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Mapping Coverage and Typology Based on Function and Spatial Configuration of Forests in Latium Region, Central Italy

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Abstract: Among the land use–land cover products, tree cover maps are essential tools for assessing forest functionality and ecosystem services, and implementing sustainable forest management. By combining open-source and ancillary high-resolution cartographic datasets, this study aims to map trees and forests in the Latium region in central Italy, highlighting their spatial configuration, function, and forest typology. The main findings show that trees cover 44.2% of the regional land area. Forests cover 508,056 ha, forming the core matrix of the Latium mountain landscape, providing significant ecological and socio-economic value for forest management and the regional wood supply chain. Although trees outside the forest represent only 3.1% of regional tree cover, they play a crucial role in enhancing ecological connectivity and landscape resilience. Approximately 2% of the tree and forest cover occurs in urban areas, contributing significantly to climate regulation and air quality in densely populated environments. The dominant forest types in Lazio include Turkey oak, temperate broadleaf, beech, downy oak, and Holm oak, which together account for 58.6% of the total tree cover. The accuracy tests confirm the feasibility of using open-source data for reliable, cost-effective forest mapping. Regular updates of these maps can support continuous monitoring and promote sustainable forest management practices.

Keywords: tree cover map; forest inventory; planning and management; remote sensing; forest type; trees outside forests

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1. Introduction

Land use and land cover (LULC) maps are key areas of research in remote sensing. They provide an essential framework for understanding the relationships between landscapes, ecosystems, and human activities [1,2]. They offer crucial insights for the development of effective land planning strategies and policies. Modern mapping techniques and tools ensure an expanding range of applications, supporting decisionmakers in addressing critical challenges in environmental and urban management [2–4]. To date, exploiting LULC maps to characterize land structures represents the basis of most ecological analyses.

As the world faces growing environmental challenges, trees and forest ecosystems play a central role in sustainability governance, and their mapping has become imperative to planning, managing, conserving, and enhancing this resource. In this context, tree and forest cover maps serve as the operational basis for initiatives primarily aimed at assessing forest disturbances [5,6], understanding forest functioning [7], and maximizing the ecosystem services (ESs) provided by trees [8]. For this purpose, cartographic representations of forested landscapes are used to inventory and analyze several quantitative (e.g., structure and composition; [9]) or qualitative (e.g., species, types, and function; [10–12]) information related to tree cover.

Tree and forest cover maps are developed from different interpretation techniques of satellite, airplane, or drone imagery [2,3,10,13,14]. Advances in remote sensing technologies and analytical methods have enabled recently developed forest maps to achieve high levels of accuracy and detail [15]. Depending on the purpose, forest mapping can be achieved on different scales [6], from local stand-level maps to broad-scale regional or global assessments. Regularly collecting, processing, and disseminating remote sensing information, especially from satellite sources, ensures that the most current and accurate data are openly available and accessible for several purposes, above all the environmental ones. This also provides the opportunity to compare time series information, allowing the continuous monitoring of trees and forest resources in relation to their major threats [5,16–18]. These pressures typically stem from LULC change processes. Examples include forest expansion resulting from land abandonment [19], the loss of trees and forest patches driven by intensive agricultural practices [20], and forest landscape fragmentation caused by urban expansion and sprawl [21].

So that trees continue to provide ES that are essential to human well-being, e.g., carbon sequestration, air pollution removal, hydrogeological risk mitigation, and biodiversity conservation [22], reliable monitoring tools are increasingly needed [23]. Although the current remote sensing sources and cartographic techniques are powerful, there can be limitations of tree and forest cover maps considering the trade-offs between their resolution and scales. Therefore, achieving high-resolution and up-to-date maps is not a straightforward task. Moreover, the complexity of forest systems requires a large amount of data for characterization, often hindering the development of comprehensive tools and limiting their support to specific targets of sustainable forest planning and management [15]. All the above can be translated into the broad effort of producing cartographic tools that have maximum usability, accuracy, and convenience in terms of time and costs [6].

