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D.1.4.5. Assessment of Transformation

Rijeka, Croatia, Camerino, Italy, 2025.

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Content

1. Assessment of Transformation - assessment of transformation of natural cover and habitats for pilot areas.

1.1. City of Novi Vinodolski

1.1.1. History of the city and the characteristics of the City of Novi Vinodolski

Novi Vinodolski (known simply as Novi until 1953) is a town, port, and tourist center located in the Croatian Littoral. Situated on the coast of the Vinodol Valley near the Suha Ričina River, it lies 22 km northwest of Senj and 47 km southeast of Rijeka. According to the 2021 census, the town has a population of 3,336.

The origins of settlement in this area date back to prehistoric times, with continuous habitation documented from the Neolithic and Eneolithic periods through to the early Middle Bronze Age. The Liburnians, and later the Iapodes, left behind traces of their cultures, including a hillfort constructed by the Iapodes on Veli Osap Hill.

During Roman rule, the Lopar fortress was built at the springs in the bay of Lišanj. In the mid-13th century, the Frankopans constructed a castle to defend the southeastern entrance to the Vinodol Valley. Around this stronghold, a compact, acropolis-type settlement developed.

Novi Vinodolski was first mentioned in historical records in 1288, when representatives of the Vinodol municipalities gathered there to draft and sign the *Vinodol Statute* (*Vinodolski zakonik*)—the first legal code written in the Glagolitic script and the Old Croatian language.

In the 14th and 15th centuries, the Pauline monks were active in the area. In 1480, King Matthias Corvinus granted the citizens of Novi a charter of freedoms and rights.

Following the Ottoman invasion of Lika in 1493, Bishop Kristofor of the Krbava-Modruš Diocese moved the diocesan seat to Novi Vinodolski.

Until 1671, the town remained under the rule of the Frankopan family. It later came under the administration of the Hungarian Court Chamber, then the Austrian Court Chamber, and remained under royal governance until 1813. With the arrival of Napoleon's army, Novi Vinodolski transitioned to civilian authority.

The National Library was established in 1845. By 1948, the town had 1,505 inhabitants, and its population continued to grow in the second half of the 20th century, partly due to the migration of people from the immediate hinterland to the coastal region.

Throughout history, Novi Vinodolski has changed its name several times: Novi Grad, Novigrad, Novi, Novi in Vinodol, Novi Vinodol, now Novi Vinodolski.

In 1962, the Municipality of Novi was abolished and merged with the Municipality of Crikvenica. In 1992. It again became a City.

The administrative area of the City of Novi Vinodolski includes twenty statistical settlements: the central town of Novi Vinodolski and nineteen surrounding settlements—Bater, Bile, Breze, Crno, Donji Zagon, Drinak, Gornji Zagon, Jakov Polje, Javorje, Klenovica, Krmpotske Vodice, Ledenice, Luka Krmpotska, Podmelnik, Povile, Ruševo Krmpotsko, Sibinj Krmpotski, Smokvica Krmpotska, and Zabukovac.

The larger settlements are predominantly located along the coastal belt, following the natural terrain. Positioned between the sea on one side and hills on the other, these settlements are more densely clustered. In contrast, those in the hinterland are smaller and more dispersed.

The City of Novi Vinodolski is located in the central part of the Primorje-Gorski Kotar County. It borders the City of Crikvenica and the Municipality of Vinodol to the northwest, the Municipality of Mrkopalj to the north, the island municipalities of Vrbnik

and Baška (on the island of Krk) to the south, and Karlovac and Lika-Senj counties to the east.

Geologically, the area is composed entirely of sedimentary deposits, dating from the Triassic, Jurassic, Cretaceous, Paleogene, and Quaternary periods.

The entire Croatian Littoral, including the area of Novi Vinodolski, is seismically active. This seismic activity is caused by the subduction of the Adriatic Plate beneath the Dinaric Alps at depth.

The coastal zone is characterized by a solid rocky foundation, a highly indented shoreline, and rich micro-relief features. The coastline is predominantly rocky, interspersed with occasional gravel and sandy beaches.

Within the city's territory lies the uninhabited islet of San Marino, located approximately 200 meters from the coast near the town of Novi Vinodolski. The city's maritime area covers 65.24 km², while the length of its mainland coastline is 27.54 km.

Primorje-Gorski Kotar County is the second most developed county in Croatia, with a gross domestic product of €3.876 billion (as of 2016). The county's key economic sectors include trade, manufacturing and related industries, and tourism. The City of Novi Vinodolski has followed a positive employment trend. The highest employment is concentrated in trade, tourism (accommodation and food services), and manufacturing, which also represent the city's main sources of income.

Figure 1. Novi Vinodolski

Figure 2. Novi Vinodolski hinterland

Figure 3. Novi Vinodolski hinterland - Zagon

Figure 4. Novi Vinodolski hinterland

1.1.2. Spatial plans

In the area of the City of Novi Vinodolski, the Spatial Plan of the City of Novi Vinodolski and urban and detailed plans are applied as follows:

Spatial Plan of the City of Novi Vinodolski

1. PPUG Novi Vinodolski (SN PGŽ 55/06, 23/10, 36/10, 1/13, 19/13, 13/14, 16/14, 41/15, 18/17, 32/17, 52/24)
2. PPPPO Vinodolske doline (SN PGŽ 30/04)

Urban regulatory plans:

1. UPU SIBINJ KRMPOTSKI 2 (T3-5) (SN PGŽ 03/22)
2. UPU ZAGORI 1 (SN PGŽ 34/20)

3. UPU poslovne zone Zapad 2023-07 (SN PGŽ 11/07,04/17)
4. UPU poslovne zone Kargač (SN PGŽ 11/07, 19/13)
5. UPU kampa Kozica (SN PGŽ 08/09)
6. UPU Panos (T2 2) neizgrađeni dio građevinskog područja - UPU 21 (SN PGŽ 17/09)
7. UPU naselja Novi Vinodolski 2023-01 (SN PGŽ 23/10, 36/10, 40/10, 19/13, 18/14, 21/16, 18/17, 19/18, 14/22, 41/22, 52/22)
8. UPU Muroskva (SN PGŽ 13/14, 10/22, 38/22)
9. UPU Porto Teplo 1 (UPU 17, T1-3) (SN PGŽ 04/17)
10. UPU novog groblja Novi Vinodolski (SN PGŽ 32/18)

Detail regulatory plans:

1. Provedbeni urbanistički plan Prisika (SN PGŽ 13/89, 46/89, 16/95, 08/99, 10/99, 32/06, 46/18)
2. DPU Centra Klenovice 2023-07 (SN PGŽ 21/98, 18/03, 10/08, 21/12)
3. DPU Autobusni kolodvor – ulaz (SN PGŽ 24/99, 04/00)
4. DPU TN Zagori (SN PGŽ 31/06)
5. DPU Turist - Lopar - Crveni Križ (SN PGŽ 24/99)

1.1.3. Land use

The administrative area of the City of Novi Vinodolski includes twenty statistical settlements: Novi Vinodolski, Bater, Bile, Breze, Crno, Donji Zagon, Drinak, Gornji Zagon, Jakov Polje, Javorje, Klenovica, Krmpotske Vodice, Ledenice, Luka Krmpotska, Podmelnik, Povile, Ruševo Krmpotsko, Sibinj Krmpotski, Smokvica Krmpotska i Zabukovac. Bigger settlements are mostly situated along the coastal line.

Number of inhabitants is: 4328 (in 2021), 5133 (in 2011). Area: 261,4 km2

Density: 16,6 inhabitants/km2

In the PPUG Novi Vinodolski (SN PGŽ 55/06, 23/10, 36/10, 1/13, 19/13, 13/14, 16/14, 41/15, 18/17, 32/17, 52/24) land use is defined as following: settlement construction areas cover 529.40 ha (2.0% of the city's area), with 435.30 ha (82.22%) built and 94.10 ha (17.78%) unbuilt, while designated construction areas outside settlements also span 529.32 ha (2.0%), with 73.77 ha (13.93%) built and 455.58 ha (86.07%) unbuilt. The total construction area is 1,058.72 ha, occupying 3.99% of the city's area, with 40.64 ha of unarranged settlement construction areas and 415.69 ha of unarranged designated construction areas, totalling 456.33 ha of unarranged construction land across the city.

Table 1 Built areas

Category	**Built Area (ha)**	**Unbuilt Area (ha)**	**Total Area (ha)**	**% of City Area**
Urban Built Areas	430.71	82.72	513.43	1.94
Built Areas for Other Purposes	76.25	466.33	542.58	2.04
Built Areas Total	506.96	549.05	1056.01	3.98

Source: PPUG Novi Vinodolski

Table 2. Total built area

	BUILT AREA (ha)	**UNBUILT AREA (ha)**	**TOTAL AREA (ha)**	**% OF CITY AREA**
CONSTRUCTION AREAS				

	BUILT AREA (ha)	UNBUILT AREA (ha)	TOTAL AREA (ha)	% OF CITY AREA
Construction areas within settlements	435.30	94.10	529.40	2.00
Total construction areas within settlements	435.30	94.10	529.40	2.00
Economic purpose – business	18.79	23.77	42.56	0.16
Hospitality-tourism purpose	52.42	48.58	101.00	0.38
Sports-recreational purpose	2.53	381.32	383.85	1.45
Infrastructure system areas	0.00	1.91	1.91	0.01
Total construction areas outside settlements	73.74	455.58	529.32	2.00
Total construction areas	509.04	549.68	1,058.72	3.99

Source: PPUG Novi Vinodolski

The data on areas were taken from the PPUG Novi Vinodolski, as the only document through which area calculations can be made. The total area of the city (land and sea) amounts to approximately 33,032 hectares. The land covers about 26,508 hectares, while the sea accounts for 6,524 hectares.

Settlement construction areas occupy a total of 529.40 hectares, which is 2.0% of the city's area. Of this, the built-up portion amounts to 435.30 hectares, representing 82.22% of the settlement construction area, while the unbuilt portion covers 94.10 hectares or 17.78%.

Separate construction areas outside settlements occupy a total of 529.32 hectares, which is also 2.0% of the city's area. Of this, the built-up portion amounts to 73.77 hectares or 13.93% of construction areas designated for specific purposes, while the unbuilt portion covers an area of 455.58 hectares or 86.07%.

The total construction area amounts to 1,058.72 hectares and occupies 3.99% of the total area of Novi Vinodolski.

The undeveloped portion of settlement construction areas totals 40.64 hectares, while the undeveloped portion of separate construction areas outside settlements amounts to 415.69 hectares. Altogether, for the entire city, this results in a total of 456.33 hectares of undeveloped construction areas.

Agricultural land, forests, and forest land are resources of national interest for Croatia and are under special protection. These areas are valuable natural and economic resources that must be actively utilized and protected from repurposing. The City of Novi Vinodolski encompasses a total of 523.78 hectares of agricultural land, 20,340.54 hectares of forest areas, and 4,581.53 hectares of other agricultural land, forests, and forest land, amounting to a total of 25,445.85 hectares or 95.99% of the city's total area.

Agricultural land is classified into particularly valuable arable soil, valuable arable soil, and other arable soil, with the majority categorized as valuable arable soil. Agriculture is a significant sector in the local economy with great potential for further development, particularly in viticulture. Besides grapevines, other crops such as figs, forest fruits, medicinal herbs, and flowers can be cultivated. Given favorable natural conditions like abundant meadows and pastures, beekeeping and livestock farming—especially sheep and goat farming—can also be developed. The number of family farms (OPG) and small

family farms (SOPG) is increasing, indicating that agriculture is becoming more prominent and agricultural land is being put to use.

Forest areas are divided into economic forests, protective forests, and special-purpose forests. Their total area amounts to 20,340.54 hectares or 76.73% of the city's total area, with economic forests being the most dominant type. The City falls under the administration of the Senj branch office for forest management, which oversees two forestry departments: Crikvenica Forestry and Novi Vinodolski Forestry. Most forests are state-owned, with a smaller portion privately owned.

The city also includes a closed quarry managed by Croatian Forests in Kolevratsko Polje ("Kolevrat – Rušica"), with its rehabilitation planned under the spatial plan (PPUG). Additionally, three locations have been designated for potential exploitation of mineral resources such as stone.

1.1.4. Protection of natural areas

Expansion of settlement construction areas

According to PPUG Novi Vinodolski (SN PGŽ 55/06, 23/10, 36/10, 1/13, 19/13, 13/14, 16/14, 41/15, 18/17, 32/17, 52/24), to expand settlement construction areas, two basic conditions must be met:

Overall built-up percentage:

- The total built-up area of settlement construction zones in the city must exceed 80% for the zones to be expanded by up to 20% of their built-up area.

Individual built-up percentage:

- If the construction zone is outside the ZOP (Coastal Area Protection Zone), its built-up area must exceed 50% to allow expansion by up to 30% of its total area.
- If the construction zone is within the ZOP, its built-up area must exceed 80% to allow expansion by up to 20% of its built-up area.

Areas Protected under the Nature Protection Act (Zakon o zaštiti prirode), according to PPUG Novi Vinodolski (SN PGŽ 55/06, 23/10, 36/10, 1/13, 19/13, 13/14, 16/14, 41/15, 18/17, 32/17, 52/24) are:

Strict Reserve:

- Bijele i Samarske stijene – 111,7 km2 - To ensure the protection, the expansion of hiking trails and construction of mountain shelters is prohibited, tourist and mountaineer visits are restricted to day trips only, all economic and other activities are banned.

