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Identification of Agricultural Areas to Restore Through Nature-Based Solutions (NbS)

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Abstract: This study aims to present a methodological approach based on the objectives of the Nature Restoration Law and the concept of Forest Landscape Restoration to identify areas that are best suited for the implementation of Nature-based Solutions for the improvement of landscape and habitat status in the city of Campobasso (1028.64 km^2). Using open data (ISPRA ecosystem services and regional land use capability), an expert based approach (questionnaire), and a multicriteria analysis (Analytical Hierarchy Process), the Total Ecosystem Services Value index was determined as a weighted additive sum of the criteria considered. The index was then classified into eight clusters, and the land use "Cropland" was extracted. Cluster 1 croplands (740.09 Ha) were identified as the areas to be allocated to Nature-based Solutions since they were those characterized by fewer ecosystem services provisioning, while Cluster 8 croplands (482.88 Ha) were identified as valuable areas to be preserved. It was then possible to compare the "Forest" areas currently present in the study area with those of a possible future scenario, represented by the areas occupied today by forest with the addition of Cluster 1 croplands. A landscape analysis was conducted; it showed greater dispersion and fragmentation of forest patches in the future scenario, but also greater connectivity and thus greater ecological functionality of the patches.

Keywords: forest; multicriteria analysis; Urban Atlas; Nature-based Solutions; croplands; ecosystem services; landscape analysis

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1. Introduction

Urbanization is proceeding at an extremely fast pace; for the first time since 2008, more than half of the world's population lives in cities [1], and it is estimated that this will affect 66% of 9.8 billion people by 2050, mainly due to the social and economic process that has progressively resulted in the abandonment of rural, hilly, and mountainous areas [2] and the consequent process of urbanization. As a result, built-up land is expanding, while surrounding natural environments and green areas within urban areas are threatened [3]. In fact, urban sprawl has a substantial ecological footprint and is a driver of land use change [4]. Although cities occupy only 2% of the earth's surface, people are already using 75% of all natural resources [1]. This implies the configuration of available urban green spaces as central elements in increasing the quality of urban settings and local resilience, resulting in positive impacts on people's health and well-being [5].

It is important to develop a network of green infrastructure, not just ancillary green, so that it can cope with the high complexity and dynamism of urban areas [6]. Another fundamental aspect to consider at the planning level is the structure and choice of areas to be allocated to green spaces, as well as their type. In general, different types of green spaces should be planned with an emphasis on biodiversity and the use of native species [5]. It is necessary for green infrastructures to be well planned as they can contribute differently to the provision of ecosystem services (ES), depending on the vegetation types and different types of green spaces and corridors (e.g., urban trees and rows), patches (e.g., isolated trees), and matrices (e.g., urban and peri-urban forests) [7]. Urban and Peri-urban forests (UPFs) provide multiple ES; in particular, they mitigate the microclimate and reduce pollution through pollutant sequestration, promote carbon storage, and are crucial for erosion control [8]. In addition, they are important as habitats for rare animal and plant species, as well as for biodiversity and pollination [3]. In some contexts, their role is also relevant in providing citizens with provisioning services such as nuts, berries, mushrooms, herbs, and hunting [9]. In addition, there are numerous physical benefits associated with green spaces; they improve mental health and well-being [10], reduce stress caused by modern lifestyles [11], and may have lasting psychological benefits [12]; benefits related to longevity have also been found [13]. Promoting UPFs by securing the ES they produce is incredibly important for human well-being and future generations; however, UPFs are threatened by accelerated urbanization, deforestation, and climate change, which also affect their ability to provide ES [14]. In addition, according to recent estimates [15], between 60 and 70% of European Union (EU) soils are unhealthy, being subject to erosion, compaction, organic matter reduction, pollution, biodiversity loss, salinization, and sealing. When soil is healthy, it can provide provisioning, regulating, supporting, and cultural services, e.g., EU croplands and grasslands produce ES amounting to 76 billion euros per year, of which only one-third is directly related to agricultural production [15].

According to the Report on Land Consumption, Spatial Dynamics and Ecosystem Services by the SNPA (National Service for Environmental Protection) [16], land consumption affects an average of 19 hectares per day in Italy, with a cemented surface area of about 21,500 km^2. This phenomenon is mainly due to urban expansion, which makes the soil impermeable, thus resulting in a greater susceptibility to flooding and increased heat waves, to the loss of biodiversity, green areas, and ES, and decreased resilience [17,18], with a damage of 8 billion euros per year [16]. Urban sprawl, together with road networks and constructions, also leads to the loss and fragmentation of agricultural lands, which can impact agricultural process inputs [19]. Peri-urban agriculture represents a substantial contribution to ES, acting as a groundwater table recharge zone and stormwater runoff sink and enhancing the aesthetic appeal while providing food security [20]. Focusing on Nature-based Solutions, increasing green infrastructures could lead to the improvement of ecosystem health by reconnecting fragmented natural and semi-natural environments and restoring damaged habitats to provide more goods and services [21].

The Nature-based Solutions (NbS) term first appeared in the early 2000s, primarily in the context of solving agricultural issues, such as the use of habitats to mitigate farm effluent [22], later giving great emphasis to NbS to major contemporary societal challenges, such as climate change [23]. It is an umbrella concept that encompasses a range of ecosystem-related terms and approaches that address societal challenges [24]. This concept represents a set of environmentally friendly alternatives that support the provision and maintenance of ES, and it integrates into other concepts, such as those of green and blue infrastructure, urban forestry, ecological engineering, etc. The strength of NbS lies in providing co-benefits and generating advantageous solutions (e.g., multifunctionality) [25]. According to the European Commission, an action can be addressed as NbS if it uses nature or natural processes if it enhances or provides social, economic, and environmental benefits, and if it has a net benefit on biodiversity [26], such as vertical forests in urban settings [27]. The accumulated knowledge on NbS demonstrates that they are locally attuned solutions to the social context and generate multiple benefits [28]; their use could address climate change and biodiversity loss while supporting various sustainable development goals [29]. In this regard, governmental and nongovernmental organizations are providing funds globally to implement NbS [30], with the main focus on reforestation and afforestation programs [31] such as the EU's "Three billion trees" [32] and the "Great Green Wall" [33]. Sustainable and successful NbS must deliver benefits for biodiversity and people [34]; trade-offs and synergies play a key role in NbS design [24].

Due to pressure from rapid urbanization and increased vulnerability to risks associated with climate change in cities around the world, NbS are increasingly being promoted and integrated, especially into urban planning [30,35,36]; however, their importance is also increasing in agricultural and forestry landscapes, with a multitude of benefits, as biodiversity conservation [37]. In fact, climate change is affecting European ecosystems and human well-being, and it is estimated that there will soon be even greater threats related to ecosystems and the socioeconomic system [38]. NbS are increasingly seen as central elements in various areas due to their efficiency in coping with climate change-related extreme events through mitigation and adaptation actions, preserving human health and psychosocial well-being, improving air quality, and increasing landscape connectivity [25]. A limitation, however, is land availability, which is a barrier to implementing NbS within cities [35]. Another limitation is associated with the fact that policy instruments for the implementation of NbS are mostly related to the municipal sphere and not at the landscape or higher levels of planning, which would instead allow the multifunctionality of NbS to be enhanced [39]. To make NbS efficient, they require integrated, cross-sectoral planning and governance strategies for their integration and deployment [40], as well as the involvement of numerous stakeholders, whose contribution is essential for NbS' long-term success [41,42]. Despite their widespread deployment in cities, there are still numerous challenges related to NbS, including the lack of information about their benefits, uncertainties about the inadequacy of existing planning systems, as well as how to plan, design, implement, and manage them adequately [43]. In fact, it is more challenging to manage NbS relying on restoration efforts than the conservation and management of native vegetation. It is fundamentally important to consider the presence of barriers to implementing NbS in degraded areas [44].

Brian Alan et al. [45] review shows that most of the studies on NBSs focus on specific aspects, including

- barriers/enablers of NBS;
- public participation/engagement/education;
- monitoring/evaluation of NbS project outcomes;
- policy and governance issues;
- social issues;
- private sector involvement.

Few studies evaluate ecological data or ES for the identification of such areas; preference is given to specific factors based on the function that NbS will have, such as land use [46], intrinsic characteristics of soils [47], landscape elements [48] or, at most, ES are evaluated but not the methodologies for identifying areas for NbS [49].

The aim of this study was to present a proper methodology approach to identify degraded agricultural areas for restoration through NbS interventions to improve the landscape and habitat status. The areas were identified from the level of ES provision and obtained through an expert-based approach.

2. Materials and Methods

2.1. Study Area

The study area is represented by the Urban Atlas [50] of the Province of Campobasso (Figure 1), which includes 38 municipalities in the Molise Region, Italy, which is also part of the study area of the PNRR-NBFC (National Biodiversity Future Center) project [51]. This choice was motivated by the desire to analyze the landscape system and the green infrastructure from a broader perspective than the mere administrative boundaries of the single city (Campobasso), which acts as a hub, in line with the political and planning guidelines of recent years.

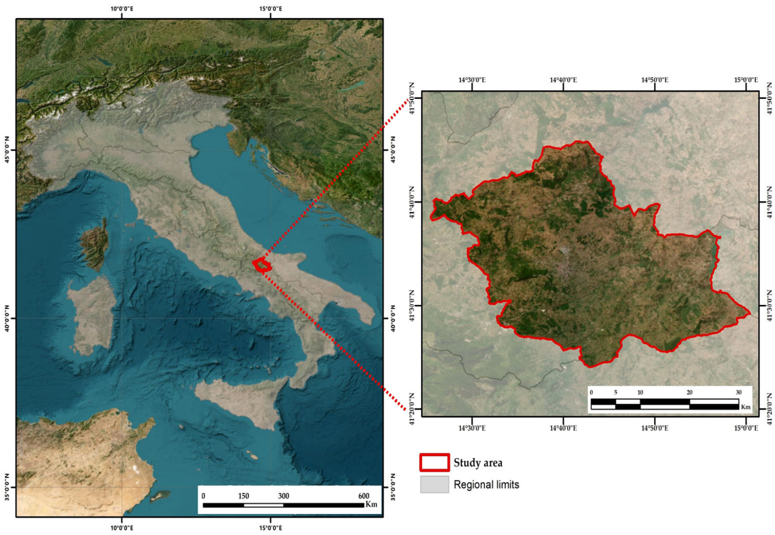


Figure 1. Study area.