This communication introduces a novel tree and forest cover mapping of the Latium region, central Italy. Mapping was carried out by adopting several cartographic techniques within a GIS environment, taking advantage of the integration of high-resolution and freely accessible land cover layers alongside the existing outdated regional datasets, thus updating the relevant geometric and typological information. A final map with a 10 m spatial resolution gathers spatially explicit data regarding the coverage, function, spatial configuration, and typological classification of trees and forests for the whole region. Based on open access and regularly updated satellite data, the Latium tree cover map represents an initial effort to develop a large-scale monitoring appliance for forest resources, which has significant implications for both scientific research and policymaking. The map is, indeed, included among the preliminary tasks as a part of the regional forest program of Latium and the Metropolitan Forest Plan of Rome, which is currently underway.

2. Materials and Methods

2.1. Geometrical, Functional, and Spatial Classification of Regional Forests

The tree and forest map covers the entire surface of the Latium region, Central Italy (41°31′49.26″ N; 12°16′50.08″ E). The study area is approximately 17,200 km^2 [24]. The Latium region presents different climatic regimes in relation to a high geographical and morphological heterogeneity. Inner mountain areas are characterized by a temperate climate that experiences high precipitation (1000–1500 mm yr^{-1}). A typically Mediterranean climate along the coasts is found. The geographical and geomorphological heterogeneity of the Latium Region results in an important diversification of habitats, biomes, and species [25]. Despite having 110 protected areas and 200 Natura2000 network sites, the Latium environment is constantly under pressure, mostly due to the presence of the Metropolitan City of Rome, which, with 5350 km^2 in surface and 4.2 million inhabitants, covers one-third of the region and represents the most populated metropolitan area in Italy [24]. Although the main anthropic pressures are concentrated in this province, secondary harmful effects are extended to the whole regional territory (e.g., widespread road, railway, airport, and naval infrastructure in support of the heavy commuting, tourism, and industrial development; [26]). Furthermore, a high population density, driven by the employment potential of the metropolitan area, causes high and sprawling land consumption in urban and peri-urban areas concurrently with the depopulation of inner mountain areas and abandonment of traditional land management practices [26].

The regional tree and forest cover mask was generated by integrating two datasets: the updated Corine Land Cover + Backbone (CLC + BB; EEA, [27]) from 2018 and the Latium Land Use (LU) Map from 2000 [25]. CLC + BB 2018 is a wall-to-wall raster product derived from multi-temporal Sentinel-2 time series data. It features a pixel-based approach with a spatial resolution of 10 m and includes 11 land cover classes. This layer is part of the broader Copernicus Land Monitoring Service, providing detailed mapping of land cover types across Europe. The use of this dataset for defining the regional forest mask is linked to key attributes of the CLC + BB 2018. Firstly, this layer is updated on a three-year cycle and is released within a short timeframe. This characteristic makes it particularly suitable for application in monitoring land cover dynamics. Furthermore, the CLC+ BB 2018 combines the qualitative accuracy of high resolution with the high reliability of land cover information. Specifically, a post-processing verification, based on the interpretation of over 42,000 sample points, revealed an overall accuracy of 92.8% (±0.3%) for the EU27 region [27].

In the first step, only the woody cover classes of CLC + BB 2018 (i.e., needle-leaved trees, broad-leaved deciduous trees, and broad-leaved evergreen trees, which are classes 2, 3, and 4 of the CLC + BB 2018 layer, respectively) were considered to define the regional forest mask. In the second step, Latium LU Map 2000 was used in order to identify trees covering agricultural areas (i.e., class 2 of the LU map), then added to the overall forest mask and classified as “trees in agricultural areas”. To complete the regional tree cover mask, trees occurring within urban areas (i.e., class 1 of the Latium LU map) were added and classified as “trees in natural areas”. Regarding trees near wetlands and water bodies (i.e., classes 4 and 5 of the LU map, respectively), they were included as “trees in natural areas” (i.e., class 3 of the LU map). Overall forest mask was, therefore, classified as distinguishing forests and Trees Outside Forest (TOF) patches.

