

Green Infrastructures, Monumental and State-Owned Assets: The Role of Tratturi in the Southern Italian Landscape

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Abstract

The ancient Tratturi, once crucial for southern Italy's transhumance economy, saw their role diminish by the early 20th century. Today these routes have become important cultural heritage and laid the basis for economic initiatives in slow tourism, especially in lowly developed Apennine regions of Italy. The Tratturi may also serve as green infrastructures, however, the knowledge about their ecological roles and the present condition of these protected lands is minimal. This research deals with the aspects of the ecological dimensions of the main Tratturi network, especially with the importance of the green linkages to the protected areas and the network of the Natura 2000 along the Apennines. Through indicators of anthropogenic disturbance, ecological integrity, habitat quality, and proximity to protected sites, the study evaluates each route's ecological contribution. One of the findings of this study shows that the successful implementation and improvement of Tratturi can become the basis of sustainable development only if eco-tourism and local economies are properly supported. Treating Tratturi as strategic eco-tourism infrastructure can maintain biodiversity and the linking of ecosystems. The present study identifies the activities of conservation and tourism as those which bring to the fore the cultural and natural heritage of the areas, whereas the advised methodology is capable of being a mode of taking care of and running other ecological networks sustainably.

Keywords

Tratturi, Cultural heritage, Sustainable development

1. Introduction

For centuries, the Tratturi (from the medieval Latin *tracturus*, meaning “path” or “ditch”)—ancient transhumance routes—have been essential in the economy of southern Italy. These routes served not only transhumance but also as critical connectors for the movement of herds and goods [Zullo, 2023]. Transhumance was a pastoral practice based on the traditional use of natural resources and ecosystem services, marked by seasonal migrations of herds between mountain pastures in summer and plains in winter. This practice shaped and maintained the landscape over centuries [Mastronardi et al., 2021], and it continues to impact the urban structure of the towns it passes through. In Italy, the Tratturi consist of grassy paths that mark the routes used by herds during these seasonal movements [Mastronardi et al.,

2023; Petrocelli, 2011]. These routes formed a network (Figure 1) of main and secondary paths, stretching about 3,000 km through Abruzzo, Molise, and Puglia, with parts in Campania and Basilicata [Mastronardi, 2000; Zullo, 2023]. The main routes had a length of 236 km (*L'Aquila-Foggia*), 207 km (*Pescasseroli-Candela*), 189 km (*Celano-Foggia*), and 35 km (*Lanciano-Cupello*), with a maximum width of about 110 m. The main tracks extended from north to south, while the smaller ones (the so-called *tratturelli* and *bracci*) from east to west, creating a dense network [Cialdea, 2007; Mastronardi et al., 2023]. Today, most of these have disappeared throughout Europe. Many paths have been lost due to agricultural abandonment, natural reforestation, and urbanization. This decline began in XX century, when transhumance began to disappear. For this, the Italian state introduced protective decrees to preserve and reintegrate the Tratturi. Currently, Tratturi lands are protected as monuments under Legislative Decree 42/2004. They are also state-owned, which creates complex management challenges. To date, the lands of the Tratturi are protected by Legislative Decree 42/2004. However, there are some that are also state-owned, creating difficult land management. Various regulations and regional initiatives were amended to relaunch economic and tourist development by enhancing the archaeological, cultural, environmental, and landscape value of the Tratturi. However, the landscapes linked to these routes have changed significantly [Mastronardi et al., 2023]. In 2019, UNESCO recognized transhumance as an intangible cultural heritage [UNESCO, 2019]. This recognition underlines the importance of these routes for both local culture and global heritage. Recently, initiatives have been intended at restoring and promoting the Tratturi for local economic growth, for example through slow tourism. Although national regulations recognize the cultural and historical value of the Tratturi, their ecological importance remains little studied. This study introduces a methodology to evaluate whether the Tratturi, given the current anthropogenic pressures and their geographical conformation, can function as ecological connectors. The analysis includes their link to protected areas, current land cover and levels of surrounding land degradation, using indicator engineering techniques developed for this purpose.

