Conca d'Oro (Palermo, NW Sicily) landscape transformation and the connected biodiversity loss risk

di Gianniantonio Domina

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1. *Introduction*

Throughout history, areas surrounding human settlements have experienced the most profound landscape alterations. What we observe today is the product of two key factors: the original geographic conditions and the layered modifications accumulated over centuries of socioeconomic shifts. Urban centers, in particular, function as major resource hubs, disproportionately consuming water reserves, soil nutrients, and native vegetation[1].

These localized transformations contribute to global environmental pressures, amplifying climate change and biodiversity loss in ways that reverberate far beyond city boundaries. The ecological footprint of urban development thus extends from immediate surroundings to planetary-scale impacts, linking local land-use decisions to worldwide sustainability challenges[2].

Recently, there has been increasing recognition of urban green spaces as vital reservoirs of biodiversity and key providers of essential ecosystem services[3]. At a time when natural spaces have been pushed out of urban centers, green areas reconstructed by humans can replace some of the ecosystem functions performed by natural ecosystems. Hence the need to understand the natural landscape and its transformations in order to

[1] Cf. J.A. López-Sáez, D. Abel-Schaad, S. Pérez-Díaz et al., *Vegetation History, Climate and Human Impact in the Spanish Central System over the Last 9000 Years*, in *Quat. Int.*, 353, 2014, 98-122.

[2] Cf. R.I. Mcdonald, P. Kareiva, R. Forman, *The Implications of Urban Growth for Global Protected Areas and Biodiversity Conservation*, in *Biol. Conserv.*, 141, 2008, 1695-1703.

[3] Cf. M.F.J. Aronson, C.A. Lepczyk, K.L. Evans et al., *Biodiversity in the City: Key Challenges for Urban Green Space Management*, in *Front. Ecol. Environ.*, 15, 2017, 189-196.

project green spaces that can best achieve their intended purpose. Green spaces, in fact, perform essential functions both ecologically and for human well-being. Plants produce oxygen and absorb pollutants from the air, mitigating the urban heat island effect by increasing shading and evapotranspiration[4]. Urban green spaces can be reservoirs of plant and animal biodiversity, forming part of a network that connects natural and semi-natural areas[5]. For humans, green spaces offer recreational and mental health benefits. Green spaces counteract soil erosion and stormwater runoff by improving overall drainage[6]. Overall, this component plays a fundamental role for cities and their surrounding areas.

This paper is a revised and simplified version of one already published by Domina et al.[7]. It studies the "Conca d'Oro" area of Palermo, a surface area of approximately 100 km^2 with just over 800,000 inhabitants. Starting from the historical study of the area and the study of land use derived from maps and historical evidence from the 18th century to the present day, we attempted to reconstruct the evolution of the landscape and its impact on the area's flora. This study offers an in-depth analysis of urban development in Palermo and its surrounding areas, providing valuable knowledge to advance sustainable biodiversity conservation strategies in Mediterranean urban and peri-urban landscapes. The results will also have broader relevance, offering insights applicable to other coastal cities across the Mediterranean region.

2. *Materials and methods*

2.1. *The study area*

The Conca d'Oro is a fertile plain spanning approximately 100 km^2, where the city of Palermo and several surrounding settlements

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[4] Cf. S. Kifayatullah, Z. Saqib, M.I. Khan et al., *Equitable urban green space planning for sustainable cities: a GIS-based analysis of spatial disparities and functional strategies*, in *Sci Rep*, 15, 2025, 22686.

[5] Cf. Y. Zhang, Y. Xue, K. Guo et al., *Biodiversity and happiness: exploring the value of nature*, in *Sustain Sci*, 2024.

[6] Cf.. Adriaenssens, T. Masschelein, A. Colpaert et al., *Implications of sustainable drainage system design on its infiltration rate and maximum water capacity*, in *Acta Hortic.*, 1429, 2025, 217-224.

[7] G. Domina, G. Barone, E. Bajona et al., *The Plant Landscape of the "Conca d'Oro" of Palermo (NW Sicily, Italy) and Its Evolution*, in *Plants*, 14, 2025, 938.

are situated. Located in northwestern Sicily (38°03'50"–38°12'14" N, 13°17'13"–13°30'26" E), it stretches between the Palermo Mountains and the Tyrrhenian Sea, bounded by Monte Gallo to the northwest and Monte Catalfano to the southeast. The plain features a gentle slope, descending from around 100 m above sea level at the mountain foothills to the coastal edge (Figure 1).

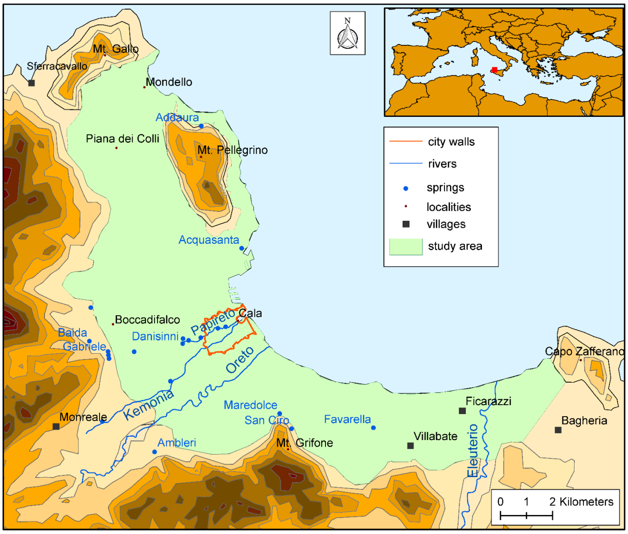

Figure 1. Area of investigation and its localization, with the main geographical elements reported in the text (From Domina et al. 2025).