The concept of TOF was discussed for the first time in 1996 during the FAO Expert Consultation on Global Forest Resources Assessment [27], recognizing their environmental and social values. As per FAO definition, they are trees or groups of trees even though they do not reach the minimum thresholds of “Forest” and “Other wooded lands” classes for extension, width, cover density, and maturity height. To discriminate between the

forest and TOF of the Latium region, we adopted the TOF definition proposed by the Italian National Forest Inventory [28], identifying in the TOF class all the tree formations of forest mask that concurrently do not satisfy the three criteria of surface area (i.e., less than 2000 square meters), cover density (i.e., less than 20%), and width (i.e., less than 20 m wide) of forest definition. To this end, the Copernicus Tree Cover Density (TCD) High Resolution Layer 2018 [27] was utilized as ancillary data. It was employed to assign cover density values to the surfaces of the forest mask.

2.2. Typological Classification and Accuracy Assessment

The typological classification scheme of forests proposed for the Latium Region follows, coherently with similar studies conducted on the national territory (e.g., [29]), hierarchical criteria. Accordingly, forest types represent the fundamental units. Forest categories and types are forests characterized by homogeneity from ecological and functional perspectives. Therefore, these forest units can be considered as key units of forest planning and management. For the classification of forest categories and types of the Latium region, the first step required the extraction of functional classes "trees in urban areas" and "trees in agricultural areas" from the forest mask. Although characterized by an artificial origin, the tree formations of the Latium agricultural landscape are generally cultivated and/or managed with a reduced impact on the environment and are able to provide, together with urban forests, important ES. A typological label (here intended for both forest category and forest types) with the analogous functional label was allocated to these two classes. Within the "trees in agricultural areas" category, two distinct sub-categories were identified at a later stage, i.e., agricultural trees, classified as "trees in agricultural areas", and olive orchards, classified as "olive groves". For the typological classification of Latium tree and forest cover, ancillary information about forest categories and types was obtained from the Latium forest types map of 2000 and the resultant Natural and Semi-Natural Environments and forest types map of the Latium region in the year 2010 [30]. This layer was derived from a detailed refinement of the pre-existing Latium Land Use Map 2000, incorporating levels IV and V of the Corine Land Cover classification. Specifically, Natural and Semi-Natural Environments and forest types maps are based on the segmentation and classification techniques of high-resolution satellite imagery and ADS40 false-color infrared digital orthophotos. The final product was consistent with the two maps both geometrically and thematically, with the forest typological classification scheme organized into 17 categories and 36 forest types according to the national classification scheme (more information about the adopted classification scheme and its harmonization with the European nomenclature are reported Table S1 in Supplementary Materials; [30,31]). In areas classified as tree-covered by both the CLC + BB 2018 and the Latium forest types map, the forest category and type classes at the highest level of detail were assigned. The rest of the tree pixels from the CLC + BB dataset classified as trees in natural areas (corresponding to classes 3, 4, and 5 of the Latium Land Use Map) were assigned to a forest type using a proximity algorithm. For this purpose, the Arcgis Euclidean Allocation command was used, which calculates, for each cell, the nearest source based on Euclidean distance. In this way, the forest type was assigned to the CLC + BB 2018 tree pixels in areas not covered by the polygons already classified by the Latium forest types map.

At the end of the processing phases for the three layers of the forest map, the accuracy of the resulting classification schemes was assessed. Initially, a sample of check points was verified through on-screen interpretation, using the dataset scheme from the Italian Land Use Inventory (IUTI 2016—10% sampling points; [32]). Tree cover, function, spatial configuration, and typological class of 2371 IUTI sample points were verified in 2018 using high-resolution color orthophotos by a photo interpreter. Additionally, 200 more

challenging sample points were selected and verified in the field during a subsequent step. The comparison between verified and classified points was performed through the implementation of a precision (or error) matrix method for each layer [33]. In this way, both the producer's accuracy and the user's accuracy of the individual classes were evaluated for each considered classification scheme. As a final valuation, the overall accuracy (OA) and the Kappa coefficient (kappa) were calculated by confusion matrices (see Tables S2–S5 in Supplementary Materials). Figure 1 describes the processes and cartographic layers used for tree and forest cover mapping and accuracy checking.