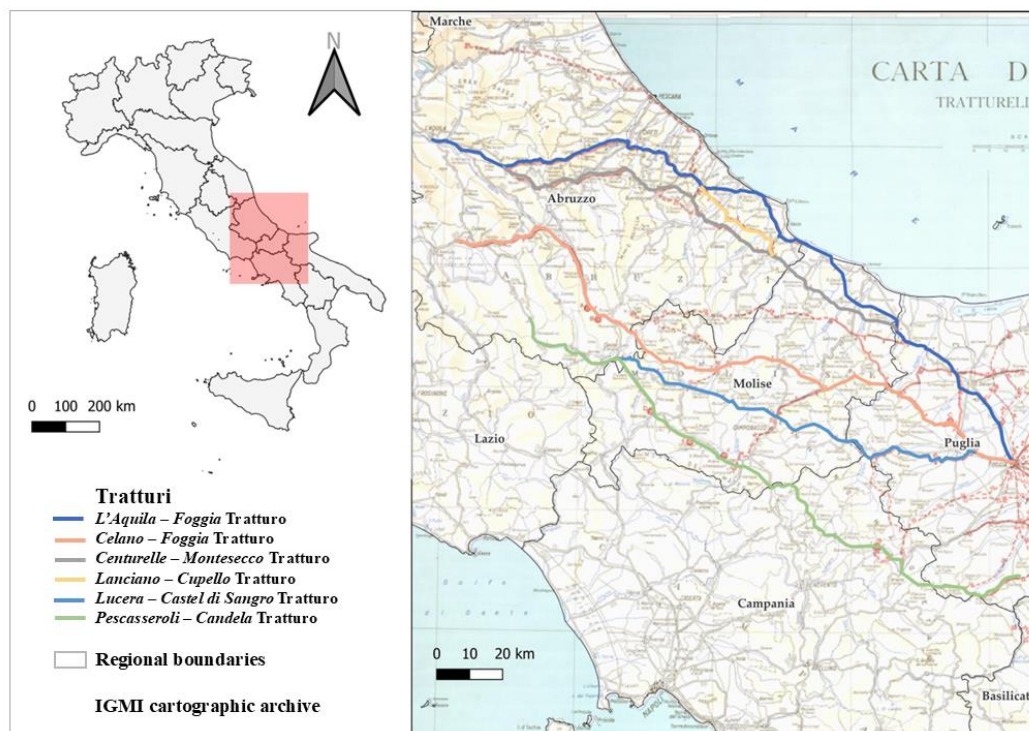


Figure 1. Map of the Tratturi. Source: IGMI cartographic archive and authors' elaboration.

2. Study background

2.1 Historical Evolution and Current State of the Tratturi

The Tratturi have been important for the culture of local communities and for the landscapes that have characterized the regions of southern Italy for centuries, in particular Abruzzo [Staffa, 2020; Violante, 2016]. When transhumance declined in the early 1800s, people began to use these lands for agriculture, and later urbanization began near populated areas. This trend was strong in regions like Abruzzo, where development pressures starting in the 1950s significantly changed the Tratturi landscape [Zullo et. al., 2024]. Figure 2 shows the historical evolution of the Tratturi.

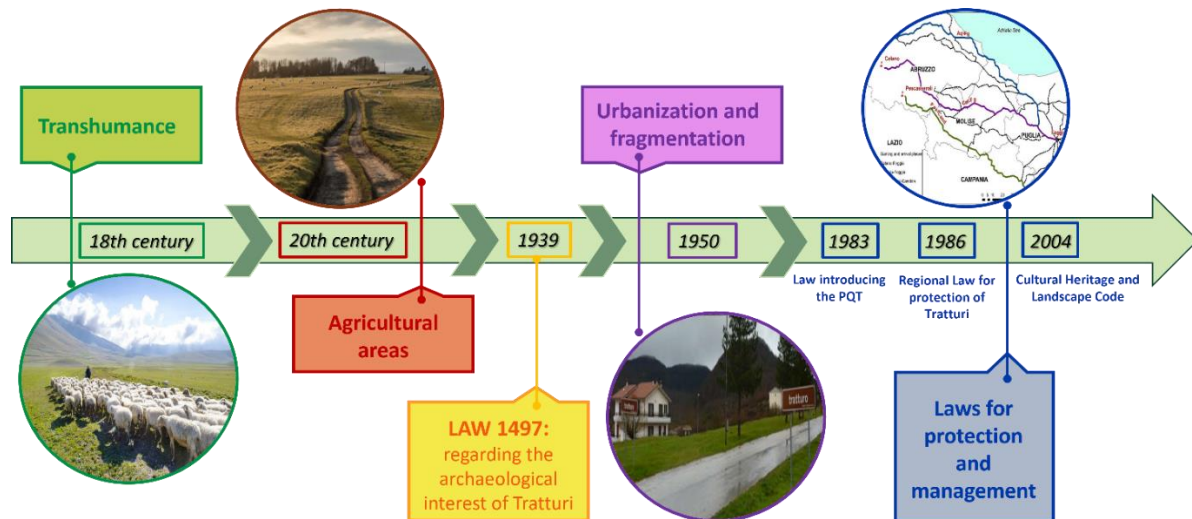


Figure 2. Historical evolution of the Tratturi. Source: Authors' elaboration.