Nature Park:

- Mount Bjelolasica (includes the outermost areas of the City of Novi Vinodolski) – the special spatial plan is required

Special Reserve:

- Tomšina, Bukova and Vodna Draga – 4,99 km2 – characterised by the nesting of rare endangered and protected birds of prey, inhabitated by a wild cat and an endangered petrophile community.
- Slopes of Veli Vrh above Tomšina Draga – 1.06 km² (within Novi Vinodolski: 0.55 km²) –characterised by the site of Velebit degenia (Degenia velebitica).
- Kolovratske Rocks (Kolovratske stijene) – 1,9 km2 – all spatial interventions are prohibited.
- Protected Landscape:
- Vinodol – 5,52 km2 (partial area) – the area is defend by a special plan and the protection activities are also defined by the same plan.
- Pleteno – 4,03 km2 – characterised by landscape value and the presence of the rare species of ants. Other environmental protection measures are also planned.

Monument:

- Cave „Špilja Va zagori“ - important habitat for various species of bats, which are all protected under the Nature Protection Act and of the Ordinance on Strictly Protected Species. Other species of fauna have been recorded (cave beetle). Special permission is required for all activities.
- spring „Vrulja“ in Žrnovnica Bay - no interventions are allowed in the vicinity of the spring.

Natural monument:

- natural pebble beaches of Novi Vinodolski and part of the Velebit channel - measures include a ban on embankment and construction in the sea and on the 100 m from the coastal zone and a ban on cleaning up marine vegetation deposits.
- Pliskavica - measures include a ban on filling and construction in the sea and on land 100 m from the coastal zone and a ban on cleaning the deposits of marine vegetation.
- puddles - measures include valorization and occasional cleaning.

Significant landscape at sea:

- Klenovica-Žrnovica – measures include: prohibition of backfilling and backfilling of habitats; preventing drying out; a ban on the clearing of marine vegetation; regulating anchoring, a ban on cage mariculture farming in specified zones; restriction of fishing

Cultural landscape:

- Vinodol (PPPO Vinodolske doline) – measures include: preserving natural features, protection of particularly valuable agricultural land from conversion, regular mowing or grazing, prohibition of filling the terrain outside the construction site, prohibition of endangering and changing the existing water regime, assuring that new construction and facilities are appropriate to the landscape.

Natural landscape:

- coastal area in City of Novi Vinodolski – it is prohibited to disturb the existing situation
- existing forests, forest limits and property limits

Natural habitats:

- sub-Mediterranean and epimediterranean dry grasslands; rocky pastures and dry grasslands of the EU - and steno-Mediterranean; littoral, thermophilic forests and downy mildew thickets – measures include: rational grazing and mowing regimes, plant protection products and mineral fertilizers, promotion of the revival of extensive livestock farming and preserving biologically significant species, preventing the introduction of non-native (allochthonous) species and genetically modified organisms.

Sea habitats:

- circalitoral solid bottoms and rocks; circalittoral sludge; infralittoral tiny sands with more or less silt; habitats of Posidonia – measures include: protection and enhancement of the favourable physical and chemical properties of seawater, treatment of urban and industrial wastewater discharged into the sea, prevention of illegal construction.

The Protected Coastal Area of the Sea (ZOP)

According to Spatial Planning Act (Zakon o prostornom uređenju NN 153/13, 65/17, 114/18, 39/19, 98/19, 67/23), the Protected Coastal Area of the Sea (ZOP) is a region of special interest to the State, encompassing coastal local government units. Spatial planning and usage within ZOP are subject to restrictions to ensure protection, sustainable development, and efficient economic use. These restrictions apply to land and islands within 1,000 meters from the coastline and sea areas within 300 meters from the coastline. Briefly those restrictions are:

The Spatial Planning Act requires to:

- Preserve and restore coastal/hinterland natural, cultural, and traditional values, promoting forest and native vegetation renewal.
- Protect land/sea environment, especially drinking water resources.
- Ensure free coastal access and public use of maritime property.
- Keep uninhabited islands for agriculture, recreation, visits, and research, without construction zones.
- Tie infrastructure development to landscape protection.
- Limit merging/expansion of construction zones, plan new ones outside forests.
- Restore abandoned industrial sites via reclamation or tourism/recreation.

Also:

- In restricted areas, construction zones can expand by up to 20% of their built-up area if it exceeds 80% of the zone's total surface.
- Isolated settlement construction zones within 100 m of the coastline cannot expand or be newly designated.
- New production-purpose construction zones outside settlements must be beyond 1000 m from the coast, except for coastal-dependent activities (e.g., shipyards, ports).
- If over half a construction zone is outside restricted areas, point 1 rules don't apply to its planning.

The Act also gives additional regulations for the planning and construction in this protected area.

Additionally, according to the PPUG Novi Vinodolski, within the City of Novi Vinodolski, the total built-up percentage for settlement construction zones is currently 82.43%, exceeding the minimum 80% required by the county plan for expansion.

According to PPUG Novi Vinodolski (SN PGŽ 55/06, 23/10, 36/10, 1/13, 19/13, 13/14, 16/14, 41/15, 18/17, 32/17, 52/24), for individual categories of protection, the County determines additional conditions for the construction and land use: Category I (Construction is prohibited), Category II (expansion of existing and the formation of new construction areas is prohibited. Construction outside the construction area of the building (in the function of the primary activity) is allowed), Category III (formation of new construction areas is prohibited), Category IV (all types of construction, expansion and formation of new construction areas are allowed, as well as the construction outside the construction area). These protection categories are applied to water springs, sea, surphace water, flooding areas, forests, agricultural soil, geotechnical aspects, and nature protection, all based on their categorisation.

1.1.5. National ecological network

Areas of ecologic network Natura 2000

The Ecological Network of the Republic of Croatia was declared by the Regulation on the Ecological Network (NN 124/2013), and represents the areas of the European Union Natura 2000 ecological network in the Republic of Croatia.

According to PPUG Novi Vinodolski, areas of Conservation Important for Species and Habitat Types (SPAs) are:

- HR2000190 Vlaška peć
- HR2000200 Zagorska peć at Novi Vinodolski
- HR2001299 Bijele i Samarske stijene
- HR2000854 Pleteno above Novi Vinodolski

- HR3000030 Mala Draga -Žrnovnica
- HR5000019 Gorski Kotar and northern Lika,
- HR2000856 Slopes of Veli vrh above Tomišina Draga
- HR2001302 Krmpotsko
- HR2001441 Bezdan nad Vučjakom

According to PPUG Novi Vinodolski, area of Conservation Important for Birds (POP) is:

- HR1000019 Gorski Kotar and northern Lika - Preserved suitable nesting habitats (open heaths and grasslands)

Table 3. Bird Species List

Croatian Name	**Znanstveni naziv vrste**	**English Name**
mala prutka	Actitis hypoleucos	Common Sandpiper
planinski ćuk	Aegolius funereus	Boreal Owl
vodomar	Alcedo atthis	Common Kingfisher
jarebica kamenjarka	Alectoris graeca	Rock Partridge
primorska trepteljka	Anthus campestris	Tawny Pipit
suri orao	Aquila chrysaetos	Golden Eagle
sova močvarica	Asio flammeus	Short-eared Owl
ještarka	Bonasa bonasia	Hazel Grouse
ušara	Bubo bubo	Eurasian Eagle-Owl
leganj	Caprimulgus europaeus	European Nightjar
crna roda	Ciconia nigra	Black Stork
zmijar	Circaetus gallicus	Short-toed Snake Eagle
eja strnjarica	Circus cyaneus	Hen Harrier
kosac	Crex crex	Corn Crake
planinski djetlić	Dendrocopos leucotos	White-backed Woodpecker
crvenoglavi djetlić	Dendrocopos medius	Middle Spotted Woodpecker
crna žuna	Dryocopus martius	Black Woodpecker
vrtna strnadica	Emberiza hortulana	Ortolan Bunting

sivi sokol	Falco peregrinus	Peregrine Falcon
bjelovrata muharica	Ficedula albicollis	Collared Flycatcher
mala muharica	Ficedula parva	Red-breasted Flycatcher
mali ćuk	Glaucidium passerinum	Eurasian Pygmy Owl
rusi svračak	Lanius collurio	Red-backed Shrike
sivi svračak	Lanius minor	Lesser Grey Shrike
ševa krunica	Lullula arborea	Woodlark
škanjac osaš	Pernis apivorus	European Honey Buzzard
troprsti djetlić	Picoides tridactylus	Three-toed Woodpecker
siva žuna	Picus canus	Grey-headed Woodpecker
jastrebača	Strix uralensis	Ural Owl
pjegava grmuša	Sylvia nisoria	Barred Warbler
tetrijeb gluhan	Tetrao urogallus	Western Capercaillie

Source: PPUG Novi Vinodolski

Guidelines for protection measures for ecological network areas indicate following protection:

- Regulate hunting and prevent poaching
- Provide incentives for traditional agriculture and livestock breeding
- Restore wet grasslands

1.1.6. Agriculture and Forestry

According to PPUG Novi Vinodolski, agricultural land, especially valuable arable soil, is considered a significant natural and economic resource. It is essential to protect it from repurposing and actively utilize it. Within the area of Novi Vinodolski, which spans 26,508 hectares, agricultural land occupies 624.78 hectares, representing 2.36% of the city's total area. Forest land covers 20,331.56 hectares, accounting for 76.70% of the city's area. This highlights the importance of forest land as a key resource for the city's

development. Historically, forestry and its related processing industries have been crucial development paths alongside tourism.

Around Novi Vinodolski, there are fields of varying quality used for agricultural production or grazing. These areas still hold potential for more intensive and higher-quality agricultural use. Forested regions, especially in Kapela, consist of mountainous pastures and meadows with exceptional landscape qualities that are integral to the overall value of the scenery. Additionally, small karst fields within Kapela offer unique beauty and should be preserved as they form the foundation for future economic (tourism) development.

According to PPUG Novi Vinodolski, the total forest land in Novi Vinodolski includes covered land: 20,243.28 ha, uncovered productive land: 37.44 ha, unproductive productive land: 91.40 ha, unproductive land: 268.14 ha, with the the total forest land amounting to 26,508 ha.

In the PPUG Novi Vinodolski, natural areas are defined as agricultural land, forest areas, other agricultural land, forests, and forest land, and marine areas, totalling 25,445.85 ha (95.99% of the city's area), with 523.78 ha of agricultural land, 20,340.54 ha of forests, and 4,581.53 ha of other agricultural and forest land.

Agriculture supports viticulture, cultivation of figs, forest fruits, medicinal herbs, flowers, beekeeping, and livestock (sheep and goat farming).

Forests, covering 76.73% of the city, are primarily economic, with coastal areas featuring low forests of holm oak and hornbeam, and higher areas dominated by beech, fir, and hornbeam, mostly state-owned with a smaller private share. The coastal areas are dominated by communities of downy oak (Quercus pubescens), white hornbeam (Carpinus orientalis), mixed forests of downy oak and black hornbeam (Ostrya carpinifolia), and forests of black hornbeam with autumn moor grass (Sesleria autumnalis). The slopes are dominated by beech forests with autumn moor grass, beech and fir forests, communities on rocky blocks, and lush grassy meadows. Mountains are dominated by pre-mountain beech forests.

The area faces a high fire risk, with most open-space fires caused by uncontrolled burning of weeds and plant waste on agricultural land.

Table 4 Agricultural Areas

	Total (ha)	% of Municipality area	Forest land area per capita (ha/person)
Particularly valuable arable land	64.36	10.30	0.25
Valuable arable land	534.00	85.47	2.01
Other arable land	26.42	4.23	0.10
Total agricultural areas	624.78	100.00	2.36

Source: PPUG Novi Vinodolski

Table 5 Forest Areas

	Total (ha)	% of Municipality area	Forest land area per capita (ha/person)
Economic forests	14,897.16	73.27	56.20
Protective forests	3,839.32	18.88	14.48
Special-purpose forests	1,595.08	7.85	6.02
Total forest areas	20,331.56	100.00	76.70

Source: PPUG Novi Vinodolski

Table 6 Agricultural and Forest Areas

	Total (ha)	% of Municipality area	Agricultural land area per capita (ha/person)
Agricultural areas	624.78	2.46	2.36
Forest areas	20,331.56	79.88	76.70
Other agricultural land, forests, and forest land	4,495.45	17.66	16.96
Total agricultural and forest areas	25,451.79	100.00	96.02

Source: PPUG Novi Vinodolski

Forests allow only essential management structures with special conditions, including a 50-meter buffer. Hunting in Novi Vinodolski requires a management plan; non-native game is banned. Agricultural land is for primary production (vineyards, olive groves, etc.), with rare infrastructure exceptions. In Vinodol Valley near Velo and Malo Polje, it is necessary to protect soil from highway construction, remediate slopes, preserve pastures, and monitor soil metals. "Transitional Slopes" near settlements require 80% agricultural use, preserving quality soils and improving them.

Table 7 Marine areas

Category	Area (ha)	% of Total
Water Areas - productionn	95.00	0.7
Aquatorium of regulated marine beaches within urban areas	154.00	2.5
Recreation	160.57	2.1
Other marine areas	6,114.43	94.7

Marine areas total	6524	

Source: PPUG Novi Vinodolski

1.2. Vinodolska općina

1.2.1. History of the municipality and the characteristics of the municipality Vinodolska općina

Vinodol Municipality, located in Primorje-Gorski Kotar County, lies in the hinterland of Crikvenica and Novi Vinodolski within the narrow flysch Vinodol Valley in the Croatian Littoral, stretching approximately 20 km from Kvarner Bay in the northwest to Novi Vinodolski in the southeast, separated from the sea by a limestone ridge and formed by terrain subsidence along a fault, with the Dubračina River flowing in the northeast and the Suha Ričina in the southeast, alongside the Hreljin–Novi Vinodolski road running nearly parallel to the Adriatic Highway.

The municipality includes four settlements, with Bribir, its administrative center, in the southeast, alongside Grižane-Belgrad and Drivenik.

Inhabited since the Stone Age, Vinodol was named Vallis vineariae by the Romans in the 2nd century BC, who built a road to Dalmatia and the Badanj fortress, later renamed by Croats, with the Frankopan and Zrinski families leaving a significant historical mark through centuries of rule, constructing nine castles in the former Vinodol Principality. The representatives were amongst those who signed the Vinodol Statute in 1288.

