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Territorial sustainable regeneration of denied areas: the GIS-based analysis of the Agro Aversano areas

Rigenerazione territoriale sostenibile delle aree negate: l'analisi GIS delle aree dell'Agro Aversano

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ABSTRACT AND KEYWORDS

Territorial sustainable regeneration of denied areas
The Provincial Territorial Plan of Caserta, approved in 2012, recognizes the 'denied areas' as parts of the territory devoid of territorial functions and marked by evident functional, physical, or environmental degradation. More than ten years after the approval of the Provincial Plan, some of these areas have been regenerated, many are still waiting for a transformation and new denied areas can be identified. The analysis of the current state of denied areas, their features, and their potential for transformation resulted in a GIS database useful both for updating the knowledge framework of the Provincial and Urban Plans, and to supporting the definition of urban and territorial regeneration strategies, the choice of alternatives, and the prioritization of actions. Thanks to the definition of a GIS database, knowledge frameworks are enriched with a repository of spatial data on the current state of denied areas and a tool to enable the setting of strategies and interventions for unlocking the potential of a sustainable revitalization of marginalized and fragile ecosystems.

Keywords: regeneration, denied areas, GIS-based analysis

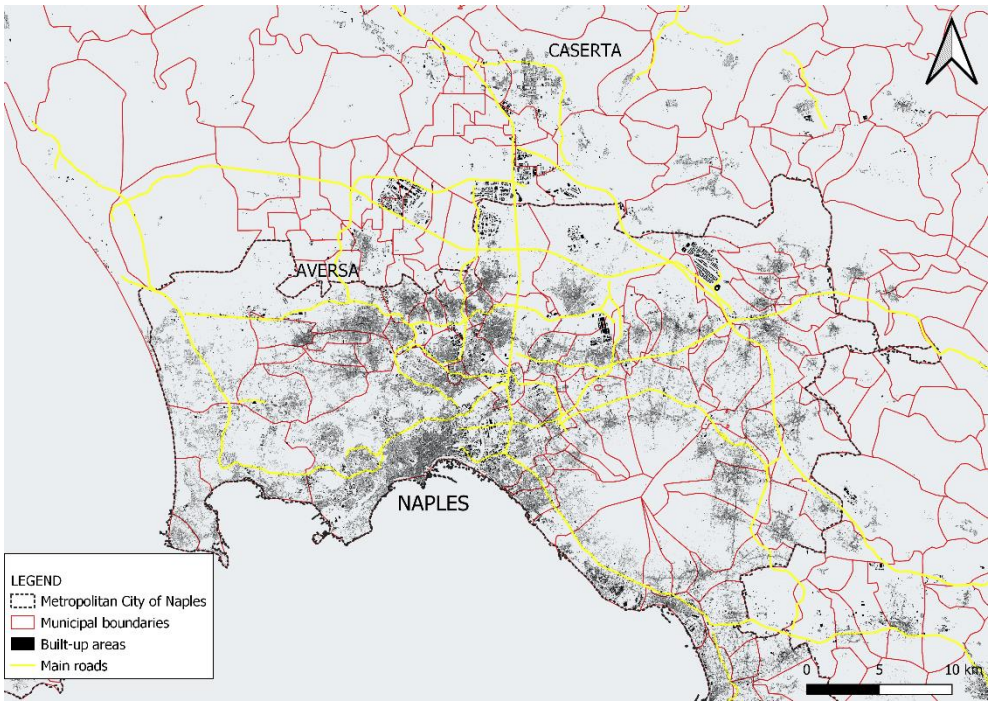
Rigenerazione territoriale sostenibile delle aree negate
Il Piano Territoriale di Coordinamento Provinciale di Caserta, approvato nel 2012, riconosce le "aree negate" come parti di territorio prive di funzioni territoriali e segnate da un evidente degrado funzionale, fisico o ambientale. A più di dieci anni dall'approvazione del Piano, alcune di queste aree sono state riqualificate, molte sono ancora in attesa di trasformazione e nuove aree negate possono essere individuate. L'analisi dello stato attuale delle aree negate, delle loro caratteristiche e del loro potenziale di trasformazione ha prodotto un database GIS utile sia per aggiornare il quadro conoscitivo sia a livello provinciale che dei Piani Urbanistici Comunali, sia per supportare la definizione di strategie di riqualificazione urbana e territoriale, la scelta di alternative e la definizione delle priorità di intervento. Grazie alla definizione del database GIS, i quadri conoscitivi si arricchiscono di un archivio di dati spaziali sullo stato attuale delle aree negate e di uno strumento utile a supportare strategie e interventi in grado di attivare una rigenerazione territoriale sostenibile di ecosistemi fragili.

Parole chiave: rigenerazione, aree negate, analisi GIS

1. Introduction

The national debate on the Italian Metropolitan Areas (MAs) and Metropolitan Cities (MCs) dates back to 1990, with the promulgation of the Law n.142/90 establishing the new authority of the Metropolitan City to respond to the dynamics of expansion of the urban areas around the main regional capitals. The Authority has the task of governing matters of supra-municipal importance. With Law n.56/2014 Delrio, the first 10 Italian MCs were established by replacing the 10 Provinces of the main regional capitals (Roma, Torino, Milano, Venezia, Genova, Bologna, Firenze, Bari, Napoli, Reggio Calabria). The debate concerns both the functions and roles of the metropolitan Authority and the real convergence between the MCs administrative boundaries and the urban conurbation that actually defines the MAs.
In particular, the MC of Naples includes the 92 municipalities of the former province and the most densely populated of the Italian MCs. However, the administrative boundary of the MC does not correspond to the metropolitan area which, to the north, includes some territories of the province of Caserta, branching out towards the Caserta area to the north-east and the Aversa area to the north-west (Figure 1).