Until the 18th century, laws protected transit and grazing rights to support the economic importance of sheep farming. However, by the end of the century, regulations allowed for different uses, such as agriculture, leading many minor Tratturi to be converted into roads in response to increasing demand for land [Mastronardi et al., 2021]. As a result, significant portions of Tratturi were sold, especially in Abruzzo and Puglia. In the early 20th century, only the main Tratturi (L'Aquila-Foggia, Celano-Foggia, Pescasseroli-Candela) remained available for herding and grazing, while others were sold or converted to agricultural use. To protect the routes from uncontrolled urbanization, Italy approved the Bottai Law (Law 1089/39) in 1939, recognizing the Tratturi as archaeological assets, declaring them inalienable for their cultural value [Meini et. al., 2014; Minotti et. al., 2018; Pellicano et. al., 2008; Pierucci, 1988; Zullo, 2023]. Since then, the Tratturi have had a dual role as both state-owned and archaeological assets, which creates difficulties to their management and protection [Cazzani et. al., 2021; Centofanti et. al., 2008]. In the 1970s, the responsibility for managing these state-owned assets was passed to the regions, while the Ministry for Cultural Heritage and local Superintendencies retained authority over preservation and acceptable uses. The building boom throughout Italy was also reflected on the land of the Tratturi, causing a considerable loss of soil and impact on the surrounding landscape. To protect the Tratturi, Molise (in 1976) and Abruzzo (with the Ministerial Decree of March 1980) have introduced a new planning tool, the Tratturi Framework Plan (PQT). This tool is mandatory for municipalities crossed by Tratturi, yet about 50% of Abruzzo's municipalities have not yet implemented it. The creation of the knowledge framework necessary for the FPT is complex: this creates technical and administrative challenges in verifying building titles and prior land sales. Over time, various regional laws and broader projects have leveraged the identity that Tratturi create for local communities and landscapes, aiming to revitalize these areas and bring renewed economic activity to the regions they cross. Walking routes and slow tourism are some of the main themes

promoted by these initiatives. Recently, however, projects like the one in Molise have also highlighted the ecological role Tratturi could play as potential connectors between areas with different levels of natural preservation. While the historical, cultural, and archaeological value of Tratturi is widely recognized and supported by various national and regional laws, the idea of their role as ecological corridors still requires extensive evidence and scientific support.

2.2. The Ecological and Cultural Role of the Tratturi

The cultural role is clear. Ecosystems, ecosystem services, and ecological networks are key aspects to be assessed, requiring specific data and verifications. The ecological role of the Tratturi depends on different factors such as their proximity to protected areas, the degree of soil sealing and the ecosystem services they provide. Each Tratturo has unique characteristics that vary from region to region but also from municipality to municipality and therefore must be evaluated individually. The morphology of the territory and the proximity to the various urban centers has played an important role to define the future of these lands. Often, areas adjacent to major urban centers or settlements encouraged urban expansion over Tratturi, while segments passing through the internal Apennine areas experienced a return to nature, with landscapes transformed by natural vegetation development. Recent studies [D'Ottavio et al., 2016; Mastronardi et al., 2021; Plieninger et al., 2016; Riviaccio et al., 2017; Sallustio et al., 2018] on the ecological potential of these paths show that while some cross areas with ecological value, others are heavily urbanized, with disturbance levels making ecological connectivity challenging. In Abruzzo, for example, only a limited portion of the Tratturi crosses protected areas or Natura 2000 sites, and human disturbance levels vary significantly (Figure 3).