The study area is 1028.64 km^2, the minimum altitude is 148 m above sea level (Municipality of Macchia Valfortore), while the maximum altitude is 1086 m above sea level (Municipality of Cercemaggiore). From a landscape point of view, according to the ISPRA (Higher Institute for Environmental Protection and Research) Map of Types and Physiographic Units of Landscape of Italy [52], the study area is classified as Terrigenous Hills Units consisting of terrigenous lithologies, with contrasted morphology, and Terrigenous Mountains Units in which the mountainous reliefs are characterized by terrigenous lithologies consisting of marls, clays, and sands. The high erodibility of these lithologies, along with the tendency for the drainage network to deepen, contributes to the modest elevation of the reliefs, which are prone to landslides and water erosion.

The 2018 ISPRA National Land Cover Map [53] with a 10 m spatial resolution was used to characterize the land use and cover. The map was obtained through the integration of data from the Copernicus Program's Land Monitoring Service with ISPRA's Land Use data. The choice of data referring to 2018 was dictated by the fact that the most recent ES data used for the computations are available for 2018 only. The study area has a strong agricultural vocation, mainly represented by arable land; in fact, these areas characterize around 63% of the territory, followed by forests that occupy 25%, non-agricultural meadows that occupy just over 6%, and artificial surfaces that occupy just under 5% of the territory, respectively.

According to the last ISPRA Report on Soil Consumption [54], around 20% of the province of Campobasso will be affected by soil consumption in 2022, for a total area of 12,337 hectares. In 2018, the reference year in this study, it is 12,822 hectares [55].

2.2. Methodology

The methodology (Figure 2) is based on the use of a series of available map layers related to ES delivery to develop a model that is extendable to a national scale and replicable in other case studies for the identification of areas characterized by low ES provision or situations of ecological degradation where environmental restoration interventions are needed. Interest fell on agricultural areas, particularly "Croplands", which occupy 50.83% of the entire area, to identify "valuable" areas characterized by high ES provision and adequate land capability and those "degraded" to restore through NbS interventions. Through a Landscape Ecology analysis, a comparison was also made in terms of ecological connectivity and functionality, making a comparison between the current ecological network arrangement present in the study area and a hypothetical scenario in which the areas identified by the above model are subject to NbS interventions.

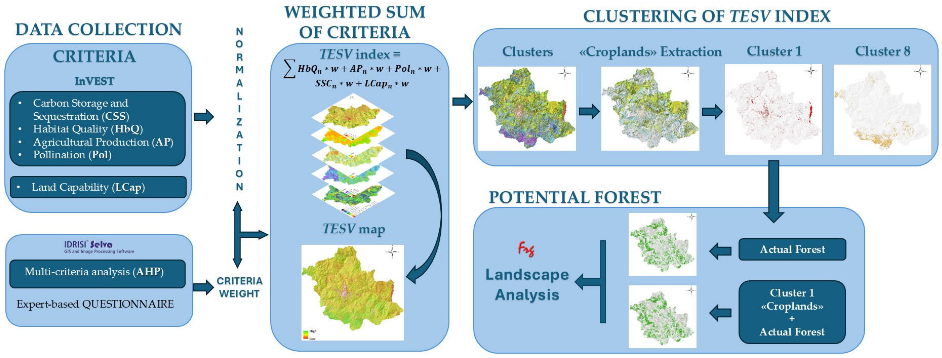


Figure 2. Study workflow.

2.3. Assessment of Ecosystem Services Provided in the Study Area

The ES maps used were created with the InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs, provided by the Natural Capital Project) (ver. 3.3.0) [56] suite of models, which provide biophysical and economic analysis of the ESs delivered by the area. The software consists of several independent packages to evaluate 17 ESs belonging to all four ES categories of the Millennium Ecosystem Assessment (MEA) [18]. The model associates each land use class with a value of ES delivery. What ensures the quality and accuracy of the outputs is the ability to take advantage of accurate inputs on land use and land biophysical characteristics, which are then used by the model to calculate ES delivery in biophysical and, therefore, economic terms [57,58]. InVEST models suite uses cartography derived from the integration of High-Resolution Layers [59], Corine Land Cover, and the 2012 [60] national land use map [58].

According to Munafò [58], four of the 17 ESs selected are the most suitable for the agricultural field—carbon storage and sequestration, habitat quality, agricultural production, and pollination (Figure 3).

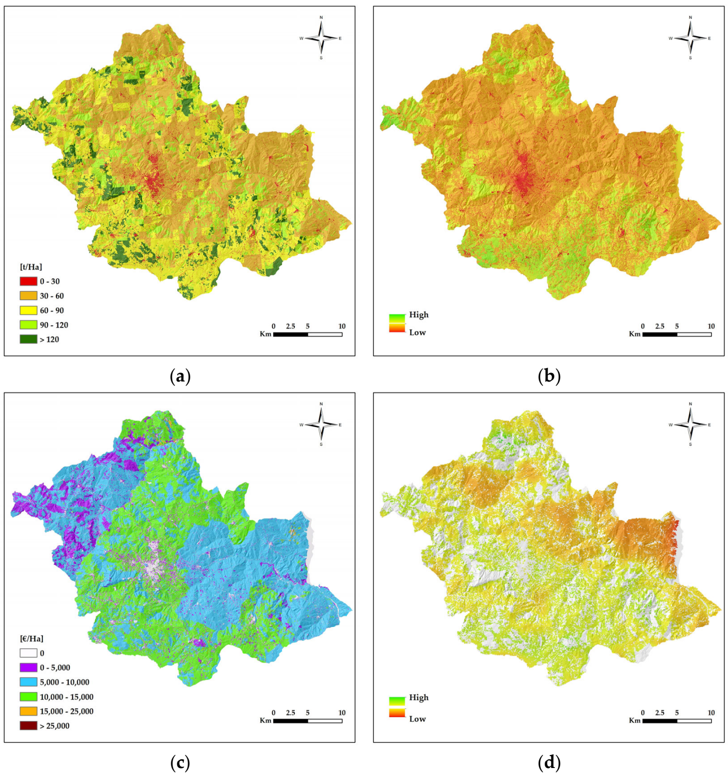


Figure 3. InVEST maps. (**a**) CSS; (**b**) HbQ; (**c**) AP; (**d**) Pol.

2.3.1. Carbon Storage and Sequestration (CSS)

CCS is a regulating service; to varying degrees, all terrestrial ecosystems contribute to providing this ES. In general, it can be said that the more natural the ecosystem, the greater its capacity to store and sequester carbon. Natural and semi-natural environments have the highest potential for sequestration and storage [57]. The estimation of this service in biophysical terms is achieved by spatializing the tons of carbon stored for each land use type [58].

2.3.2. Habitat Quality (HbQ)

HbQ is a supporting service; in fact, it is used as a proxy for assessing the state of land biodiversity [61]. Due to multiple pressures, such as land use change, sealing, urbanization, etc., habitats are subject to degradation and alteration, ecosystem fragmentation, and reduced ecological resilience. The InVEST model outputs a dimensionless index of quality ranging from 0 to 1; this index expresses values that are not absolute values of quality but rather relative to the environmental conditions of the study area; the value associated with each unit is derived from the relationship between each unit and neighboring units [58].

2.3.3. Agricultural Production (AP)

AP is part of the provisioning services, an important service related to the many areas used for productive purposes in agriculture. This service is influenced by climatic-stational factors, such as latitude, climate, exposure, slope, altitude, etc., and the type of use, whether intensive or extensive. Soil consumption, in the context of agricultural production, leads to loss of service in the present and the future since the soil is a nonrenewable resource [61]. For the assessment of this ES, the average agricultural values were used, divided, and spatialized for each rural region [58]. The study area is characterized by four of the seven rural regions of Molise (specifically 1, 2, 4, and 6) [62].

2.3.4. Pollination (Pol)

Pol is a very important regulating service; it is provided by pollinating animal organisms, such as bees and bumblebees, and by agents, such as wind and water. This service is guaranteed depending on the availability of nesting habitat and floral resources, climate, and the foraging distance of pollinators, that is, the distance that must be traveled to reach nectar and pollen sources. The InVEST model outputs a dimensionless Pol index ranging from 0 to 1, depending on the suitability of a given portion of land to host pollinators [63]. For further details on the InVEST model and the mapping used, see ISPRA [58].

2.4. Land Capability (LCap)

LCap, also referred to as "natural use", is an indispensable element in land use planning and development policies; it is based on many soil parameters, such as clinometry, erosion, rockiness, flooding frequency, soil depth, soil composition (clay, sand, silt) and hydromorphy. Indeed, land use that deviates greatly from its natural use causes severe impacts on the environment, including soil erosion and reduced fertility [64]. The land capability classification was developed by the U.S. Department of Soil Conservation Service; it is useful for assessing the distribution of constraints, including slope, erosion risk, climatic conditions, and soil depth, that create restrictions in agriculture. Eight classes have been defined; the first four, with different propensities, are found to be appropriate for agricultural activity, while the latter have more restrictions (Figure 4). For further information, see Klingebiel A. & Montgomery [65].

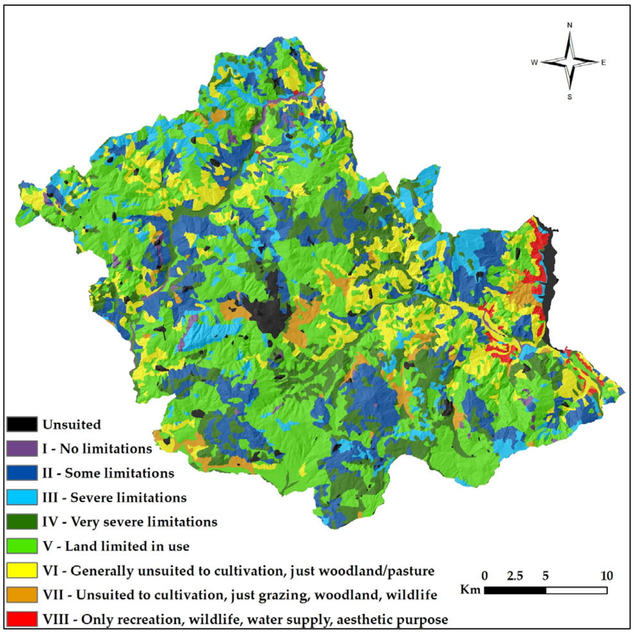


Figure 4. Land capability in the study area.