Figure 1. The extension of the MC of Naples to the northern urban areas of Aversa and Caserta



Source: Authors' elaboration

The Aversa conurbation area includes 19 small and medium size municipalities divided into three nuclei:
– main nucleus, including Aversa, Lusciano, Trentola-Ducenta, San Marcellino, Frignano, Casaluce, Teverola, Carinaro;
– secondary nucleus, including Villa di Briano, Parete, Gricignano d'Aversa, Cesa;
– satellite nucleus, including Villa Literno, Casal di Principe, San Cipriano d'Aversa, Casapesenna, Orta di Atella, Sant'Arpino and Succivo (Losco and De Biase, 2023).

The territory is highly infrastructured, rich in territorial facilities, but poor in essential services. Also, it is characterized by high urban spawl and land

consumption and several environmental and social problems. According to the Regional Territorial Plan Report (Campania Region 2008) the area is a system of peripheral areas devoted to the sole residential function where the community has lost the relationship with the identity heritage of the places. The Aversa conurbation has had a notable expansion in the last fifty year going from an area of 9.2 sqkm in1951 to an area of 47.5 sqkm in 2005, an increase in percentage equivalent to 420%. According to ten-years ISTAT censuses, the population in the area has increased from 241'657 in 2001 to 300'150 in 2021. Also, data on land consumption confirm the growth of urban conurbation. Table 1 shows the data extracted from the latest Annual Report on Land Consumption (Munafò, 2023) for the year 2022 and the comparison with the 2006 data. While Municipalities such as Aversa, Sant'Arpino and Casapesenna show percentages of land consumed already very high since 2006 and tend to become saturated, other municipalities such as Villa Literno, Gricignano, Carinaro, Teverola show significant increases in recent years demonstrating the progressive growth of such a territory.

Table 1. Variation of land consumption from 2006 to 2022

	Land consumption				Variation
	2006		2022		2006-22
	[%]	[ha]	[%]	[ha]	[ha]
Aversa	**63,8**	562,3	**65,8**	580,5	18,2
Carinaro	39,3	247,0	47,4	298,1	**51,1**
Casal di Principe	19,8	464,6	20,7	484,2	19,5
Casaluce	17,0	161,7	18,5	176,3	14,7
Casapesenna	49,9	151,4	**51,2**	155,4	4,0
Cesa	37,2	101,5	40,8	111,1	9,7
Frignano	16,9	165,5	18,2	178,5	13,0
Gricignano di Aversa	36,1	358,8	45,0	447,6	**88,7**
Lusciano	44,3	201,2	47,9	217,7	16,5
Orta di Atella	26,7	288,6	27,8	300,3	11,8
Parete	28,3	158,4	31,7	177,3	19,0
San Cipriano d'Aversa	42,1	259,5	43,1	265,5	6,0
San Marcellino	44,4	203,8	47,9	220,0	16,2
Sant'Arpino	**56,0**	178,3	**59,4**	189,3	11,0
Succivo	19,4	139,3	20,6	148,3	9,0
Teverola	41,6	277,8	47,7	318,0	**40,1**
Trentola Ducenta	40,6	269,2	43,1	285,5	16,3
Villa di Briano	18,6	158,7	19,2	163,7	5,0
Villa Literno	8,2	503,5	10,1	624,4	**120,8**

Source: ISPRA, 2023

The expansion of the urban conurbation over the years has not only been the result of urban planning, many settlements have built out of any urban plans regulations or illegally. The data provided by the Provincial Plan of Caserta, approved in 2012, show that, in the period 1984-2004, approximately 12 hectares were covered by buildings built in the absence of urban plans. The maximum concentration of these settlements are located in the conurbations of Caserta, Aversa and Domitio coast (De Biase and Losco 2023).

The dynamics of socio-spatial transformation and the progressive crumbling of the urban fabric have led to the formation of "vacant land", "spaces in-between", "drosscape" (Pagano and Bowman 2000, Berger 2006, Gabbianelli 2017). This generates both ecological-environmental and socio-cultural conflicts, but also offers

insights into their potential reuse by reading the dynamics and forms of the context (Pagano and Bowman 2000; Németh and Langhorst 2014; Chaffin et al. 2014).
Once the complexity of such a context has been framed, the contribution proposes in the following sections a qualitative and quantitative analysis of the so-called “denied areas” of the Aversa conurbation area with the aim of identifying portions of territory which, showing particular conditions of degradation, as well as specific potential, can be the primary interested by urban and territorial regeneration interventions. The Provincial Plan of Caserta recognizes the functional, physical, and environmental degradation of some areas by identifying the so-called "denied areas", i.e. those parts of the territory devoid of territorial functions and marked by evident functional, physical, or environmental degradation (Galderisi and De Biase, 2021).
More than ten years after the approval of the Provincial Plan, some of these areas have been regenerated, many are still waiting for a transformation and new denied areas can be identified.
Section 2 explains the three-step methodology that leads from the analysis of the denied areas based on their current function and type of degradation, to the definition of the potential for transformation (Petrella 2003), to the organization of the GIS-database as support tool for the planning and localization of future regeneration interventions by the Provincial and Municipal administrations. Section 3 shows the main results of the application to the case study of the 19 municipalities in the Aversa area providing both some summary maps and some insights into particularly interesting areas.
In section 4 the main outcomes of the research are discussed by focusing on the achievement of the following objectives:

- developing a methodology aimed at investigating the conditions of denied areas as a preliminary condition for effectively orienting widespread regeneration interventions;
- providing a GIS-database of the current conditions of the denied areas of the Aversa territory through an update of the cartographic base of the Provincial Plan;
- identifying the potential for transformation of the denied areas starting from their multiple intrinsic features and their relationship within the context.