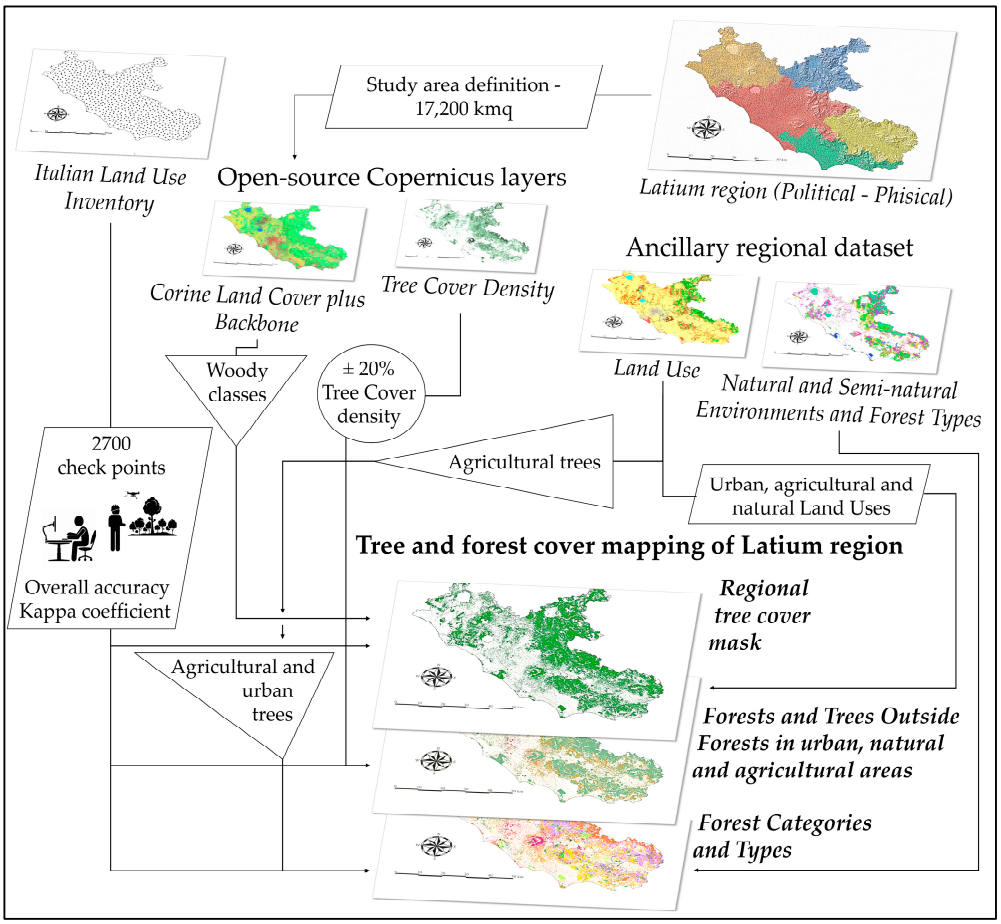


Figure 1. Flow chart for tree and forest cover mapping of the Latium region.

3. Results and Discussion

3.1. Trees and Forest Cover of Latium Region

A detailed view of the tree and forest mask of the Latium region is shown in Figure 2b. The tree and forest cover mapping of the Latium region displays a total coverage of 760,737 ha, corresponding to 44.2% of the total regional land area. Excluding the area covered by agricultural trees, olive groves, and TOF, forests and trees cover a total of 559,234 ha, equal to 32.6% of the regional land area (for more details and data, see Tables S6 and S7 in Supplementary Materials). This result is matched with the Italian National Forest Inventory [28], which estimates for the Latium region a forest area and a forest cover index (i.e., forest area as a proportion of the total land area) equal to 558,060 ha and 32.6%, respectively.