2.5. Normalization of Criteria

Since the information used was very heterogeneous in terms of data types and units of measurement, it was necessary to harmonize it through normalization to make it comparable and usable by the model.

For the CSS, HbQ, Pol, and AP services, normalization was performed on the minimum and maximum values, i.e., by setting the minimum value of the service in the study area to 0 and the maximum to 1 and scaling the intermediate values linearly again.

As for the normalization of LCap, however, 0 corresponds to built-up areas, which have no propensity for agricultural use, while one corresponds to areas with little or no restrictions and, therefore, with a better propensity for agricultural use.

2.6. Multi-Criteria Analysis for the Assessment of Ecosystem Services and Identification of Valuable and Degraded Areas

The approach used to identify areas for NbS is based on multi-criteria analysis (MCA). MCA represents an umbrella concept that encompasses more than a hundred methods that evaluate an object by considering different dimensions of interest and the interactions between multiple, often conflicting objectives and different decision criteria and metrics. The performance of an option against the various objectives and criteria, which can be assigned different weights, in this case from 0 to 1, are identified by scores. Higher scores are associated with higher performances [66].

The Analytic Hierarchy Process (AHP) method, developed by Thomas L. Saaty between 1971 and 1975 and later improved and integrated within spatially explicit models and tools (e.g., GIS), was chosen. This method organizes information by having different criteria interacting in different ways so that they are able to reflect their relative importance to the objective at hand [67]. The criteria used for the analysis model were the four ESs and the LCap.

To give weight to each of the five criteria, an expert-based approach was followed by administering a questionnaire to 19 experts in academia from the following disciplinary fields: Forestry, Environmental Sciences, Biological Sciences, Economics, and Natural Sciences. This questionnaire was structured to compare all criteria with each other in pairs, in a pairwise comparison, assigning a relative weight based on five options.

- Equally important (1);
- Moderately more important (3);

- Strongly more important (5);
- Clearly more important (7);
- Extremely more important (9).

Sixteen of the 19 experts answered the questionnaire; each questionnaire was subsequently analyzed using the Weight Tool of the IDRISI Selva software (Free ver. 17.0) to determine the relative weight assigned by each expert to each criterion considered.

The software output provides the relative weight of the criteria associated with each questionnaire and the Consistency Ratio (CR). The CR is a measure of the consistency of the judgment matrix, and it shows the probability that the values in the pair comparison matrix are randomly generated [68]. Thomas L. Saaty defines CR as

$$CR = \frac{CI}{Mean\ Random\ CI}$$

The CR is defined as the ratio of the Consistency Index (CI) to the average of the CIs obtained from a large sample of randomly generated matrices.

In turn, CI is defined as

$$CI = \frac{\lambda max - n}{n-1}$$

where λmax is the largest principal eigenvalue of a positive pairwise comparison matrix. The index, in each case, is only based on pairwise comparisons that have already been made previously.

According to Saaty, the CR is acceptable if its value is less than 10% (between 0 and 0.10); however, a value of up to 20% (<0.20) is also considered tolerable [69]. Of the 16 CR values, six were out of the acceptable/tolerable range because they had a value higher than 0.20; therefore, they were not examined, as they were inconsistent according to the methodology adopted. The average value of all the CRs considered (Table 1) was 0.103, which is considered acceptable.

Table 1. Relative weights of considered criteria.

	HbQ	**Pol**	**LCap**	**CSS**	**AP**	**CR**
Q1	0.1687	0.1687	0.4195	0.0743	0.1687	0.03
Q3	0.5557	0.1193	0.0572	0.2337	0.034	0.10
Q4	0.2896	0.1367	0.2552	0.2724	0.0461	0.08
Q5	0.3349	0.1195	0.2945	0.1243	0.1268	0.2
Q7	0.3686	0.2339	0.1335	0.0546	0.2093	0.07
Q8	0.327	0.3643	0.1004	0.1376	0.0707	0.08
Q9	0.5131	0.259	0.0514	0.1481	0.0285	0.08
Q12	0.3257	0.3799	0.1101	0.1451	0.0393	0.08
Q13	0.4533	0.1148	0.1353	0.0821	0.2145	0.16
Q16	0.3188	0.2832	0.0699	0.2969	0.0311	0.15

The relative values of the individual criteria defined by the questionnaires are shown in Table 1.

The final weights to be given to the five criteria are shown in Table 2 and are equal to the average of the relative weights given in Table 1. This sum must always be equal to 1.

Table 2. Weights assigned to layers using expert based approach and respective standard deviation.

Criteria	**Weight**	**Standard Dev.**
HbQ	0.36554	0.11
Pol	0.21793	0.10
LCap	0.1627	0.12
CSS	0.15691	0.08
AP	0.0969	0.08

For completeness, the standard deviation was also calculated for each criterion considered.

2.6.1. Weighted Sum of the Considered Criteria

Once all criteria were normalized, the weighted sum was performed using the weights obtained previously. The final index, the Total Ecosystem Services Value (TESV) [70], was then equal to

$$TESV = \sum HbQ_n * w + AP_n * w + Pol_n * w + SSC_n * w + LCap_n * w$$

where subscript n denotes the normalized (0 to 1) scale value of the individual ES while w denotes its relative weight obtained by the expert-based approach. The TESV values range from a minimum of 0 to a maximum of 1.

2.6.2. Clustering of TESV Index: K-Means for Grids

To clearly identify valuable and degraded areas, the TESV index was clustered using the K-means clustering algorithm "Hill-Climbing" in the SAGA GIS environment.

According to the eight land capability classes, eight clusters were generated, with a distribution of increasing values from cluster 1 to cluster 8; cluster 1, i.e., the one characterized by lower ES provision and lower agricultural land use predisposition, was considered, from which the areas of "Cropland" were extracted to identify the areas to be targeted for NbS interventions.

2.7. Analysis of Changes in Terms of Landscape Fragmentation and Ecological Connectivity

2.7.1. Current Forest and Future Scenarios

Once the arable land to be targeted for NbS interventions was identified, starting from the current forest area map (current scenario), a hypothetical future scenario (potential scenario) was created, in which the current forest area is added to the newly created areas related to the "Cropland" areas of Cluster 1. To assess the possible changes in terms of ecological connectivity and functionality in the two scenarios, maps of both the current and potential forests were produced. This analysis was conducted using Landscape Ecology techniques, the discipline that studies and implements the relationship between spatial patterns and ecological processes at multiple scales and organizational levels [71].

2.7.2. Landscape Metrics

The ecological connectivity and functionality analysis of the two scenarios was conducted using a set of class and landscape metrics referring to the land use class "Forest" by means of the Fragstats 4.2 software [72].

The selected metrics are shown in Table 3.

Table 3. Selected class and landscape metrics.

Class Metrics	Landscape Metrics
Patch Density (PD) Landscape Similarity Index (LSI) Total Core Area (TCA) Euclidean Nearest Neighbor Distance (ENN_MN) Euclidean Nearest Neighbor Distance (Area–Weighted Mean) (ENN_AM) Percentage of like adjacencies (PLADJ) Normalized Landscape shape index (NLSI)	Average Area (AREA_MN) Mean Radius of Gyration (GYRATE_MN) Number of Disjunct Core Area (NDCA) Disjunct Core Area Density (DCAD) Aggregation Index (AI)

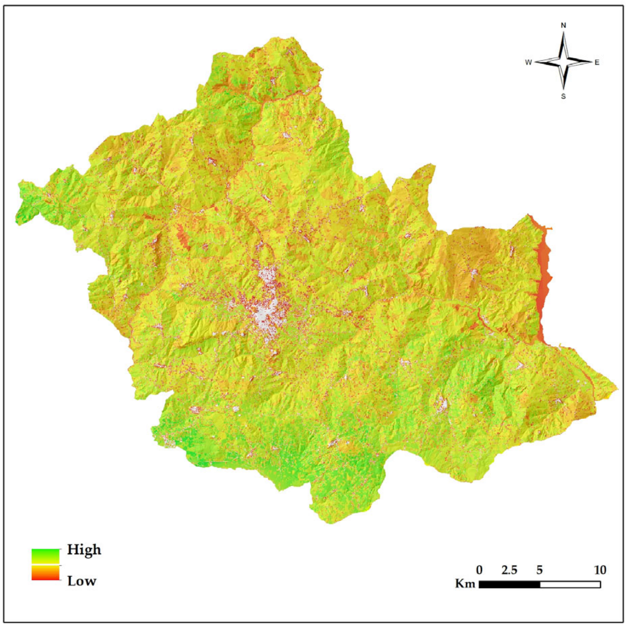
3. Results

3.1. Processing of the Final Cartography (TESV Index)

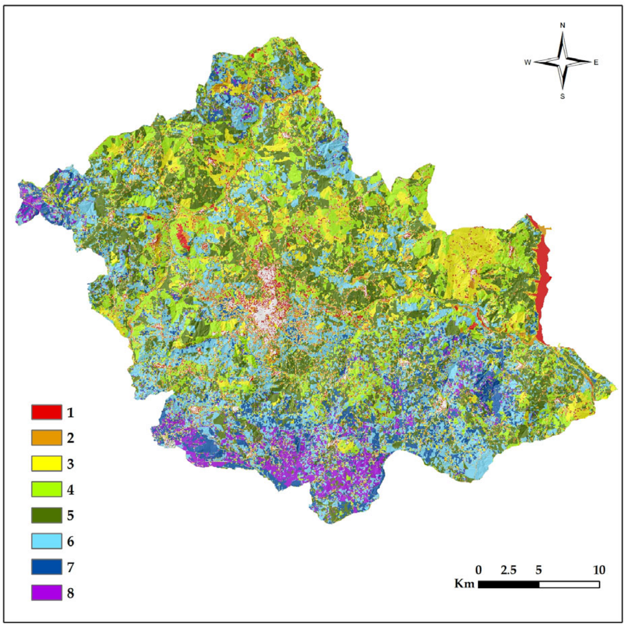
The analysis of data (Table 4) showed that the spatial distribution of the TESV index in the study area ranges from 0.046 to 0.823, with an average value of around 0.451 and a coefficient of a variation of 19.06%. Almost 45% of the area is classified as intermediate clusters 4 and 5; the highest values are concentrated in the south, particularly the southwest and northwest, while the lowest values are in the east. The spatial distribution of the TESV index is shown in Figure 5a.