2. The three-step methodology

2.1 Current state analysis of the denied area

The denied areas have been defined by the Provincial Plan of Caserta as those parts of the territory devoid of territorial functions and marked by evident functional, physical, or environmental degradation.
More than ten years after their identification and classification, an update of their current status is essential to understand how many of them and how they have been recovered, how many are still in a state of degradation and whether, over the years, new denied areas can be identified.
With this first step, the denied areas identified by the Provincial Plan are analysed for each Municipality through preliminary Google Earth investigations in-depth inspections. They are classified as recovered denied areas and denied areas still awaiting transformation. In the first case, the analysis concerns the current function: residential, environmental, agricultural, productive-commercial, facilities, mixed. In the second case, the analysis concerns the current type of degradation: physical, environmental, urban-functional.
Also, following the same steps of investigation, the new denied areas for each

Municipality can be identified and classified according to the type of degradation.
The first results of the analysis are organized in a GIS database where the following features are available:

- Municipality
- ID number
- area [sqm]
- denied area identified by the Provincial Plan [yes/no]
- recovered area [yes/no]
- new denied area
- current function [only recovered areas]
- type of degradation [only still and new denied areas].

2.2 The path towards the definition of the potential for transformation

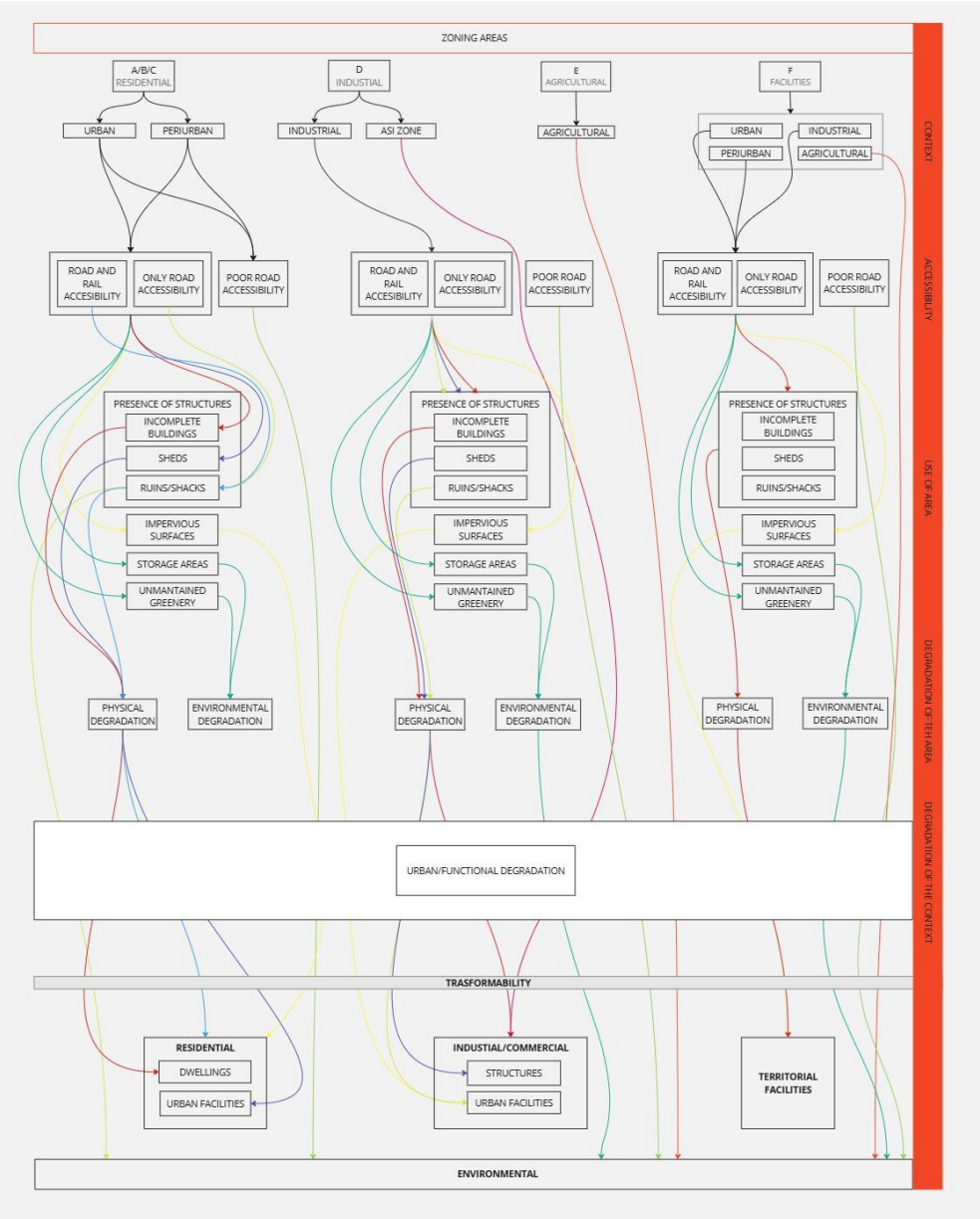
The Provincial Plan details the denied areas also based on their future vocation, by distinguishing areas with potential for new settlements and areas with environmental potential. However, this is a first distinction, and it requires more in-depth analysis to investigate both the intrinsic features of the area and the relation with the context. Indeed, the transformability of areas is conditioned by the possibility of resolving issues and criticalities (both environmental and socio-economics) of the urban context (Petrella 2003).
To this end, a further classification of the denied areas is here proposed starting from the in-depth analysis of the following features:

- presence of buildings (dismissed or ruins)
- context (urban, peri-urban, agricultural, etc.)
- accessibility (access to main roads, secondary roads, distance from train stations)
- zoning class provided by municipal plan (residential, agricultural, industrial, etc.)
- type of denied area and potential identified by the Provincial Plan
- imperviousness
- type of degradation (physical and/or environmental degradation of the area, urban-functional degradation of the context)
- natural hazards
- restrictions.