The area remained part of the former Crikvenica Municipality until Croatia's territorial reorganization.

Figure 5 Tribalj lake

Figure 6 Vinodolska općina hinterland

Figure 7 Vinodol Valley

1.2.2. Spatial plans

In the area of the Vinodolska Municipality, he spatial plans, urban and detailed plans are applied as follows:

Spatial Plan of the Vinodolska Municipality

1. PPUO Vinodolske općine (SN PGŽ 01/06, 19/09, 11/11, 13/15, 21/16, 30/20,27/24)
2. PPPPO Vinodolske doline (SN PGŽ 30/04)

Urban regulatory plans:

1. UPU 1 - Bribir (NA 11) i površina izvan naselja za izdvojene namjene (groblje – G1) (SN PGŽ 46/07)
2. UPU 2 - Tribalj (NA 21) i površine izvan naselja za izdvojene namjene (sport i rekreacija - R1 i groblje – G2) (SN PGŽ 46/07, 55/10, 35/23)
3. UPU 3 - Grižane - Belgrad (NA31) (SN PGŽ 46/07, 55/10, 10/11)
4. UPU 4 - Drivenik (NA 41) (SN PGŽ 46/07, 22/21)
5. UPU 7 - "Barci" (K12) (SN PGŽ 46/07)
6. UPU 8 - "Kamenolom" (K14) (SN PGŽ 46/07, 37/18)
7. UPU dijela građevnog područja naselja Podgori (dio NA1-5-3) (SN PGŽ 29/18)

Detail regulatory plans:

1. DPU povijesnog grada Drivenik (SN PGŽ 26/01)

1.2.3. Land use

The administrative area of the Vinodolska općina contains four settlements: Bribir, Drivenik, Grižane-Belgrad and Tribalj, each with further smaller settlements.

Number of inhabitants is: 3226 (in 2021), 3577 (in 2011).

Area: 152,9 km2

Density: 21 inhabitants/km2

According to the PPUO Vinodolske općine (SN PGŽ 01/06, 19/09, 11/11, 13/15, 21/16, 30/20,27/24), the total area of the built-up part of the construction area of all settlements in the Municipality is 489.68 ha. Planned construction areas are 532.29 ha (existing and new).

In Municipality Vinodolska općina, the total area for economic use is 10.00 ha, with the production zone covering 7.21 ha, of which 69% is built. The Primorje-Gorski Kotar County Spatial Plan allows a maximum of 10.00 ha for business zones. The hospitality-tourism zone spans 36.11 ha, and areas designated for sports-recreation use total approximately 17.44 ha.

Table 8 Built area

Category	Constructed Area (ha)	Unbuilt Area (ha)	Total Area (ha)	% of Municipality Area
Urban Construction Areas	489.68	42.61	532.29	3.51
Construction Areas for Other Purposes			75.52	0.5
Construction Areas Total				

Source: PPUO Vinodolske općine

Table 9 Built area

	BUILT-UP AREA (ha)	UNBUILT AREA (ha)	TOTAL AREA (ha)	% OF CITY AREA
Economic purpose – business	0.95	8.55	9.5	0.05
Economic purpose – production	4.95	2.26	7.21	0.06
Hospitality-tourism purpose	3.44		3.44	
Sports-recreational purpose	0.7	16.81	17.58	0.12
Infrastructure system areas			0.96	
Total construction areas outside settlements			75.52	0.5

Source: PPUO Vinodolske općine

1.2.4. Protection and natural areas

Expansion of settlement construction areas

According to PPUO Vinodolske općine, to expand settlement construction areas, the same two basic conditions must be as in the City of Novi Vinodolski, therefore it is already described in the 1.1.4. Protection and natural areas, in the first part of the chapter.

According to PPUO Vinodolske općine, some areas are protected:

Cultural landscape

- entire Vinodol Valley with all its settlements

Special Reserve

- Vinodol cliffs and hinterland (black Adriatic fir forest): ornithological-botanical reserve with rare fauna, unique flora.
- Rocky slope above Drivenik station: fir forest with ivy, linden, Apollo butterfly habitat.
- Ornithological-botanical reserve: nests endangered birds (white-tailed eagle, long-eared owl, kestrel, peregrine falcon), supports petrophilic birds, mammals, reptiles, alpine species; rare plants (campion, Wulfen's spurge, butcher's broom, holm oak).
- Forest vegetation reserve.

Protected landscape

- Vinodol Valley - Vinodol cliffs, Suha Ričina and Dubračina in Vinodol - This geomorphologically distinct area, features a flysch valley and watercourses hosting numerous continental species near the sea, while its steep south-facing cliffs and faults support both continental and Mediterranean species.
- Ravno-Lukovo-Maševo.

Nature monument

- areas of the peak part of Viševica.

Areas protected by PPPPO Vinodolske doline (SN PGŽ 30/04)

- Vinodol cliffs: Protect vegetation, prevent erosion, reduce instability/rockslide risks, remediate quarries/sandpits, ban waste dumping, avoid new builds on unstable slopes, prohibit plant/animal harm, non-native species, melioration, economic activities.
- Flysch groves/meadows: Preserve grassy areas, maintain natural flysch watercourses, continue landslide remediation, protect wetland forests/meadows, align new builds with landscape conservation.
- Terraced slopes: Revive traditional agriculture, align new developments with landscape conservation.
- Drivenik Castle hill: Preserve castle and surrounding landscape.
- Vinodol watercourses: Use hydromelioration for landscape/biodiversity, protect freshwater/wetland habitats, maintain footpaths for tourism, safeguard Tribalj Lake's landscape, water, fish, wildlife.
- Slani potok: Enhance landslide remediation, avoid new builds due to geological sensitivity.
- Velo polje - environmental and agricultural management measures.
- Malo polje – environment conservation measures.

The plan defines zone to preserve landscape values:

Zone I - Strict Protection (Special Reserve) it is required to: protect the highly valuable, sensitive natural landscape with minimal interventions, prohibit activities altering forests, cliffs, or springs, except for maintaining paths/roads or preventing rockslides, ban artificial afforestation of plateau grasslands, cliff climbing, and spring damage, allow scientific, educational, and limited tourism use (sightseeing), adapt infrastructure to strict landscape protection standards.

Zone II - Guided Protection (Protected Landscape) it is required to: preserve significant natural and cultural-historical areas, mainly cultivated landscapes, protect natural features, agricultural land from repurposing, and pastures/meadows via mowing or grazing to prevent forest spread, ban non-native species in native forests, except limited soil-stabilizing species for landslide remediation, continue landslide repairs and conduct water management, prohibit dumping construction waste outside designated areas or altering water regimes at sensitive biological sites, ensure new constructions match the landscape in size, function, and materials, protect key scenic views, maintain existing roads, build new access paths, and safeguard viewpoints from inappropriate interventions.

There are also some specific areas defined for the protection for their particular value such as ornithological-botanical reserves, protected landscapes, sensitive areas, biodiversity, Karst. All those areas defined by the plan are also protected by series of protective measures.

1.2.5. National ecological network

The area HR5000019 Gorski Kotar and northern Lika is area of Conservation Important for Species and Habitat Types (SPAs) and area of Conservation Important for Birds (POP). The characteristics and protection measures are described in 1.1.5. National ecological network.

1.2.6. Agriculture and forestry

According to PPUO Vinodolske općine, forests are categorized into economic forests, protective forests, and special-purpose forests, while the delineation of other agricultural land, forests, and forest land is based on criteria for distinguishing agricultural and forest land, allowing such areas to be used as designated for either forest or agricultural purposes. Water surfaces within the plan's scope include more than 25 bigger elements and also some smaller ones.

Table 10 Agricultural Areas

	Total (ha)	% of Municipality area
Particularly valuable arable land	71.45	4.7
Valuable arable land	352.04	2.3
Other arable land	1153.76	7.6
Total agricultural areas	1577.25	10.4

Source: PPUO Vinodolske općine

Table 11 Forest Areas

	Total (ha)	% of Municipality area
Economic forests	9474.67	62.5
Protective forests	1382.56	9.1
Special-purpose forests	539.87	3.5
Total forest areas	11397.10	75.15

Source: PPUO Vinodolske općine

Table 12 Agricultural and Forest Areas

	Total (ha)	% of Municipality area
Agricultural areas	1577.25	10.4
Forest areas	11397.10	75.2
Other agricultural land, forests, and forest land	1472.93	9.7
Water areas	110.91	0.7
Total agricultural and forest areas	14558.19	96.1

Source: PPUO Vinodolske općine

According to PPPPO Vinodolske doline agriculture, forestry and economic activities are also regulated.

Agriculture has to focus on organic farming (crops, fruit, vineyards, livestock) without mineral fertilizers, pesticides, or hormones.

Forestry and Hunting are obliged to manage commercial forests for ecosystem sustainability, enhancing public benefits, promoting seed-grown trees, and ensuring stable native vegetation for wood production. Protective forests prioritize ecosystem permanence and public functions, with sanitary felling of only diseased or fallen trees. Special-purpose forests (scientific) have strict usage limits. Hunting is commercial-recreational, supporting tourism development.

To protect agricultural land it is required to promote sustainable, intensive agriculture, focusing on drainage and irrigation, enhance viticulture, fruit, and vegetable production, monitor soil heavy metal pollution, prevent soil erosion, prioritize agricultural land, plan land consolidation and support family farms.

Other economic activities have to revitalize existing construction zones, allowing limited new buildings with approval from heritage protection authorities. It is necessary to avoid unnecessary settlement expansion; new constructions must respect local ambiance, traditional materials, and urban structure. Hospitality-tourism zones allow revitalization, repurposing, or new buildings that blend with the environment, subject to heritage approvals. It is necessary to use stone, wood, or brick for construction, respecting existing building proportions, and landscape with native plants. Mineral extraction sites are permitted for technical-construction stone.

1.3. CLC Change

1.3.1. Choice of the datasets

Datasets that cover the area of both administrative units was CORINE Land Cover. For example, Urban Atlas and Coastal Zones, do not cover whole area of both administrative units.

CORINE Land Cover (CLC) offers distinct advantages over raw satellite imagery for land cover analysis, particularly in the European context, due to standardized methodology and integrated design.

It uses consistent land cover classes across Europe, enabling cross-border comparisons and alignment with EU environmental policies. Updates are done every 6 years since 1990, so the CLC provides a multi-decadal baseline for tracking land cover trends. CLC is tailored for EU environmental monitoring and has 85% accuracy. CLC's 100 m resolution is insufficient for fine-scale features (e.g., small agricultural plots). 6-year updates may miss rapid changes.

1.3.2. Land use change

Land use/land cover (LULC) dataset used is CORINE Land Cover. Although the spatial and thematic detail of the dataset is relatively coarse with respect to the size of the research area (Tables 13,14), it is the only LULC dataset available that provides the LULC for the whole spatial extent.

Table 13 Comparison of spatial characteristics of the available LULC datasets

LULC database	Minimum mapping units (MMU)		Scale
	Area (ha)	Width (m)	
UA	0,25 (urban) / 1 (rural)	10	1:5000
CZ	0,5	10	1:5000 – 1:10.000
N2K	0,5	10	1:5000 – 1:10.000
CLC	25	100	1:100.000

Table 14 Comparison of thematic characteristics of the available LULC datasets

LULC database	No. of classes at the 1st Level	No. of levels		No. of classes at the last level	
		Artificial surface	Natural surfaces	Artificial surface	Natural surfaces
UA	5	4	2	16	5
CZ	8	4	3	20	8
N2K	8	3	3	9	8
CLC	5	3	3	11	11

UA: Urban Atlas; CZ: Coastal Zones; N2K: Natura 2000; CLC: CORINE Land Cover

CLC dataset is a pan-European land cover and land use inventory with 44 thematic classes, and it is updated with new status and change layers every six years. The most recent update is 2018.

Most of the research area is covered with the natural cover: broad-leaved and mixed forest, followed by the natural grasslands (Table 15, Figure 8).

