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Contested novel ecosystems: Socio-ecological processes and evidence from Italy

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ABSTRACT

In the context of contemporary global climate and environmental change, both natural and social scientists have stressed the role green areas play in global warming adaptation strategies and in improving the healthiness of the urban environment. Indeed, in recent years these spaces have become central to institutional political debates and various policies have been designed for their valorization. However, little attention has been paid to rewilded urban spaces, recently defined as novel urban ecosystems, and to their socio-ecological complexity. By adopting an interdisciplinary approach that links natural and social science perspectives, this article aims to highlight the role of novel urban ecosystems in the reconfiguration of urban policies. Indeed, this contribution analyzes ecosystem services coupled with the hybrid, contested socio-ecological nature of four case studies in Italy characterized by grassroots socio-environmental mobilization. Data were collected through comparative quantitative and qualitative methods. The evidence shows that the specific ecological features of novel urban ecosystems are strategic in terms of actual and potential ecosystem service provision for cities and suggests that citizens play a fundamental role in recognizing and valorizing them. In parallel, these spaces, reconceptualized as contested novel ecosystems, emerge as controversial hybrid urban socio-natures that enable community empowerment and produce a heterogeneous, grassroots political space oriented towards urban commons and environmental-climate justice.

1. Introduction

In recent years, global institutional and political debates have become increasingly aware of the climate and environmental crisis and related socio-ecological challenges. A wide spectrum of policies and initiatives have been launched to strengthen climate and environmental change adaptation and to preserve nature more generally (Robbins, 2004). This is especially true with regard to urban spaces, where the role of green areas, parks and natural ecosystems has become central to political agendas due to their importance in urban climate regulation (Sandberg et al., 2015). In the framework of natural sciences, various scholars have recently emphasized the key role urban green areas play in providing a wide spectrum of ecosystem services (Chen, 2017; Schwarz et al., 2017; Semeraro et al.,

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2021). These studies have looked at the performance in ecosystem services provision of a wide variety of urban green infrastructure types, highlighting its significant role in reduction of heat-related illnesses and in mitigation of greenhouse gas emissions, with particular reference at local (i.e. municipal level) scale (see [Brzoska and Spägle, 2020](#)).

In parallel, social scientists and scholars of critical urban geography, political ecology and sociology, have highlighted the socio-political and cultural dimensions of these spaces in terms of urban commons and community participation in their preservation, as well as of their conflicting nature ([Heynen et al., 2006](#); [Foster and Sandberg, 2017](#)). Indeed, green space urban policies remain controversial due to ambiguous participatory governance mechanisms and, in certain cases, to regeneration processes oriented towards infrastructural development and capital valorization initiatives ([Karlsson, 2016](#)).

The recent visibility abandoned urban sites have acquired due to the implementation of urban regeneration initiatives has revealed that many cities host complex green spaces deriving from natural rewilding processes. Indeed, in both growing and shrinking cities abandoned lands represent vital spaces for the development of spontaneous vegetation ([Bonthoux et al., 2014](#); [Newman et al., 2018](#)). They can reach more than a hundred hectares in some post-industrial landscapes like the Ruhr in Germany (e.g. [Kowarik and Körner, 2005](#)), or they can be small patches in different type of urban landscapes (e.g. [Sitzia et al., 2016](#); [Rega-Brodsky et al., 2018](#)). With particular regard to those cities affected by deindustrialization processes and by the dismantlement of military structures, abandoned sites enabled complex natural rewilding process that significantly reconfigured their nature. However, over the last years these sites have been considered by different urban governments and private investors not as spaces to be preserved but as urban voids to be valorize and commodify in capital terms. It is important to highlight that especially wild urban ecosystems provide several ecosystem services to citizens ([Mathey et al., 2015](#); [Säumel et al., 2016](#); [McKinney et al., 2018](#)) which are additional to those provided by conventional urban green areas (e.g. gardens and parks). These services vary widely on the qualitative and quantitative level based on the each site's specific features (e.g. structural attributes, abiotic characteristics, successional stages, etc. see [Kowarik, 2011](#)). Since the 2000s, research studies have focused on their role in connecting people with nature (e.g. [Kowarik, 2017](#); [Threlfal and Kendal, 2018](#)), as well as their controversial and conflictual character ([Hester et al., 1999](#); [Soulsbury and White Piran, 2015](#)).

Within this framework, our article aims to advance the analysis on vacant or abandoned urban sites (e.g. former industrial, military and agricultural areas) characterized by spontaneous ruderal succession processes. These sites can be considered novel urban ecosystems due to their original, anthropogenic site conditions and species assemblages that usually differ from near-natural ecosystems ([Kowarik, 2011](#)). By adopting an interdisciplinary approach that bridges natural and social sciences and through an empirical focus on four examples of novel urban ecosystems in Italy, our article seeks firstly to provide evidence of ecosystem services provision by analyzing available site-specific literature. Secondly, we analyze these novel ecosystems as hybrid socio-natures in urban spaces, specifically delving into their socio-political and cultural dimensions. Indeed, our research explores the role these spaces play in the rise of grassroots socio-environmental networks that are aware of their fundamental role in enhancing the livability of urban spaces. Empirically, we focus on four different Italian novel ecosystems: Piazza d'Armi in Milano, Prati di Caprara in Bologna, Ex-Snia in Roma and Foresta Urbana in Lecce. Despite the cities where case studies are identified are very different from each other in terms of urban spaces, demographic size, political weight and socio-economic relations (see [ISTAT, 2020](#)), they share similar and suitable comparable contexts in terms of rewilded abandoned urban spaces and related socio-environmental movements mobilization. These spaces progressively emerged through heterogeneous ruderal succession processes occurring over the last few decades after the original industrial and military sites were abandoned. An interdisciplinary perspective and comparative approach enable us to advance research on the complex socio-ecological character of such sites and to conceptualize their contested nature.

With regard to methods, our research focuses on ecosystem services together with participatory observations, action and community-based research: semi-structured interviews and informal talks were carried out with members and representatives of grassroots socio-environmental movements. The article opens with a theoretical and conceptual discussion of the socio-political dimension of wild urban nature and its conflicting role in relation to urban regeneration policies. The following section presents the case-studies and methods adopted to introduce novel ecosystems in light of their key role in ecosystem services provision and urban environmental wellbeing. This section is followed by an analysis of our four selected case studies and their complex socio-ecological nature. This latter is discussed through the adoption of a comparative approach while the last section presents some evidences about the contested dimension of novel ecosystems. Recommendations on the governance of these challenging sites are also provided.