Table 4. Range of values for each identified cluster (**A**), and area both in hectares and percentage by cluster (**B**).

A			B		
Cluster	**Minimum Value**	**Maximum Value**	**Cluster**	**Area (Ha)**	**Area %**
1	0.046	0.268	1	3470.3	3.37
2	0.268	0.348	2	8139.9	7.91
3	0.348	0.403	3	12,930.2	12.57
4	0.403	0.446	4	18,292.2	17.78
5	0.446	0.484	5	25,334.4	24.63
6	0.484	0.529	6	20,966.9	20.38
7	0.529	0.597	7	9011.6	8.76
8	0.597	0.823	8	4718.2	4.59



(**a**)



(**b**)

Figure 5. (**a**) Spatialized TESV index; (**b**) Clusters identified with K-means for grids from SAGA GIS.

After the spatialization of the TESV index, it was clustered into eight clusters according to the index values. Figure 5b shows the spatial distribution of the TESV index ranked in the eight clusters mentioned above.

Following the identification of the eight clusters, it was possible to extract only the cluster area of "Cropland" (Table 5) in order to analyze the distribution of the clusters within this land use class. As for the total area, the highest values are mostly concentrated in the southern part of the study area, while the lowest ones are in the eastern part (Figure 6).

Table 5. Percentage of individual clusters compared to the area of the class "Croplands".

Cluster	Area (Ha)	Area %
1	740.09	1.42
2	3450.09	6.60
3	5991.32	11.46
4	10,637.76	20.35
5	16,843.73	32.22
6	12,116.36	23.18
7	2012.49	3.85
8	482.88	0.92

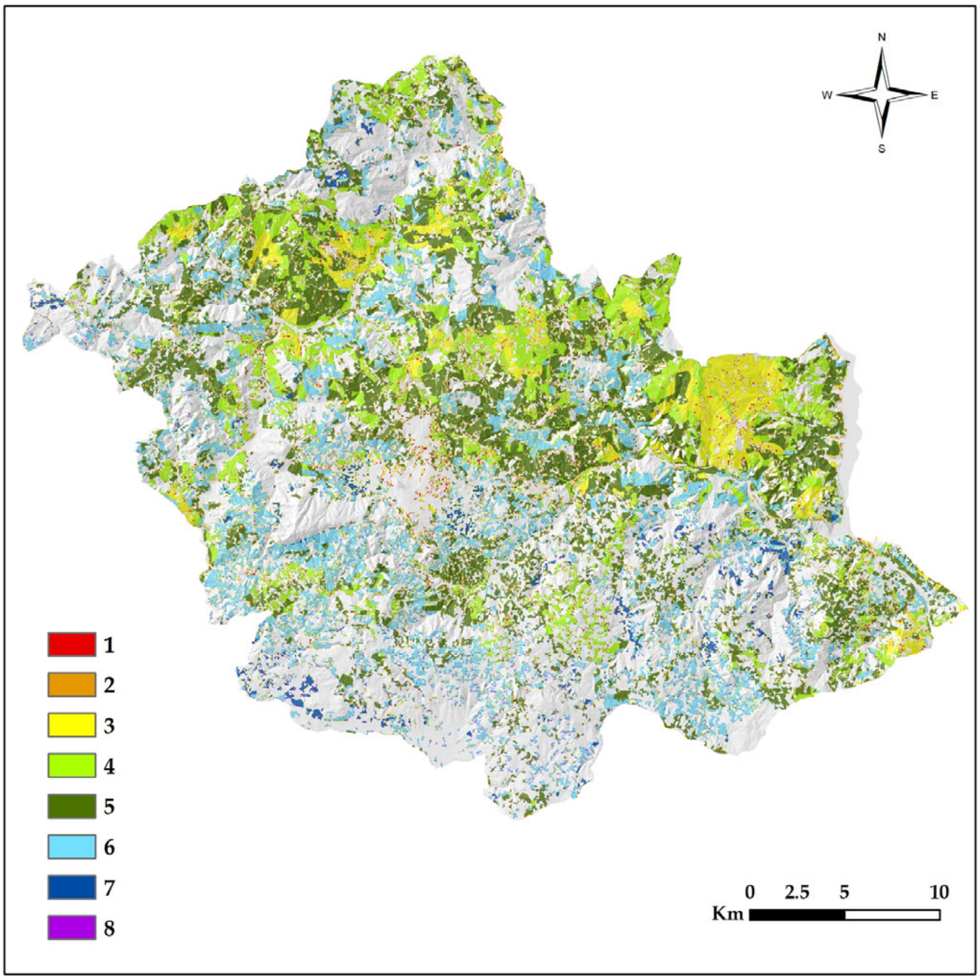
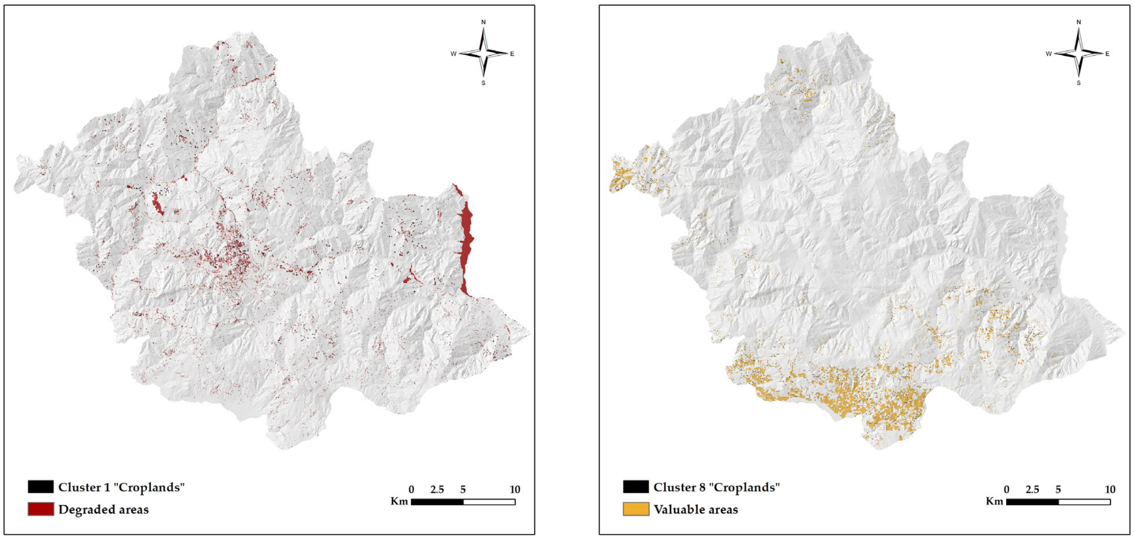


Figure 6. Distribution of clusters according to "Croplands".

More than 70% of "Croplands" are represented by intermediate clusters (4, 5, and 6), with a range from 0.403 to 0.529.

3.2. Cartographies of Valuable Areas and Degraded Areas

Cluster 8 is identified as the one representing the most valuable areas based on the highest TESV values, with a range between 0.597 and 0.823 (Figure 7b). These areas cover a total of 4718.2 hectares, accounting for just 4.59% of the study area, and are predominantly located in the southwest. Only 9.5% of total valuable areas (448.23 Ha) fall within Natura2000 sites. In addition, just 10.23% of cluster 8 areas (482.88 Ha) are classified under the "Croplands" land use class.



(**a**) (**b**)

Figure 7. (**a**) Cluster 1 detailing those falling under Croplands; (**b**) Cluster 8 detailing those falling under Croplands.

On the other hand, the areas to be designated for NbS have the most degraded agricultural land use, particularly those in Cluster 1 of the "Croplands" class (Figure 7a), which represent 1.42% of this land use class (740.09 hectares). This portion represents 0.72% of the entire study area, and 22.62% (750.21 hectares) of "Croplands" in cluster 1 fall within the Natura2000 protected areas.

3.3. Future Scenarios: Potential Forest

By transforming the "Croplands" land use of Cluster 1 into forests and adding them to the "Forest" class, it was possible to obtain the map of potential forests, which would occur if these agricultural areas were subject to NbS interventions (Figure 8). The current "Forest" covers an area of 25,976.06 hectares, while the potential forest would have an area of 26,718.36 hectares, with an increase of 2.86% over the present situation (+742.30 hectares).

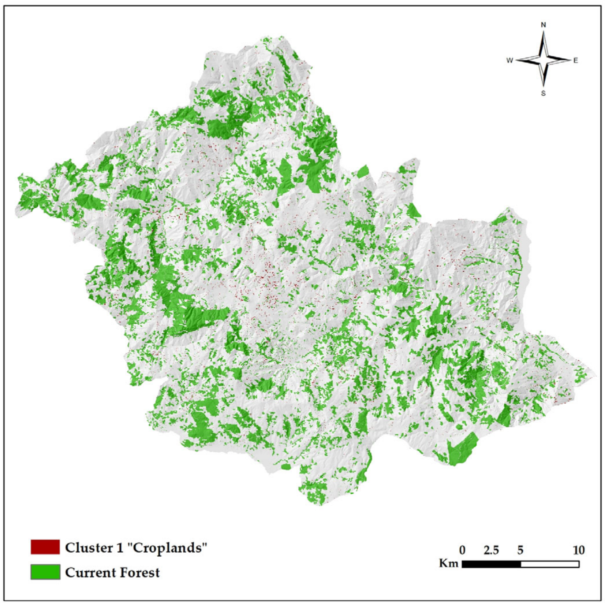


Figure 8. Potential Forest. In red are the newly added areas (cluster 1 Croplands).