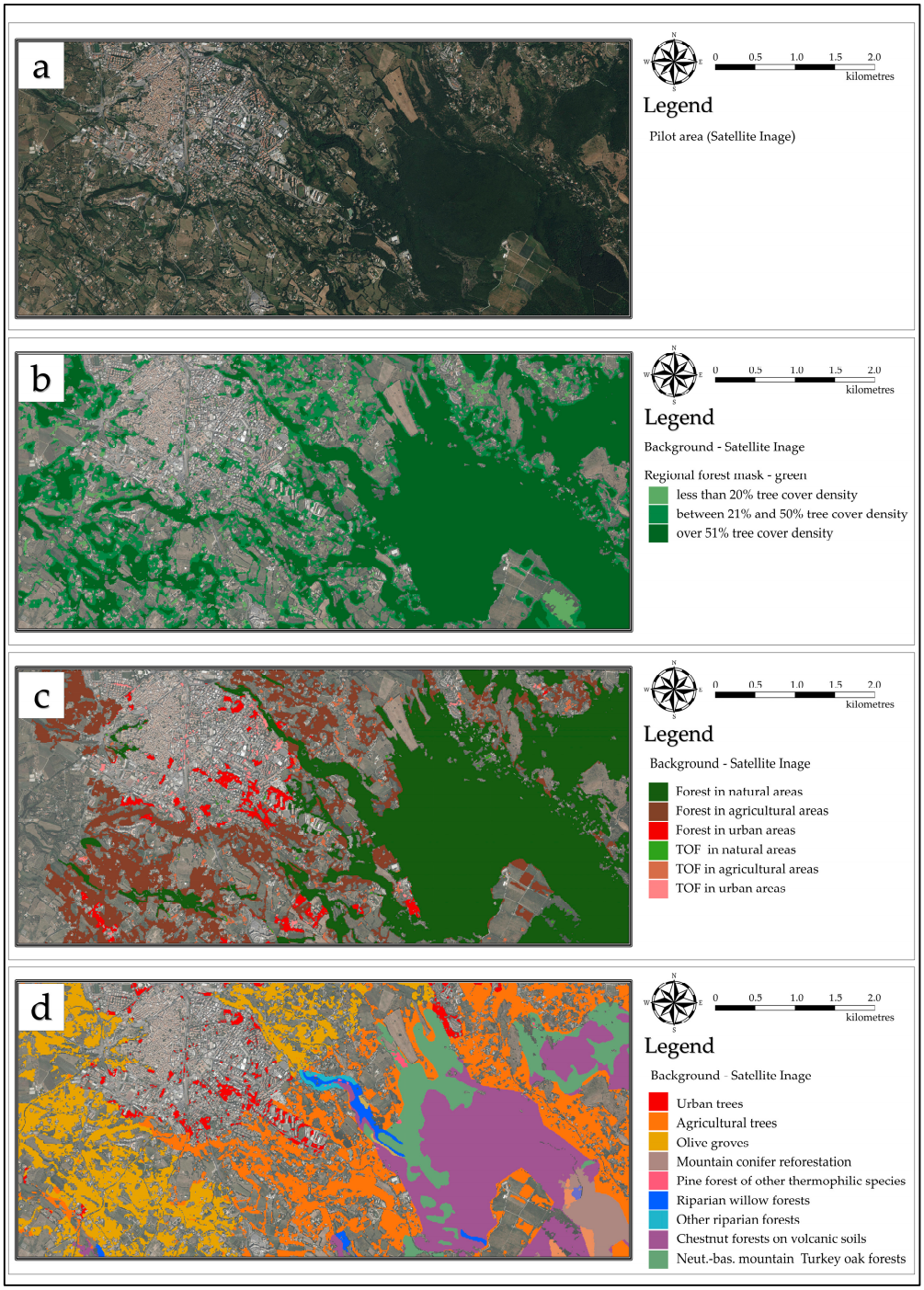


Figure 2. Detailed views of the tree and forest cover mapping of the Latium region, central Italy. The highlighted area represents a sample portion of the study area (**a**). The views represent the mapping of the regional tree and forest mask (**b**); the characterization of forests and Trees Outside Forest (TOF) in urban, agricultural, and natural areas (**c**); and the typological classification of the trees and forests of Latium (**d**). The complete maps are shown in the Supplementary Materials in Figures S1–S3, respectively.