These criteria allow to analyze the current state of the areas (presence of buildings, imperviousness), the forecasts for the transformation (zoning, risks, and constraints), the relationships with the context (accessibility, functional characteristics, urban role). The proposed analysis represents an adaptation of the methodology proposed by Petrella (2003). The types of degradation considered are three: urban-functional, i.e. lack of primary and secondary facilities and public services; physical degradation, i.e. a condition of decay of manufacts and pertinencies; environmental degradation, i.e. result of human activities such as noise, pollution, traffic, abandonment of open and outdoor spaces, lack of maintenance of streets.
Once all this information has been acquired in the GIS database, an abacus of the possible combinations is prepared to determine the potential for transformation of each denied area (Figure 2).
For each area the transformability can be residential, environmental, industrial-commercial or for the settlement of territorial facilities. In the case of areas with vocation for environmental transformation, the predominant criteria are the absence of buildings and sealed soil, the poor accessibility, and the possibility of strengthening existing green connections while preserving their ecosystem function. In the case of areas with a vocation for residential transformation, the predominant criteria are the existence of buildings and sealed soil, the good accessibility, and the

proximity to dense urban fabric to ensure completion interventions and avoid urban sprawl. Also, areas closest to urban settlements are more suitable for a residential transformation and may include essential services for residents. In the case of areas with a vocation for industrial-commercial transformation, the predominant criteria are the existing of an industrial-commercial context, the presence of industrial buildings and sealed soil and a good intermodal accessibility. As in the case of residential vocation, the identified areas can be used to host public services serving existing industrial sites. Few areas have been identified as suitable for hosting territorial facilities. These are medium-large areas, close to urban settlements and with good accessibility.

Figure 2. The abacus of the possible combination for determining the potential for transformation



Source: Authors' elaboration

2.3 The role of the GIS database

The full implementation of the proposed methodological path, developed so far on a sample area discussed in Section 3, allows to have a knowledge base for all the

denied areas of the Province of Caserta area as an update and implementation of the study carried out for the Provincial Plan in 2012, by providing a comprehensive overview of the territory and aids in defining strategic priorities. Such a GIS-database facilitates municipal administrations in identifying homogeneous clusters of areas for the activation of regeneration strategies since denied territories represent key areas for triggering spread regeneration processes by re-establishing reparative and co-evolutionary relationships between the natural and anthropogenic systems (Newman and Kim 2017). The use of GIS systems enables local governments to visually interpret spatial data, to visualize and understand complex territorial dynamics and to foster informed decision-making processes.

Also, GIS systems are valuable tool for the comparison and aggregation of data from heterogeneous sources, facilitating a multifaceted analysis of territorial features (Douglas et al. 2004).

By implementing the proposed study both in terms of investigated area and topics/layers, such a tool could help in strengthening spatial planning efforts and enhancing the overall effectiveness of land management policies by including environmental, social, and economic aspects, essential for the territorialization of diverse strategies.

In particular, territories facing significant challenges such as urban sprawl and spatial disorganization, pollution and environmental degradation, fragmentation of agricultural areas, lack of public spaces, presence of illegal settlements worth GIS systems capable of providing complex layers of information and addressing such multifaceted issues (Lukasheh et al. 2001; Malczewsji and Rinner 2015). By offering a spatial representation of these criticalities, GIS allows for the identification of patterns and correlations that might not be evident through simple analytical reports. This allows for developing unified visions, while still both respecting the complexity of these territories and addressing specific issues with targeted interventions.

Operatively, the process of analysis of the denied areas has been carried out starting from the overlapping of the denied area surveyed by the plan (2012) and the current satellite images in order to identify the current use and features of the area (presence of buildings, context, imperviousness, type of degradation). Also, the overlapping with the mosaic of the zoning maps provided by each municipality – as raster layers – allowed to associate the characteristics related to the to the forecasts of the municipal plans. Thanks to the layer provided by the national database on natural hazards, any risk areas have been highlighted. In the end, the overlapping of the road and railways network allowed to classify the areas in terms of accessibility by the network analysis plugin.

3. Case study: the denied areas of Agro Aversano municipalities

The Provincial Plan of Caserta, approved by Provincial Council Resolution No. 26 on 26/04/2012, introduces the concept of “denied areas,” which refers to “areas belonging to both the urban system and the open space system that lack a clearly defined function and are marked by evident signs of degradation” (Province of Caserta, 2012). The expression refers to the concept of residual landscape and the definition of “Third Landscape,” as suggested by Gilles Clement (2004).