The Conca d'Oro primarily lies within Palermo's municipal boundaries (population ≈650,000), while its eastern portion extends into the neighboring towns of Villabate (≈19,500 inhabitants), Ficarazzi (≈13,000 inhabitants), and, to a lesser degree, Bagheria (≈53,000 inhabitants).

The name Conca d'Oro, which has been used since the 15th century, refers to the fertility of the soil and the richness of the crops[8].

The Palermo Plain was historically characterized by abundant water springs emerging at the mountain foothills, which formed streams and wetlands. The main watercourses included the Oreto River (still existing with an average annual flow of 0.86 m^3/s), the Eleuterio River (0.5 m^3/s),

[8] Cf. A. De Stefano, *Il "De laudibus Messanae" di Angelo Callimaco Siculo*, in *Boll. Cent. Stud. Filolog. Linguist. Sicil.*, 3, 1955, 84-129.

and the now-buried Kemonia and Papireto streams (filled in the 16th century)[9]. Spring-fed wetlands such as Acqua di Ambleri, Baida, Gabriele, San Ciro, Piana dei Colli, Acquasanta, Addaura, and Favare di Villabate were gradually drained and repurposed over time. Additionally, river courses were straightened and channelized, while the brackish Mondello wetlands were reclaimed in the early 20th century[10].

The study area exhibits a Mediterranean pluviseasonal oceanic bioclimate, classified as thermomediterranean thermotype and dry-subhumid ombrotype[11]. Climatic data reveal January as the coldest month (avg. min. = 7.8°C, avg. max. = 15.7°C) and August as the hottest (avg. min. = 20.8°C, avg. max. = 29.9°C). Annual precipitation averages 679.4 mm, distributed over 78 rainy days[12]. The Palermo Plain is made up of Pleistocene deposits (calcarenites and sandy clays) superimposed on the clay and marl soils of Numidic Flysch (Oligo-Miocene)[13].

The deepest and most fertile soils are alluvial and are found along the Oreto and Eleuterio Rivers in the depressions and southern and eastern areas of the Conca the rest of the territory has Red Mediterranean soils and Lithosols with reduced depth and fertility[14]. The coastline has undergone little transformations over the past 10,000 years, mainly limited through sediment deposition processes. At the Cala, substantial shoreline advancement occurred due to alluvial deposits from the Kemonia River. Additionally, the coastline extended approximately 200 meters at the est of the Cala due to rubble from buildings destroyed during the 1943 bombings[15] [16].

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[9] Ministero Dei Lavori Pubblici, *Le Sorgenti Italiane Elenco e Descrizione*, Roma, 1934.

[10] S. Troisi, *Vedute di Palermo*, Palermo, 1991.

[11] G. Bazan, P. Marino, R. Guarino et al., *Bioclimatology and vegetation series in Sicily: A geostatistical approach*, in *Ann. Bot. Fenn.*, 52, 2015, 1-18.

[12] A. Drago, *Atlante climatologico della Sicilia – Seconda edizione*, in *Riv. Ital. Agrometeorol.*, 2, 2005, 67-83.

[13]Cf. B. Abate, R. Catalano, P. Renda, *Schema geologico dei monti di Palermo (Sicilia)*, in *Boll. Soc. Geol. Ital.*, 97, 1978, 807-819.

[14] Cf. G. Fierotti, *I Suoli della Sicilia*, Palermo, 1997.

[15] Cf. P. Todaro, *Le paludi del Papireto e la bonifica idraulica del XVI secolo*, in *Not. Archeol. Soprintend.* Palermo, 47, 2019, 1-14.

[16] Cf. C. De .Maria, P. Violi, *Reading Memory Sites Through Signs*, Amsterdam, 2023.

2.2. *Methods*

This study integrates multiple data sources according to their historical availability: bibliographical records (from early human settlements to the 18th century), cartographic materials (18th century onward), and herbarium collections (19th century to present).

Eight cartographic bases were used to study an area of approximately 17 km^2 (1754–2024) around the city of Palermo and four cartographic bases for the entire Conca d'Oro (1904–2024). The analyses were conducted in a GIS environment. The cartographic data were first converted into land use codes according to Corine Land Cover 3rd level[17] and then grouped into macro-categories for analysis.

The annual rate of change for each land use class was calculated using the formula suggested by Suleiman et al.[18]. The floristic study is based on bibliographic sources[19] and herbarium specimens preserved at the *Herbarium Mediterraneum Panormitanum* (PAL).

3. *Results*

The area of the city of Palermo has been inhabited since prehistoric times, each of the dominations that followed one another[20] contributed to the development of the city and the modification of its surroundings through the exploitation of natural resources.

At the time of initial human settlement (8th century BC), the landscape supported continuous vegetation cover featuring distinct plant communities: lowland forests of *Quercus pubescens* Willd. s.l. dominated deep alluvial soils near waterways[21], while marshes with rushes and *Cyperaceae* bordered watercourses. Most of the plain hosted holm oak (*Quercus ilex* L.) forests on

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[17] Copernicus Land Monitoring Service, https://land.copernicus.eu/en (accessed on 6 February 2025).

[18] M.S. Suleiman, O.V. Wasonga, J.S. Mbau, J.A. Elhadim, *Spatial and temporal analysis of forest cover change in Falgore Game Reserve in Kano*, Nigeria, in *Ecol. Process.*, 6, 2017, 11.