With respect to the regional topography [24], 291,144 ha of regional mountain areas are covered by trees and forests (i.e., 38.3%). As for hilly and floodplain contexts, the tree and forest cover amounts to 211,623 ha and 257,970 ha, respectively. The Latium region does not have a large mountainous area, with 77.0% of its surface located below 600 m a. s. l. and more than half of the region (i.e., 53.6%) consisting of plains [24]. In the latter domains, strong anthropic pressure is concentrated, mainly connected to intensive

agriculture; a widespread road, railway, and industrial infrastructure development; and the never-ending urban sprawl of the Metropolitan City of Rome [26]. Although the trees and forests of the hilly and plain areas of the Latium region represent only a quarter of the whole territory extension, they play a key role in preventing and restraining several environmental threats. Within the hill and plain areas, trees can represent the primary obstacle to land consumption, imperviousness, and landscape homogenization [34]. Moreover, in these areas, regulating ESs is essential to mitigate the polluting effects of anthropic pressure on air, water, and soil. In this regard, the forest map of the Latium region offers the great advantage of spatial explicit tree density information. Canopy density is, indeed, the most adopted proxy for estimating several ecosystem services from forests [21], being directly proportional to ES supply according to the assumption that the higher the canopy density, the higher the ecosystem functionality and services.

This is further confirmed by examining the distribution of regional tree and forest cover across the five provincial districts of Latium. Despite having 212,545 ha of tree and forest cover (39.7% of the whole metropolitan territory and 12.4% of the regional areas), the Metropolitan City of Rome is the largest province in terms of area but has one of the lowest forest and tree cover indices, which is notably lower than the regional average. However, the province with the lowest relative forest and tree cover in the Latium region is Viterbo, with a relative index equal to 31.7%. With 12,934 ha of forest and tree coverage, the administrative district with the largest index is Rieti (65.5%), followed by the provinces of Frosinone, Rome, and Latina (53.3%, 39.7%, and 36.1%, respectively).

3.2. Forest and Trees Outside Forest in Natural, Agricultural and Urban Areas of Latium Region

Figure 2c displays a detailed view of the mapping of forest and TOF in urban, agricultural, and natural areas of the Latium region. The tree and forest cover of Latium region is represented by 96.9% of forests and 3.1% of TOF. Excluding agricultural and urban trees, olive groves, and TOF patches, forests in natural areas represent 66.8% of all the regional forest and tree cover, occupying a total surface of about 508,056 ha. They constitute the fundamental matrix of the Apennine mountain landscapes of Latium as well as of the pre-Apennine volcanic and carbonate reliefs. They have a high landscape and naturalistic value recognized by being the main constituent part of several regional protected areas and two national parks including the most important for Central Italy, which is the Abruzzo and Molise National Park. Besides the ecological role, these forests keep a central socio-economic interest linked to the regional beech, chestnut, and oak wood supply chains, characterized by a long tradition of forest management for high-quality timber, firewood, and charcoal production [35,36]. In these areas, where forest and tree cover maximize their benefits related to ecological and socio-economic functions, the availability of an updated and spatial explicit inventory is required to implement sustainable management of forest resources. Furthermore, regional forest and tree cover mapping provides strategic support to identify priority and/or vulnerable areas and define planning goals and actions at both stand and landscape scales.

The total forest and tree cover surface in agricultural areas corresponds to 173,647 ha (22.8% of the total) divided into 90.5% of forests and 9.5% of TOF patches. Trees and forests play a key role in Latium rural systems. While agricultural expansion and intensification can conflict with tree conservation due to competition for space, there is increasing recognition of the numerous benefits of incorporating trees and small patches of forest into farming landscapes. In the face of the current global changes, this integration is needed for more protecting (for instance, through the atmospheric carbon storage in tree biomass), resilient (e.g., by preventing erosion, runoff, and hydrological risks linked to extreme events, which are expected to increase due to climate change) and sustainable (conserving biodiversity

and habitats and improving landscape diversification and functions) agricultural systems. Tree cover mapping is, therefore, a key process for understanding the interaction between forest ecosystems and human activities in landscape patterns dominated by agricultural matrix, where trees represent ecological corridors within very fragmented habitats for biodiversity conservation [37]. Considering the high vulnerability of agricultural areas to hydrogeological risk following past deforestation activities and the adoption of monocropping systems that reduce the soil capacity to retain water, trees and forests in Latium agricultural backgrounds can also influence hydrogeological risk, positively contributing to soil protection and water cycle regulation [38].