Table 15 CLC classes in the research area

CLC 2018	Description	Area (ha)	Area (%)
112	Discontinuous urban fabric	659,68	1,60
133	Construction sites	1,57	0,004
231	Pastures	129,97	0,32
242	Complex cultivation patterns	61,18	0,15
243	Land principally occupied by agriculture with significant areas of natural vegetation	276,03	0,67
311	Broad-leaved forest	16157,92	39,10
312	Coniferous forest	2796,94	6,77
313	Mixed forest	12006,70	29,05

321	Natural grasslands	3796,87	9,19
323	Sclerophyllous vegetation	2626,49	6,35
324	Transitional woodland-shrub	2345,82	5,68
333	Sparsely vegetated areas	426,99	1,03
512	Water bodies	41,76	0,10

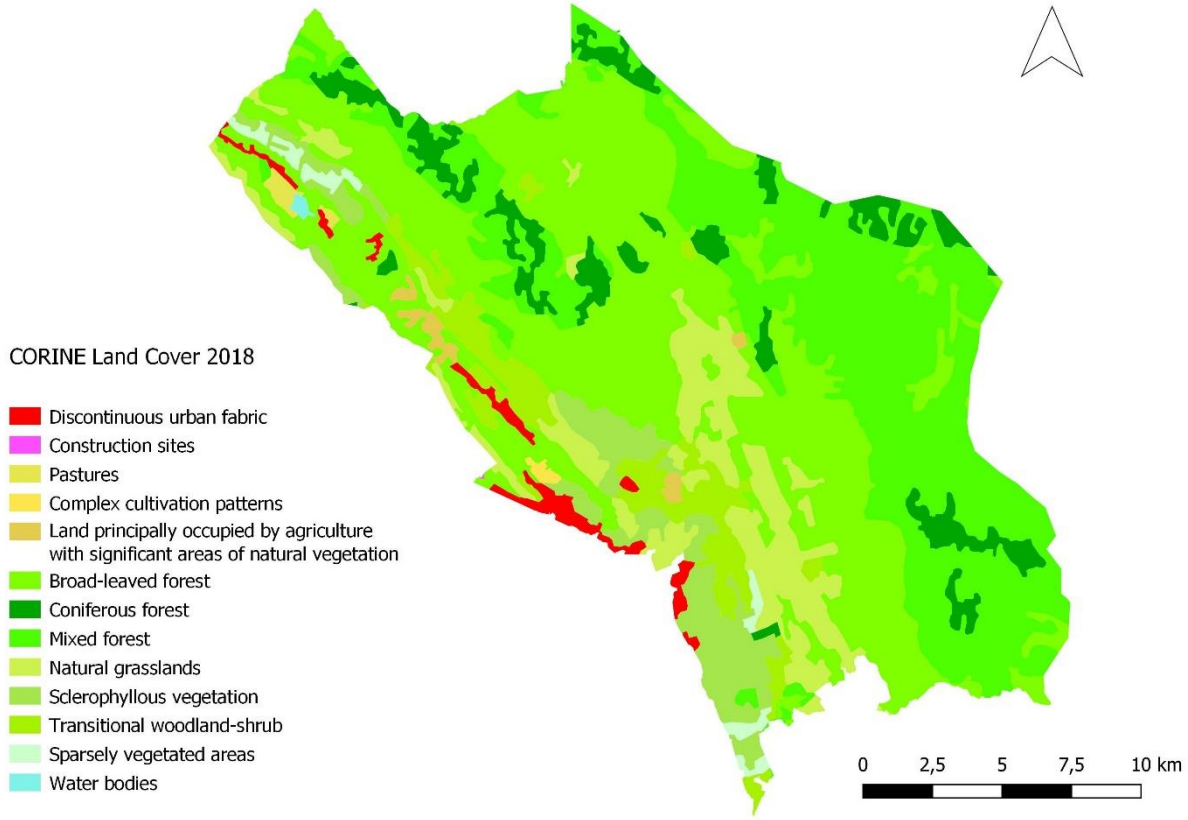


Figure 8 CLC classes in the research area

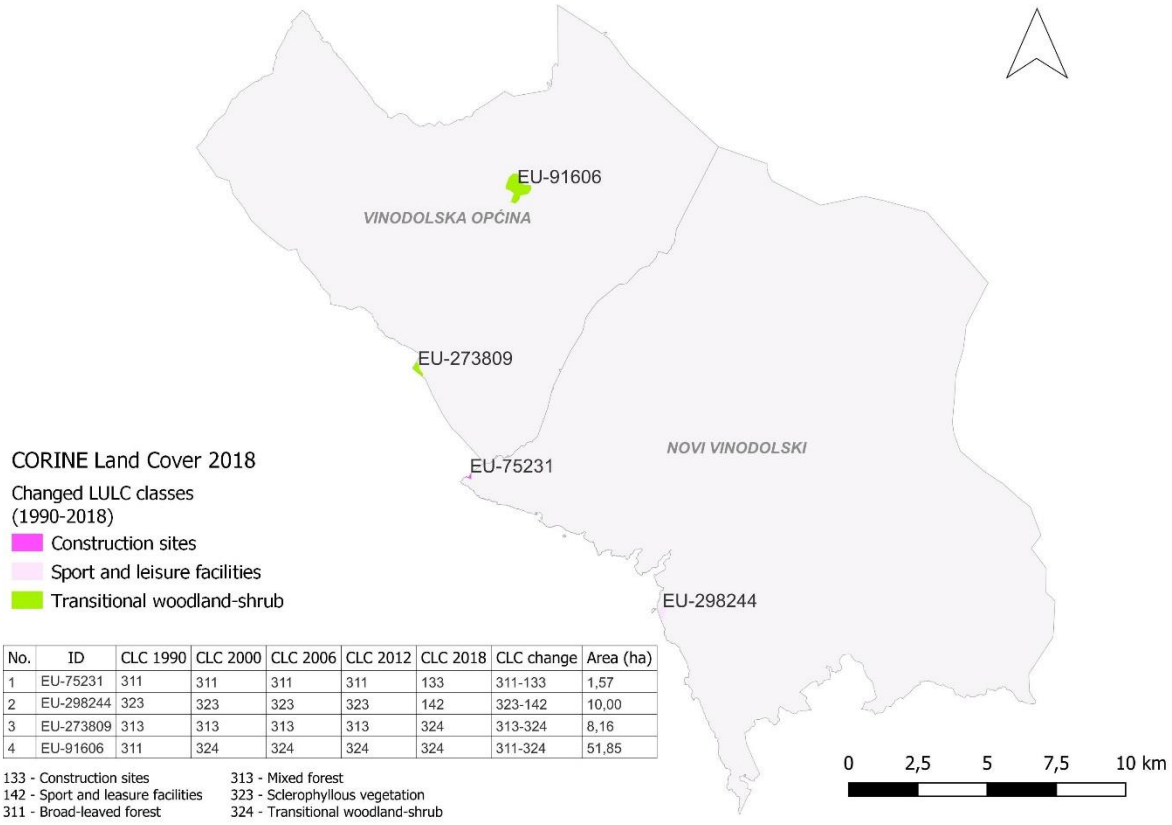
Change of the LULC for City of Novi Vinodolski already exist as a part od planning documents, but the same map was not done for the Municipality of Vinodolska općina or for the two administrative units that include landscape of Vinodolska valley.

Change of the LULC of the area is not significant (Figure 9): only small portion of the land have changed with respect to the management practices:

- 311-133: broad-leaved forest to construction site,
- 323-142: schlerophyllous vegetation to sport and leisure activities,
- 313-324: mixed forest to transitional woodland-shrub,
- 311-324: broad -leaved forest to transitional woodland-shrub.

1.3.3. Interpretation of CORINE Land Cover Changes (1990–2018) in Novi Vinodolski and Vinodolska Općina

The analysis of CORINE Land Cover (CLC) data from 1990 to 2018 reveals a limited spatial extent of land use and land cover (LULC) changes within the administrative areas of Novi Vinodolski and Vinodolska Općina. Only four distinct locations exhibit LULC transitions over the 28-year period, totalling less than 72 hectares in surface area. This low degree of transformation suggests relatively stable landscape dynamics and potentially effective spatial planning and environmental protection measures in place.



No.	ID	CLC 1990	CLC 2000	CLC 2006	CLC 2012	CLC 2018	CLC change	Area (ha)
1	EU-75231	311	311	311	311	133	311-133	1,57
2	EU-298244	323	323	323	323	142	323-142	10,00
3	EU-273809	313	313	313	313	324	313-324	8,16
4	EU-91606	311	324	324	324	324	311-324	51,85

133 - Construction sites
142 - Sport and leasure facilities
311 - Broad-leaved forest
313 - Mixed forest
323 - Sclerophyllous vegetation
324 - Transitional woodland-shrub

Figure 9 Change of the LULC during the period 1990-2018

Three primary types of change are observed:

- Urban development: A small area (1.57 ha) in the southern part of Vinodolska Općina (EU-75231) transitioned from broad-leaved forest (CLC 311) to construction sites (CLC 133), indicating localized anthropogenic intervention.

- Tourism and recreation infrastructure: In Novi Vinodolski (EU-298244), 10 ha of sclerophyllous vegetation (CLC 323) were converted into sport and leisure facilities (CLC 142), reflecting investment in the tourism sector.
- Natural succession or degradation: Two larger areas (EU-91606 and EU-273809, totaling nearly 60 ha) experienced transitions from forest cover (CLC 311/313) to transitional woodland-shrub (CLC 324), which may be attributed to forest degradation, abandonment, or natural ecological succession.

Spatially, the most significant land cover transition (51.85 ha) occurred in the northern section of Vinodolska Općina, while the coastal zone of Novi Vinodolski is more affected by tourism-driven changes.

1.4. Conclusions

The limited extent of land use change, alongside the high level of spatial protection observed in the two administrative units, suggests that current regulatory frameworks — particularly those imposing restrictions on urban expansion and enforcing environmental protection across designated protected areas — are effective in mitigating significant landscape transformation, at least in terms of spatial extent.

Future research should increasingly focus on the qualitative dimensions of land use change, such as the visual and ecological impact of succession areas, or the performance and coverage of infrastructure and public services, as well as the possible impact of such high restrictions on the development possibilities.

Given that most settlements have reached their maximum designated built-up area, it is advisable to strengthen monitoring of social and demographic needs to avoid inadvertently constraining sustainable growth and development.

1.5. Literature

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Artificial intelligence was used to extrapolate data, edit text and translate the study.

1.6. Part 1 REPORT – Pescara, Montesilvano, Spoltore

1.6.1. The history of the Abruzzo and Pescara Coast

The Pilot Area Pescara-Montesilvano-Spoltore, in its coastal part, belongs to a section of the central Adriatic coast of Italy characterized by an "urban-dominated" landscape, with an urbanization density exceeding 40-50% and the presence of environmental components and constraints generally below 20% (Romano, et al. 2015). This coastal system has historically experienced alternating phases of anthropization and abandonment. It is well documented through texts and maps that coastal forests of various types once covered the area, forming a vast and dense woodland, also referred to as "selve," composed of both conifers and broadleaf trees. These forests were highly significant for the local population as a source of sustenance. Moreover, the earliest cartographic representation of Pescara's ancient coastline (1647) depicts a dense pine forest extending from the mouth of the Pescara River to the Salino River (Cumara flumen), covering an area that could be estimated at least 10,000 hectares, encompassing the entire territory between Pescara and Montesilvano.

Figure 10 Map "Abrvzzo citra, et vltra", Benjamin Wright in scale 1:360000 (1647)

According to the sources, this pine forest extended as far as the Vomano River to the north. The central tree species of the Pescara coastal forest was "Pinus halepensis". The existence of this vast coastal pine forest (Selva dei Chiappini) in the 14th century was reported by Muzii (1923) and documented in a text titled "Platea storica di Pescara" (1713). The forest was so extensive and the human population density so low that only areas near towns could be exploited. Razzi (1576) described it as: "so beautiful that it framed the sea." In 1653, massive logging of this forest took place to strengthen the Fortress of Pescara. Palma (1837) described the entire Abruzzo region, also referring to its vegetation: "At sea level, Vitex agnus-castus (chaste tree), Pistacia lentiscus (mastic

tree), Rosmarinus officinalis (rosemary), Myrtus communis (myrtle), Juniperus deltoids (prickly juniper), and Pinus halepensis (Aleppo pine) grow naturally."

Over time, the transfer of land to private owners and the intensive use of soil—first for agriculture and later for urbanization—led to changes that compromised the coastal area's identity, slope stability, and biodiversity. This process reduced and altered biotic communities and populations, often leading to the extinction of plants and animals (Pirone & Conti, 1996). Today, only small remnants of the ancient forests remain, and ecological restoration efforts face significant technical, political, and socio-economic challenges. These transformation processes became particularly aggressive in the early 19th century when many coastal forests and lowland woods were destroyed to encourage the formation of small private properties and expand cultivated fields. Further forest fragmentation occurred after the unification of Italy due to the construction of railways, with “Quercus” wood being highly sought after for railway sleepers.

Between the 19th and 20th centuries, the Abruzzo coastal area still retained significant landscape features. The poet Gabriele D’Annunzio described his memories of the Pescara Adriatic coast, calling it “wild and green like mountain pastures.” Between the two World Wars, most of the area was already dedicated to agriculture and livestock farming. The ancient forests had almost entirely disappeared, and land reclamation was nearly complete. Coastal towns began to emerge, inhabited by farmers, fishermen, herders, and merchants. Meanwhile, tourism among the wealthy began to develop, leading to the construction of “garden cities” with villas surrounded by parks featuring exotic plant species. During this period, the city of Pescara undertook a significant afforestation campaign, planting trees along city streets for ornamental purposes. However, up to the present day, with the explosion of tourism, concrete has replaced nature along the Abruzzo coast (Cianfaglione et al., 2014).

1.6.2. Present Days

The study of the Main Physiographic Units (UFCP) of the Adriatic coast, aimed at analyzing coastal dynamics along with assessing adaptation actions to the effects of climate change (Zullo et al., 2021), evaluated the extent of land use/land cover transitions for UF 2 (Coastal Areas of the Abruzzo and Marche Regions) over the period 2012-2018. It highlighted the area between Ancona and Pescara as one of the most affected by transformative processes.

Table 16 Extent of land use/land cover transitions for each of the investigated UF (time frame 2012-2018)

Main Coastal Physiographic Unit	From agricultural to urban	From natural to urban	From agricultural to natural	From natural to agricultural	% of total transitions from other uses to urban	Surface area subject to land use/land cover change
UF2	183,17 ha	54,68	56,43	23,22	24,246	981

From a settlement and demographic development perspective, the coastal area of the Abruzzo Region can be divided into two distinct sectors: a northern and a southern part, with the pilot area at the center, represented by the coastal municipalities of Montesilvano and Pescara. Since 1950, particularly between 1960 and 1980, the Abruzzo coast experienced an average population increase of +128%, while urbanization reached +718%. In the northern part, demographic changes were consistently positive; the municipality of Montesilvano recorded the highest population growth at +635%, while total urbanization variation reached +1800%. The municipality

of Pescara has a population density of 3,479 inhabitants/km², which is significantly high compared to the national average (around 200 inhabitants/km²) and the regional average (around 120 inhabitants/km²) (Montaldi et al., 2024). The southern zone, on the other hand, is characterized by minor variations, except for the settlement systems of Vasto and San Salvo. This is mainly due to the recent development of coastal tourism. Urbanization began to decline across the coast from 1980 and stabilized between 1990 and 2010. Currently, the rate remains nearly unchanged, and future inferential projections up to 2050 do not indicate significant variations [60]. More specifically, considering environmental, settlement, and economic characteristics, a further subdivision can be made. In the northern section, corresponding to the coastal area of the Province of Teramo, a dense settlement system has developed over time, along with productive and tourism-related activities, leading to increased human activity. The beach is sandy, and the area includes a marine protected zone (Torre del Cerrano) and a regional nature reserve (Riserva Regionale del Borsacchio). The presence of the port of Giulianova and the A24 highway makes this one of the most developed areas in the entire region. The central section is characterized by low sandy beaches and includes the study area with the municipality and city of Pescara, the primary economic hub of the entire Abruzzo Region, and the municipality and city of Montesilvano.