2. Urban natures, politics and conflicts

Cities and wilderness have a complex relationship based on constantly changing human-nature interactions and social values. In Western culture, society and nature have been traditionally considered opposite realms. The Western idea of nature, singular and abstract, has always been ambivalent and even ambiguous, and therefore problematic. In his seminal, critical account, [Williams \(1980\)](#) addresses the multiplicity and diversity of concrete "natures", overcoming the classic separation between nature and society – and, therefore, nature and the city. Since the 1990s in particular, cultural and social research has recognized the role practices play in the production and consumption of nature and has moved beyond the dichotomy of domesticated and controlled nature versus pristine nature deserving of protection.

By reflecting on these interactions, [Smith \(1984\)](#), [Swyngedouw \(1996\)](#) and [Castree \(2003\)](#), and the perspective of critical geography more generally, have drawn attention to the social production of nature by conceptualizing "urban socio-natures" as complex hybrid ecosystems in which physical and biological dynamics are deeply interconnected with historical and socio-political processes. Contemporary social research therefore addresses perceived, embodied, experienced, concrete and ordinary natures ([Macnaghten and Urry, 1998](#); [Macnaghten, 2003](#); [Bartoletti and Cecchelin, 2016](#)). This perspective is clearly consistent with "the Four Natures approach" and a new recognition of wilderness in interaction with urban life ([Kowarik, 2005](#)). As a consequence, we recognize that

citizens are voicing a growing demand for nature in the city and acknowledge that this issue is pivotal in many contemporary forms of civic engagement and mobilization in European cities (McKay 2011; Bergamaschi, 2012; De Biase et al., 2018; Bartoletti and Faccioli, 2020). Conversely, urban nature continues to represent a controversial matter, particularly when connected with wilderness.

Several approaches in social science (e.g. Latour, 2007; Latour, 2017; Blok, 2013) regarding Actor Network Theory and Science and Technological Studies' approaches, as well as socio-semiotics (e.g., Finocchi and Pezzini, 2020), tried to find a new functional classification for these types of spaces, both at the level of their epistemological and ontological status and from a methodological perspective. The aim of these approaches is to take into account the complexity and multi-faceted multi-identity of such spaces. More generally, the task is to rethink these spaces as real 'socio-cultural hybrid' actors: natural spaces in cities, such approaches argue, are also 'urban green assemblages' constructed by both their material elements and the practices and discourses they give rise to (Blok, 2013; Farias and Bender, 2010). Furthermore, scholars studying the socio-cultural history of forests, that is, the way nature is perceived in its relationship with cities, show that forests have always had this dual role (Küster, 2009): since ancient times, they have never been wholly natural objects. And this not only because they have been subjected to anthropization, but because their borders, their frontiers, have always been porous. This is even true of the novel urban ecosystems conceptualized by Kowarik (2011) that grow up on previously built-up areas or heavily altered urban lands. They represent an outcome of the intersection of spontaneous successional dynamics bringing new urban wilderness into interaction with urban policies and on-going socio-political processes (Sandberg et al., 2015; Heynen, 2014). Indeed, in the context of the progressive neoliberalization of urban spaces, novel urban ecosystems have acquired a central position in urban agendas and policy-making across Europe, policies often designed to valorize such spaces, due to their urban void nature and to their strategic location in the city (e.g. proximity to the city center or to the main key infrastructures), with a view to commodification and capital accumulation (Heynen et al., 2006; Zinzani and Curzi, 2020). Indeed, urban governments and policy-makers often did not recognize the socio-ecological value of novel urban ecosystems due to their hybrid and spontaneous nature combined with the presence of post-industrial and post-military wastes (Trentanovi et al., 2021). Although urban valorization policies have often contained participatory components, they have been contested by citizens and social groups claiming their right to take part in decision-making processes regarding the future of these ecosystems and expressing conflicting visions and interests. Therefore, these hybrid spaces could be analyzed through the perspective of socio-environmental conflict, defined as a conflicting process of negotiations, politics, claims-making and struggles around environmental issues, their governance and their futures (Martinez-Alier, 2002; Robbins, 2004). Furthermore, with regard to citizens engagement and the public's role in decision-making processes, such conflict represents a strategic process of community empowerment and production of political spaces oriented towards the redemocratization of urban policies (Wilson and Swyngedouw, 2014; Torre, 2017). This perspective is thus important for reflecting on the hybrid socio-ecological dimension of these spaces.

3. Novel urban ecosystems: socio-ecological resilience vs. capital valorization

3.1. Overview of the nature of novel urban ecosystems and urban regeneration processes: case studies in Italy

As mentioned in the introduction, we refer to novel ecosystems (Kowarik, 2011) that have developed spontaneously through successional processes of vegetation growth on vacant or abandoned urban sites. These can include remnants of concrete buildings and asphalt paving that are totally or partially covered by ruderal vegetation as well as other smaller human artefacts. They are often not recognized by land planning legislation and are therefore not easily integrated into standard urban land use patterns and processes (Trentanovi et al., 2021). Transitional nature can entail very different types of wild (i.e. mostly not managed by humans) ecosystems that differ from the human-made and artificially maintained green spaces normally found in cities (Mathey et al., 2015). Over a period of years, these sites can develop habitat structures unique to urban areas providing valuable refuge as well as substitute or stepping-stone habitats for animal and plant species. Their habitat composition is mainly the result of colonization from adjacent seed sources, previously planted ornamentals and co-occurring wild species that provide additional seed sources in rewilded green spaces (Kowarik et al., 2019). Especially for brownfield sites, soil characteristics (e.g. level of nutrient availability) is a key feature influencing biodiversity evolution patterns (Schadek et al., 2009; Bonthoux et al., 2014).

When reflecting on novel ecosystems in relation to contemporary urban transformations, it is fundamental to highlight that these spaces are closely related to deindustrialization, demilitarization and infrastructural transformation processes. Whereas on one hand these sites are characterized by wild ecosystems and are therefore important in terms of biodiversity, on the other hand they have become strategic sites of value upgrading for capital investment in recent years (Harvey, 2013; Roberts and Roberts, 2017). Therefore, urban regeneration policies have focused on these spaces for capital investment projects such as developing new neighborhoods, infrastructure, residential and commercial buildings to attract the global private sector and advance public-private partnerships (Swyngedouw, 1996; Brenner, 1998). At the same time, urban regeneration policies have heavily emphasized governance mechanisms, making them a strategic pillar for replacing public control over urban transformations and boosting the role of private investors together with civil society involvement in decision-making processes. However, critical urban geography scholars have pointed out that most cities only adopt these mechanisms, and citizens involvement in particular, to legitimize projects already formalized in their urban agendas (Heynen, 2014; Wilson and Swyngedouw, 2014). Indeed, members of civil society, community associations and movements in multiple urban contexts have questioned top-down participatory mechanisms and demanded more substantive involvement in decision-making processes. With regard to urban green spaces, these social actors have often demanded that such spaces be preserved by virtue of their socio-ecological importance and mounted serious contestation around their governance and futures, as illustrated, among others, by the European cases of Tempelhof in Berlin and Gezi Park in Istanbul (Ernstson and Swyngedouw, 2019).