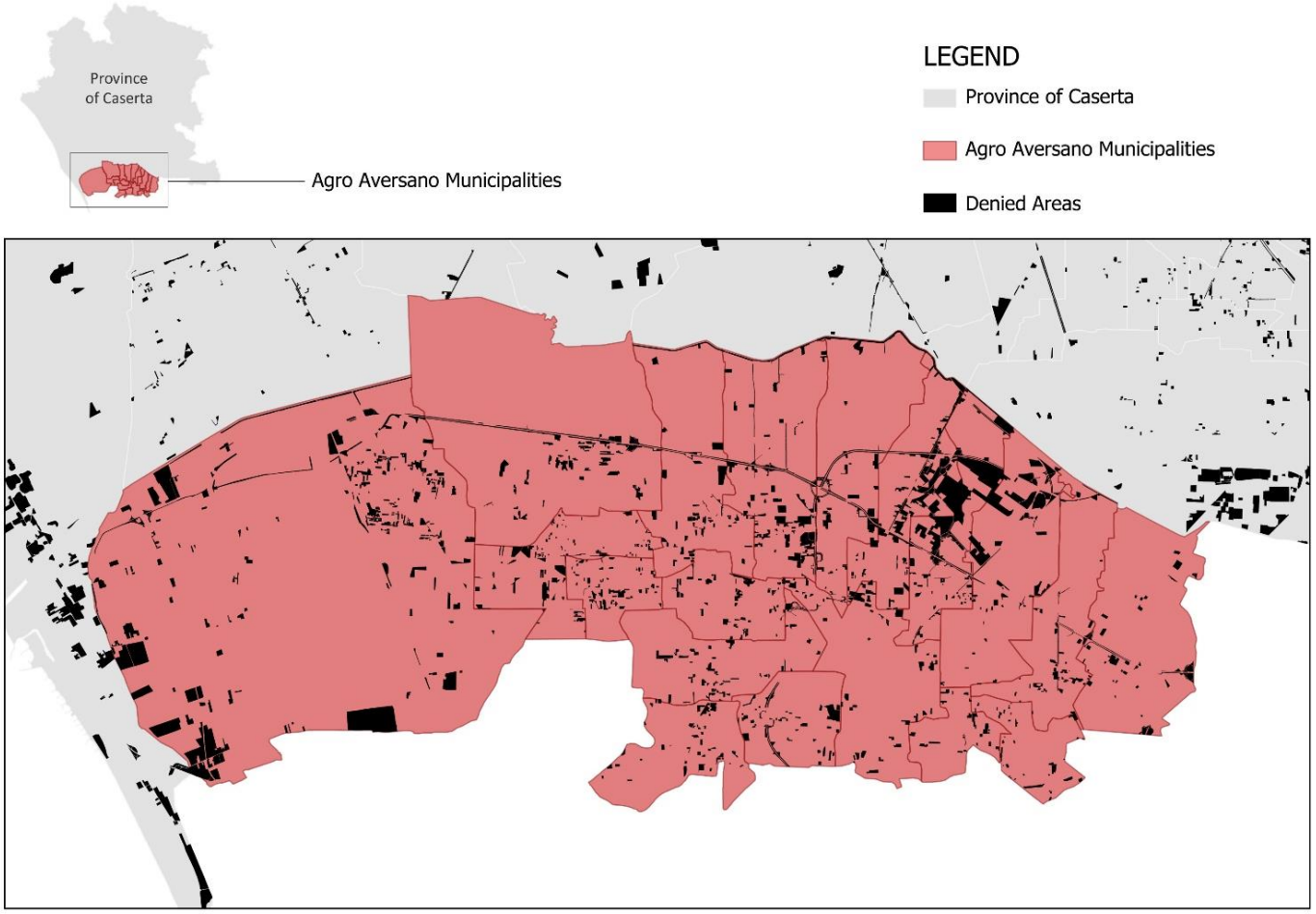
The Provincial Plan classifies the denied areas, as identified in each municipality into five categories:

- Urban areas, further divided into: disused, with newly constructed unused buildings, underutilized;
- Areas related to infrastructure, divided into: railway, road, watercourses;

– Open space areas, subdivided into: areas with land movements, with the presence of waste, unused;
– Quarries, classified as: active and inactive;
– Areas with waste accumulation, classified as: landfills, transfer sites, ecoball deposits. (Province of Caserta, 2012).

The plan also details the types of areas based on their future potential, distinguishing between Areas with settlement potential and Areas with environmental potential. For the former, urban transformation interventions aimed at achieving urban standards can be considered, while for the latter, reclamation, restoration, and recovery of landscape values should be planned. However, the realization of these guidelines would require further knowledge and design studies to be developed within municipal planning. The precise knowledge of the "denied" assets is, in fact, already a source of resources, making parts of the territory visible and available, often located in central and strategic positions in relation to the urban context, for new "compatible" uses (Galderisi and De Biase, 2021)

Figure 3. Denied areas of Provincial Plan: Agro Aversano Municipalities



Source: Authors' elaboration

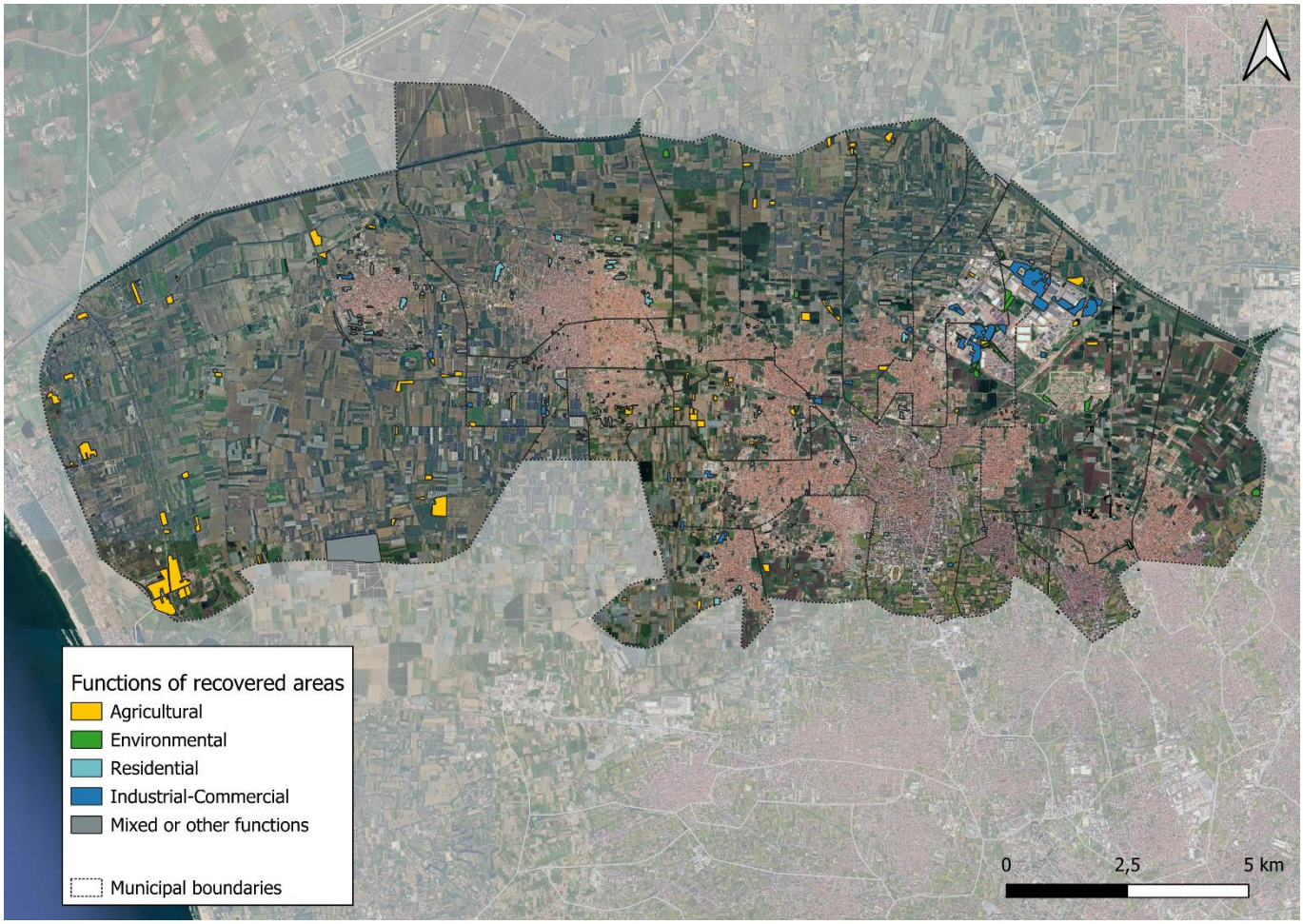
Whit reference to our field of analysis, regarding the 19 municipalities of the Agro Aversano, the Provincial Plan identifies 1,419 denied areas, covering a surface of approximately 1,289.3 hectares, representing a significant portion of the approximately 5,000 denied areas in the entire provincial territory, or about 25%. Specifically, this includes 606 urban critical areas, 405 critical open space areas, 400