The municipality of Spoltore lies behind this coastal system and is predominantly hilly. This central area ends at the Pescara River canal port and features the regional reserves of *Pineta Dannunziana* and *Santa Filomena*. The port is connected to the highway and the nearby Abruzzo Airport (the region's only airport). South of Pescara, the coastline continues with low sandy beaches, but near the port of Ortona, the coast becomes predominantly high and rocky. Unlike the northern and central parts of the region, this stretch has a strong agricultural presence. The fourth and final section is primarily rocky and ends at the mouth of the Trigno River. Here lies the regional protected area known as the Riserva Naturale alla Foce del fiume Sinello (within the southern border of the municipality of Casalbordino). Although settlement pressures along the Adriatic coast have significantly decreased compared to the levels recorded in the past century, environmental degradation and the decline in ecosystem quality remain critical issues.

The pilot area is the most densely urbanized along the Abruzzo coast and holds a central position within the regional context.

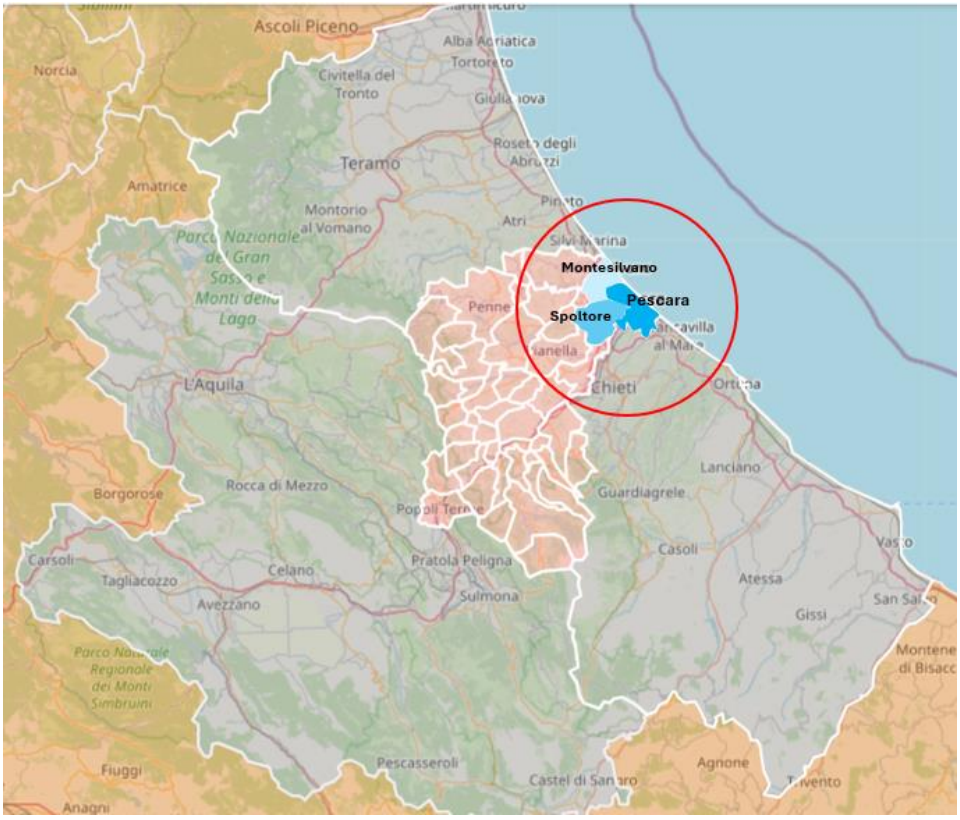

Figure 11 Study area

Based on the ISTAT series from 2006 to 2023, the following characteristics emerge:

- **Pescara**: Municipal area of **33.95 km²** (3,395 hectares) with a population of **118,829 inhabitants**.
- **Montesilvano**: Municipal area of **23.37 km²** (2,337 hectares) with a population of **53,493 inhabitants**.

- **Spoltore: 37.04 km²** (equivalent to 3,704 ha) with **19,066** inhabitants

Table 17 Main data on study area

Consumed Soil at 2006 Ha	**Consumed soil at 2006 %**	**Consumed soil at 2016 Ha**	**Consumed soil at 2016 %**	**Consumed soil at 2023 Ha**	**Consumed soil at 2023 %**	**Population**
Pescara						2024
1713,99 ha	50%	1747,48	51%	1768, 83	51,59%	118.829
Montesilvano						
757,36 ha	32,12%	786,9	33,37%	805,93	34,18%	53.493
Spoltore						
429,65 ha	11,65	443,49	12,02%	459,32	12,45%	19.066

This area, which is undergoing a merger process of the three municipalities under study, set to be completed in 2027, is part of the conurbation formed by the integration of the cities of Pescara and Chieti. This urban expansion and industrialization process in the Pescara metropolitan area began in the 1950s. According to Eurostat, the Functional Urban Area (FUA) of Pescara had approximately 238,500 inhabitants in 2023 [ec europa eu, 2024], while a 2013 OECD study estimated the population at 363,000 inhabitants (OECD, 2013). The extensive urbanization along the central Adriatic coastline has led to a gradual reduction in the surface area of natural and semi-natural environments and an increase in their isolation. The resulting decrease in ecological connectivity negatively affects the resilience and capacity of habitats to provide ecosystem services, improve air quality in urban areas, and support the health of city residents. Territorial and landscape fragmentation is a key factor in protecting, conserving, and enhancing the EU's natural capital. Therefore, it must be considered in spatial and landscape planning at various territorial levels. Below are a series of images

extracted from the ECOATL@NTE ISPRA platform (https://ecoatlante.isprambiente.it/) that assess land use in the pilot area.

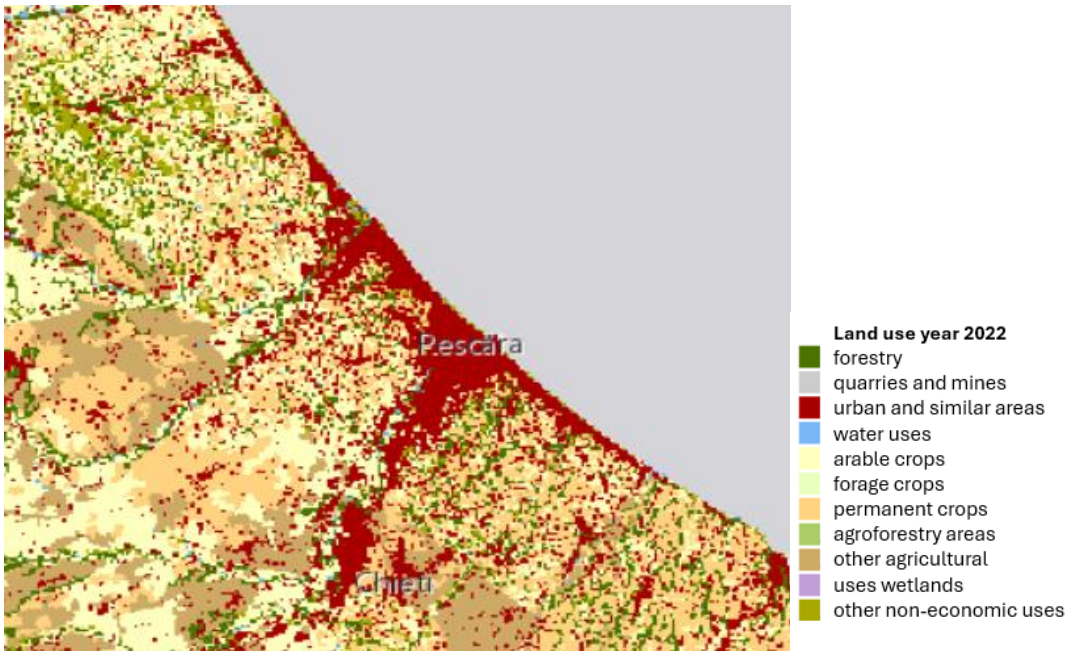

Figure 12 Land use

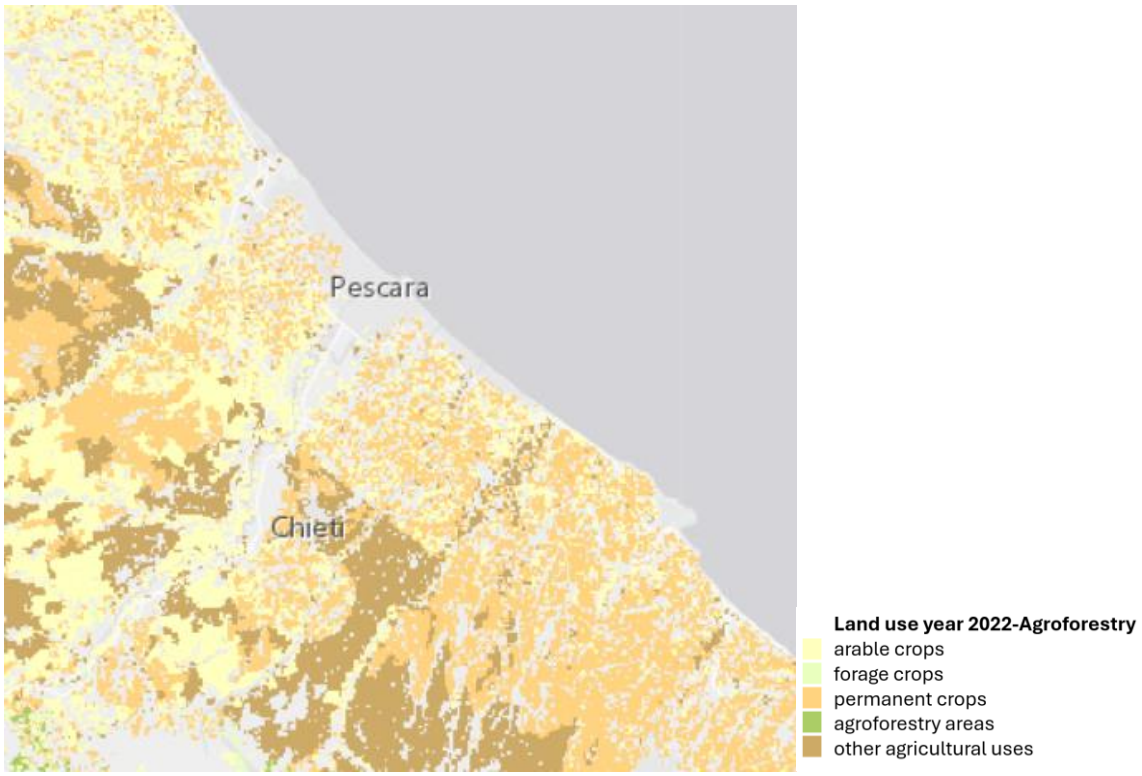

Figure 13 Agroforestal use at 2022

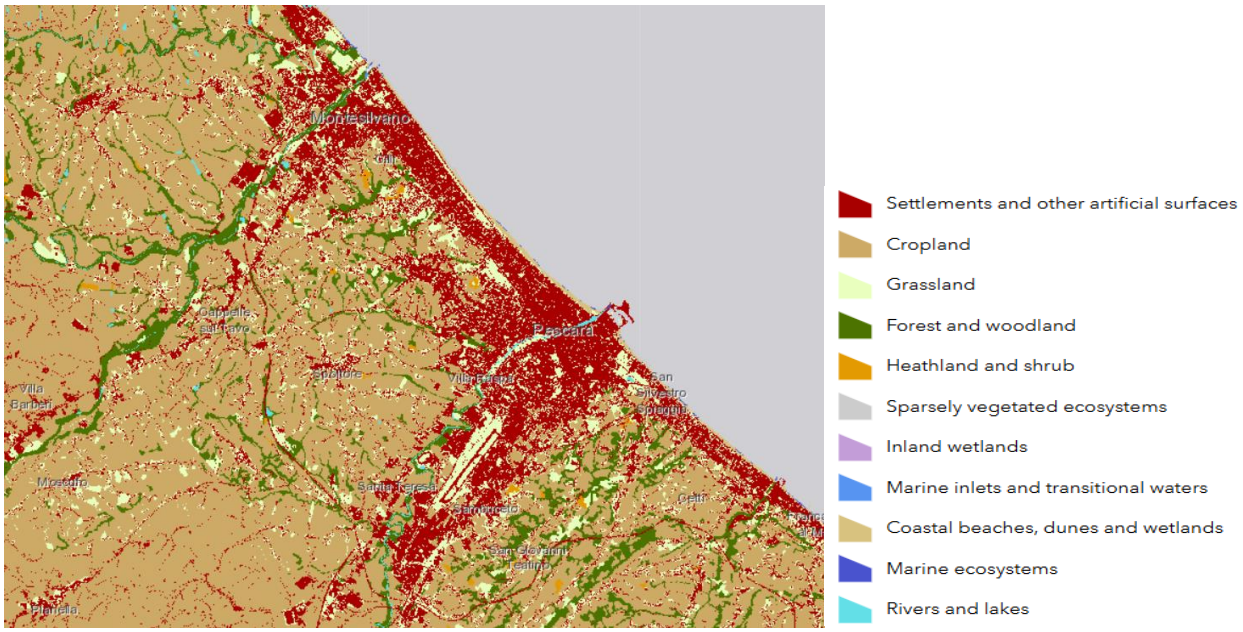

Figure 14 Ecosystem Type

Calculated based on a regular 1 km² grid (reporting unit), considering artificial land cover as the fragmenting element, evaluated through analyses conducted on the ISPRA-SNPA national land consumption map.