With the aim of contributing to this debate by exploring novel ecosystems' socio-ecological nature, this research focuses on four case-studies in Italy located from the north to the south of the country, specifically in Milano, Bologna, Roma, and Lecce (Fig. 1). These case-studies were selected among others Italian novel ecosystems due to their role in urban regeneration policies and due to the rise of comparable grassroots citizens mobilization. The four sites are quite different in terms of area, neglect dynamics, actual vegetation, ownership and previous land use (Table 1 and Fig. 2). In addition, the capital value of the land, in real estate and infrastructural development terms, is also quite different depending on the cities and the spatial location of novel ecosystems. However, they have in common the rise of different grassroots socio-environmental movements aimed at preserving and valorizing them through collective governance.

3.2. Methods and data collection: combining natural and social sciences perspectives

From various sources collection related to each of the selected case studies, we extrapolated data on (a) evidence of provision of the ecosystem services and (b) the conflicting socio-political dimension of the city's regeneration process. We collected data from four main sources: grey literature, websites and blogs (WEB), peer-reviewed journal articles (PRJ), and semi-structured in-depth interviews with key informants (INT). As illustrated in Fig. 3, these latter were used to complement, revise and assess grey literature and WEB sources. Grey literature is divided into scientific online reports (REP), conference presentations (CON), and institutional and legal sources (LEG, e.g. approved planning documents and national and regional measures). Scientific online reports include environmental information about the sites that are not published in peer-reviewed journals but are the results of studies conducted by various specialists who worked *pro-bono* in collaboration with grass-roots movements. A total of 4 in-depth interviews were conducted in January and February 2021 with 8 key activists (3 males and 5 females) of the main associations or citizen committees engaged in protecting and valorizing the selected sites. The interviews were designed to investigate more in detail the conflicting socio-political dimension, through the investigation of the following macro-areas: a) the social characteristics of the site; b) the origin and development of citizen engagement around the site and the objectives of the association/committee; c) the network of actors involved in preserving the site and fostering its urban regeneration; d) social uses of and practices enacted in the site, including potentially conflicting uses; e) connections between the movement working to preserve the site and environmental social movements and policies at the national and transnational levels. The interviews, which lasted approximately 1 h—an hour and a half, were transcribed *verbatim* and analyzed jointly with all the other sources.

These diverse sources are very important in interdisciplinary analysis, particularly when scientific studies are supported by grassroots movements and manifold stakeholders are involved (Mahood et al., 2014). Through this approach we were able to review a broader body of literature providing a more comprehensive view of the available evidences.

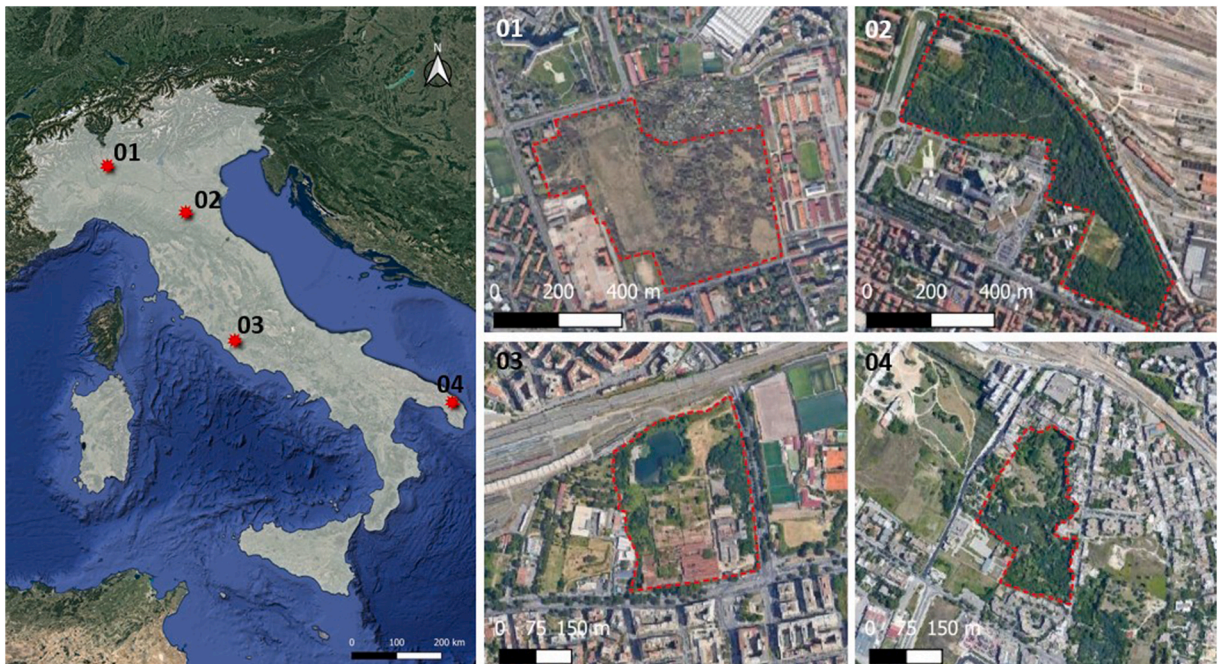


Fig. 1. Distribution of the selected case studies in Italy and satellite images identifying the sites (dotted red lines show their perimeters). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Table 1

Main characteristics of the selected cases. Area derives from a calculation of the total surface area currently not being managed and characterized by secondary succession of vegetation (including abandoned human artefacts), except for the case of Lecce (n.4) where the area comprises the whole quarry site. (*) Within bracket, actual (2020) resident population from ISTAT (2021).

COD	Area (ha)	City (*)	Local name	Previous land use	Time since abandonment (years)	Grass-roots movement	Ownership
1	28	Milano (1.406.242)	Piazza D'Armi	military area	30	Associazione Parco Piazza d'Armi-le Giardiniere (2011 - present)	public
2	27	Bologna (395.416)	Prati di Caprara est	military area	40	Comitato Rigenerazione No Speculazione (2017 - present)	public
3	9	Roma (2.808.293)	Ex-SNIA	industrial area	20	Forum Territoriale Permanente "Parco delle Energie - Ex SNIA" (2008 - present)	mixed
4	5	Lecce (93.865)	Foresta Urbana	quarry	40	WWF Salento (2015 - present)	private