In the current scenario, 18.20% of the "Forest" (4727.38 hectares) are Natura2000 areas; in the potential scenario, however, these increase to 49.38 hectares.

3.4. Analysis of Metrics

To investigate how connectivity and ecological functionality vary between the two scenarios, current forest, and potential forest, class, and landscape metrics were calculated using Fragstats software (ver. 4.2.1).

Table 6 shows the results obtained as outputs for the class metrics.

Table 6. Class metrics comparison between current and potential forest.

Metrics	Current Forest	Potential Forest
PD	4.8177	7.6036
LSI	96.6678	109.9036
TCA	26,269.55	27,011.85
ENN_MN	50.9801	44.3603
ENN_AM	28.2223	26.0803
PLADJ	94.0350	93.3110
NLSI	0.0591	0.0663

Analyzing the difference between current forest and potential forest (Table 6), it is evident that PD increases, in line with the addition of new patches from agricultural land. The same trend can be seen with the LSI, as the increase in forest class patches automatically makes them less rare. The increase in TCA is interesting, and it denotes an increase in patch contiguity and a reduction in fragmentation and edge effect; ENN_MN decreases, which means that the distance between patches decreases as their number increases, even in areas initially lacking "Forest" land use class, which was confirmed by ENN_AM. The reduction in the PLADJ shows a reduction in patch density not due to a reduction in number but to a greater dispersion of patches, resulting in greater fragmentation of the forest due to the addition of new patches. In addition, the increase in NLSI is indicative of greater class complexity and irregularity.

Table 7 shows the results obtained as outputs for the landscape metrics.

Table 7. Landscape metrics comparison between current and potential forest.

Metrics	Current Forest	Potential Forest
AREA_MN	2.7146	1.7686
GYRATE_MN	28.9786	22.7855
NDCA	9677	15,273
DCAD	4.8177	7.6036
AI	94.0930	93.3679

The "landscape" metrics considered (Table 7) are in line with the considerations made above for the "class" metrics. The AREA_MN increases due to the addition of new smaller forest patches. Also, the decrease in GYRATE_MN represents a reduction in the dispersion of patches around their center of mass, hence greater connectivity. The increase in NDCA denotes the increase in core areas, i.e., the increase in portions of habitat that are far from the edge and not affected by the edge effect, supported by the increase in DCAD. The reduction in AI, moreover, tends to emphasize a lower aggregation of particles, mainly due to the increase of forest patches even in areas that were initially devoid and, consequently, a greater dispersion of patches.

4. Discussion

4.1. Analysis Model

While developing the analysis model, it soon became clear that there was limited literature on the subject, not for what concerns mapping ESs, which are widely covered and studied, but more for identifying areas characterized by poor ES delivery to be improved and for the extraction of degraded areas. Fahrudin et al. [73] stand out among the studies; its aim was to identify priority areas for afforestation and reforestation using an approach that integrates MCA and machine learning techniques based on indicators of ES, fire susceptibility, and environmental pressure. It is a multi-indicator approach, as this study, but uses different ES—carbon sequestration for climate change mitigation, biodiversity, and clean water. The present study differs both in the choice of parameters and areas, which in this case was achieved through the historical analysis of areas that have experienced deforestation due to various factors; however, the Fahrudin et al. survey was conducted on areas that were, in any case, characterized by disturbance, while the present study investigates low ES provision and inappropriate land use, according to the Land Capability map.

Another study examined was that of Coelho et al. [68], who developed a similar methodology, using AHP to develop an EVI (Environmental Vulnerability Index) based on four criteria—land use adequacy (like LCap), a burned area, erosion susceptibility, and quantitative water balance. The weights of the criteria derive from an expert-based approach. The final index was then spatialized, and five areas of equal size were divided within the study area. However, in addition to environmental factors, our study also considers economic factors, which were ignored by Coelho et al.

Among the few examples of models found, it was then decided to base this study on the one conducted by the working group of the University of Molise, in collaboration with ISPRA, on the Metropolitan City of Rome (MCR) [74], whose aim was the identification of agricultural areas of greater and lesser value. The MCR model used 4 ESs (CSS, QHb, Imp, and AP), then normalized and summed them together. In this study, as well as adding the information related to LCap, which influences the capacity of ESs to be delivered, it was decided to include an expert-based approach to get the weight of individual criteria to finally define the TESV index.

However, there are still some aspects that could be improved. The choice to submit the questionnaire only to experts was dictated by the need to have competent people in the investigation, but in a subsequent phase, stakeholders could also be involved, such as policymakers, local communities, as well as environmental NGOs, to obtain a broader opinion, not in particular in the definition of this index, but first for the choice of priority areas for intervention and what other needs the NbS to be created should satisfy, thus giving indications on the type and characteristics of the NbS to be created.

Another possible aspect to consider is related to the nature of ownership, public or private, of the identified areas. This information is fundamental for defining the management and restoration policies of the territory. In Italy, this information is accessible thanks to the national land cadastre, which is totally computerized and georeferenced, allowing it to be interrogated in order to know the ownership of each parcel. The system also allows a WMS (Web Map Service) to be used with all GIS software. Starting from the cartography of degraded agricultural areas to improve through NbS would make it possible to overlap the two layers and identify the parcels of interest and, thus, also the ownership in an exact manner. Nevertheless, areas around infrastructures are mostly publicly owned but managed by different entities depending on the infrastructure typology, so it would be possible to access public funding for NbS interventions in these areas. It would be useful to check the feasibility of projects aimed at improving the delivery of ES by minimizing the implications for private properties or by providing for public/private agreements aimed at improving the return for both [75].

The proposed model could be easily replicable for most of the Italian Regions; the availability of national data regarding the 4 ESs considered would allow for a large-scale analysis. In addition to this, it has been verified that 14 of the Italian regions have publicly accessible land capability maps available online, while the remaining seven may also have such maps, though they are not directly accessible online. For example, the Molise land capability map was not directly accessible, but it was provided by the Molise Regional Geological Services.

4.2. Distribution of Clusters

Looking at the distribution of the TESV index throughout the study area, it is possible to state that the most prevalent values are the average ones. In fact, the most represented clusters are Clusters 4, 5, and 6 (values between 0.403 and 0.529), with an average TESV of 0.451. In fact, the valuable areas (Cluster 8), together with those of lesser value (Custer 1), occupy less than 8% of the entire territory; if only agricultural areas are analyzed, out of the total of about 52,274 hectares, the percentage of the territory occupied by Clusters 1 and 8 is 2.34%. Parallel to the need to act on the rehabilitation of low TESV areas, the low presence of high value agricultural areas triggers considerations as to whether NbS should be used to increase them.

To analyze the location of degraded areas, a 60 m buffer was made around the urban land use of the ISPRA land use map (code 11000), in accordance with SNPA [16], to identify areas subject to influence by anthropogenic disturbances and to assess the percentage of degraded areas that fall within this buffer. Of the 3470.3 total hectares in Cluster 1, 70.61% fall within the buffer, while of the 740.09 hectares of arable land in the same Cluster, 86.18% (2990.7 Ha) fall within the buffer (Figure 9).

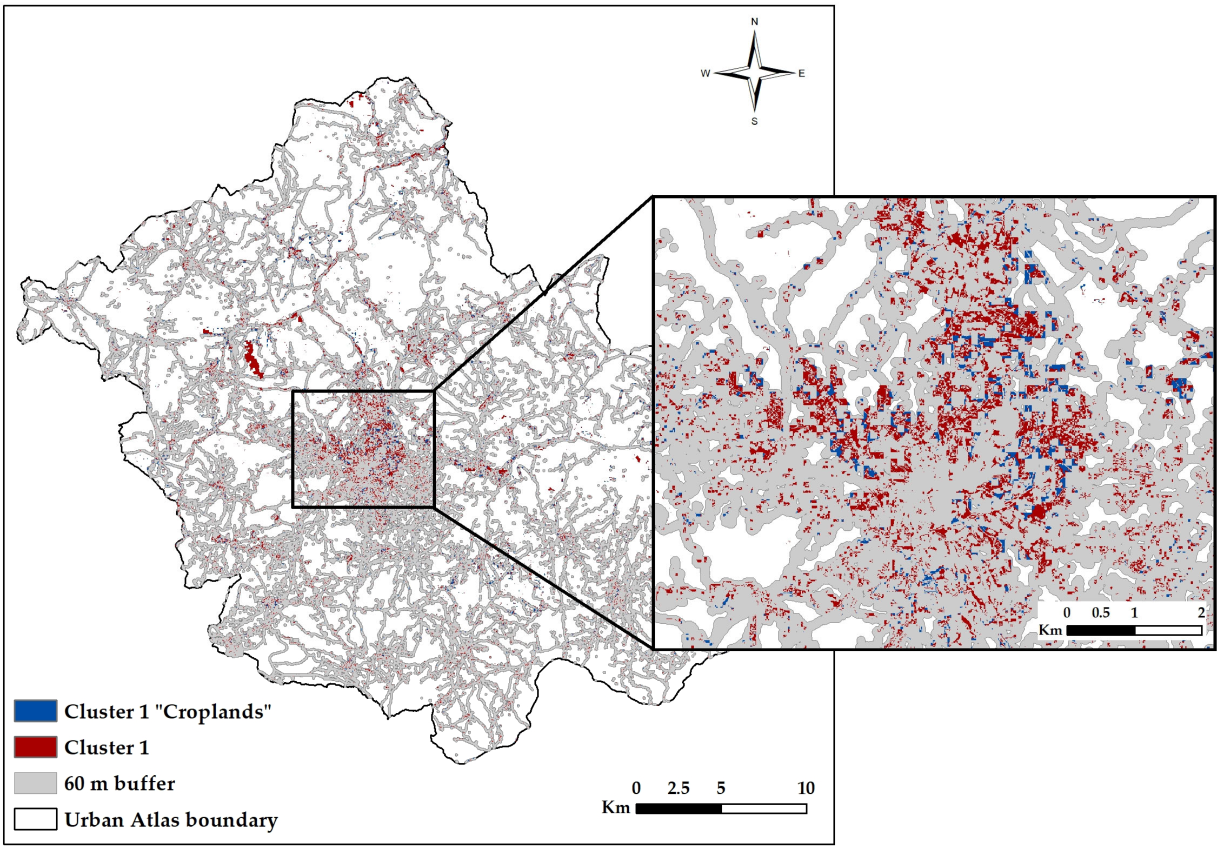


Figure 9. Degraded areas and 60 m urban buffer.