[19] G. Domina, E. Di Gristina, F. Scafidi et al., *The urban vascular flora of Palermo (Sicily, Italy)*, in *Plant Biosyst.*, 154, 2019, 627-634.

[20] Cf. R. La Duca, *Storia di Palermo*, Palermo, 1999.

[21] Cf. S. Brullo, L. Gianguzzi, A. La Mantia, G. Siracusa, *La Classe Quercetea Ilicis in Sicilia*, in *Boll. Accad. Gioenia Sci. Nat.*, 41, 2008, 1-80.

developed soils[22], transitioning to xeric maquis with *Olea europaea, Phillyrea latifolia* L., and *Pistacia lentiscus* L. in drier marginal zones[23]. Coastal areas featured dwarf palm (*Chamaerops humilis* L.) scrub and dune vegetation along sandy shores.

The first major deforestations occurred during Roman domination, which invested huge amounts of capital to create large estates and wide properties dedicated to cereal cultivation[24]. During the Arab period (9th-11th centuries), Palermo's urban and peri-urban landscape was shaped by a complex water management system. Natural springs within and around the city walls fed streams that served multiple purposes: providing drinking water, irrigating vegetable gardens and orchards, and powering water mills. The agricultural hinterland featured smallholdings with vineyards and fruit trees, sustained through sophisticated irrigation methods including stream diversions, wells, and qanat systems – underground channels that efficiently transported groundwater. The riverbanks featured extensive marshlands, including along the Papireto stream where *Cyperus papyrus* L. was cultivated for producing ropes, baskets, and paper[25]. The Mondello wetlands served also as natural mooring sites[26].

In the late 10th century, urban expansion reached extra-urban areas, exemplified by the construction of the "Favara di Maredolce" complex east of Palermo. This remarkable hydraulic engineering project transformed a marshland into an artificial 20-hectare fishpond, featuring a 3.4-hectare artificial island at its center fed by the Maredolce and San Ciro springs[27].

The Normans (1071–1266) adopted and continued the Arab agricultural traditions, maintaining sophisticated cultivation systems. They developed mixed-crop gardens combining vegetables, fruit trees, and vines in humid areas, while olive and mulberry groves thrived in drier soils. In

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[22] Cf. L. Gianguzzi, O. Caldarella, P. Campisi et al., *Plant Diversity in Old-GrowthWoods: The Case of the Forest Edges of the Favorita Park in Palermo (North-Western Sicily, Italy)*, in *Plant Sociol.*, 61, 2024, 1-29.

[23] Cf. S. Gentile, *Memoria Illustrativa della Carta della Vegetazione Naturale Potenziale della Sicilia: Prima Approssimazione*, in *Quad. Ist. Bot. Univ. Lab. Crittogam.*, 40, 1968, 1-114.

[24] Cf. C. Bertagnolli, *Delle Vicende dell'Agricoltura in Italia*, Firenze, 1881.

[25] Cf. M. Amari, *Biblioteca Arabo-Sicula*, Torino, 1880.

[26] Cf. F. Alfonso Spagna, *Sulla Topografia Agraria di Palermo, Conferenza del Prof Giuseppe Inzenga*, in *Annali di Agricoltura Siciliana*, n.s., 1, 1869, 285-295, 309-332.

[27] Cf. G. Barbera, P. Boschiero, L. Latini, *Maredolce-La Favara*, Treviso, 2015.

peripheral upland areas near the mountains, they practiced rain-fed agriculture, cultivating cereals along with drought-resistant trees like carob, olive, almond, and walnut[28].

During the early 13th century, sugarcane (*Saccharum officinarum* L.) cultivation – initially introduced by the Arabs as a minor crop – experienced a revival, gaining significant economic importance by the 14th century[29]. Throughout this period, the agricultural landscape remained relatively stable, with intensive irrigation systems primarily concentrated between the Oreto River and present-day Porta di Termini, where vegetable gardens dominated. The traditional mixed-orchard systems persisted with little modification[30]. Sugarcane cultivation marked an agricultural revolution on the Palermo Plain, transforming local farming practices from rain-fed cereal and vine cultivation for domestic consumption to irrigated cash crops for international trade. The industry peaked between 1541-1620, but ultimately declined due to competition from American sugar imports, ceasing production by 1690[31].

The 18th century witnessed significant agricultural intensification in Palermo's peri-urban areas, characterized by the emergence of new walled enclosures ("firríati") containing vegetable plots, orchards, and tree-lined fields[32]. While the Piana dei Colli and Monreale foothills became dominated by vineyards and orchards, these cultivated zones still contained numerous uncultivated patches interspersed throughout the landscape[33]. Beginning in the 18th century, Palermo's northern expansion was propelled by aristocratic development, as noble families constructed new suburban villas and transformed existing farmhouses into summer retreats[34]. At the dawn of the 20th century, Palermo's population exceeded 330,000 inhabitants[35], sparking northern expansion into the Mondello coastal

[28] Cf. G. Barbera, *Parchi, frutteti, giardini e orti nella Conca d'Oro di Palermo araba e normanna*, Italus Hortus, 14, 2007, 14-27.

[29] Cf. A. Morreale, *Insula Dulcis. L'industria della Canna da Zucchero in Sicilia (Secoli XV-XVII)*, Napoli, 2006.

[30] Cf. C. Trasselli, *Storia dello Zucchero Siciliano*, Caltanissetta, 1982.

[31] Cf. A. Morreale, lc.

[32] Cf. R. La Duca, lc.

[33] Cf. D. Scinà, *La Topografia di Palermo e dei Suoi Contorni*, Palermo, 1818.