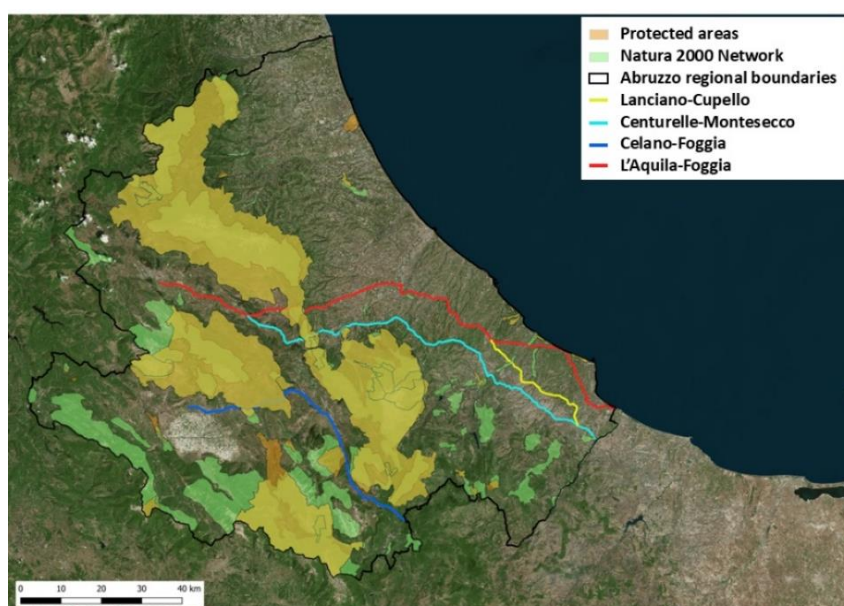


Figure 3. Map of Protected areas, Natura 2000 Network and the Tratturi in Abruzzo. Source: Zullo, 2023.

Infrastructure and urbanization have compromised much of their ecological integrity, making policies and interventions on these issues more difficult [Zullo et al., 2022; Zullo et al., 2024]. Urban sprawl [Romano et al., 2017] and intensive agriculture [Van Vliet et al., 2015] were the main factors that transformed the landscape, also influenced by demographic dynamics [Dupras et al., 2015]. In addition, political, institutional and cultural factors, together with agricultural policies, have had a strong impact on changes in land use [Mastronardi et al., 2021; Plieninger et al., 2016]. In Italy, recent phenomena include the abandonment of agricultural areas, with consequent forest expansion and natural regrowth in marginal

areas, and the urbanization of plains, coasts and easily accessible areas [Mastronardi et al., 2021; Sallustio et al., 2018]. Intensive agriculture, with the conversion of pastures to intensive crops such as cereals, has reduced natural habitats. Hedgerows were eliminated and the use of fertilizers and pesticides increased. This has led to a decline in the cultural ecosystem services needed to improve the Tratturi [Schirpke et al., 2013], especially in favorable agricultural areas [Pinto-Correia and Kristensen, 2013]. This intensification has led to strong land use [Rivieccio et al., 2017] and the homogenization of landscapes, with the loss and fragmentation of natural areas [Pinto-Correia et al., 2006]. Meanwhile, urbanization has damaged ecosystems and landscape sustainability [Brunori et al., 2016], creating landscapes with simplified forms and functions [Romano et al., 2017]. Today, the condition of Tratturi lands is highly complex and varied. Assigning them an ecological role, as mentioned, requires consideration of multiple significant aspects. Promoting slow tourism and connecting these routes to the paths requires a good knowledge of the territories crossed. Elements such as road crossings, the presence and arrangement of accommodation facilities, integration with other historical-cultural assets, or significant species along the route are essential to establishing such pathways. The same approach applies to their potential as ecological corridors, which necessitates thorough technical evaluations.

3. Methodology

In order to understand the potential of the Tratturi as ecological corridors, it is necessary to analyze a wide range of variables that must be interpreted through different keys and different territorial scales. The first output is the number of municipalities crossed by the Tratturi (Table 1). In Molise, 50% of the municipalities are crossed by these, whereas the final destinations of transhumance activities, Campania and Puglia, have increasingly less Tratturi. The knowledge of Tratturi and protected areas (National Parks, Natura 2000 Network), and the status of land transformation on their trajectories is essential to characterize the current states of Tratturi [Zullo, 2023].

Regions	No. Of Municipalities with Tratturi	Total Municipalities	(%) of municipalities with Tratturi compared to the total number of regional municipalities
Abruzzo	93	305	30,5%
Campania	15	550	2,7%
Molise	57	136	41,9%
Puglia	23	257	8,9%

Table 1. Number of municipalities crossed by the Tratturi. Source: Authors' elaboration.