The output is in line with the values of the HbQ service, which is also the ES given the highest relative weight by most experts. As stated by Sallustio et al. [61], the quality and degradation of habitats are highly dependent on the distribution and intensity of anthropogenic impacts, and consequently also on the proximity of the disturbance, as well as on the suitability of a given portion of land to host species and habitats. The impact on HbQ increases as the distance from the disturbance decreases. The fact that the areas of greatest degradation fall largely within the buffer is a significant finding. Targeted interventions could, in fact, encourage an increase in the quality of contiguous agricultural areas (e.g., through agroforestry facilities, which would increase the supply of ESs within the areas under consideration). In addition, they also prevent further land consumption due to unprofitable agricultural areas, which could be abandoned or built upon, further implementing land consumption and the deterioration of the structural and functional characteristics of the landscape matrix as a whole.

4.3. Connectivity

Linear soil sealing (e.g., roads and highways) plays a real barrier effect on migratory routes and animal movements in general, thus resulting in a serious threat to biodiversity [76].

The Landscape Ecology analysis was useful in highlighting an increase in the dispersion of the forest land use class, due, however, not to the fragmentation of existing patches, as they have not been reduced or converted to other land uses, but to the increase in the number of small forest patches ("Croplands", Cluster 1) within areas initially devoid of this land use. A further problem is that, unfortunately, in some agricultural landscapes, these small forest patches are decreasing, including in Molise [77]. Another relevant aspect is the increase in core areas as well as increased patch complexity and irregularity, highlighted, respectively, by the TCA and NLSI class metrics together with the DCAD landscape metric. Despite forest fragmentation and disaggregation increase, the ENN_MN and ENN_AM class metrics emphasize greater connectivity. In fact, the increase in the number of smaller patches decreases their spacing, which renders better connectivity at the landscape level, which is highlighted by the GYRATE_MN landscape metric. The newly added patches can be configured as true steppingstones, fostering the connectivity and movement of species, and represent the starting point for the creation of continuous linear elements and green corridors, mainly close to the road network, also in line with the National Urban Green Strategy [2], whose purpose is to implement the Ecological Network at the national level, fostering connectivity between different areas (human, agricultural and natural).

4.4. Which NbS?

The choice of NbS to use to improve the delivery of ES is mainly dictated by the characteristics and location of degraded areas. For the rehabilitation and improvement of areas close to roads, one might consider investing mainly in green corridors or peri-urban forests. Much depends, however, on the type of ES to be enhanced, the available budget for its implementation and maintenance [78,79], or other policy-planning requirements.

It is crucial to plant trees, either isolated or in groups, as they are considered the best natural element to increase the spectrum of ES provisions [25], and they have the potential to reach high-standard restoration goals [80]; tree planting, in fact, would play a positive role in increasing connectivity and ecological restoration. Also not to be underestimated is the aesthetic perception of the landscape and how it might improve because of tree planting. A survey conducted by Di Cristofaro et al. [81] emphasized the aesthetic preference towards landscapes rich in out-of-forest trees in anthropized contexts, confirming the theory that the most common landscape preference is for increased exposure to nature, even more so in highly built-up areas.

Ultimately, the present experiment has highlighted the validity of the TESV index for identifying degraded areas and areas of value as a tool to support wide area spatial planning, as a connecting element between guidelines and policies, and the detailed planning level at a municipal scale, in line with Munafò et al. [74]. Since most works focus on the city and site scales [82], it could be an important approach to assess areas for NbS implementation at different scales.

The choice of the most suitable NbS for each case can be made with specific tools, such as those provided by the NBFC Project—Nature-based Solutions and Ecological Restoration (Spoke 4) [51]. The objectives of this project also included the implementation of a catalog and tool to support the design of NbS for the restoration and maximization of ecosystem services based on scientific evidence obtained in the field and laboratory through innovative approaches. Planned actions include the cataloging of NbS case studies in degraded areas and the assessment of their impact, identification and testing of the most suitable tree and herbaceous species for NbS implementation.

5. Conclusions

The MCA applied for the identification of agricultural areas for NbS interventions seemed suitable for achieving our outlined objective; this method can be improved, but it is already possible to extend it to most of the national regions. The provision of ES in urban and peri-urban areas is an increasingly topical and relevant issue, considering that built-up land is expanding, urban permeable unforested lands are decreasing [83], and this brings with it a number of future challenges; land consumption is increasingly impactful and, in order to improve the lives of citizens, as well as the quality of productive agricultural land, it is important to incentivize such provisions. NbS could ultimately be the central aspect of achieving this goal in a variety of ways. The first way could be Agroforestry restoration [84], encouraged and financed by the European Union policy from the Common Agricultural Policy (CAP) [85], which provides numerous provisioning, regulating, cultural, and supporting ecosystem services and environmental benefits while promoting ecointensification based on more efficient use of the resources [86].

Moreover, this methodology could be excellent support at various levels of planning, first and foremost at the municipal level, where there is often a shortage of funds to conduct ground surveys, direct management policies, and implement the structure of ecological networks at the national level. In addition, reducing fragmentation and fostering greater connectivity between urban, agricultural, and natural areas could improve the delivery of a multitude of ES, including cultural ones.

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References

1. Salbitano, F.; Borelli, S.; Conigliaro, M.; Chen, Y. *Guidelines on Urban and Peri-Urban Forestry*; Food and Agriculture Organization of the United Nations (FAO): Rome, Italy, 2016; ISBN 9789251094426.
2. Atelli, M.; Blasi, C.; Boldini, G.; Cignini, B.; Cosenza, G.; Emiliani, V.; Marchetti, M.; Maria Maggiore, A.; Pericoli, T.; Ricciardi, A.; et al. *Strategia Nazionale Del Verde Urbano (Comitato Del Verde Pubblico)*; Ministero dell'Ambiente e della Sicurezza Energetica: Rome, Italy, 2018.
3. Baumeister, C.F.; Gerstenberg, T.; Plieninger, T.; Schraml, U. Exploring Cultural Ecosystem Service Hotspots: Linking Multiple Urban Forest Features with Public Participation Mapping Data. *Urban For. Urban Green.* **2020**, *48*, 126561. [CrossRef]
4. Churkina, G. Modeling the Carbon Cycle of Urban Systems. *Ecol Modell* **2008**, *216*, 107–113. [CrossRef]
5. World Health Organization—Regional Office for Europe. *Urban Green Spaces: A Brief for Action*; WHO: Geneva, Switzerland, 2017.