[34] Cf. G. Sommariva, *Bagli e Ville di Palermo e Dintorni-Conca d'Oro e Piana dei Colli*, Palermo, 2005.

[35] Cf. L. Maroi, *Alcune monografie di storia demografica*, in *Riv. Internazionale Sci. Soc. Discip. Ausiliari*, 94, 1922, 215-223.

area. This transformation saw the bourgeoisie-led development of Valdesi-Mondello village on reclaimed marshlands, replacing former citrus orchards and vineyards that once dominated the area[36].

3.1. *Spatial analysis*

The land-use analysis centered on Palermo reveals dramatic environmental transformations (Figure 2, Table 1). Forest/semi-natural areas plummeted from 22.33% (1754) to under 3% (1818), later stabilizing at 4.35% today. Wetlands never exceeded 3.78% (1904 peak). Agricultural land peaked at 67.4% (1849) after 18th-century expansion, then collapsed by 1968. Conversely, urban areas grew steadily from 26.81% (1754) to 44.93% (1904), then skyrocketed to 83.65% (1968). The most explosive growth occurred post-WWII, when Palermo's built environment expanded from 600 to 7,000 hectares in just four decades[37]. The analysis of the whole Coca d'Oro (Figure 3, Table 2). reveals striking land-use transformations: Forests and semi-natural areas declined sharply from 17.7% (1904) to 7.67% (2024), showing a negative annual change rate until 1968 before modest recovery (Table 3). Wetlands experienced similar pressures, shrinking from 36.55% to 15.05% over the same period, though with partial regeneration post-1968. Agricultural land peaked at 75.45% (1912) after initial expansion from 69.16% (1904), then collapsed to 26.01% by 2024. Meanwhile, urban surfaces remained limited (<12%) until 1912, but surged to 35.52% by 1968, marking a dramatic landscape transformation.

Over the past three centuries, Palermo's landscape has progressively shifted from semi-natural areas to agricultural zones and eventually to urbanized spaces. Initially confined within its historic walls until the early 1900s, the city experienced rapid expansion after World War II.

In 1754, the landscape was dominated by rain-fed arable land and tree crops, though data on irrigated areas is unavailable. By 1818, vegetable gardens had encircled the urban core, reflecting intensified peri-urban agriculture. The mid-19th century marked a transition to citrus cultivation, with arable lands south of the city converted to groves by 1849, followed by expansion into the northwest by 1864.

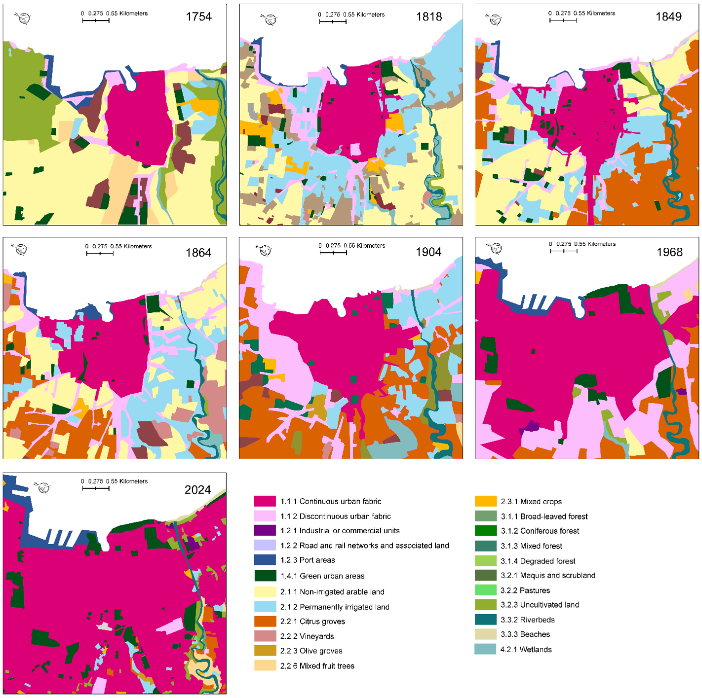
Urban growth between 1864 and 1904 followed radial roads into

[36] Cf. S. Troisi, *Vedute di Palermo*, Palermo, 1991.

[37] Cf. A. Chirco, *Palermo: Tremila Anni tra Storia e Arte*, Palermo, 1992.

the countryside, evolving from scattered low-density industrial sites to continuous high-density development. The 1904 maps reveal two distinct agricultural zones: vegetable gardens along the eastern coastal stretch from the Oreto River and a citrus-dominated belt between Palermo and Bagheria.

By 1968, low-density urban expansion had created a uniform suburban fabric around the historic center, while citrus groves remained the predominant agricultural feature. Today, high-density urbanization dominates, with citrus cultivation now largely restricted to the southeastern mountain slopes. The remaining peri-urban areas have been transformed into low-density urban developments, completing the centuries-long transition from natural and agricultural landscapes to a fully urbanized



metropolitan area.

Figure 2. Analysis of land use in an area of about 17 km^2 centered on the town of Palermo from 1754 to today (from Domina et al. 2025) . Classes according to Corine Land Cover (https://land.copernicus.eu/en).