As visible in Figure 4, the traces of the Tratturi overlap with the system of protected regional areas. These findings highlight how many protected areas and Natura 2000 sites are crossed by the Tratturi, as well as the ecological role of these historic routes as important ecological corridors, albeit varied across the regions of southern Italy. Redirecting now to Abruzzo, the Tratturi cross very significant portions of National Parks and Special Protection Areas, amounting to roughly 73% and 70% of the areas involved, respectively. This makes the value of the Tratturi for the protection of biodiversity in Abruzzo clear. Tratturi are mainly proposed in the Special Areas of Conservation (SCI) areas, a protected status which covers more than 70% of the areas of Molise planned for planting, whereas they are running through the rest of the SACs/SPAs. The role of the Tratturi as ecological corridors is emphasized, given their importance for the conservation of biodiversity and as viable protected areas in an area with limited protected areas such as Puglia and

Campania. This fact shows that these ancient paths are only weakly associated with the protected territories of Puglia and Campania region. The data referring to Abruzzo and Molise presents quite the opposite situation that characterizes The Tratturi, not only cultural and historical roads, but also important green belts for biodiversity and ecological linking of natural spaces. These similarities of interests are strongly expressed in the regions and interest in the prospects of the continuity of the well-known Apennine ecosystems.

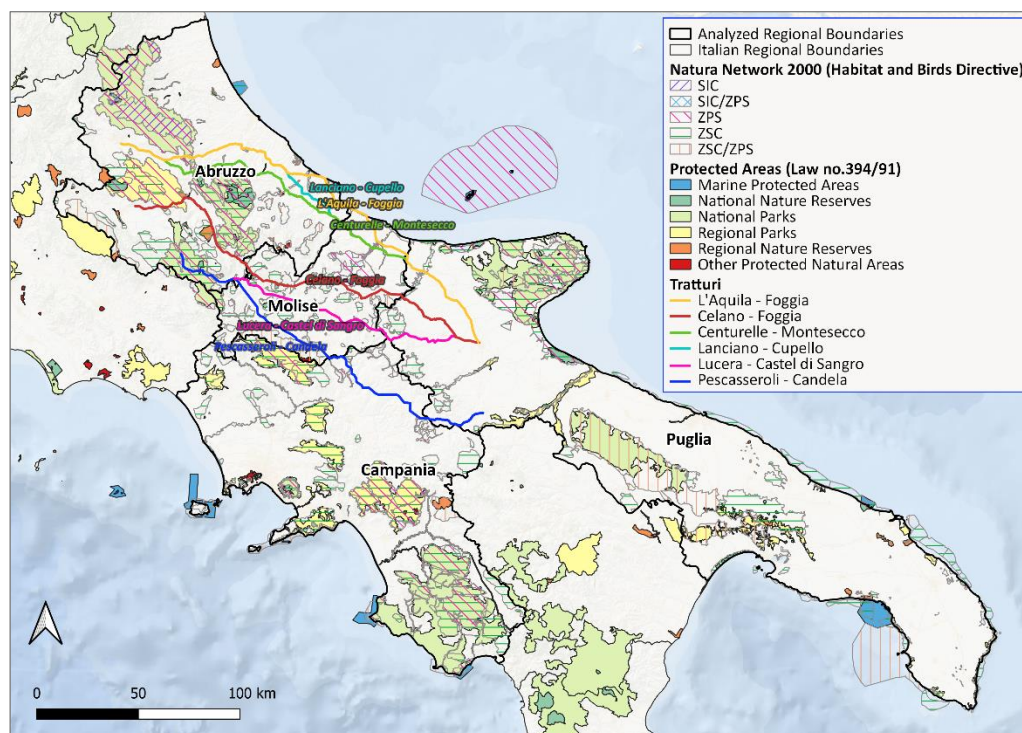


Figure 4. Map of Protected areas, Natura 2000 Network, and the Tratturi in Abruzzo, Campania, Molise, and Puglia. Source: Authors' elaboration.

The analysis can be done using Geographic Information Systems (GIS) based mapping of the areas involved, by sectorizing the Tratturi, through defining measures of urban pressure, and by defining the areas of ecological value and connectivity. From 1956 up to 1997 urbanized areas were evaluated using IGMI and regional maps and comparisons were made with current data from the Civil Protection pertaining to building aggregates. The DU (Urbanization Density) indicator indicates the extent to which the urban pattern has compromised or fragmented the original path, deterring the restoration and ecological function of the original path. As illustrated in Fig. 5, the percentage of land use (% DU) adopted along sections of six main Tratturi in southern Italy has been attributed on a regional basis (Abruzzo, Molise, Campania and Puglia) and two reference years, 1950 and 2000. There are substantial divergences between the regions which also shows diverse pressure on the land and might influence the ecological and cultural richness of the Tratturi. The DU 50 graph indicates that the distribution of Abruzzo and Molise is fairly similar in terms of land uses in almost all Tratturi, with spikes of approximately 1.5–2%. On the contrary, Campania records lower values, except for the Regio Tratturo Pescasseroli-Candela that wins around 1%. Puglia maintains low percentages in this period, with the exception of the Regio Tratturo Pescasseroli-Candela where it exceeds 2%, which is already an index of growing pressure. What did change was the DU 2000 desk and other sources what also brought large land use percentage numbers especially