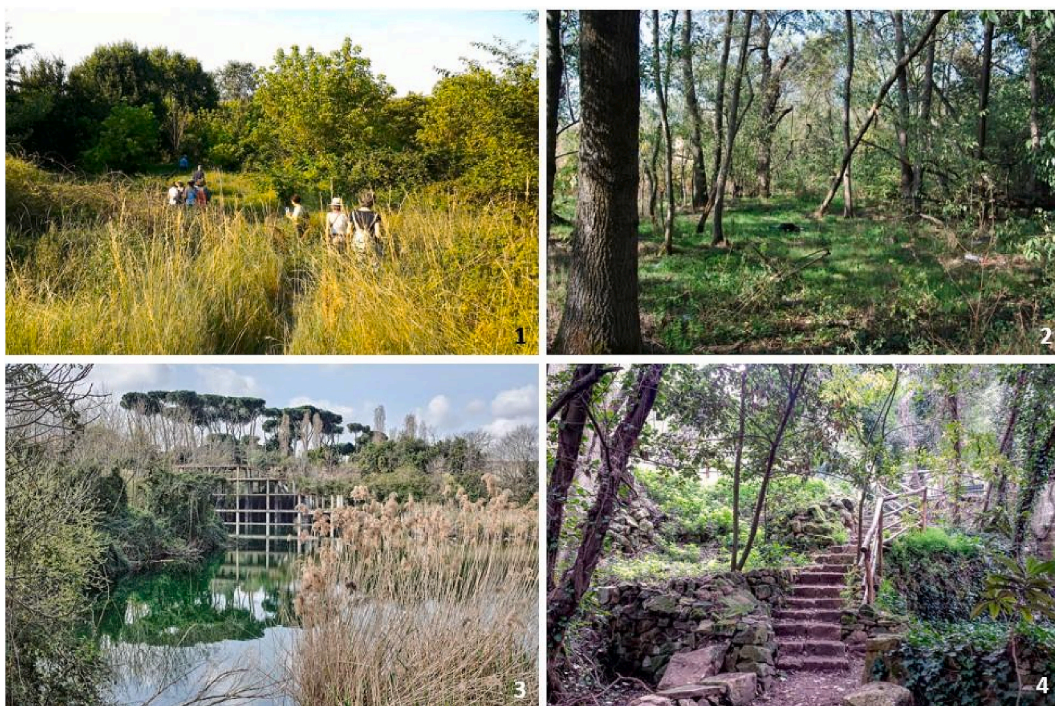


Fig. 2. Illustrative photographs of main vegetation types of the four cases: meadows in Roma, forest in Bologna, lakeside in Roma and, again, forest in Lecce. Photograph of case no. 1 is by courtesy of the Associazione Parco Piazza d'Armi-le Giardiniere, no. 2 was taken by the authors, no. 3 by courtesy of Forum Territoriale Permanente "Parco delle Energie - Ex SNIA" and no. 4 by courtesy of WWF Salento.

4. Novel urban ecosystems in Italy: socio-ecological processes and urban regeneration

The interdisciplinary methodological approach was applied to the four selected case-studies and therefore this section explores their actual status, historical processes and socio-ecological nature, highlighting citizens engagement and the rise of grassroots socio-environmental movements.

4.1. Piazza d'Armi in Milano

Piazza d'Armi is a flat, 40-ha area located in a densely populated, built-up area in the western part of Milano, not far from the city center. Since the late 1980s, the demilitarization of the site has led to spontaneous vegetation encroachment all over the unoccupied land (35 ha). It is characterized by a mosaic of meadows (53%), shrublands (15%) and small woodland patches (32%) of mixed deciduous species, the most common of which are *Populus* spp., *Ulmus* spp., *Carpinus betulus* and *Acer campestre*. There is also a wetland area (ca. 1 ha) inside the biggest woodland patch of the site's inner area that is highly significant for the conservation of amphibious species.

The grassroots movement arose in 2011 thanks to the initiative of a group of women who formed an association called *Parco Piazza*

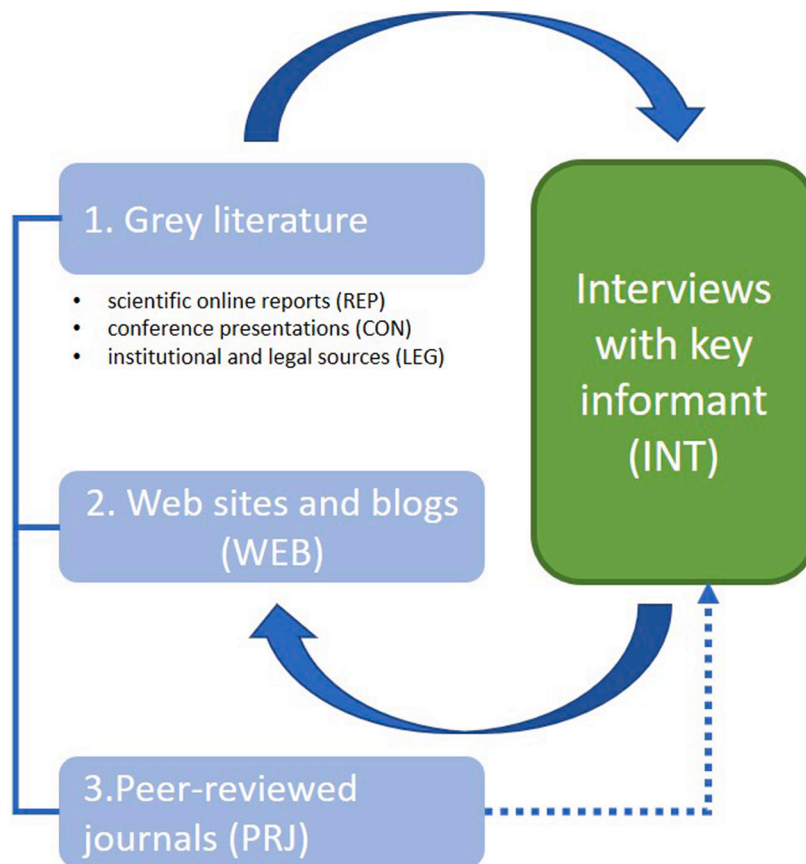


Fig. 3. Illustration of the relationships between the data sources used for the analysis.

d'Armi Le Giardinere and subsequently joined forces with the *Comitato Cittadini per Piazza d'Armi* in 2017. These two groups, alongside other environmental associations, have launched various initiatives aimed at protecting what they consider to be a common good, raising awareness about its history and educating the public about its environmental importance. They demand both the conservation of the military buildings, because of their architectural and historical value, and the preservation of the renaturalized land. Meanwhile, the Italian state - the owner of the site - and city institutions planned to construct a new urban district that would include both residential and service functions. This position clearly reflects their neglect in the recognition of the socio-ecological value of the area and their strategy of capital valorization through urban development projects. Since 2016, the area has been under the management of Invimit, which is an organization controlled by the Ministry of Finance whose mission is the capital valorization of abandoned urban sites. This development parallels those that occurred in other ex-military areas such as Prati di Caprara in Bologna.