For assessing the level of fragmentation using effective mesh density, the five fragmentation classes identified by the European Environment Agency for the Landscape Fragmentation Indicator - Effective Mesh Density (Seff) were considered:

Table 18 Fragmentation classes

Seff (n° meshes per 1.000 km²)	**Fragmentation class**
(0 – 1,5]	very low
(1,5 – 10]	low
(10 – 50]	medium
(50 – 250]	high
> 250	very high

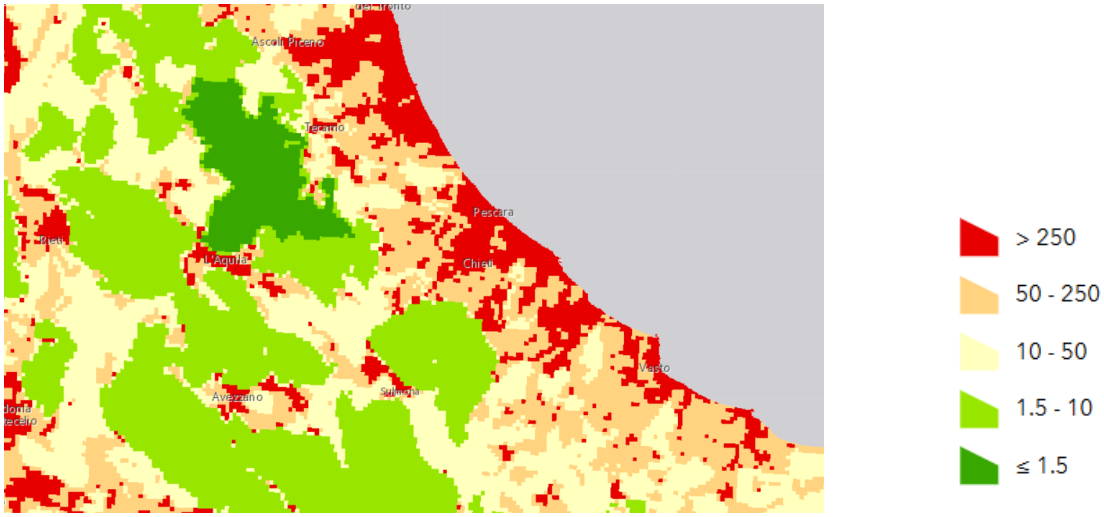

Figure 15 The level of land fragmentation as of 2022

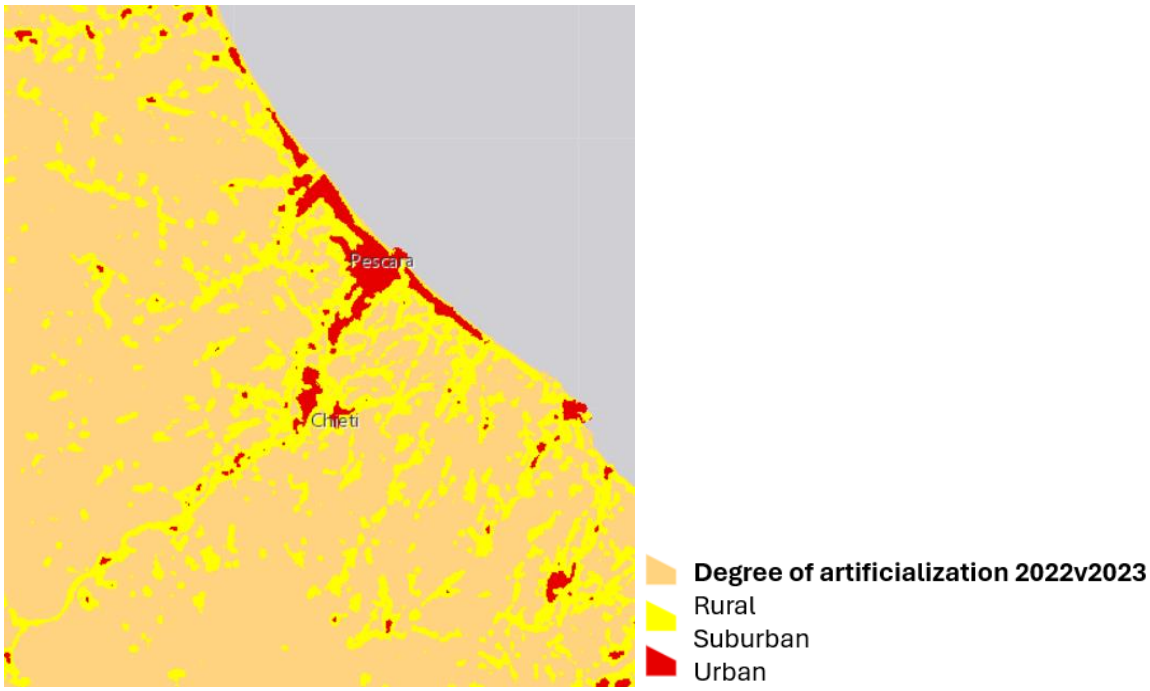

Figure 16 Degree of artificial transformation

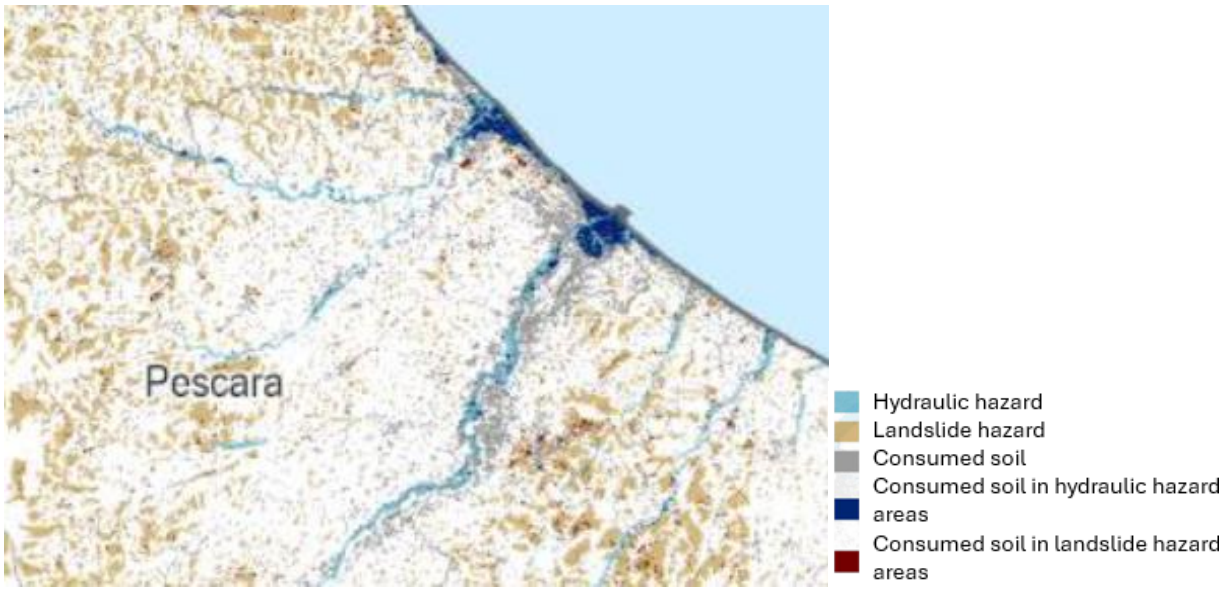

Figure 17 Soil consumed as of 2022 in areas with hydraulic hazard. From Regional Sheets. Land Consumption, Territorial Dynamics, and Ecosystem Services. SNPA System Report 37, 2023.

From these maps, the extreme fragility of the environmental system along the coastal territory of the Abruzzo Region emerges. In response to this fragility, two European projects—Life Calliope and Life+ A_GreeNet—have studied the natural coverage of this area from two different perspectives. The Calliope Project has focused on coastal dune habitats, while the Life+ A_GreeNet project has analyzed the ecosystem services provided by green areas. However, the latter does not cover the entire Abruzzo coastal area and, in our study area, includes only the municipality of Pescara.

1.7. Life Project "Calliope"

CALLIOPE stands for Coastal dune hAbitats, subLittoraL sandbanks, marInereefs: cOnservation, Protection, and thrEats mitigation (coastal dune habitats, sandy seabeds,

marine reefs: conservation, protection, and conflict mitigation). The LIFE17 NAT/IT/000565 CALLIOPE project is co-financed by the European Union under the LIFE Program. It is coordinated by the Abruzzo Region (Italy) with partners including the Ministry of Agriculture, Rural Development, and Environment (Cyprus), the University of Molise (Italy), Frederick University (Cyprus), and CIRSPE – the Italian Research and Studies Center for Fisheries (Italy).

Regarding vegetation, the Calliope Project identifies the following zones:

- The emerged beach with *Cakileto*
- Embryonic dunes with *Elimeto*
- Mobile dunes with *Ammofileto*
- Interdunal areas with annual grasslands and vegetation of *Verbascum niveum subsp. garganicum*

Within our pilot area, some natural and protected areas have been analyzed within the Calliope Project. Along this zonation, only a few locations in Abruzzo have preserved interdunal wet depressions and Mediterranean scrub with coastal woodlands. The evergreen shrub and tree vegetation develops in the innermost part of the dune system, known as “fixed dunes.” The Mediterranean scrub includes *Pistacia lentiscus* and *Phillyrea latifolia*, along with climbing species such as *Smilax aspera* and *Lonicera implexa,* classified under habitat 2260 – Dunes with sclerophyllous vegetation of *Cisto-Lavanduletalia* (Directive 92/43/EEC). In more inland areas with more developed soils, holm oak (Quercus ilex) appears, which would typically form the coastal forest (Lecceta). However, in Abruzzo, these formations have almost disappeared due to urban expansion and have been replaced in many cases by reforested Mediterranean pines (Pinus pinea, P. pinaster, P. halepensis), classified under habitat 2270 – Dunes with forests of Pinus pinea and/or Pinus pinaster.

Among the reforested pine forests, two Regional Nature Reserves stand out:

- Santa Filomena Pinewood (20 ha)

- Dannunziana Pinewood (56 ha)

Both are within the pilot area.

1.7.1. Santa Filomena Regional Nature Reserve

Located in the municipalities of Pescara and Montesilvano, this reserve was planted between 1926 and 1933, mainly with Aleppo pine (Pinus halepensis) and stone pine (*Pinus pinea*). In recent years, other species such as holm oak (Quercus ilex), English oak (Quercus robur), and narrow-leafed ash (Fraxinus angustifolia) have been introduced. The reserve also hosts Mediterranean shrubs like strawberry tree (Arbutus unedo) and laurel (Laurus nobilis), as well as typical coastal dune species due to its proximity to the shoreline.

1.7.2. Dannunziana Regional Nature Reserve

Located entirely within the city of Pescara and spanning 53 ha, this reserve is also known as Pineta D'Avalos, as it was owned by the D'Avalos family during the Bourbon period. It was later renamed due to its strong connection with the poet Gabriele D'Annunzio. The forest preserves a high level of biodiversity, with Aleppo pine, downy oak (Quercus pubescens), elm (Ulmus sp.), maritime pine (Pinus pinaster), and stone pine (Pinus pinea). The fauna is diverse, with 107 bird species, 14 mammal species, and 11 amphibian and reptile species recorded. The flora includes species of great botanical interest, such as Ravenna grass (Erianthus ravennae), black rush (Schoenus nigricans), Tommasini's rush (Juncus littoralis), white mullein (Verbascum niveum subsp. garganicum), and beach trefoil (Lotus cytisoides) (Tammaro & Pirone, 1981). In 2021, a major wildfire affected Sector 5 of the reserve, destroying numerous rare plant species.

1.7.3. The Pilot Area in the Life Calliope Project

As part of the Calliope Project, the Pescara-Montesilvano coastal area was surveyed to identify areas of natural interest for defining a Regional Coastal Action Plan for Abruzzo (ARCA). The project identified four sites:

1. **Montesilvano**: Public beach
2. **Montesilvano-Pescara:** Santa Filomena Regional Nature Reserve
3. **Pescara:** Public beach near the north pier of the port
4. **Pescara**: Dannunziana Regional Nature Reserve

These sites represent key areas for the conservation and protection of coastal habitats in the Abruzzo Region.

