exponential
Tomar and Potenza	Agricultural areas	8	0.5	Exponential
Tomar and Potenza	Roads and railways	1	0.6	Exponential
Tomar and Potenza	Pollution	4	0.5	Linear
Tomar	Fire	6	0.9	Linear
Potenza	Wind power	6	0.9	Linear

Table 2. Habitat and sensitivity summary table.

LULC	Habitat	Residential areas	Agricultural areas	Fire	Pollution	Roads, railways
Water bodies	1	0.8	0.4	0	0.8	0.7
Residential areas	0	0	0	0	0	0
Industrial areas	0	0	0	0	0	0
Roads and railways	0	0	0	0	0	0
Quarries	0	0	0	0	0	0
Urban green and gardens	0	0	0	0	0	0
Wind power	0	0	0	0	0	0
Vineyards and olive groves	1	0.6	0	0.8	0.8	0.7
Landfill sites	0	0	0	0	0	0
Orchards and citrus groves	1	0.6	0	0.8	0.8	0.7
Deciduous forest	1	1	0.6	0.9	0.9	0.9
Coniferous forest	1	1	0.6	0.9	0.9	0.9
Fallow field	1	0.6	0	0.8	0.8	0.7
Forest	1	1	0.6	0.9	0.9	0.9
Vegetable gardens	1	0.6	0	0.8	0.8	0.7
Arable land	1	0.6	0	0.8	0.8	0.7

for Potenza. Each threat considered has been constructed from land use maps, and the information for each threat considered is listed in Table 1.

To compute on-board effects, an area with a greater extent was considered by a buffer operation equal to 10 km, the maximum distance from the threat i-th considered. In order to assign suitability, it was necessary to reclassify the land use classes to make them as homogeneous as possible, assigning to each class a value, 0 or 1, to de-scribe the propensity to perform a habitat function. A land use type could be considered as habitat in relation to the level of biodiversity present and the intensity of human activities [39]. The threat parameters were determined by an expert survey and are summarized in Table 2.

4 Discussion and Conclusion

The model returns in output a spatial distribution of habitats degradation, relative to the years considered, assuming a more intense coloration in the areas more degraded (see Fig. 3 (A) and (B)). The first difference is that Tomar degradation level achieved is fairly homogeneous and widespread over the whole area of study, because, as highlighted in the context analyses, major territorial transformations are not of anthropic origin but linked to the phenomenon of forest fires; instead, in Potenza it is evidenced a negative impact mainly in correspondence of inhabited centers and more anthropized areas.

By comparisons over time we have a second difference that emerges: in Tomar there is a decrease of habitat quality in wooded areas facing residential settlements, highlighting as most vulnerable areas the transition zones from woodland to residential; in Potenza there is a decrease of habitat quality in the area located to the North-West of the compact town, following the installation of wind generators, as from 2014 to 2018 the number of wind turbines has considerably increased. Therefore, the main threat to Tomar is represented by the forest fires, this source of impact is not negligible if we consider that the tree species are the more easily flammable ones and that propagate the fire, and furthermore this source of impact is believed to be potentially increasing because it is indirectly linked to climate change; in Potenza the main source of degradation is represented by the wind farms installation, these changes are justified by the common need to fight climate change, but they have taken place in a regulatory framework that is not adequate to balance this with all territorial values, preventing adequate control and the consequent impact on the territory. In conclusion, the most degraded area between the two ones is Tomar, as result of the threat sources considered. As regards the interpretation of final results, it should be noted that the linear overlap of the effects related to different threats has the disadvantage of neglecting a certainly non-linear interaction between different sources of impact which, acting simultaneously, can amplify the effects of the other. The proposed method, applicable to the different planning scales [40, 41], provides a low-precision biodiversity indicator, but may provide a synthetic support for land-use assessment in terms of reducing the habitats quality [42]and may provide appropriate information on a land-use planning [43] and management system that ensures [44], among other quality objectives, the reduction of soil consumption, taking into account territorial characteristics and their ecosystem functionality, with a view to the conservation of biodiversity not considering natural processes as, for example, landslides [45]. As highlighted in previous works [46–49], the ecosystem services approach reveal

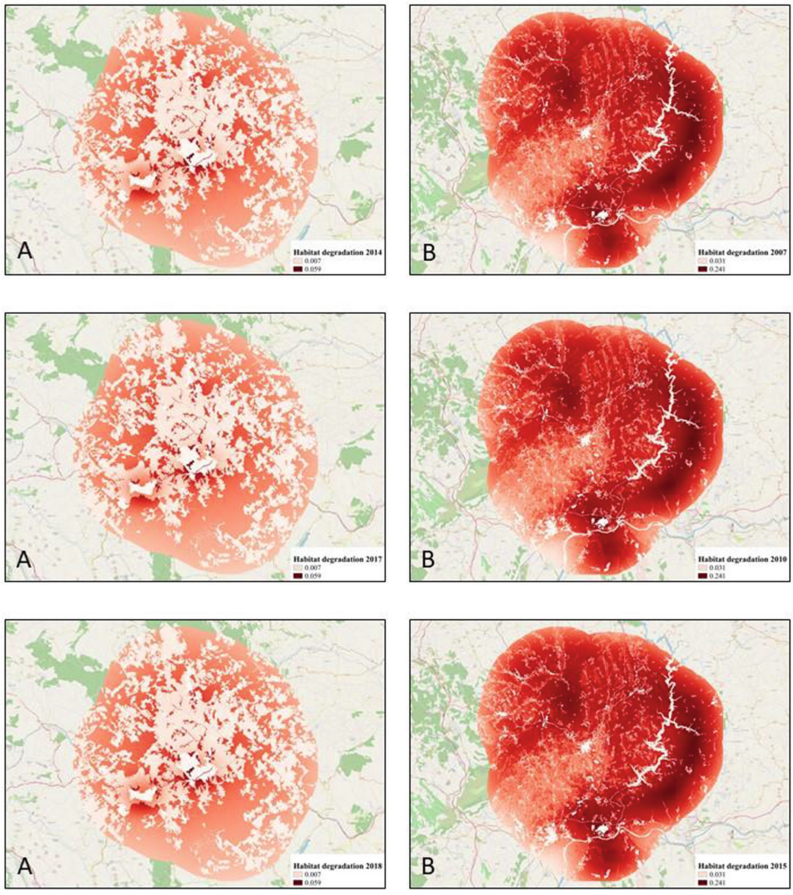


Fig. 3. Degradation maps for Potenza (A) and Tomar (B) study areas

to be particularly useful in supporting decision making and in designing conservation policies, but also in offering the possibility to use an effective monitoring tool of territorial transformation [35] and in overcoming a piecemeal structure of the normative framework [50].

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