Indeed, members of these grassroots committees have spoken out about the fact that financial real estate actors play a key role in shaping urban planning and decision-making in Milano, as well as the close relations between these actors and the city council in terms of policy negotiations, partnerships and their shared vision for the capital valorization of urban space. *Parco Piazza d'Armi Le Giardinere* and *Comitato Cittadini per Piazza d'Armi* presented a petition to the European Commission requesting that the entire existing green area be maintained and enhanced as a "capital of natural biodiversity". Following this initiative, the Ministry of Cultural Heritage and Activities and Tourism (MIBACT) instituted historical-relational restrictions to conserve 31 of the 35 ha under discussion, imposing a construction ban and requiring the site to be classified as "a small hamlet" if the military warehouses were ever demolished. At the end of 2019, the military warehouses were razed and only two of the protected buildings were conserved. The City Council's Territorial Governance Plan (PGT), approved in October 2019, acknowledged the restriction guidelines but, in establishing an urban park with naturalistic characteristics, failed to reduce the amount of construction foreseen for Piazza d'Armi. It was transferred wholesale onto the site of the former warehouses (about 7 ha), a choice which was heavily criticized by the committees.

4.2. Prati di Caprara in Bologna

Prati di Caprara in Bologna has socio-ecological features similar to Piazza d'Armi. Located in the north-western part of Bologna, it is divided into two sections and the eastern one, which is the focus of the study, and it represents a novel urban ecosystem of 27 ha. Over the last few decades, this area has undergone a successional process which led to the progressive growth of a forest. The site is currently

covered mainly in woodlands (70%), grasslands (20%) and shrublands (10%). The woodland is mainly composed of *Robinia pseudoacacia*, *Fraxinus angustifolia*, *Ulmus* spp. and *Populus* spp. In some areas, black locust (*Robinia pseudoacacia*) has been progressively replaced by a renewal of *Quercus robur* and other species typical of the lowland forests. In the inner part of the woodland area, there are several small (<50 mq) wet areas that host amphibian species. The site was a former military area dismantled since the 1980s, and now is owned by Invimit. After four decades of institutional discussion about the future of the area, in 2016 Prati di Caprara was included in an urban regeneration policy plan aimed at combating the area's presumed socio-environmental degradation through a redevelopment project focused on the construction of commercial and residential buildings, a school and a new park. The project, formalized by Invimit, the city council and supported by multinational private investors, would have involved destroying the vast majority of the forest. The redevelopment project was legitimized through a narrative based on the need to deal with degradation and potential contamination of the site and emphasizing the project's sustainable nature due to the creation of a traditional green areas (i.e. not wild).

In 2017, local citizens together with various members of the neighborhood community, created a committee called *Rigenerazione No Speculazione* to strengthen their claims and protect the site. The committee highlighted the area's role in ecosystem provision for the citizens while asserting that the forest constitutes an urban common, emphasizing its public nature in the face of privatization and speculation processes. In addition, *Rigenerazione No Speculazione* stressed the need to re-democratize urban politics through public participation in decision-making processes. Over the last few years, through diverse grassroots practices such as community involvement, area visits, participatory seminars and rallies, *Rigenerazione No Speculazione* has been able to raise awareness about the forest, involve civil society and secure the support of multiple social and environmental associations as well as local political parties. Indeed, by adopting formal institutional mechanisms, the Committee was able to profoundly shape the vision and political discourse of local institutions and especially the city council. Furthermore, working together with the socio-environmental network that emerged over the last few years, it was able to discuss the nature of the urban regeneration project and temporarily stop it from being implemented. In parallel, the network advances different visions for the future of the area that would be achieved through grassroots participation and community governance.

4.3. Lake and ex-SNIA space in roma

The "ex-SNIA" area is located in a semi-central part of Roma old industrial periphery. It is currently characterized mainly by a natural lake (ca. 7000 mq) with associated vegetation communities and the remnants of a former factory (comprising about half of the entire site). The natural habitats are mainly small hygrophilous communities composed of *Phragmites australis* and woody species such as *Salix alba* and *Populus alba*, and Mediterranean woodland areas made up primarily of Mediterranean pine (*Pinus halepensis*) and laurel (*Laurus nobilis*). Scattered grassland patches are located between the lake and the woodlands.

The site was originally a factory located near Roma's Prenestina train station, north of the former working class neighborhood of Pigneto. From the '20s until the early '80s, it housed a chemical factory that shut down and sold the grounds in the '90s. At the end of the '60s, natural conservation restrictions were placed on the pinewood that had grown up near the factory. This made the site particularly valuable, and in the '90s a real estate company attempted to secure the site to construct a luxury property. Following investigations spurred by initial citizen mobilizations, this building permit was cancelled (in 1992) and the recently built structures were ordered to be demolished. The owners opposed the demolition order and, according to the accounts of citizens' committees, their appeal was accepted in part by the judge on the grounds that there had been "institutional lapses".

This construction work, later permanently suspended, included a large excavation that gave rise over time to a spring water-fed lake, its water quality assessed as "high" and the lake recognized as having ecological value and a significant role in the hydraulic regulation of the whole urban district. The municipality was asked to intervene by filing a further appeal with the judge, and in 1997 a city council resolution established this site as "delle Energie" park. Citizens mobilized in various stages. In 1995, the existing building was occupied and the squatters founded a social center (CSOAxSnia). Inside the park, a "house of energy park" gave rise to a local documentation center. The MIBACT included the park among its areas of archaeological interest. After the first expropriations that took place before the year 2000, a "house of the park" was realized under the push of citizens' committees. A permanent local forum was set up (based since 2008 on the mobilization of committees and citizens' groups) and this body decided to build a multifunctional arena inside the site.

Citizens also opposed a second phase of speculation. In 2011, a local WWF management committee was formed and began its task of managing the "House of the Park" through the participation of multiple kinds of stakeholders (artistic, cultural, sports). An attempt was then made to delegitimize the forum and participating committees. Finally, in March 2015 there was a significant turning point when the first of many 'mobilization days' was held, coordinated jointly by the committees and municipality, focusing on creating "A lake for everyone" so as to bring this collective good back into the hands of the city. This event was followed by numerous artistic initiatives. The lake was accredited as a "natural monument", and this campaign's inaugural document did a good job in explaining the site's complex and stratified nature. Indeed, "ex-SNIA" is simultaneously a natural site, an industrial archaeology site, a historical pinewood, a documentation center and park house and a multipurpose "square" for sports and artistic-cultural activities. Finally, in 2020 the "ex-Snia" site, also locally named as "lake bullicante" due to the lake water origin, was formalized as a natural monument by Lazio province government body.