infrastructure-related critical areas, 7 quarries, and 1 waste accumulation area.
Among all the municipalities in the province of Caserta, those in the Aversa district are among the most significant for each type of area. Teverola and Carinaro have the highest percentage of urban denied areas relative to urbanized land, and since they have a smaller territorial extension, the impact of degraded areas is greater, at 32% and 28,6%, respectively. For the denied open space areas, which are either unused or show signs of human intervention or are sometimes characterized by the presence of bulky waste, one of the most affected Municipality is Villa Literno, were these areas cover a surface of 264,5 hectares. With regard to critical areas related to infrastructure, the three municipalities in the province of Caserta that mostly present this type are Villa Literno, with a concentration of areas mainly along the Regi Lagni canal and the support axis of the Ss7quater, covering an area of 45.14 hectares; followed by the municipalities of Carinaro and Frignano, with areas mostly along the Ss7B, particularly near the junctions, covering an area of 32.06 and 27.99 hectares, respectively. In relation to waste accumulation areas, the municipality of Villa Literno once again stands out for the largest area, 56.11 hectares, which characterizes the waste storage sites at Taverna del Re (Province of Caserta, 2012).

3.1 Current state of denied areas

As of 2023, many of these areas remain inaccessible, while others have been recovered and redeveloped for various uses, with different purposes: residential, environmental, agricultural, and productive/commercial.