3.2. *Floristic study*

The Conca d'Oro hosts 18 endemic plant taxa, including eight Italian endemics and ten Sicilian endemics (Table 4). Their distribution reflects distinct ecological preferences: nine cliff-dwelling species primarily occupy mountain outcrops with minimal lowland presence (Figure 4), while eight taxa thrive in pastoral landscapes. Notable species exhibit specialized habitats – *Limonium bocconei* (Lojac.) Litard., colonizes coastal rocks, whereas *Antirrhinum siculum* Mill. and *Biscutella maritima* Ten. show widespread distribution. The area features significant phytogeographic records: the Eleuterio River-Baida zone sustains *Euphorbia ceratocarpa* Ten., while the Oreto River represents both the type locality of *Carex panormitana* Guss. (a Sicily-Sardinia-Tunisia disjunct) and the westernmost stand of *Platanus orientalis* L.[38].

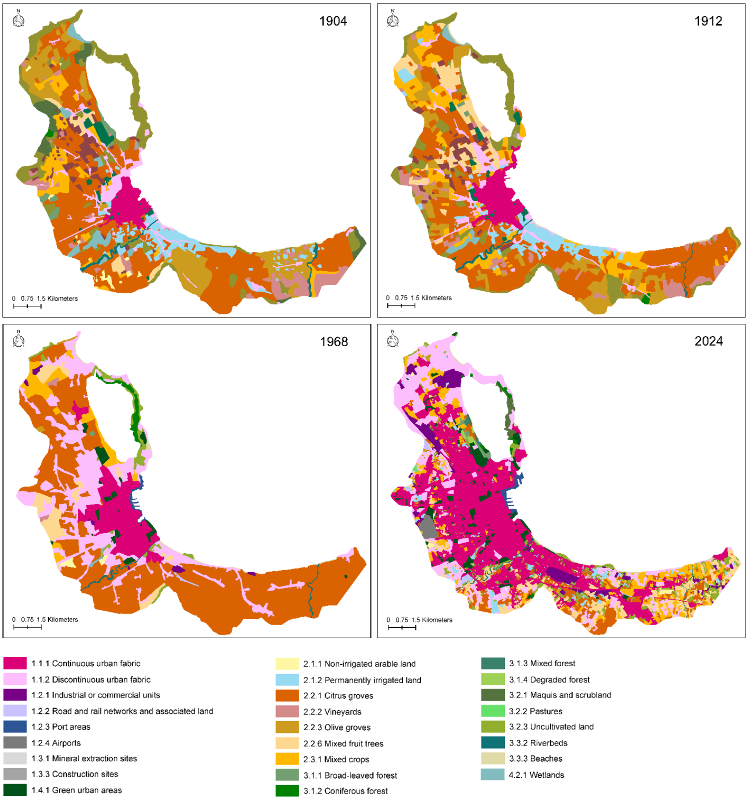
Table 1. Analysis of classes of land use in an area of about 17 km^2 centered on the town of Palermo from 1754 until today.

Artificial surfaces includes: Continuous urban fabric, discontinuous urban fabric, industrial or commercial units, road, rail networks, and associated land, port areas, airports, mineral extraction sites, construction sites, green urban areas; *Agricultural areas* includes: Non-irrigated arable land; permanently irrigated land, citrus groves, vineyards, olive groves, mixed orchards, complex agricultural systems; *Forest and semi-natual areas* includes: Broad-le-

Classes of Land Uses	**2024**		**1968**		**1904**		**1864**	
	Km²	**%**	**Km²**	**%**	**Km²**	**%**	**Km²**	**%**
Artificial surfaces	15.60	89.99	14.27	83.65	7.34	44.93	8.22	31.89
Agricultural areas	0.98	5.65	2.07	12.13	7.34	44.93	16.96	65.77
Forest and semi-natural areas	0.75	4.35	0.63	3.72	1.04	6.36	0.43	1.67
Wetlands	0.00	0.00	0.09	0.51	0.62	3.78	0.17	0.66
TOTAL	**17.33**		**17.07**		**16.33**		**25.78**	

Classes of Land Uses	**1849**		**1818**		**1754**	
	Km²	**%**	**Km²**	**%**	**Km²**	**%**
Artificial surfaces	4.76	29.50	4.17	29.40	4.00	26.81
Agricultural areas	10.88	67.40	9.34	65.88	7.42	49.66
Forest and semi-natural areas	0.48	2.95	0.34	2.42	3.33	22.33
Wetlands	0.02	0.14	0.32	2.29	0.18	1.21
TOTAL	**16.14**		**14.18**		**14.94**	

[38] Cf. L. Gianguzzi, F.M. Raimondo, S. Riggio, *Relics of riverine Platanus orientalis L. forest in the Oreto valley, Palermo*, in *Giorn. Bot. Ital.*, 129, 1995, 274.



aved forests, coniferous forests, mixed forests, degraded forests, maquis, pasture, uncultivated land, riverbeds, beaches; *Wetlands* include marshes.

Figure 3. Analysis of land use throughout the whole Conca d'Oro from 1904 to today (from Domina et al. 2025). Classes according to Corine Land Cover (https://land.copernicus.eu/en).

Land Uses	**2024**		**1968**		**1904**		**1864**	
	Km²	**%**	**Km²**	**%**	**Km²**	**%**	**Km²**	**%**
Artificial surfaces	67.74	66.46	36.01	35.52	11.68	11.95	11.20	11.46
Agricultural areas	26.52	26.01	60.75	59.92	73.74	75.45	67.60	69.16
Forest and semi-natural areas	7.67	7.53	4.47	4.41	11.32	11.59	16.78	17.17
Wetlands	15.34	15.05	9.10	8.97	23.64	24.19	35.73	36.55
TOTAL	**101.93**		**101.39**		**97.74**		**97.74**	

Table 2. Analysis of land use throughout the whole Conca d'Oro from 1864 until today. Classes follow table 1.