Covering approximately 15,206 ha, the trees and forests in urban and peri-urban contexts (urban forest, UF) represent only 2.0% of the regional forest and tree cover. Only a quarter (i.e., 3758 ha) of the Latium UF consists of TOF. Although small in size and overall extension, these tree patches often serve as the residual and precious natural components in areas with the highest levels of human activity. Understanding the distribution of trees and forests in the urban and peri-urban areas of the Latium region is of great magnitude for developing nature-based solutions to tackle recent urban challenges, such as stormwater management, heat island mitigation, and air quality improvement [39]. Not surprisingly, here, the described forest and tree cover mapping is an integral part of the metropolitan master plan of Rome in progress. Strategies aimed at new tree plantations in the Latium region are indeed based on the conservation of the existing tree cover by the replacement of single diseased plants or the whole stand if necessary. Besides their mitigation role, UF faces numerous diseases that threaten trees' health, often exacerbated by human activities and specific stressors. A striking and current example is represented by the *Toumeyella parvicornis*, which is causing widespread mortality of stone pine (*Pinus pinea* L.) trees [40]. Since the reporting of the first attacks of the parasite on pine trees in the Latium region in 2020, infestations have quickly spread, particularly in urban and peri-urban areas, where large historic gardens with high pine density are present. To date, there is no spatial explicit information about the regional parasite distribution yet. Thus, the spatial inventory of the present map can represent a priceless tool for monitoring the state and health of pine forests in these areas, where forest patches represent a key element for landscape, as well as the main constraint to urbanization and the loss of permeable soil [34].

3.3. Forest Categories and Types

A detailed view of the forest types' mapping of the Latium region is displayed in Figure 2d. The distribution by forest categories, forest types, and TOF in the Latium region is shown in Table S7 in Supplementary Materials. Most part (58.6%) of the Latium forest and tree cover concerns Turkey oak forests, temperate broadleaf mixed forests, beech forests, downy oak forests, and Holm oak forests. These categories represent the most widespread forest categories, respectively, covering 140,902 ha, 87,872 ha, 87,837 ha, 78,249 ha, and 51,230 ha. The results are in line with estimates reported by the Italian National Forest Inventory [28], which describes for these five forest categories an overall covered surface of 434,879 ha. In this comparison, the slightly higher estimate of Turkey oak, beech, and Holm oak forests' coverage is chiefly due to the inclusion in the Latium tree cover map of forest formations that are not defined as forests by the national inventory. The findings, thus, provide strong validation of the accuracy of the tree cover map for the Latium region, establishing it as a reliable tool to support strategic forest management. Data availability may be a core part of the next Forest Regional Program, the instrument that will guide the forestry policy of Latium in the coming years, in the implementation of the objectives of the European and National Forestry Strategy through the enhancement of multifunctional forest management.

The main findings also focus on the tree cover by the urban forest category, which makes up 4.4% of the total tree cover (equivalent to 33,790 ha of the regional area), as well as the agricultural categories. Agricultural trees cover 113,718.4 ha, and olive groves cover 77,835 ha. Their extension and spatial distribution are a very relevant subject considering their role in highly anthropized contexts in relation to biodiversity conservation and ES provision, first of all, the high value of biomass and carbon stock. Furthermore, 9.1% of the total area of these three categories consists of TOF, serving as the main element of ecological connectivity, diversification, and cultural value in both urban and rural landscapes [41,42].

4. Methodological Remarks and Accuracy

The main technique for representing the classification accuracy of remotely sensed data is through the error matrix method [33]. The error matrices of the tree and forest cover map of Latium were generated through 2700 check points. On one hand, each matrix contained information about cover, function, spatial configuration, and forest category/type for each check point. On the other hand, the information obtained from both on-screen and in-field surveys of the 2700 check points was reported. We estimated the overall accuracy and kappa coefficient by cross-referencing the map and survey information. The mapping presented in this paper achieved overall accuracies of 91.6% for the tree canopy mask (tree versus non-tree land cover), 91.4% for spatial configuration (Forest or TOF), 88.8% for land use classification (trees in natural, agricultural, or urban areas), and 84.4% for forest type classes. The kappa coefficients of tree cover mask, configuration, use, and types were 82.8%, 83.5%, 80.3%, and 75.6%, respectively.