Figure 4. Recovered areas



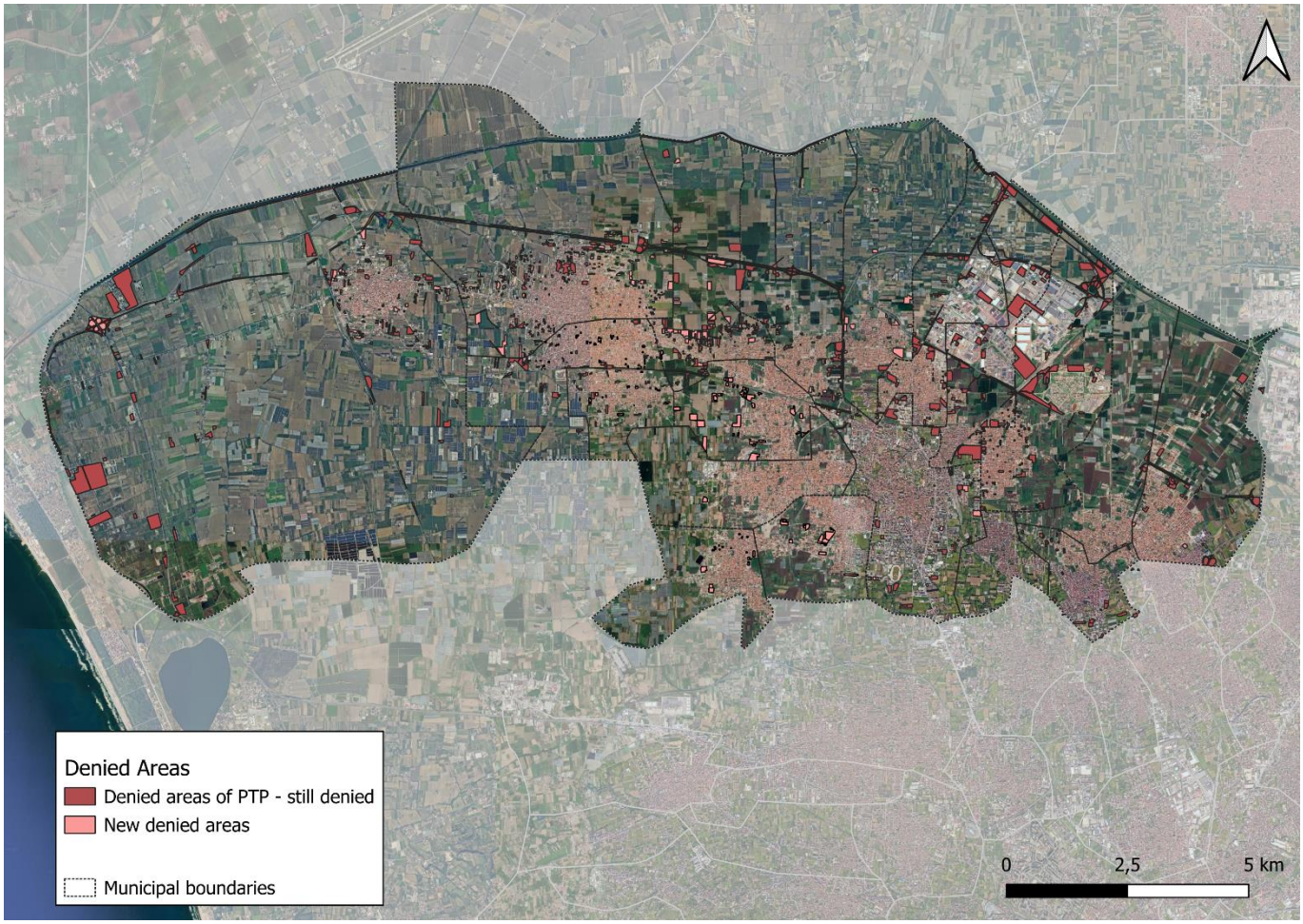
Source: Authors' elaboration

Specifically, about 37% has been designated for residential purposes, 20% for productive or commercial purposes, 14% for agricultural functions, and only 10% has taken on an environmental role. The remaining 19% has been allocated to other uses or is suitable for a combination of different functions.
Regarding the areas that have not yet been recovered, the percentage distribution varies significantly across the different municipalities. In the municipalities of Casapesenna, Parete, San Cipriano, and Trentola, the percentage is below 25%; in the municipalities of Lusciano, San Marcellino, Succivo, and Teverola, it increases, ranging between 25% and 50%. Finally, in the remaining 11 municipalities, the percentage of unrecovered areas exceeds 50%, highlighting an even more critical situation of lack of recovery.

3.2 New denies areas

Over the years, other parts of the territory have been progressively abandoned and have gradually taken on the characteristics of restricted areas, adding to those already identified by the Plan and still awaiting transformation. The total number of restricted areas has thus increased to 1,685.

Figure 5. Total denied areas



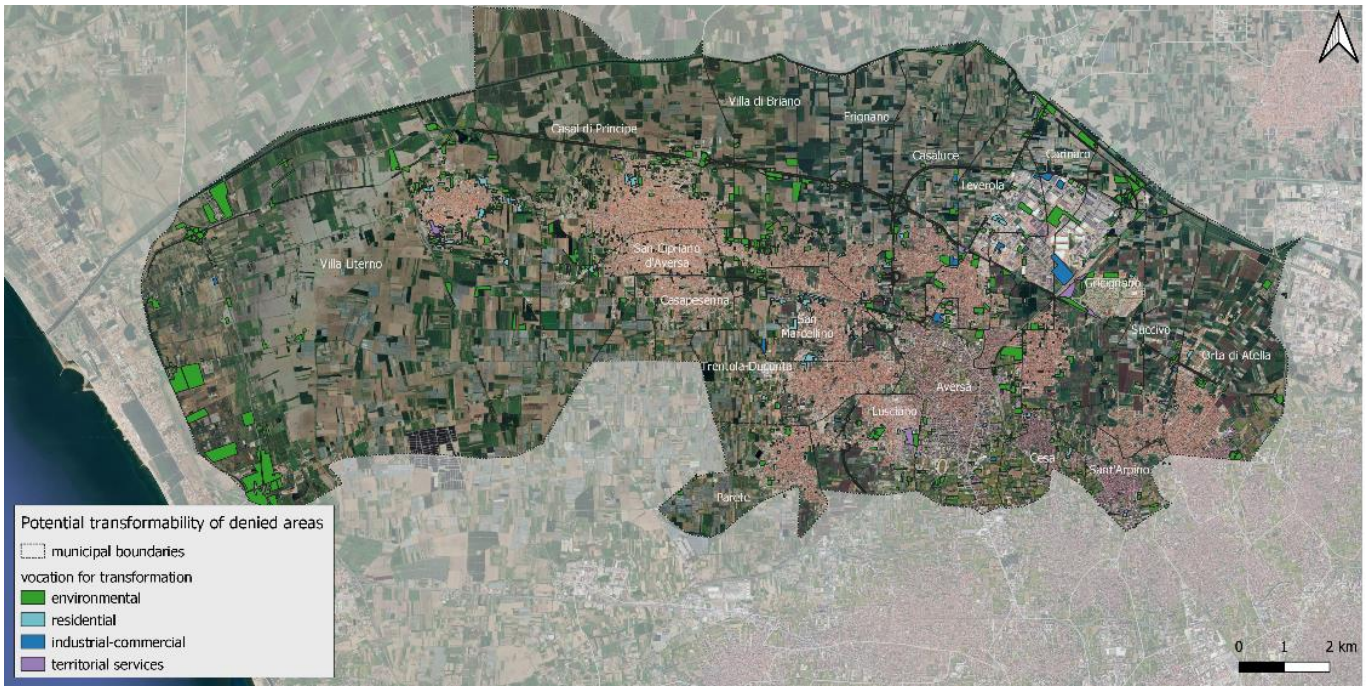
Source: Authors' elaboration

Regarding the types of degradation, which can be physical, environmental, or urban-functional, 50% of the new areas are characterized by multiple types of degradation, 48% by environmental degradation, and the remaining 2% by physical or urban-functional degradation.