6. Fusaro, L.; Salvatori, E.; Mereu, S.; Marando, F.; Scassellati, E.; Abbate, G.; Manes, F. Urban and Peri-Urban Forests in the Metropolitan Area of Rome: Ecophysiological Response of *Quercus ilex* L. in Two Green Infrastructures in an Ecosystem Services Perspective. *Urban For. Urban Green.* **2015**, *14*, 1147–1156. [CrossRef]
7. Gill, S.E.; Handley, J.F.; Ennos, A.R.; Pauleit, S. Adapting Cities for Climate Change: The Role of the Green Infrastructure. *Built Environ.* **2007**, *33*, 115–133. [CrossRef]
8. Pulighe, G.; Fava, F.; Lupia, F. Insights and Opportunities from Mapping Ecosystem Services of Urban Green Spaces and Potentials in Planning. *Ecosyst. Serv.* **2016**, *22*, 1–10. [CrossRef]
9. Poe, M.R.; LeCompte, J.; McLain, R.; Hurley, P. Urban Foraging and the Relational Ecologies of Belonging. *Soc. Cult. Geogr.* **2014**, *15*, 901–919. [CrossRef]
10. Lee, A.C.K.; Maheswaran, R. The Health Benefits of Urban Green Spaces: A Review of the Evidence. *J. Public. Health* **2011**, *33*, 212–222. [CrossRef]
11. Campagnaro, T.; Vecchiato, D.; Arnberger, A.; Celegato, R.; Da Re, R.; Rizzetto, R.; Semenzato, P.; Sitzia, T.; Tempesta, T.; Cattaneo, D. General, Stress Relief and Perceived Safety Preferences for Green Spaces in the Historic City of Padua (Italy). *Urban For. Urban Green.* **2020**, *52*, 126695. [CrossRef]
12. Sacker, A.; Cable, N. Do Adolescent Leisure-Time Physical Activities Foster Health and Well-Being in Adulthood? Evidence from Two British Birth Cohorts. *Eur. J. Public Health* **2006**, *16*, 331–335. [CrossRef]
13. Takano, T.; Nakamura, K.; Watanabe, M. Urban Residential Environments and Senior Citizens' Longevity in Megacity Areas: The Importance of Walkable Green Spaces. *J. Epidemiol. Community Health* **2002**, *56*, 913–918. [CrossRef]
14. Cueva, J.; Yakouchenkova, I.A.; Fröhlich, K.; Dermann, A.F.; Dermann, F.; Köhler, M.; Grossmann, J.; Meier, W.; Bauhus, J.; Schröder, D.; et al. Synergies and Trade-Offs in Ecosystem Services from Urban and Peri-urban Forests and Their Implication to Sustainable City Design and Planning. *Sustain. Cities Soc.* **2022**, *82*, 103903. [CrossRef]
15. Munafò, M. (Ed.) *Consumo Di Suolo, Dinamiche Territoriali e Servizi Ecosistemici. Edizione 2021*; Report SNPA 22/21; SNPA: Rome, Italy, 2021; ISBN 978-88-448-1059-7.
16. Munafò, M. (Ed.) *Consumo Di Suolo, Dinamiche Territoriali e Servizi Ecosistemici. Edizione 2022*; Report SNPA 32/22; SNPA: Rome, Italy, 2022; ISBN 978-88-448-1124-2.
17. Marull, J.; Pino, J.; Tello, E.; Cordobilla, M.J. Social Metabolism, Landscape Change and Land-Use Planning in the Barcelona Metropolitan Region. *Land Use Policy* **2010**, *27*, 497–510. [CrossRef]
18. Millennium Ecosystem Assessment (MEA). *Ecosystems and Human Well-Being*; A Report of the Millennium Ecosystem Assessment; Island Press: Washington, DC, USA, 2005.
19. Youssef, A.; Sewilam, H.; Khadr, Z. Impact of Urban Sprawl on Agriculture Lands in Greater Cairo. *J. Urban Plan. Dev.* **2020**, *146*, 05020027. [CrossRef]
20. Parece, T.E.; Campbell, J.B. Geospatial Evaluation for Urban Agriculture Land Inventory. *Int. J. Appl. Geospat. Res.* **2017**, *8*, 43–63. [CrossRef]
21. European Union. *Building a Green Infrastructure for Europe*; Publ. Office of the European Union: Luxembourg, 2013; ISBN 978-92-793-3428-3.
22. Potschin, M.; Haines-Young, R.H. *Nature-Based Solutions ESMERALDA-Enhancing Ecosystem Services Mapping for Policy and Decision Making View Project*; European Commission: Luxembourg, 2015.
23. Eisenberg, B. *Nature Based Solutions-Technical Handbook INTERESS-I: Integrierte Strategien Zur Stärkung Urbaner Blau-Grüner Infrastrukturen View Project Space Syntax and Open Space Planning View Project*; UnaLab: Eindhoven, The Netherlands, 2019. [CrossRef]
24. Price, R. *Nature-Based Solutions (NbS)-What Are They and What Are the Barriers and Enablers to Their Use?* Institute of Development Studies: Brighton, UK, 2021.
25. Di Pirro, E.; Sallustio, L.; Castellar, J.A.C.; Sgrigna, G.; Marchetti, M.; Lasserre, B. Facing Multiple Environmental Challenges through Maximizing the Co-Benefits of Nature-Based Solutions at a National Scale in Italy. *Forests* **2022**, *13*, 548. [CrossRef]
26. Science for Environment Policy. *FUTURE BRIEF: The Solution is in Nature–Issue 24*; Brief Produced for the European Commission DG Environment; Science Communication Unit, UWE Bristol: Bristol, UK, 2021.
27. Sowińska-Świerkosz, B.; García, J. What Are Nature-Based Solutions (NBS)? Setting Core Ideas for Concept Clarification. *Nat.-Based Solut.* **2022**, *2*, 100009. [CrossRef]
28. Nesshöver, C.; Assmuth, T.; Irvine, K.N.; Rusch, G.M.; Waylen, K.A.; Delbaere, B.; Haase, D.; Jones-Walters, L.; Keune, H.; Kovacs, E.; et al. The Science, Policy and Practice of Nature-Based Solutions: An Interdisciplinary Perspective. *Sci. Total Environ.* **2017**, *579*, 1215–1227. [CrossRef]
29. Seddon, N.; Chausson, A.; Berry, P.; Girardin, C.A.J.; Smith, A.; Turner, B. Understanding the Value and Limits of Nature-Based Solutions to Climate Change and Other Global Challenges. *Philos. Trans. R. Soc. B Biol. Sci.* **2020**, *375*, 20190120. [CrossRef]
30. Frantzeskaki, N.; McPhearson, T.; Collier, M.J.; Kendal, D.; Bulkeley, H.; Dumitru, A.; Walsh, C.; Noble, K.; van Wyk, E.; Ordóñez, C.; et al. Nature-Based Solutions for Urban Climate Change Adaptation: Linking Science, Policy, and Practice Communities for Evidence-Based Decision-Making. *Bioscience* **2019**, *69*, 455–466. [CrossRef]
31. Chausson, A.; Turner, B.; Seddon, D.; Chabaneix, N.; Girardin, C.A.J.; Kapos, V.; Key, I.; Roe, D.; Smith, A.; Woroniecki, S.; et al. Mapping the Effectiveness of Nature-based Solutions for Climate Change Adaptation. *Glob. Chang. Biol.* **2020**, *26*, 6134–6155. [CrossRef]

32. European Commission. 3 Billion Trees Pledge. Available online: https://knowledge4policy.ec.europa.eu/publication/commission-staff-working-document-swd2021651-3-billion-tree-planting-pledge-2030_en (accessed on 15 June 2024).
33. Goffner, D.; Sinare, H.; Gordon, L.J. The Great Green Wall for the Sahara and the Sahel Initiative as an Opportunity to Enhance Resilience in Sahelian Landscapes and Livelihoods. *Reg. Environ. Chang.* **2019**, *19*, 1417–1428. [CrossRef]
34. Seddon, N.; Smith, A.; Smith, P.; Key, I.; Chausson, A.; Girardin, C.; House, J.; Srivastava, S.; Turner, B. Getting the Message Right on Nature-based Solutions to Climate Change. *Glob. Chang. Biol.* **2021**, *27*, 1518–1546. [CrossRef] [PubMed]
35. Kapos, V.; Wicander, S.; Salvaterra, T.; Dawkins, K.; Hicks, C. *The Role of the Natural Environment in Adaptation, Background Paper for the Global Commission on Adaptation*; Global Commission on Adaptation: Rotterdam, The Netherlands; Washington, DC, USA, 2019.
36. Zhu, D.; Zhang, Y.; Kendal, D.; Fraser, L.; Flies, E.J. Nature-Based Solutions in Australia: A Systematic Quantitative Literature Review of Terms, Application and Policy Relevance. *Nat.-Based Solut.* **2023**, *4*, 100092. [CrossRef]
37. Molloy, A.; Collier, M.; Buckley, Y.M. *Identification and as Sessment of Best Practice in Nature-Based Solutions for Climate Action and Ecosystem Restoration in Ireland*; Working Paper No. 26; Climate Change Advisory Council: Dublin, Ireland, 2024.
38. Di Pirro, E.; Mendes, R.; Fidélis, T.; Sallustio, L.; Roebeling, P.; Marchetti, M.; Lasserre, B. The Embeddedness of Nature-Based Solutions in the Recovery and Resilience Plans as Multifunctional Approaches to Foster the Climate Transition: The Cases of Italy and Portugal. *Land* **2022**, *11*, 1254. [CrossRef]
39. Mendonça, R.; Roebeling, P.; Fidélis, T.; Saraiva, M. Policy Instruments to Encourage the Adoption of Nature-Based Solutions in Urban Landscapes. *Resources* **2021**, *10*, 81. [CrossRef]
40. Dorst, H.; van der Jagt, A.; Raven, R.; Runhaar, H. Urban Greening through Nature-Based Solutions—Key Characteristics of an Emerging Concept. *Sustain. Cities Soc.* **2019**, *49*, 101620. [CrossRef]
41. Chazdon, R.L. Beyond Deforestation: Restoring Forests and Ecosystem Services on Degraded Lands. *Science* **2008**, *320*, 1458–1460. [CrossRef]
42. Urgenson, L.S.; Ryan, C.M.; Halpern, C.B.; Bakker, J.D.; Belote, R.T.; Franklin, J.F.; Haugo, R.D.; Nelson, C.R.; Waltz, A.E.M. Visions of Restoration in Fire-Adapted Forest Landscapes: Lessons from the Collaborative Forest Landscape Restoration Program. *Environ. Manag.* **2017**, *59*, 338–353. [CrossRef]
43. Voskamp, I.M.; de Luca, C.; Polo-Ballinas, M.B.; Hulsman, H.; Brolsma, R. Nature-Based Solutions Tools for Planning Urban Climate Adaptation: State of the Art. *Sustainability* **2021**, *13*, 6381. [CrossRef]
44. Standish, R.J.; Hobbs, R.J.; Mayfield, M.M.; Bestelmeyer, B.T.; Suding, K.N.; Battaglia, L.L.; Eviner, V.; Hawkes, C.V.; Temperton, V.M.; Cramer, V.A.; et al. Resilience in Ecology: Abstraction, Distraction, or Where the Action Is? *Biol. Conserv.* **2014**, *177*, 43–51. [CrossRef]
45. Johnson, B.A.; Kumar, P.; Okano, N.; Dasgupta, R.; Shivakoti, B.R. Nature-Based Solutions for Climate Change Adaptation: A Systematic Review of Systematic Reviews. *Nat.-Based Solut.* **2022**, *2*, 100042. [CrossRef]
46. Battisti, L.; Giacco, G.; Moraca, M.; Pettenati, G.; Dansero, E.; Larcher, F. Spatializing Urban Forests as Nature-Based Solutions: A Methodological Proposal. *Cities* **2024**, *144*, 104629. [CrossRef]
47. Yimer, E.A.; De Trift, L.; Dondeyne, S.; Speijer, L.; Huysmans, M.; Cools, J.; Nossent, J.; van Griensven, A. Framework for Mapping Large-Scale Nature-Based Solutions for Drought Mitigation: Regional Application in Flanders. *Water Res.* **2024**, *261*, 122003. [CrossRef] [PubMed]
48. Guerrero, P.; Haase, D.; Albert, C. Locating Spatial Opportunities for Nature-Based Solutions: A River Landscape Application. *Water* **2018**, *10*, 1869. [CrossRef]
49. Balzan, M.V.; Zulian, G.; Maes, J.; Borg, M. Assessing Urban Ecosystem Services to Prioritise Nature-Based Solutions in a High-Density Urban Area. *Nat.-Based Solut.* **2021**, *1*, 100007. [CrossRef]
50. European Commission. Mapping Guide Urban Atlas. 2023. Available online: https://insitu.copernicus.eu/library/reports/summary-report-of-the-methodological-improvement-of-urban-atlas-layer-1-2-00-jan-2024 (accessed on 23 September 2024).
51. NBFC (National Biodiversity Future Center) Project. Funded under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.4. 2021. Available online: https://www.nbfc.it/progetto (accessed on 29 October 2024).
52. Amadei, M.; Bagnaia, R.; Di Bucci, D.; Laureti, L.; Lugeri, F.R.; Nisio, S.; Salvucci, R. Carta Della Natura Alla Scala 1:250.000: Carta Dei Tipi e Delle Unità Fisiografiche Di Paesaggio d'Italia, 2003rd ed. 2000. Available online: https://www.isprambiente.gov.it/it/servizi/sistema-carta-della-natura/cartografia/carta-della-natura-a-scala-nazionale/la-carta-dei-tipi-e-delle-unita-fisiografiche-di-paesaggio-d2019italia (accessed on 1 June 2024).
53. ISPRA. *Carta Di Copertura Del Suolo 2018 Basata Su Dati Copernicus e Su Dati ISPRA*; ISPRA: Rome, Italy, 2018.
54. Munafò, M. (Ed.) *Consumo Di Suolo, Dinamiche Territoriali e Servizi Ecosistemici. Edizione 2023*; Report SNPA 37/23; SNPA: Rome, Italy, 2023; ISBN 978-88-448-1178-5.
55. Munafò, M. (Ed.) *Consumo Di Suolo, Dinamiche Territoriali e Servizi Ecosistemici. Edizione 2018*; Report SNPA 08/19; SNPA: Rome, Italy, 2019; ISBN 978-88-448-0964-5.
56. Stanford University; University of Minnesota; Chinese Academy of Sciences; The Nature Conservancy; World Wildlife Fund; Stockholm Resilience Centre; Royal Swedish Academy of Sciences. Natural Capital Project, InVEST 0.0. 2024. Available online: https://naturalcapitalproject.stanford.edu/software/invest (accessed on 15 July 2024).
57. Sallustio, L.; Quatrini, V.; Geneletti, D.; Corona, P.; Marchetti, M. Assessing Land Take by Urban Development and Its Impact on Carbon Storage: Findings from Two Case Studies in Italy. *Environ. Impact Assess Rev.* **2015**, *54*, 80–90. [CrossRef]