in Puglia. Specifically, in Puglia, the contents of the Aquila-Foggia, Celano-Foggia, Lanciano-Cupello, and Pescasseroli-Candela Tratturi are greater than those of DU 50, exceeding even 10%. Notably, Abruzzo and Molise maintain their high percentages, especially for the Aquila-Foggia, Celano-Foggia and Centurelle-Montesecco Tratturi, while Campania is marginal, excepted for a few routes such as the Pescasseroli-Candela Tratturo. At the same time, these data also show a significant increase in land use along the Tratturi in the regions of Abruzzo, Molise, and Puglia, with more than 4% increase of DU 2000 along the Tratturi axis. This trend might suggest more anthropogenic and urban pressure that might impact the ecological function and historical value of these ancient routes. Indeed, with reference to Puglia, such growth data from DU 2000 may reveal important variations in territory-dynamics, of significance with respect to conservation of the Tratturi and development of soft tourism, ecological connectivity and sustainability. In summary, the analysis of the land use along the Tratturi in the studied areas highlights the different levels of the territorial pressure between the three regions, where Abruzzo, Molise and Puglia find the highest values of pressure. This trend emphasizes the need for specific planning interventions aimed at the conservation of the ecological and historical-genetic sensibility of the Tratturi, with particular regard to the heaviest territorial pressure regions.

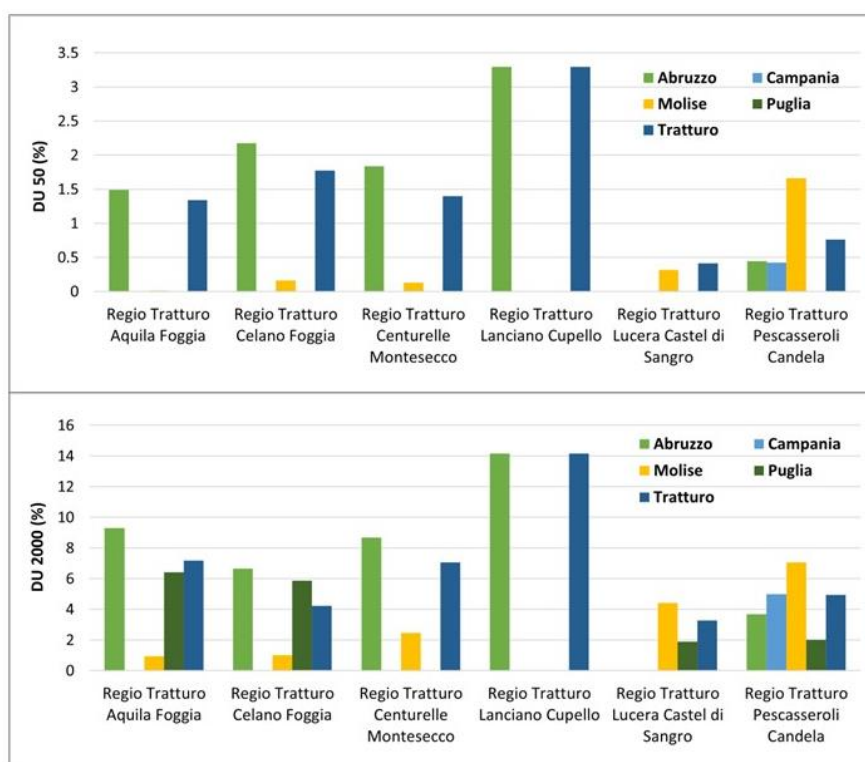


Figure 5. Urbanization Density (%) in 1950 and 2000. Source: Authors' elaboration.

The system density (DIn) gives an idea of how much infrastructure in relation to the reference area [Zullo, 2023]. For the calculation, Open Street Map (OSM) serves as the database, as it delivers more complete data compared to aggregates of regional sources, including service roads and agricultural access roads. DIn is therefore an useful metric for quantifying the fragmentation in an ecological graph and to locate those novelties to tackle measures for connectivity improvement. Recent infrastructures have cut to pieces the Tratturi, limiting their efficiency as biodiversity corridors or tourist routes. Figure 6 presents the kilometers of different infrastructure types along six major Tratturi in southern Italy,

offering understandings about the level and nature of development across the regions.