3.3 Trasformability

For areas subject to potential residential transformation, the predominant criteria are the presence of buildings and impermeable surfaces, good accessibility, and proximity to dense urban areas to ensure infill development and prevent urban sprawl. Additionally, areas closest to urban settlements are better suited for residential transformation and can include essential services for residents.
In the case of areas designated for environmental transformation, the predominant criteria are the absence of buildings and impermeable surfaces, limited accessibility, and the potential to strengthen existing green connections while preserving their ecosystem function. In our territory, there is a strong environmental vocation in peri-urban areas and along major transportation infrastructure.
For areas with an industrial-commercial future, the predominant criteria are the existence of an industrial-commercial context, the presence of industrial buildings and impermeable surfaces, and good intermodal accessibility. As with residential vocation, the identified areas can be used to host public services serving existing industrial sites.
The areas identified as suitable for hosting territorial services are few; these are medium-to-large areas, close to urban settlements, and with good accessibility.

Figure 6. Potential trasformation of denied areas



Source: Authors' elaboration

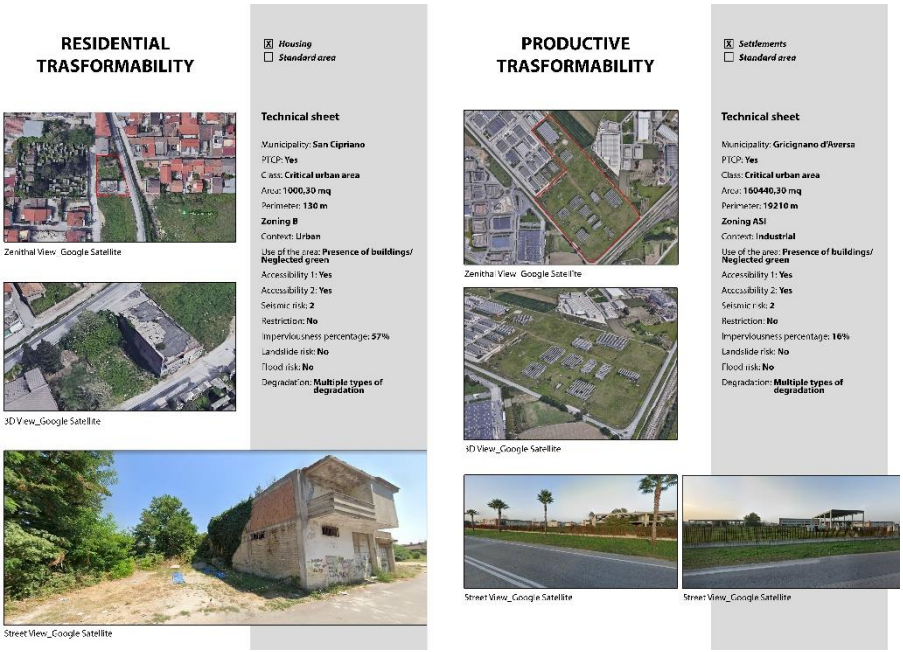
For each area, a technical sheet has been compiled containing all the parameters necessary to define its potential transformation. Below are some examples of how the transformability of areas is defined based on the established parameters. The first sheet examines a restricted area identified by the Provincial Plan in the municipality of San Cipriano. This area falls within a Zone B, has medium-high accessibility, and is characterized by the presence of volumes; the degree of soil impermeability is also high. Additionally, given the presence of a building with characteristics suitable for residential use, it is possible to define the area as having residential transformability and a potential designation for housing. The second sheet examines a restricted area identified by the Provincial Plan in the municipality of Gricignano d'Aversa. This

area falls within an ASI Zone, has medium-high accessibility, and is characterized by the presence of volumes. Given the context and characteristics of the area, it is possible to define it as having productive transformability.

Figure 7. Sheets

Source: Authors' elaboration

Figure 8. Sheets



Source: Authors' elaboration

The third sheet examines a restricted area identified by the Provincial Plan in the municipality of Casal di Principe. This area falls within a Zone F, has medium accessibility, and is characterized by the presence of volumes, as well as a high degree of soil impermeability. Given these conditions, it is possible to define its

transformability for the establishment of facilities of general interest. The fourth sheet examines a restricted area identified by the Provincial Plan in the municipality of Sant'Arpino. This area also falls within a Zone F, but accessibility is poor and there are no volumes present. In this case, it is possible to define its transformability as environmental.

4. Conclusions

The high heterogeneity of the portfolio of abandoned and restricted areas necessitates a precise and constantly updated inventory of these assets. This is a complex task that, if extended to the entire provincial territory, would require the establishment of a dedicated Observatory. This Observatory would be based on shared criteria for inventorying and classifying areas and would support municipalities in identifying priorities and the most suitable types of intervention for the specific characteristics of each area, within a comprehensive vision for territorial development. The research conducted so far, a first step towards a more systematic survey of the restricted areas in Caserta, has outlined—through analytical and design examples related to the Aversano territorial system—a methodological approach with the dual aim of updating knowledge and providing a support tool for regeneration decisions at the municipal level.

Because of the role of the agro-aversano system as urban continuum of the metropolitan area of Naples, the regeneration of such territories offers opportunities for a territorial integrated regeneration strategy starting from shared approach with the broader urban and environmental dynamics of the entire territorial system.

Author Contributions

Conceptualization, C.DB.; Methodology, C.DB.; Validation, C.DB.; Formal Analysis, G.L, A.N.; Investigation, G.L., A..N.; Data Curation, G.L., A..N.; Writing - Original draft preparation, G.L., A..N.; Writing - Review & Editing. C. DB., G.L.

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Conflicts of Interest

The authors declare no conflict of interest.

Originality

The authors declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere, in English or any other language. The manuscript has been read and approved by all named authors and there are no other persons who satisfied the criteria for authorship but are not listed. The authors also declare to have obtained the permission to reproduce in this manuscript any text, illustrations, charts, tables, photographs, or other material from previously published sources (journals, books, websites, etc).

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