Table 3. Land cover change in different periods and annual rate of change throughout the whole Conca d'Oro from 1864 until today. Classes follow Table 1.

Classes of Land Uses	Change (1864–1904) % [a]	Change (1904–1968) % [a]	Change (1968–2024) % [a]	Annual Rate of Change (1864–1904) % [b]	Annual Rate of Change (1904–1968) % [b]	Annual Rate of Change (1968–2024) % [b]
Artificial surfaces	0.49	23.57	30.94	0.11	3.25	1.57
Agricultural areas	6.29	−15.53	−33.91	0.23	−0.28	−1.01
Forest and semi-natural areas	−5.58	−7.18	3.12	−0.81	−0.95	1.28
Wetlands	−12.36	−15.22	6.08	−0.85	−0.96	1.22

[a] Percentage change in the component; [b] Percentage of the annual rate of change in each class.

Taxon	Chorotype	Habitat
Antirrhinum siculum Mill.	Endem. Ital.	rocks, walls
Biscutella maritima Ten.	Endem. Ital.	fields, uncultivated lands
Brassica rupestris Raf. subsp. *rupestris*	Endem. Ital.	rocks
Carlina sicula Ten. subsp. *sicula*	Endem. Sic.	dry pastures
Centaurea panormitana Lojac.	Endem. Sic.	rocks
Centaurea todaroi Lacaita	Endem. Sic.	rocks
Cymbalaria pubescens (C.Presl) Cufod.	Endem. Sic.	rocks
Euphorbia ceratocarpa Ten.	Endem. Sic.	uncultivated lands
Hexaphylla rupestris (Tineo) P.Caputo and Del Guacchio	Endem. Sic.	rocks
Lathyrus odoratus L.	Endem. Ital.	uncultivated lands
Limonium bocconei (Lojac.) Litard.	Endem. Sic.	sea rocks
Micromeria graeca subsp. *fruticulosa* (Bertol.) Guinea	Endem. Ital.	rocks
Micromeria graeca subsp. *tenuifolia* (Ten.) Nyman	Endem. Ital.	rocks
Ophrys sphegodes subsp. *panormitana* (Tod.) E.Nelson	Endem. Ital.	rocky pastures
Orchis brancifortii Biv.	Endem. Ital.	rocky pastures
Pimpinella gussonei (C.Presl) Bertol.	Endem. Sic.	rocky pastures
Romulea linaresii Parl. subsp. *linaresii*	Endem. Sic.	rocky pastures
Seseli bocconei Guss.	Endem. Sic.	rocks

Table 4. Chorothype and habitats of endemic taxa occurring in the investigated area.

In total, 40 taxa historically reported for the Conca d'Oro are no longer present in the territory (Table 5)[39]. The disappeared flora of the

[39] G. Domina, E. Di Gristina, F. Scafidi et al., *The urban vascular flora of Palermo*

Conca d'Oro primarily occupies humid habitats and coastal areas, with fewer species adapted to dry cultivated or uncultivated lands. The most severe habitat losses occurred in transformed wetlands, particularly the reclaimed marshes of Mondello, the Oreto River delta, and the San Ciro and Baida wetlands.

Several species have faced local extinction due to changing agricultural practices, including *Descurainia sophia* (L.) Webb ex Prantl, *Elatine macropoda* Guss., and *Stuckenia pectinata* (L.) Börner, which depended on irrigation ditches that have since disappeared. Historical records confirm their former presence (*Figure 4*). Another vanished group includes sandy coastal specialists like *Cressa cretica* (listed as endangered in Italy), *Echium arenarium*, and Sporobolus pungens. These losses reflect broader ecological shifts as traditional irrigated fields have declined, eliminating critical microhabitats for moisture-dependent species.

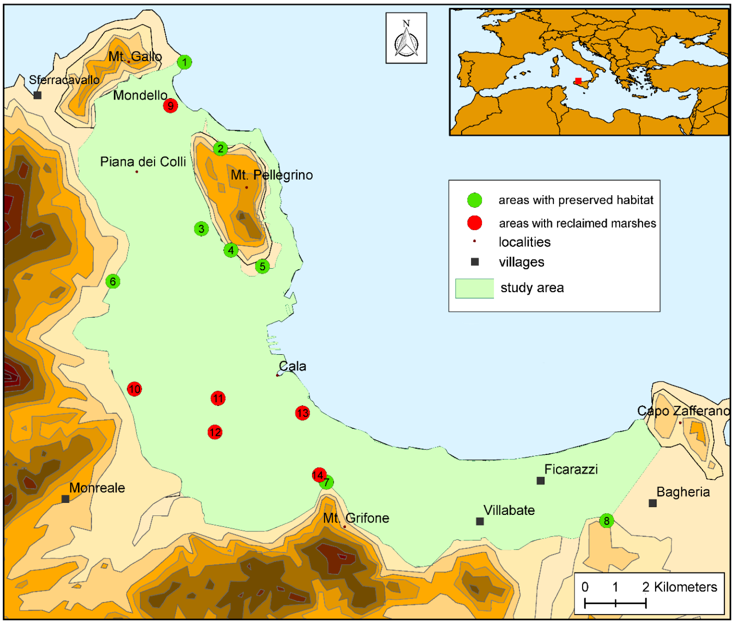


Figure 4. Areas with preserved habitat (in green) and areas with reclaimed marshes (in red) in the investigated area: (1) see rock in Piano Gallo; (2) north slope cliffs of Mt. Pellegrino; (3) Bosco Niscemi; (4) west slope cliffs of Mt. Pellegrino; (5) south slope cliffs of Mt. Pellegrino; (6) cliffs of Baida; (7) cliffs of Mt. Grifone; (8) cliffs of Mt.