58. Munafò, M. (Ed.) *Consumo Di Suolo, Dinamiche Territoriali e Servizi Ecosistemici. Edizione 2016*; Report SNPA 248/16; SNPA: Rome, Italy, 2016; ISBN 978-88-448-0776-4.
59. European Environment Agency. *High Resolution Layers*; European Environment Agency: Copenhagen, Denmark, 2023.
60. EEA. *CORINE Land Cover 2012 (Vector/Raster 100 m), Europe, 6-Yearly*; EEA: Copenhagen, Denmark, 2012.
61. Sallustio, L.; De Toni, A.; Strollo, A.; Di Febbraro, M.; Gissi, E.; Casella, L.; Geneletti, D.; Munafò, M.; Vizzarri, M.; Marchetti, M. Assessing Habitat Quality in Relation to the Spatial Distribution of Protected Areas in Italy. *J. Environ. Manag.* **2017**, *201*, 129–137. [CrossRef]
62. Agenzia Entrate Valori Agricoli Medi. Available online: https://www.agenziaentrate.gov.it/portale/web/guest/schede/fabbricatiterreni/omi/banche-dati/valori-agricoli-medi/valori-agricoli-medi-molise (accessed on 12 June 2024).
63. Bellucci, V.; Bianco, P.M.; Strollo, A.; Marchetti, M.; Marino, D.; Marucci, A.; Munafò, M.; Palmieri, M.; Sallustio, L.; Soraci, M. Distribuzione Potenziale Degli Impollinatori Nelle Aree Agricole Secondo Il Modello InVest. *L'apicoltore Ital.* **2016**, *7*, 9–12.
64. Araújo Costa, R.C.; Pereira, G.T.; Tarlé Pissarra, T.C.; Silva Siqueira, D.; Sanches Fernandes, L.F.; Vasconcelos, V.; Fernandes, L.A.; Pacheco, F.A.L. Land Capability of Multiple-Landform Watersheds with Environmental Land Use Conflicts. *Land Use Policy* **2019**, *81*, 689–704. [CrossRef]
65. Klingebiel, A.A.; Montgomery, P.H. *Land-Capability Classification*; Soil Conservation Service, US Department of Agriculture: Washington, DC, USA, 1961; Volume 210.
66. Dean, M. A Practical Guide to Multi-Criteria Analysis MORE (Multi-Modal Optimisation of Road-Space in Europe) Project View Project Achieving Transitions to Zero Carbon Emissions and Sustainable Urban Mobility View Project. 2022. Available online: https://www.researchgate.net/publication/358131153 (accessed on 2 June 2024). [CrossRef]
67. Saaty, R.W. The Analytic Hierarchy Process—What It Is and How It Is Used. *Math. Model.* **1987**, *9*, 161–176. [CrossRef]
68. Coelho, C.D.; da Silva, D.D.; Amorim, R.S.S.; Vasconcelos, B.N.F.; Possato, E.L.; Filho, E.I.F.; Brandão, P.C.; Ferreira Neto, J.A.; Silva, L.V. Development and Application of an Environmental Vulnerability Index (EVI) for Identifying Priority Restoration Areas in the São Francisco River Basin, Brazil. *Land* **2024**, *13*, 1475. [CrossRef]
69. Wedley, W.C. Consistency Prediction for Incomplete AHP Matrices. *Math. Comput. Model.* **1993**, *17*, 151–161. [CrossRef]
70. Vizzarri, M.; Sallustio, L.; Travaglini, D.; Bottalico, F.; Chirici, G.; Garfì, V.; Lafortezza, R.; Veca, D.S.L.M.; Lombardi, F.; Maetzke, F.; et al. The MIMOSE Approach to Support Sustainable Forest Management Planning at Regional Scale in Mediterranean Contexts. *Sustainability* **2017**, *9*, 316. [CrossRef]
71. Wu, J. Landscape Ecology. In *Ecological Systems*; Springer: New York, NY, USA, 2013; pp. 179–200.
72. McGarigal, K.; Marks, B.J. *FRAGSTATS: Spatial Pattern Analysis Program for Quantifying Landscape Structure*; US Department of Agriculture, Forest Service, Pacific Northwest Research Station: Portland, OR, USA, 1995.
73. Fahrudin; Sakti, A.D.; Komara, H.Y.; Sumarga, E.; Choiruddin, A.; Hendrawan, V.S.A.; Hati, T.; Anna, Z.; Wikantika, K. Optimizing Afforestation and Reforestation Strategies to Enhance Ecosystem Services in Critically Degraded Regions. *Trees For. People* **2024**, *18*, 100700. [CrossRef]
74. Munafò, M.; Strollo, A.; Tonti, D.; Marchetti, M. Consumo Di Suolo e Dinamiche Territoriali Ed Ecologiche. In *Roma Città-Territorio—Abitare Un Contesto Metropolitano*; Quodllibet: Macerata, Italy, 2024; ISBN 978-88-229-2251-9.
75. ETIFOR Oltrepò Pavese: Governance e Finanziamenti. Available online: https://www.etifor.com/it/portfolio/oltrepo-pavese/ (accessed on 19 October 2024).
76. De Toni, A.; Casella, L.; Marchetti, M. *ISPRA_2016_QualitàHabitatDeToni*; ISPRA: Rome, Italy, 2016.
77. Ottaviano, M.; Marchetti, M. Census and Dynamics of Trees Outside Forests in Central Italy: Changes, Net Balance and Implications on the Landscape. *Land* **2023**, *12*, 1013. [CrossRef]
78. Raymond, C.M.; Frantzeskaki, N.; Kabisch, N.; Berry, P.; Breil, M.; Nita, M.R.; Geneletti, D.; Calfapietra, C. A Framework for Assessing and Implementing the Co-Benefits of Nature-Based Solutions in Urban Areas. *Environ. Sci. Policy* **2017**, *77*, 15–24. [CrossRef]
79. Connop, S.; Vandergert, P.; Eisenberg, B.; Collier, M.J.; Nash, C.; Clough, J.; Newport, D. Renaturing Cities Using a Regionally-Focused Biodiversity-Led Multifunctional Benefits Approach to Urban Green Infrastructure. *Environ. Sci. Policy* **2016**, *62*, 99–111. [CrossRef]
80. Standish, R.J.; Parkhurst, T. Interventions for Resilient Nature-based Solutions: An Ecological Perspective. *J. Ecol.* **2024**, *112*, 2502–2509. [CrossRef]
81. Di Cristofaro, M.; Sallustio, L.; Sitzia, T.; Marchetti, M.; Lasserre, B. Landscape Preference for Trees Outside Forests along an Urban–Rural–Natural Gradient. *Forests* **2020**, *11*, 728. [CrossRef]
82. Ernstson, H.; Barthel, S.; Andersson, E.; Borgström, S.T. Scale-Crossing Brokers and Network Governance of Urban Ecosystem Services: The Case of Stockholm. *Ecol. Soc.* **2010**, *15*, 28. [CrossRef]
83. Di Cristofaro, M.; Di Pirro, E.; Ottaviano, M.; Marchetti, M.; Lasserre, B.; Sallustio, L. Greener or Greyer? Exploring the Trends of Sealed and Permeable Spaces Availability in Italian Built-Up Areas during the Last Three Decades. *Forests* **2022**, *13*, 1983. [CrossRef]
84. Quintero-Angel, M.; Cerón-Hernández, V.A.; Ospina-Salazar, D.I. Applications and Perspectives for Land Restoration through Nature-Based Solutions. *Curr. Opin. Environ. Sci. Health* **2023**, *36*, 100518. [CrossRef]

85. European Commission. *The Common Agricultural Policy*; European Commission: Luxembourg, 2023.
86. Pantera, A.; Mosquera-Losada, M.R.; Herzog, F.; den Herder, M. Agroforestry and the Environment. *Agrofor. Syst.* **2021**, *95*, 767–774. [CrossRef]