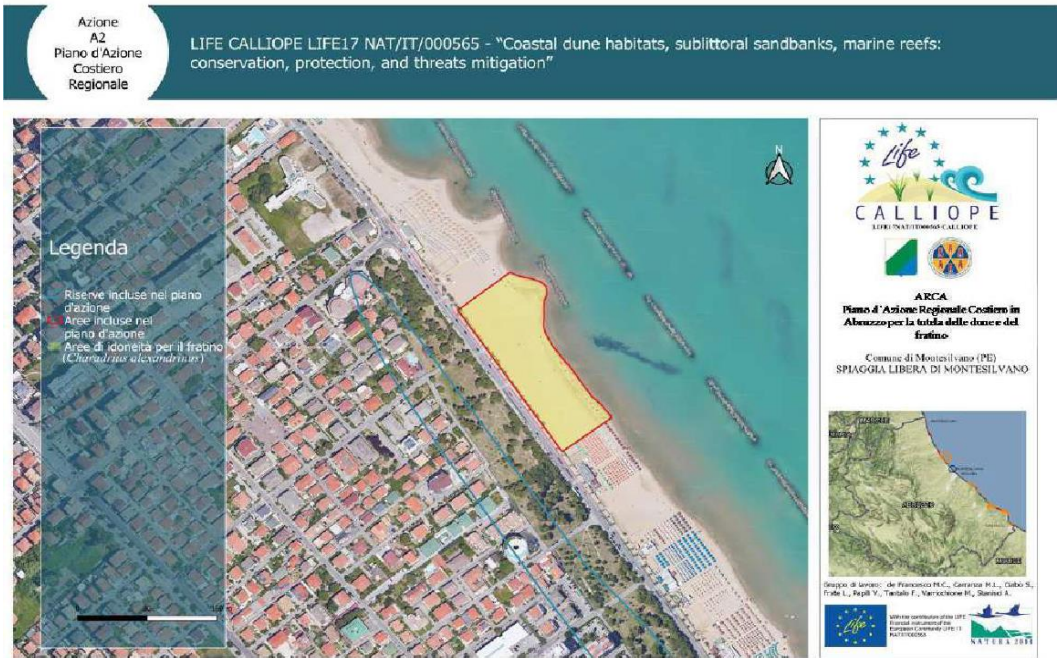

Figure 18 Municipality of Montesilvano: free beach

1.7.4. *Vegetation*

The public beach area is characterized by a low, sandy terrain with the presence of some native species from embryonic dunes and grasslands. However, due to the high anthropogenic pressure in the area, many alien and ruderal species have also established themselves.

1.7.5. Suitability of the Site for Charadrius alexandrinus (Kentish Plover)

With careful bio-restoration aimed at dune habitat recovery, the low sandy beach could become a suitable area for the presence and potential nesting of the Kentish Plover. This would play a crucial role in reducing environmental fragmentation along the coastal strip.

1.7.6. *Proposed Conservation Measures*

Reducing human pressure, primarily caused by beach resorts, and adopting proper beach cleaning methods—removing only waste without using mechanical equipment—are the first steps toward bio-restoration. These measures are essential to ensure that, in the near future, the Kentish Plover may establish itself in this protected beach area.

Figure 19 Municipalities of Montesilvano-Pescara: Santa Filomena Regional Nature Reserve

1.7.7. Vegetation

This green strip extends for approximately 3 km along the coastline between the municipalities of Pescara and Montesilvano, with an average width of 60 meters and a total area of 19.72 hectares. The pine forest was planted between 1926 and 1933 as a windbreak to protect the agricultural fields behind it. It mainly consists of Aleppo pine (*Pinus halepensis*) and stone pine (*Pinus pinea*), with more recent additions of holm oak (*Quercus ilex*), English oak (*Quercus robur*), and narrow-leafed ash (*Fraxinus angustifolia*). The tree component is further shielded from wind and marine salt spray by a belt of evergreen Mediterranean shrubs, such as laurel (*Laurus nobilis*), strawberry tree (*Arbutus unedo*), and mock privet (*Phillyrea* spp.).

Adjacent to the reserve is the **Pescara Wildlife Rescue Center**, which is dedicated to the care and rehabilitation of animals in distress. The center also offers internships and conducts educational and outreach initiatives to raise public awareness about wildlife conservation.

1.7.8. *Proposed Conservation Measures*

Due to its proximity to urban areas, the **Santa Filomena Pinewood** serves important functions, including tourism, recreation, landscape enhancement, and public health benefits. A key factor in its conservation is reducing human pressure around the forest and establishing a possible ecological connection with the coastal dune environments.

Figure 20 Municipality of Pescara: Free Beach of Pescara, North Pier of the Port

1.7.9. *Vegetation*

The public beach area along the northern coast near the Pescara River is characterized by a low, sandy terrain, hosting some native species of embryonic dunes and grasslands, such as *Salsola kali*, *Cakile maritima*, *Elymus farctus*, *Polygonum maritimum*, and *Lotus cytisoides*.

1.7.10. *Suitability of the Site for Charadrius alexandrinus (Kentish Plover)*

The presence of dune vegetation, protected by wooden posts, ropes, and a designated sandy walkway for pedestrians, has previously allowed the observation of the Kentish Plover. Between 2016 and 2018, a total of five nests were recorded. However, in recent years, the species' presence has been inconsistent. Despite this, the area remains well-suited to host the Kentish Plover.

1.7.11. *Proposed Conservation Measures*

The area requires environmental bio-restoration actions, such as planting native dune species and regulating access for pet dogs. Increased surveillance, controlled entry with leashed dogs, manual waste removal, and awareness campaigns—including educational events for students and adults—are essential conservation measures. These efforts are necessary to restore conditions favorable for the Kentish Plover to nest on this beach again.

Figure 21 Municipality of Pescara: Area Facing the Regional Nature Reserve Pineta Dannunziana

1.7.12. *Vegetation*

The section facing the sea is currently designated exclusively for beach tourism and no longer retains the typical environmental characteristics of natural Adriatic dunes.

1.7.13. Suitability of the Site for Charadrius alexandrinus (Kentish Plover)

With careful bio-restoration aimed at restoring the dune environment, the low, sandy beach could become a suitable area for the presence and potential nesting of the Kentish Plover. This would play a crucial role in reducing environmental fragmentation along the coastal strip.

1.7.14. *Proposed Conservation Measures*

Reducing human pressure—mainly caused by beach resorts—and implementing proper beach cleaning practices that remove only waste without using mechanical equipment are the first steps toward bio-restoration. These measures are essential to create the necessary conditions for the Kentish Plover to establish itself in this protected stretch of beach in the near future.

1.8. The Life "A_GReeNet" Project

The study conducted as part of the Life+A_GReeNet Project aimed to evaluate and map the urban, peri-urban, and rural systems of the coastal area covered by the Life Project. By analyzing land-use maps, particularly the **Copernicus Coastal Zones (CCZ) 2018**, and integrating geospatial data based on the **MAES method**, the project assessed various ecological factors, including:

1.8.1. Vegetation vigor (SAVI indeks) Presence of linear natural elements (potential ecological corridors), Protection regimes across the territory

Through this analysis, specific maps were developed, providing insights into the ecological status of the Pescara area:

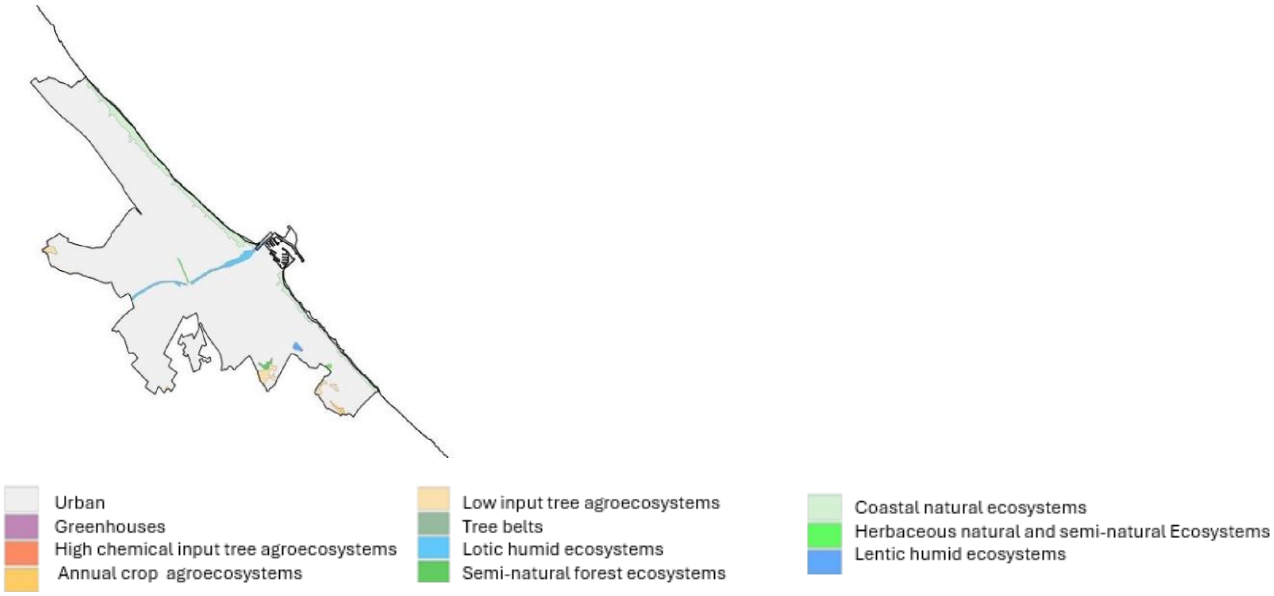

Figure 22 Reading of ecosystems

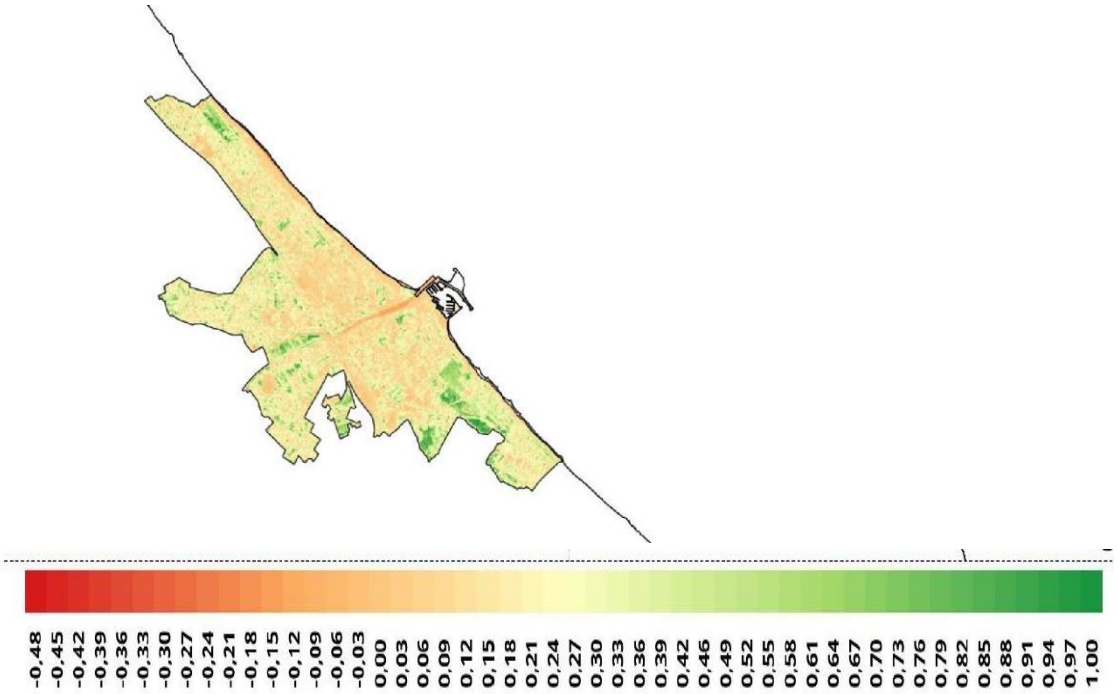

Figure 23 SAVI index

Soil-Adjusted Vegetation Index (SAVI) is an indicator used to evaluate plant health in a specific area including factors such as water stress, without being significantly influenced by soil effects. It is no coincidence that in the case of Pescara, plant health is better in the area of the Pineta d'Annunzio and along the Pescara river.

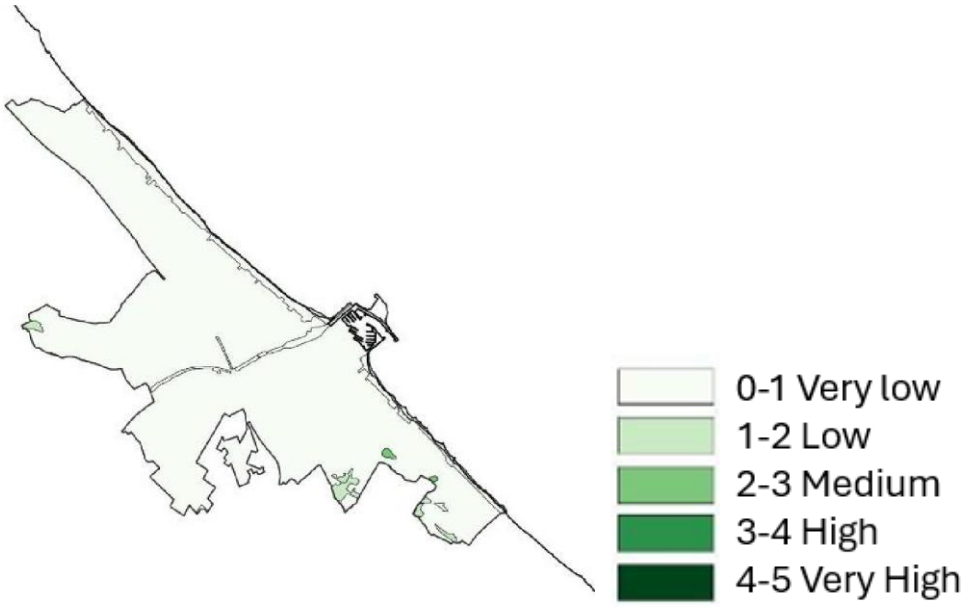

Figure 24 Ecosystem Values

Urban Cooling is an ecosystem service related to the ability of urban green areas to lower temperatures in cities. Trees and other plants absorb heat and release water vapor through transpiration, helping to mitigate the urban heat island effect.