(Sicily, Italy), in *Plant Biosyst.*, 154, 2019, 627-634.

Giancaldo; (9) marshes of Mondello; (10) marshes of Boccadifalco; (11) marshes of Danisinni; (12) marshes of Porrazzi; (13) marshes at the mouth of Oreto River; (14) marshes of San Ciro (From Domina et al. 2025).

Table 5. Taxa no longer found in the territory of the Conca d'oro, their chorotype, localities, habitat.

Taxon	Chorotype	Localities	Habitat	Last record
Alopecurus bulbosus Gouan subsp. *bulbosus*	Eurimedit.	Mondello	Coastal marshes	19th century
Althaea officinalis L.	Subcosmop.	City center; Mondello	Ditches	19th century
Anchusa undulata subsp. *hybrida* (Ten.) Bég.	Stenomedit.	Arenella and Vergine Maria	Uncultivated lands	19th century
Artemisia campestris subsp. *variabilis* (Ten.) Greuter	Endem. Ital.	Mondello	Ditches	19th century
Bolboschoenus maritimus (L.) Palla	Cosmop.	Baida, Mondello	Marshes	19th century
Calamagrostis arenaria subsp. *arundinacea* (Husn.) Banfi, Galasso & Bartolucci	Eurimedit	Mondello	Sandy dunes	19th century
Callitriche brutia Petagna	Subatlant.	Mondello	Seasonal wetlands	19th century
Callitriche palustris L.	Circumbor.	Mondello	Seasonal wetlands	19th century
Callitriche truncata Guss. subsp. *truncata*	Subatlant.	Arenella, Vergine Maria	Wetlands	19th century
Catabrosa aquatica (L.) P.Beauv.	Circumbor.	Roccazzo	Marshes	19th century
Cressa cretica L.	Subcosmop.	Sferracavallo	Beaches, brackish wetlands	19th century
Cyperus capitatus Vand.	Stenomedit.	Fondachelli, Mondello, Villabate	Sandy dunes	19th century
Cyperus fuscus L.	Paleotemp.	San Ciro	Seasonally wet areas	19th century
Cyperus papyrus L.	African	Papireto river	river banks	10th century
Descurainia sophia (L.) Webb ex Prantl	Subcosmop.	Oreto river	Vegetable gardens	19th century
Echium arenarium Guss.	Stenomedit.	Vergine Maria	Beaches	19th century
Elatine macropoda Guss.	Stenomedit.	Mondello	Irrigation ducts	19th century
Groenlandia densa (L.)	Eurosiber.	San Ciro	Water pools	19th century
Humulus lupulus L.	Paleotemp.	Porrazzi	Riverbanks	19th century
Hypericum pubescens Boiss.	W-Stenomedit.	Mondello	Wetlands, springs	19th century
Ipomoea sagittata Poir.	Anfiatlant.	Mondello	Marshes	19th century

Isolepis cernua (Vahl) Roem. & Schult.	Subcosmop.	Mondello, San Ciro, Villabate, Roccazzo, Boccadifalco	Ponds, marshes	19th century
Juncus acutiflorus Ehrh. ex Hoffm.	Europ.	Baida, Roccazzo	Marshes	19th century
Myosotis sylvatica subsp. *subarvensis* Grau	Europ.	Mondello	Wet soils	19th century
Nanozostera noltei (Hornem.) Toml. & Posl.	Subatlant., Medit.	Mondello	Coastal lagoons	19th century
Potamogeton pusillus L.	Subcosmop.	Oreto river	Lakes, rivers	19th century
Rumex palustris Sm.	Eurasiat.	Boccadifalco	Marshes	19th century
Saccharum biflorum Forssk.	Paleotrop.	Fiume Oreto at bridge Corleone and bridge della Grazia	Seasonally moist soils	19th century
Salicornia fruticosa (L.) L.	Eurimedit.	Arenella, Mondello	Salt marshes	19th century
Salvia fruticosa subsp. *thomasii* (Lacaita) Brullo, Guglielmo, Pavone & Terrasi	Endem. Ital.	Piana dei Colli	Arid grasslands	19th century
Salvia viridis L.	Stenomedit.	Base of Mt Gallo	Arid grasslands	19th century
Schoenus nigricans L.	Subcosmop.	Boccadifalco, Mondello	Wet meadows	19th century
Scirpoides holoschoenus (L.) Soják	Eurimedit.	Mondello, San Ciro	Wetlands	19th century
Solenopsis bivonae (Tineo) M.B.Crespo, Serra & Juan	Stenomedit.	Guadagna, Mondello, city center	Seasonally wet soil	19th century
Solenopsis laurentia (L.) C. Presl	Stenomedit.	Mondello	Seasonally wet soil	19th century
Sporobolus pungens (Schreb.) Kunth	Pantrop.	Romagnolo	Beaches	19th century
Stuckenia pectinata (L.) Börner	Subcosmop.	Mondello	Irrigation ducts	19th century
Bulliarda vaillantii (Willd.) DC.	Subatlant.	Mondello	Seasonally wet soil	19th century
Thinopyrum elongatum (Host) D.R.Dewey	Eurimedit.	Mondello	Beaches	19th century
Veronica anagalloides Guss.	Euromedit.	Mondello	Marshes	19th century

4. *Discussion and conclusion*

The plant landscape of Palermo's Conca d'Oro has undergone five major transformations: (1) Roman-era deforestation (254 BC-444 AD) of holm oak forests for cereal cultivation; (2) Arab-introduced irrigation (9th century) reducing dryland farming; (3) 16th century wetland reclamation eliminating humid habitats; (4) 19th century citrus monoculture expansion (lemons/mandarins)[40]; and (5) post-WWII urbanization replacing agricultural land. As observed elsewhere in Europe[41], these shifts reflect deliberate political-economic decisions whose unintended consequences include biodiversity decline and soil degradation[42]. A historical analysis of land-use policies reveals their long-term ecological impacts, offering insights for more sustainable future planning[43].