	Infrastructures (km)									
	Highway	State road	Railways	Roads in residential areas	Regional and provincial roads	Service roads	Municipal roads	Roads for agricultural areas	Unclassified roads	Total
Regio Tratturo Aquila-Foggia	9.02	48.39	11.13	25.97	27.47	35.81	67.81	60.69	31.86	318.15
Regio Tratturo Celano-Foggia	6.09	19.86	4.61	10.84	18.27	19.24	20.30	68.20	25.84	193.24
Regio Tratturo Centurelle-Montesecco	0.48	7.31	0.44	14.68	5.41	10.31	30.88	38.81	23.77	132.09
Regio Tratturo Lanciano-Cupello	0.10	0.00	0.15	5.66	2.42	4.57	14.49	8.63	7.03	43.05
Regio Tratturo Lucera-Castel di Sangro	2.77	7.41	0.34	6.16	5.15	3.90	10.86	52.75	7.44	96.78
Regio Tratturo Pescasseroli-Candela	3.38	11.55	1.60	7.31	2.32	9.64	13.16	26.87	21.24	97.06

Figure 6. Infrastructure Endowment Index in the Tratturi. Source: Authors' elaboration.

The Regio Tratturo Aquila-Foggia, Celano-Foggia, Centurelle-Montesecco, Lanciano-Cupello, Lucera-Castel di Sangro and Pescasseroli-Candela are among the Tratturi listed. The Aquila-Foggia and Celano-Foggia sheep tracks have a higher infrastructural diversification than the others, with abundant presence of state, municipal and agricultural roads. This structure shows a higher level of urbanization and good integration with regional networks promoting access locally and in rural zones. The latter, however, are mainly composed of agricultural and unclassified roads, with a low degree of urbanization. That configurational preservation might reflect a preservation of the historical and rural character of these areas. Lastly, the Lanciano-Cupello Tratturo, the one having the least infrastructural development overall, widespread municipal and agricultural roads, due to the few regional interconnections. Contrasting with this, less completed tratto, as Lucera-Castel di Sangro, Pescasseroli-Candela and Lanciano-Cupello, have retained a mostly rural function that to preserve in the territory cultural and environmental backgrounds. This analysis reveals significant variations in the distribution of infrastructure across the Tratturi which correspond to their differing functions. Tratturi where this percentage is higher (e.g., Aquila-Foggia and Celano-Foggia) could thus be important arteries for local communities, as well as for agricultural carrying on, thus more easily in sight of urban development pressures. Dotted around the Tratturi with its vast stretch of roads or minor unclassified roads like the Lanciano-Cupello that benefit from a conservation standpoint has remained a better choice from an ecological and historical point of view. As— related information provides the bases of developing sustainable development and conservation strategies for the respective regions. This implies that for lesser developed tracts of Tratturi, focus would lie with each regional planner ensuring ecological continuities and protection of culture, should any development be allowed while the opposite would apply to highly developed areas. Urban proximity and degree of urbanization will need to be analyzed and factored into determining ecological quality of these lands. Land of finale: Since Tratturi enters into a buffer zone here, the description can help spatial analyse when compared with adjoining urban settlements. Upon this foundation, it becomes possible to consider some parameters intended to imposed as regards whether Tratturo continues to practice ecological asset in its primary function, that being the reduction of pollution, increase of biodiversity and so on and so forth. This provides an analysis that helps identify what sections still provide these and what is impacted by built environments and urban planning. Abounding ecological sustainability of Tratturi regions, the methodology contributes to decision making processes for Tratturi protection, protection and enhancement. This is still a nascent process, but it will be crucial in grasping the spatial and ecological significance of the routes.