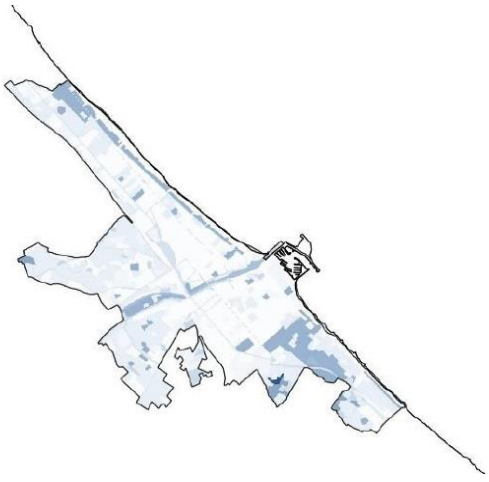

Figure 25 Urban Cooling Service

Carbon storage is the process by which natural ecosystems—such as forests, soils, and oceans—absorb and store carbon dioxide (CO_2) from the atmosphere. This ecosystem service is essential for mitigating climate change, as it reduces the concentration of CO_2, one of the main greenhouse gases. Plants absorb CO_2 during photosynthesis and store it in their biomass and soil.

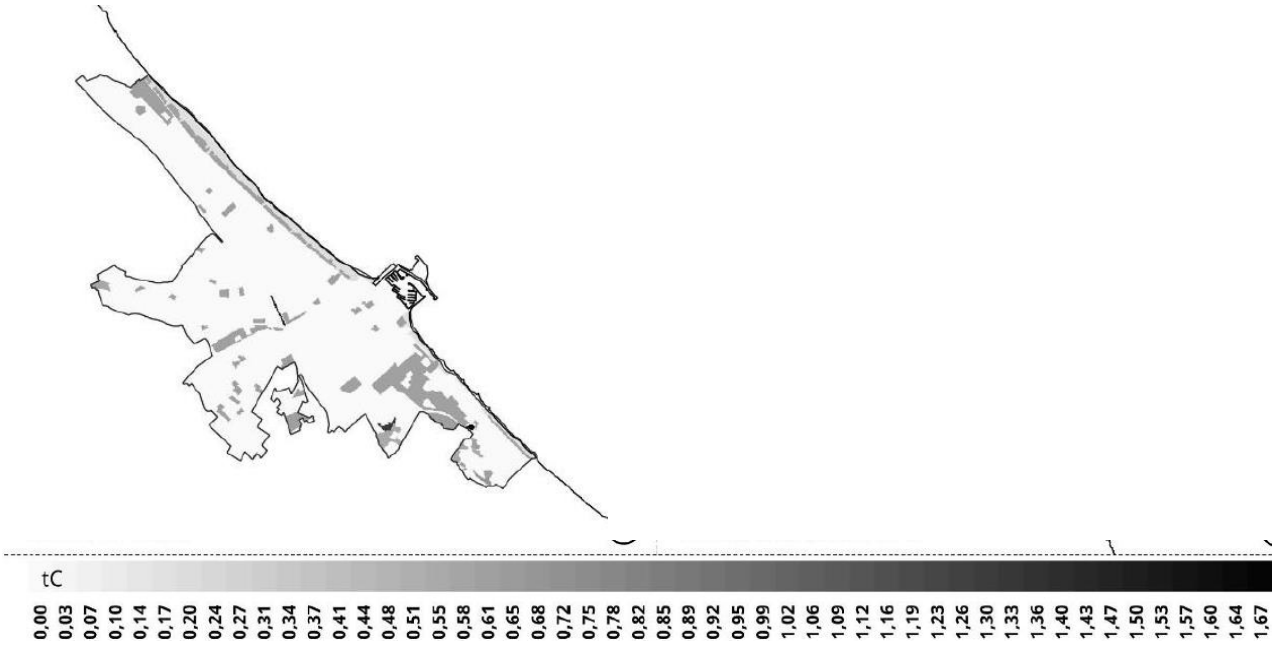

Figure 26 Carbon storage

1.8.2. References

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1.9. Part II MAPS

1.9.1. Methodology for the assessment of transformation of natural cover and habitat for pilot areas.

The maps of "the assessment of transformation of natural cover and habitat for pilot areas" were elaborated using database LCZ of Copernicus and of InVEST Habitat Quality model of the InVest software. In order to evaluate and map the present habitats in the pilot areas of the Municipalities of Pescara, Montesilvano and Spoltore, as first data, the use of soil cartography was used. Specifically, the Copernicus Coastal zones (Copernicus Marine Environment Monitoring Service, 2018), referring to the Vth level. Furthermore, with the goal to evaluate the quality of habitats, keeping in mind the objectives of the project, the tool Habitat Quality of InVEST was used (Nature Capital Project, 2023). This tool uses the quality of the habitat as a proxy for the representation of biodiversity of a landscape, estimating the extent of habitat types and its degradation state.[1] The result is capable of providing a knowledge framework with regard to the quality degradation level of different habitats, however, without trying to provide a monetary value to the biodiversity.

The first step to take is to create a raster of the threats present on the territory, starting from the aforementioned cartography Copernicus Coastal Zones of 2018, besides the global raster of the interested studied areas. Further to this step, the drafting of threat and sensitivity table is carried out. The table of threats is constructed as followed:

- Max_distance: The maximum distance over which each threat affects habitat quality.
- Weight: The impact of each threat on habitat quality, relative to other threats

[1] For more information visit the following link: "Habitat quality" http://releases.naturalcapitalproject.org/invest-userguide/latest/en/habitat_quality.html

- Threat: Name of the threat.
- Decay: The type of decay over space for each threat (linear or exponential)
- Cur_path: Path to a raster of the threat's distribution in the current scenario

While the table of sensitivity is constructed as follows:

- LULC: LULC codes from the LULC raster.
- Habitat: Suitability of this LULC class as habitat, where 0 is not suitable and 1 is completely suitable
- Threat: The relative sensitivity of each LULC class to each type of threat, where 1 represents high sensitivity and 0 represents that it is unaffected
- Half-saturation constant: Half-saturation constant used in the degradation equation.

The calculation of the Habitat Quality model requires the following data of input provided in the next table:

Table 19 input data for Habitat Quality model

arameter	**Type**	**Unit**	**Description**
Land Use/Land Cover	Raster	-	Map of LULC for the interested area. All values have to have corresponding items in the Sensitivity and Threats tables.
Threats Table	.csv	-	Table mapping each threat to its effects concerning maximum distance, weight, and decay. Each identified threat must correspond to a raster representing the threat
Sensitivity Table	.csv	-	Table mapping, for each identified threat, the sensitivity degree of each value in the LULC raster. All values in the LULC raster

			must have corresponding entries in this table.

The tool Habitat Quality of InVEST provides two results: **degradation and Habitat quality**

The raster referring to the degradation, called deg_sum_c, describes the level of degradation of the habitat within the landscape in the actual state. A high level of a cell within the grid means that the degradation of a habitat is high.

The raster dedicated to the quality of habitat, called quality c, describes the level referred to the quality of the habitat within the actual landscape. The high levels indicate a better quality of the habitat with respect to the distribution of the remaining landscape. The areas of the landscape that are not classified as object habitat receive a score equal to 0. Such a score does not refer to any particular measure of biodiversity.

Further, the two results given by the tool give the possibility to highlight how the areas with higher Quality of Habitat interest primarily the natural protected areas (Pine forest Dannunziana e Pineta di Santa Filomena), the fluvial system of Pescara and of Saline. The minor water network in the hilly agricultural area and its vegetation, the wooded areas of the hilly regions. Within the coastal settlement system, only a few parks and the beach stand out. The rest of the territory exhibits low quality, as discussed in the first part.

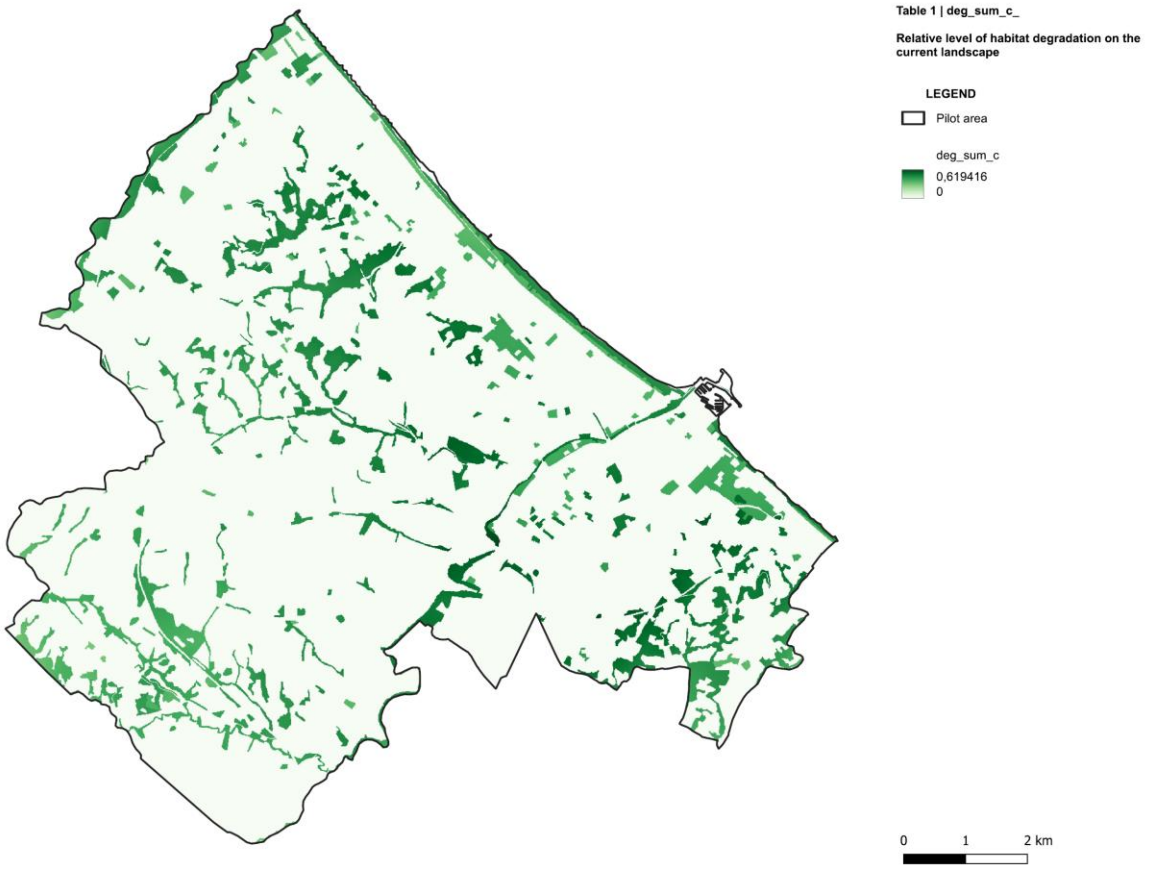

Figure 27 Map 1 Relative level of habitat degradation in current landscape

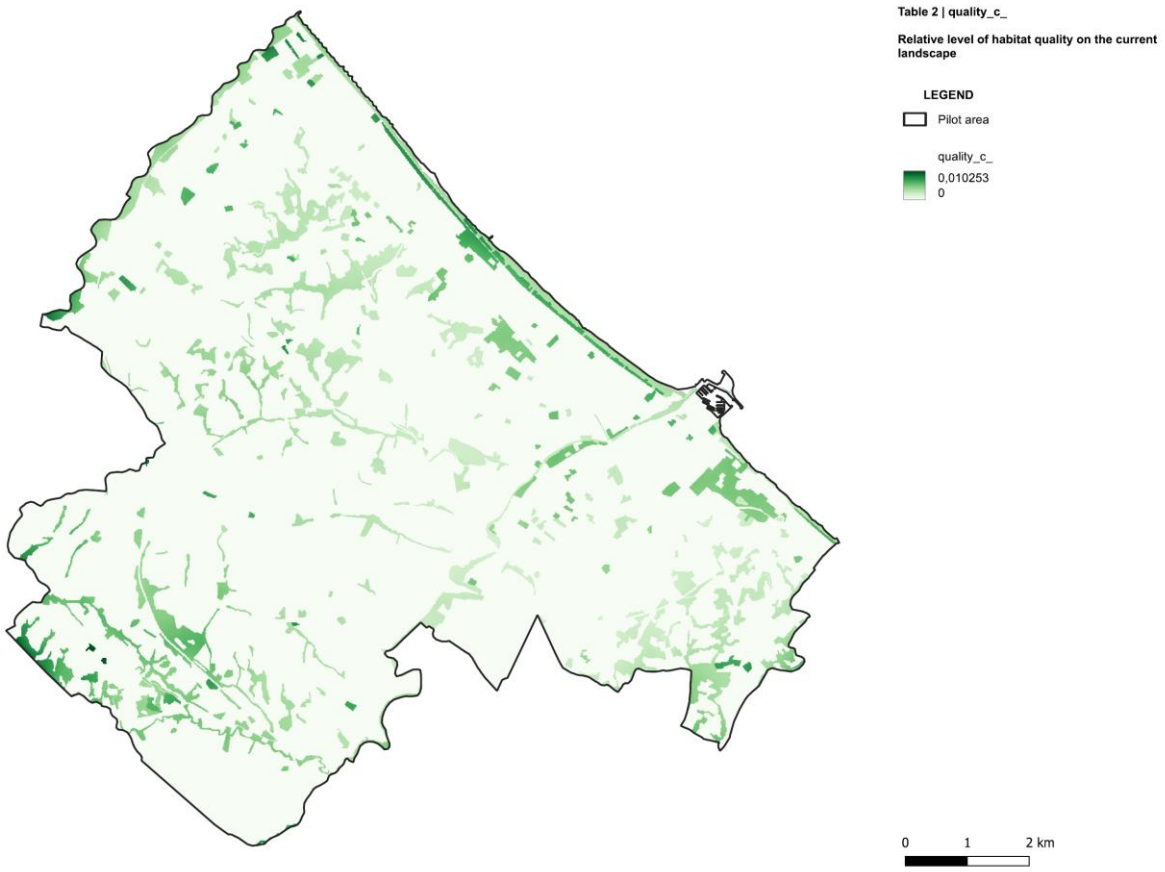

Figure 28 Map 2 Relative level of habitat quality on the current landscape

1.9.1. References

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