The confusion matrices for the estimation of the overall accuracy and kappa coefficients are reported in the Supplementary Materials (for major details, see Tables S2–S5). The forest and tree cover map of the Latium region meets the accuracy requirements of major international standards, which set a minimum threshold for the overall thematic accuracy at 85% to 90% [41,42]. Thus, the proposed methodology for forest and tree cover mapping at high spatial resolution and regional scale has proven to be reliable for similar applications. The lower accuracy of the typological map is related to the operational limits of the exploited ancillary data, deriving from obsolete segmentation software [31]. Nevertheless, this study has successfully demonstrated the feasibility of producing reliable and cost-effective regional forest resource maps primarily using open-source data. We argue that the map represents a valuable source of data for future ecological assessments at the regional scale, primarily the estimation and spatialization of the ES supply by the trees and forests of Latium. At the same time, much of its value lies in the constant updating and assessment of land changes and ES demand. In this regard, the regular release of exploited open-source data enables rapid updates to these maps and supports their use for monitoring purposes.

5. Conclusions

The tree and forest cover of the Latium region is extensive, covering 760,737 ha (44.2% of the regional total land area), 559,234 ha of which (32.6% of the regional total land area) is dedicated to forests, excluding TOF, agricultural trees, urban trees, and olive groves. The distribution of forests and tree cover varies with topography, with 38.3% of the mountain areas covered by forests and trees, and significant coverage in hilly and floodplain zones. Despite comprising a quarter of the total territory, these areas play a critical role in mitigating anthropogenic pressures, particularly in the face of intensive agriculture, urbanization, and infrastructure development. Forests, especially those in mountain areas, offer key ecological and socio-economic functions, and the availability of up-to-date forest mapping is crucial for sustainable forest management and planning at various scales. The study also distinguished between forests and Trees Outside Forests

(TOF), with the forest class accounting for 96.9% of the total tree cover. Forests in natural areas make up most of the regional forest cover, while forests in agricultural landscapes contribute to their resilience and biodiversity conservation. Urban forests, though limited in size (2.0% of total tree cover), offer essential benefits such as heat island mitigation and air quality improvement. TOF in agricultural and urban areas also serve key roles for ecological connectivity and landscape diversification. Furthermore, the Latium region is home to a diverse range of forest categories, with Turkey oak, temperate broadleaf, beech, and downy oak forests as the most common. These forests support the local wood supply chains, one of the main drivers of the economy in inner areas. The findings underline the importance of regular forest mapping to monitor changes in forest and tree distributions, especially in the urban–rural fringe of the Metropolitan area of Rome. Estimates of the overall accuracy and kappa coefficient obtained by confusion matrices show that the presented map meets the accuracy requirements of the main international standards. In this sense, data generated from this study can provide the foundation for effective forest management strategies and sustainable development, enhancing the ecological, socio-economic, and environmental resilience of Latium landscapes. Based on open access and regularly updated satellite data, our methodology has provided useful information, demonstrating cost, time, and accuracy suitability for the implementation of forest resources' monitoring tools at the regional scale.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/land14020331/s1, Figure S1. Tree and forest cover map and density of the Latium region, central Italy. Figure S2. Forests and Trees Outside Forest (TOF) in natural, agricultural and urban areas of Latium region, central Italy. Figure S3. Map of forest categories and forest types in Latium region, central Italy. Table S1. Typological classification scheme of the tree cover of Latium and harmonization with the European forest categories. Table S2. Estimation of Overall Accuracy (OA) and the Kappa coefficient (kappa) of the forest and tree cover mapping through confusion matrix. Table S3. Estimation of Overall Accuracy (OA) and the Kappa coefficient (kappa) of the Forests and Trees Outside Forest mapping through confusion matrix. Table S4. Estimation of Overall Accuracy (OA) and the Kappa coefficient (kappa) of the function classification of the forest and tree function mapping through confusion matrix. Table S5. Estimation of Overall Accuracy (OA) and the Kappa coefficient (kappa) of the typological classification of forest and tree cover mapping through confusion matrix. Table S6. Forest and tree cover distribution in relation to administrative and physical boundaries of Latium region. Table S7. Forests and Trees Outside Forests in natural agricultural and urban areas of Latium region.

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