4. Revitalizing Tratturi: Challenges and Opportunities

The lack of resources and infrastructure along the Tratturi does not allow these paths to be simply transformed into green infrastructures for tourism and ecosystems. Many of these paths cross economically and demographically disadvantaged areas in the Italian Apennines, where local administrations often lack the funding to invest in tourism infrastructure or ecological restoration. Slow tourism, however, offers a good approach to encourage the rediscovery of these places, creating local economies by initiating positive cycles [Fistola et. al., 2018; Gaeta et. al., 2019]. The "La via del Tratturo" project in Abruzzo and Molise [La Via del Tratturo, 2020], which spans 112 kilometers across six stages, shows how Tratturi can support trekking and experiential tourism. With this route, people can renew their bond with the land and its cultural and natural heritage, making the most out of the ecosystem services. A master plan for the restoration of the Molise Tratturi was introduced in Molise in March of 2024. This plan focuses on revitalizing historical transhumance routes by integrating them with the cultural and tourism landscape of Molise's historic villages. The main goal is to bring these paths back to life, increasing their accessibility, but also, by coiling history into a spiral, showing village connections, and turning the Tratturi into biodiverse and ecologically competitive corridors. This approach creates local synergies that are important for the regional economy and the infrastructure that declines each year. The policies that are in line with the necessities of the region are the key to success in implementing projects like the Special Territorial Plans. These ancient itineraries require a comprehensive network of strenuous trails, as well as basic services, such as parking, the latter of which is vital to the tourism industry and the local economy in general. In the aftermath of these consequences, it is evident that the current initiatives reach only the local level which in turn leads to the non-fulfillment of the projects. The communities concerning the local Superintendencies are more secure and can render appropriate infrastructure for the implementation of projects because they have a good history and a detailed survey of the routes. One of the most apparent goals of these projects is to have an up-to-date mapping of the paths to make the project planning phase easier and already a map [Ulisse et.al., 2024].

5. Conclusions

The Tratturi in Southern Italy at the moment are on the crucial cusp of a turning point. These ancient roads, whose past existence was of great importance for the transhumant movement and the local economy, are now being transformed into green infrastructures with the ability to accelerate long-term sustainability in these rural areas. Though, to maximize their role as important ecological corridors, as well as the resources which can be derived from them as objects of cultural and tourism, a few major issues need to be resolved: information voids, infrastructure deficiencies, unproductive territorial management, and lack of attention from the local planning authorities. The work presented here indicates that the identification of an ecological function for the Tratturi and the development of slow tourism require targeted action laid down at the regional or Tratturi-wide scale, complemented by science-based and numerical data. The survey reveals that biodiversity conservation and the economic potential go hand in hand with the proper use of technology. Their ability to protect biodiversity and bring about sustainable economic growth depends on integrated planning and using new tools and techniques for effective monitoring and control activities. Adding the Tratturi to slow channels of mobility provides one avenue to conserve and develop cultural and natural heritage but entails a full understanding of their present state and related problems. Accurate and up-to-date data are the key components of sustainable interventions that retain the intrinsic value of these landscapes. In short, Tratturi conservation is an emerging sector but still affected by social (especially economic) processes and policies, requiring tailored interventions according to land use and the morphological nature of routes (Fig. 1; Table 4). Without a corridor through degraded areas they will be lost to the urban environment, so this is critically important. Intensive farming [where the same product is

grown in cycles, or multiple crops are grown on the same piece of land] is exacerbated by the regular hype of economies to re-encourage the farm owners, more than is required, further stressing them, while to help the case of the same will be more than businesses often resetting for growing crops and joining the local tourism sector. The good policies should be in the spirit of their initial intent, that is, the rehabilitation of old unspoiled tracks and the viability of compatible uses. The first step to take is an action plan established jointly with a local authority, a number of volunteers, farmers and a land management program. Through joint management mode of the reclaimed lands apprenticeships of the workers, identification with local cultural environment, the promotion of local tradition and sustainable development of the rural localities is as follows. On the other hand, the recognition of Transhumance as a World Intangible Cultural Heritage by UNESCO makes it not only historically relevant, and significant, but also from the point of view of local and international development. Only in this way, it will be possible to ensure a sustainable recovery of the economy of the entire area, involving local authorities, tour operators, and environmental institutions as a key element of the synergistic and multidisciplinary approach adopted. The Tratturi are state-managed archaeological assets of primary and extraordinary importance. However, the situation is difficult since many Municipalities in the area do not have the specific master plans of their Tratturi networks (PQT) while many of them have not organized their GIS rooms for relative access. The 1983 decree was approved which added the obligation of drafting PQT but did not specify any deadline, so many towns and cities, however continuous their demands for these plans, have been and remain behind. The delay originated from this and also from the transparent procedure that does not respect the regulation and created in this way many administrative problems and consequently it did not allow the proper evaluation of the condition of the land of the Tratturi. To improve management, it should be made an integrated SIT with the Territorial Information System to make the processing of permits and planning clearer and efficiency of the management and many of these processes should be online. The PQTs will have to be digitized, and all the municipalities will have to have the software to do that.

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