4.4. Foresta urbana in lecce

Lecce's Foresta urbana is located in the south-western part of the city, close to the center and the main railway station. Most of it

(85%) is covered in a dense forest featuring primarily tree of heaven (*Ailanthus altissima*) and laurel species. A significant part of the woodland also hosts scattered examples of ancient cultivar species such as medlar (*Mespilus germanica*), common fig (*Ficus carica*), wild cherry (*Prunus avium*) and many more. Like the urban ecosystems of Milano, Bologna and Roma, this site is also deeply entangled with the socio-spatial and economic transformations that occurred over the last few decades. It progressively took shape in a private quarry for extracting “pietra leccese”, a stone typical of the Salento area, before being gradually abandoned since 1960. The quarry, a site of approximately 6 ha, was largely forgotten by both city institutions and local citizens and became an illegal dump. At the same time, a complex spontaneous rewinding process led to the growth of a dense urban forest. In 1984 the municipality of Lecce began to rethink the future of the area and envisage it as the potential site for a public park, but the initiative was never realized. In 2001, therefore, the local WWF office supported by citizens of the surrounding neighborhoods proposed to enhance the site through a combination of multiple activities such as preserving the forest, creating paths and organizing public visits in collaboration with various scientific research initiatives. After years of complex negotiations between the WWF and members of the city council, in 2015 Lecce’s Foresta urbana was included in the newly established *Parco delle Cave* in order to preserve the area and raise awareness about its socio-ecological nature. Today, the forest is managed by the WWF under a temporary agreement with the municipality according to logics of participatory association governance. Indeed, members of the WWF have claimed that the Foresta Urbana of Lecce represents a successful example of grassroots urban regeneration aimed at preserving and valorizing a unique example of a novel urban ecosystem. Due to its specific characteristics and form of urban governance, this case was covered and highlighted by national mass media and, at the same time, held up by various socio-environmental associations and groups as a successful example of partnership between citizens and public institutions. Furthermore, evidence shows that Lecce’s Foresta Urbana and the evolution of its associated

Table 2

Ecosystem services provided by the sites and categorized based on the work of Mathey et al. (2013). Symbol “-” indicates “no information available”; in square brackets is reported the type of data source. HAB 01: number of species (multi-taxonomic surveys); HAB 02: species and habitats protected by European directives and national laws; HAB 03: pollination values; REG 01: heat island mitigation; REG 02: air quality improvement and carbon sequestration; REG 03: water regulation services; CUL 01: outdoor activities; CUL 02: educational events, social activities, artistic events; CUL 03: elements of historical value. With the term ‘unauthorized’ we refer to activities that are legally banned by site property (for Prati di Caprara in Bologna). See [Supplementary material \(S1\)](#) for additional information on the reference sources.

	SE	Site 1 Piazza D’Armi	Site 2 Prati di Caprara	Site 3 Ex-SNIA	Site 4 Foresta Urbana
Habitat services	HAB 01	39 species of bird, 5 species of amphibians and 4 species of reptiles [REP, CON]	200 species of vascular flora, 60 of birds, 40 species of diurnal butterflies, 7 species of amphibians and reptiles, 22 species of ants and at least 60 species of macrofungi [REP]	at least 63 species of birds, 358 species of vascular flora [PRJ]	several plant and bird species typical of the Mediterranean areas and fruit trees ancient varieties [WEB, INT]
	HAB 02 (*)	3 species protected by EU Directives: <i>Triturus carnifex</i> , <i>Bufo viridis</i> , <i>Lacerta bilineata</i> [REP, CON]	3 species protected by EU Directives: <i>Lycena dispar</i> , <i>Falco peregrinus</i> , <i>Triturus carnifex</i> [REP]	4 habitat types (6110, 6220, 5230, 9540) and 3 bird species (<i>Ardeola ralloides</i> , <i>Falco peregrinus</i> , <i>Alcedo atthis</i>) protected by EU Directives [PRJ]	-
Regulation services	HAB 03	ongoing research (2021) on pollinators [REP]	-	-	-
	REG 01	-	the site contributes to heat island effect mitigation [LEG]	the site contributes to heat island effect mitigation [LEG]	-
	REG 02	the site contributes significantly to carbon sequestration and air quality improvement [CON]	the site contributes significantly to carbon sequestration and air quality improvement [REP]	-	-
	REG 03	the site contributes to water detention and purification [CON]	-	the site contributes to protecting groundwater quality and preventing water hazards [PRJ, REP]	-
Cultural services	CUL 01	several activities (e.g. sport activities, yoga) [WEB]	several unauthorized activities (e.g. spring walks, picnics, biking, yoga and many others) [REP, WEB]	several activities (e.g. spring walks, canoeing, basketball, and yoga) [WEB]	not suited to outdoor events [INT]
	CUL 02	several educational events (e.g. children’s outdoor education activities, educational field trips) and social activities [WEB]	the site is used for several unauthorized educational events (e.g. children’s outdoor education activities, educational field trips) [REP, WEB]	several educational, artistic events (e.g. land art, musical performances), educational activities, documentation center, social activities [REP, WEB]	several artistic events (e.g. land art, musical performances) [WEB]
	CUL 03	a portion of the site is recognized by the Italian Ministry of Cultural Heritage and Activities and Tourism (MIBACT) as having particular cultural, aesthetic and biodiversity value [LEG]	cultural value linked to the site multiple historical uses [REP, WEB]	cultural and historical values linked to industrial archaeology elements [REP, WEB]	presence of industrial archaeology (evidence of former quarry activities), ancient dry stone walls [INT, CON] and fruit trees ancient varieties [WEB, INT]

socio-political relations represent a less contested and conflictual case than the novel urban ecosystems of Bologna, Milano and Roma. However, as reported by members of the WWF, their grassroots governance is challenged by the fact that the site's private owners are interested in potentially redeveloping it in the next future in terms of capital valorization.

5. Contested novel ecosystems and their socio-ecological and conflicting dimensions: a comparative analysis

5.1. Evidence of ecosystem services provision

Biodiversity, with particular reference to plant and avian communities (Table 2, habitat services), is the most frequently analyzed of ecosystem services since – it is the one most highly valued by citizens and policymakers (Schröter et al., 2017). For three of the four sites, the data show very significant overall species diversity as well as a high incidence of species targeted for protection under national and international laws. In particular, the multi-taxonomic analyses conducted in Milano and Bologna revealed that these areas support manifold ecological niches, as well as several protected habitats by European Directive (92/43/EEC) as in the Roma site (Battisti et al., 2017). Among our cases, species whose habitat needs involve standing water (temporarily or continuously) are found specifically in those sites in which past human activities have unintentionally given rise to water storage (e.g. where the soil is more compacted or where past excavation has created depressions in the landscape). There is currently no evidence of protected wild species in the Lecce site. In terms of vegetational composition, this latter, with its countless tree of heaven (*Ailanthus altissima*), is certainly the most affected by past and present human activity. Many other exotic species such as black locust (*Robinia pseudoacacia*) in Prati di Caprara are dominant, but they have been often gradually replaced by more typical lowland forest species. Only Piazza d'Armi has been found to provide significant pollination services in keeping with its main ecosystem type (i.e. polyspecific meadows), and there are several ongoing projects seeking to preserve and reinforce this ecosystem service. For instance, an apiarist has been using the site since many years to house a number of hives.