The distribution of crops in the Conca d'Oro has historically been shaped by soil properties and water availability[44]. However, intensive land use has nearly eliminated humid zones and dune ecosystems, which rank among Italy's most endangered habitats[45]. The degradation followed a clear sequence: wetlands were the first to disappear, followed by coastal areas, and finally dry grasslands and traditional farmlands.

While rocky cliffs (Figure 4, areas 1–8) persist as biodiversity refuges for specialized species, most former wetlands (Figure 4, areas 9–13) are now irreversibly lost beneath urban development. Only the San Ciro marshes (Figure 4, area 14) at the city's edge offer potential for restoration, particularly in conjunction with the Maredolce castle and its historic lake.

The Oreto River remains a critical stronghold for plant diversity, with its carbonate canyons preserving near-natural vegetation of biogeo-

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[40] Cf. F.M. Raimondo, H.W. Lack, *Le Mele d'Oro*, Palermo, 1997.

[41] Cf. E. Piškinaitė, D. Veteikis, *The Results of Digitizing Historical Maps: Comparison of Lithuanian Land-Use Structure in the 19th and 21st Centuries*, in *Land*, 12, 2023, 946.

[42] Cf. R. Sheehan, J.M. Vadjunec, *Placing community through actor-network theory in Oklahoma's 'No Man's Land'*, in Soc. Cult. *Geogr.*, 13, 2012, 915-936.

[43] Cf. G.B. Carrasco Galvan, J.M. Vadjunec, T.D. Fagin, *Lessons from the Archives: Understanding Historical Agricultural Change in the Southern Great Plains*, in *Land*, 13, 2024, 196.

[44] Cf. E. Papadias, V. Detsis, A. Hadjikyriakou et al., *Long-Term Dynamics of Viticultural Landscape in Cyprus – Four Centuries of Expansion, Contraction and Spatial Displacement*, in *Land*, 12, 2023, 1143.

[45] Cf. L. Blasi, G. Zavattero, S. Capotorti et al., *Lista Rossa degli Ecosistemi d'Italia*, Rome, 2023.

graphic significance. In contrast, the Eleuterio River's clay-based, gently sloping banks have been fully converted to agriculture. Overall, the least disturbed ecosystems are those that have avoided cultivation, underscoring the impact of human activity on landscape transformation.

This study reconstructs the ecological transformation of Palermo's Conca d'Oro from antiquity to the present, analyzing how political-economic forces have reshaped its vegetation patterns through space and time. By synthesizing historical cartographic sources with contemporary data, we demonstrate that landscape evolution reflects broader societal transitions, despite the interpretative challenges inherent to archival materials.

The research reveals two critical insights: first, that remnant natural features like cliff ecosystems and river gorges constitute vital biodiversity refugia needing urgent protection; second, that these relict habitats provide urban residents with rare opportunities for nature connection. Moving forward, we identify four key priorities: (1) establishing long-term ecological monitoring programs responsive to climate change, (2) systematically tracking threatened plant populations, (3) quantifying urbanization-biodiversity tradeoffs, and (4) developing advanced modeling frameworks that combine historical knowledge with emerging technologies for more accurate landscape projections.

Abstract

This study examines the landscape transformation of Palermo's Conca d'Oro from antiquity to the present, analyzing how human activities have reshaped its ecology. Through historical maps, floristic records, and spatial analysis, five key phases were identified: Roman deforestation, Arab irrigation, wetland reclamation, 19th-century citrus monoculture, and post-WWII urbanization. Results show dramatic declines in forests (22.3% to 4.4%) and wetlands (36.6% to 15.1%), alongside urban expansion (26.8% to 83.7%). Endemic flora now persists only in fragmented refuges like cliffs and river canyons, and 40 taxa are locally extinct. The findings highlight the need for conservation of remaining biodiversity hotspots and sustainable urban planning to mitigate further ecological degradation in Mediterranean coastal regions.

La trasformazione del paesaggio della Conca d'Oro
(Palermo, Sicilia nord-occidentale)
e il rischio connesso di perdita di biodiversità

Questo studio esamina la trasformazione del paesaggio della Conca d'Oro di Palermo dall'antichità ad oggi, analizzando come le attività umane ne abbiano rimodellato l'ecologia. Attraverso mappe storiche, dati floristici e analisi spaziali, sono state identificate cinque fasi chiave: la deforestazione romana, l'irrigazione araba, la bonifica delle zone umide, la monocoltura ad agrumi del XIX secolo e l'urbanizzazione del secondo dopoguerra. I risultati mostrano un drastico declino delle foreste (dal 22,3% al 4,4%) e delle zone umide (dal 36,6% al 15,1%), insieme all'espansione urbana (dal 26,8% all'83,7%). La flora endemica persiste ora solo in rifugi frammentati come rupi e canyon fluviali, e 40 taxa risultano localmente estinti. I risultati evidenziano la necessità di conservare gli hotspot di biodiversità rimanenti e di una pianificazione urbana sostenibile per mitigare l'ulteriore degrado ecologico nelle regioni costiere del Mediterraneo.