In terms of climate regulation services provision (Table 2, regulation services), we found evidence for all the sites except for the Lecce one's. Prati di Caprara in particular was reported to mitigate the effects of the urban heat island (UHI) of the entire urban district, a finding that is significant given by its wide woodland area. The evidence of UHI mitigation derives from a specific preliminary analysis carried out when designing a new urban plan as part of Bologna's climate adaptation policy. Carbon sequestration and air pollution amelioration are provided by the wide sites of Piazza d'Armi and Prati di Caprara, while in ex-SNIA site in Roma data show that the actual vegetation contributes to groundwater quality conservation and to the reduction of hydrogeological instability of surrounding urbanised areas. As for cultural and recreational services (Table 2, cultural services), all of the sites provide specific services linked mainly to their natural and morphological characteristics (e.g. a mosaic of different semi-natural spaces, walking paths, historical artefacts, etc.). Most of these services could stand to be improved, as the sites in Milano and Bologna are not open to the public, and citizens thus cannot access to their benefits. Given its natural and morphological features as well as the fact that it is freely accessible, the ecosystem services provided by Lecce's Foresta Urbana currently involve more artistic and cultural events than the other sites. The natural elements of this space (i.e. plantations featuring ancient cultivars) represent a significant cultural resource.

5.2. The sociocultural dimension: meanings and uses

All of the selected sites were originally located on the outskirts of their respective cities. As a result of urbanization processes unfolding throughout the 20th century, however, they were gradually hemmed in by densely populated built-up areas. These areas, most of which are now covered in spontaneous vegetation, thus represent visible ruptures in the surrounding urban fabric. Local citizens view these unconventional green spaces in a positive light, as resources for the public. Indeed, the activists we interviewed chose the word "oasis" (Roma, Milano and Lecce) to define these sites, indicating a discrete space, radically different from its surrounding context; a refreshing haven that breathes new life into both citizens and the city itself. These sites offer the citizenry a form of nature that has been recognized as extraordinary and qualitatively different from that of more conventional public and private gardens or urban parks. However, they are called, be it oasis, or urban forest (in Bologna), the current uses and planned future transformations of these spontaneously re-naturalized urban spaces attest to their complexity and controversial character. The fact that these spaces have been abandoned by their owners and claimed by citizens' groups has served to legitimize and, in some cases, institutionalize spontaneous and marginal uses of the land, like the urban vegetable allotments in Piazza d'Armi or the fruit orchards in Lecce's urban forest. While processes of institutional acknowledgement are more advanced for the sites in Roma and Lecce, the status of the two former military areas in Milano, and especially the space in Bologna, is still extremely uncertain. Citizens are only able to gain access to these sites when the owners grant authorization for individual initiatives or by engaging in (illegal) civil disobedience. Alongside the various formal and informal reappropriation procedures enacted by the citizens involved (visits, walking trails, or educational and sporting activities) the two ex-military areas are also used in informal, conflictual ways. In Bologna, part of the woodland area actually hosts a number of scattered unauthorized settlements and illegal dumping sites, illicit uses that can be seen as instances of urban blight. There is much less activity of this kind in the Milano site. Meanwhile, in Roma and Lecce damaging activities of this kind are curbed by a citizens' monitoring that enjoys the support of municipal or regional public institutions. When it comes to the futures of these spaces, the very move to protect them seems to entail some ambivalence. Notions of biodiversity conservation and ecosystem services provision prevail among all the activists mobilizing around all the sites, including in their visions for the future. At the same time, however, the various visions for these spaces span a *continuum* between protection and public access, exclusively environmental concerns and the desire for social and recreational uses as well.

5.3. The institutional dimension and actors networks

Complex networks have formed among the actors involved in all four sites, and they have become more and more consolidated over time. And yet each case displays different dynamics in terms of both how its respective network was established and relations among antagonistic actors. It is relevant to highlight that, in terms of institutional actors, private and public owners of the analyzed sites such as Invimit have shared for years visions and interests with the city councils, especially those of Milano, Bologna and Roma. The common and shared aims of novel ecosystems urban regeneration policies was to reconfigure them in capital valorization and accumulation terms through real estate development projects. Recently ideas and policies of city councils have been changing, in conflict with Invimit, due to the mobilization of diverse formal and informal socio-environmental actors.

In the cases of Roma, Milano and Bologna, for example, the stakeholders include a mix of actors both “informal” (e.g. individuals and citizen committees that have gradually formed over time) and “formal”, which are mostly organisations with official status such as local branches of national and international non-profit associations. In our cases, these latter are the World Wide Fund for Nature (WWF), Legambiente and the Italian Fund for the Environment (FAI).

Site dynamics are similar in some ways, particularly the fact that in all cases citizens have needed to mobilize to protect or reappropriate abandoned places in opposition to speculation processes aimed at constructing new built-up areas. The substantial difference between the cases of Roma and Lecce, on one hand, and the former military areas in Milano and Bologna, on the other, stem from the process of site “co-management” through a partnership (at least partial) between public institutions and the citizens’ committees. Indeed, in the first two cases the committees have become both “institutions” and “actors in the field of conflict” (see for instance Kowarik and Langer, 2005). This is particularly evident in Roma: the *Forum Territoriale Permanente* has opted to manage the area in collaboration with the public authority but, at the same time, the Forum also frequently comes into conflict with the municipality (or the region, when the matter at hand involves requests for certificates or declarations conceding a change in the way the space may be used). As stated by the interviewees themselves, this co-management relationship is collaborative but also conflictual in that it creates and amplifies further tensions and points of divergence within the network of actors (e.g. conflicts over ‘who should govern what’ and how so, from tree cutting to lake management or organizing security procedures). Collective actors therefore tend to become hybrids with fuzzy contours. On the other hand, in the case of Bologna, the local committee *Rigenerazione No Speculazione* (together with other associations) has as its counterpart the municipal administration, although conflict-fueled tensions also surface at various other levels depending on the urban planning and political scenario of the moment. To date, this arrangement has allowed the Bologna committee to operate as a relatively autonomous actor of both “claim and project”, although it is sometimes impacted by the city’s larger political dynamics. The case of Piazza d’Armi in Milano is similar to that of Bologna in terms of its inter-actor dynamics and relationship with institutions, as the citizens’ committee comprises various alliances and subjects trying to defend green spaces from speculation and land consumption. The “urban forest” space in Lecce represents a different situation in that it is currently managed by the WWF. This association takes care of contacting citizens and mediating between the public and the private owner of the space.

5.4. The political dimension and the conflict

The findings outlined above show that the institutional regeneration initiatives targeting novel ecosystems are contested and characterized by conflict in all four of the sites. The cases of Bologna, Milano and Roma show how the emergence of heterogeneous socio-environmental movements together with dynamics of contestation around the future of novel ecosystems granted these movements the power to call into question and ultimately reconfigure the institutional policies and urban strategies formerly pursued by local authorities. At the same time, in all the cases except Lecce’s *Foresta Urbana* these contested, novel urban ecosystems have emerged as strategic areas in which global capital’s multi-scalar investment strategies converged through real estate speculation and capital accumulation processes. Socio-environmental movements and their claims thus responded by highlighting the political nature of urban regeneration policies. Indeed, in these cases individuals and citizens variously marginalized by neoliberal policies have gathered together to bolster their claims-making around demands such as the need for novel practices of urban grassroots participatory governance focused on the interests of communities (i.e. the improved wellbeing of the urban environment). Moreover, over the last few years the committee members in Bologna, Milano, Roma and Lecce have demonstrated a capacity to conduct research, involve scientists and experts, and produce knowledge aimed at raising awareness about the key role novel urban ecosystems play in ecosystem services provision, especially with regard to those connected to public health. The strategy of questioning institutional policies while simultaneously working for grassroots social and political emancipation has proved highly effective for empowering socio-environmental movements. Albeit with some differences, *Rigenerazione no Speculazione*, *Le Giardiniere* and *Cittadini per Piazza d’Armi*, and the *Forum del Parco delle Energie Ex Snia* have all been able to use the inclusion and involvement of different associations, groups and individuals to create urban socio-environmental networks prioritizing the role and preservation of novel urban ecosystems in opposition to real estate speculation and privatization which brings to new soil consumption. These empowerment processes were fueled by a variety of practices such as organizing events, demonstrations and rallies and successfully forging shared discourses, visions and approaches; they led to the rise of a grassroots political space oriented towards social, environmental justice and alternative urban futures. Over the last several years, the socio-environmental networks of Milano, Bologna and Roma in particular have progressively acquired the bargaining power necessary to shape institutional policies and rethink the future of Lago ex Snia and, in part, Prati di Caprara and Piazza d’Armi. Therefore, this evolution in the variously conflictual interactions between socio-environmental networks and institutions can be defined as not just emancipatory but also transformative in relation to urban regeneration.

6. The present and future of contested novel ecosystems

Through interdisciplinary reflection, our research highlights the complex socio-ecological nature of a specific type of novel urban ecosystem. On one hand, it stresses the biodiversity and ecosystem services sink of such spaces; on the other hand, it reveals their complex, heterogeneous and contested character. Interestingly, are the citizens who have been the first to recognize the ecological role of novel ecosystems. They have come to this awareness thanks to several studies and projects launched by individuals or groups of citizens particularly responsive to environmental concerns. With the support of a number of experts conducting *pro-bono* surveys and several environmental associations, citizens have contributed to bringing these novel ecosystems, often considered by planning authorities to be ‘transient occupants’ (see Trentanovi et al., 2021), onto the agendas of new urban settlement projects. Most of the studies evidence that these spaces provide specific ecosystem services in a way that complements and supplements that of more conventional green spaces. The heterogeneous origins and developmental trajectories of these wild green spaces provide ecosystem services that vary according to the ecological characteristics of the site and, for cultural ecosystem services specifically, depending on which social groups are able to glean benefits from them.

Furthermore, the results of the four case studies scattered within different cities from north to the south of Italy enable us to highlight the hybrid and conflictual nature of these sites as ‘contested novel ecosystems’. Building on the socio-environmental conflict perspective (Martinez-Alier, 2002; Robbins, 2004), we argue that these sites firstly enabled grassroots community mobilization and helped these community groups pursue emancipation in terms of socio-cultural identity, social relations, bargaining power with institutions, and the progressive forging of new political spaces. Secondly, through the conflict and its processes, socio-environmental movements and the networks generated during moments of mobilization have been able to shape institutional and public political discourse about the key role of green spaces and the environment in urban landscapes, especially as a response to the global climate crisis. Thirdly, grassroots movements have strategically gained the power to open up urban regeneration and redevelopment initiatives to critical discussion and, in some cases, to radically reconfigure ongoing urban plans. Furthermore, by reflecting on the agendas, experiences and practices of the four committees and associations leading these movements, and on the Lecce case in particular, we argue that grassroots participatory governance could represent an innovative mechanism for managing contested novel ecosystems in the future.

However, our research also reveals the radical indeterminacy of these spaces, as none of the institutions in the selected cases have definitively recognized the ecological value of the site and assured its future protection. On one hand, public or private owners continue to display an interest in gleaning financial profit from these spaces. On the other hand, even when these sites are finally recognized as public parks or natural heritage sites (such as in Lecce, partially in Roma, and potentially in Milano), activists are afraid that urban policies driven by either public authorities or private actors will end up transforming them into more conventional green spaces, thereby diminishing their socio-political and ecological value.

On the basis of case studies in Italy and by reflecting on common urban politics and socio-ecological relations in different geographical and social contexts, we argue that contested novel ecosystems currently represent strategic spaces for raising the environmental awareness of European cities. Moreover, these sites have the potential to generate novel grassroots political spaces aimed at fostering radical new urban socio-environmental futures moving in the direction of environmental and climate justice. The combination of natural and social sciences perspective and of mixed qualitative and quantitative methods is strategic to emphasize the socio-ecological nature of novel ecosystems and the need to advance inter-disciplinary research with regard to socio-ecological relations in urban spaces. These methods could therefore be adopted to different contexts and scenarios at the global scale.

Further research and new perspectives could involve a wider comparative investigation that also considers different spaces at the European level, with a special focus on the central role of grassroots movements in innovative urban policies and in the management and the socio-ecological valorization of wild urban natures. The proposed interdisciplinary approach could bring together the qualitative perspective, due to the heterogeneous contribution of social sciences, with the quantitative one, thanks to the monitoring of urban areas transformations and its implications in changing ecosystem services provision. Moreover, the further consolidation of grassroots socio-environmental movements claims and outcomes in terms of urban policies reconfiguration is another key process to deepen through semantic or mapping analysis, evaluating its impact on socio-environmental justice at national or global scale.

Author contributions

Conceptualisation, G.T.; methodology, G.T., A. Z., R.B.; formal analysis, R.B., F.M.; investigation, all.; writing—original draft preparation, all.; writing—review and editing, all.; visualisation, G.T.; supervision, R.B. All authors have read and agreed to the published version of the manuscript.

Declaration of competing interest

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Appendix A. Supplementary data

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