A Meta-Overview and Bibliometric Analysis of Resilience in Spatial Planning – the Relevance of Place-Based Approaches

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Abstract
This study offers a literature review and bibliometric analysis aiming to enhance our understanding of the actual contribution of resilience approaches to spatial and territorial development and planning studies. Using citation link-based clustering and statistical text-mining techniques (in terms of prevalence of topics, over time, extraction of relevant terms, keywords frequencies), our study maps scientific domains that include the spatial dimension of resilience thinking. It offers a systematic assessment of modern approaches by connecting profoundly theoretical views to more instrumental and policy-oriented approaches. Firstly, the theoretical background of spatial resilience used in numerous studies in various fields is analysed from the viewpoint of the type of embedded resilience (engineering, ecological, social-ecological, economic, social etc.). Secondly, we review and discuss the significance of three main and consistent research directions in terms of different scales and political/institutional contexts that matter from the viewpoint of spatial and territorial planning. Our findings show that spatial resilience debates are far from being settled, as according to many scientists, resilience measurements are often based on technical-reductionist frameworks that cannot comprehensively reflect the complex systems and issues they address. Our conclusions highlight the necessity of a harmonized framework and integrated perspective on resilience in sustainable territorial planning and development, in both theoretical and empirical contexts.

Keywords Spatial · Territorial · Resilience · Planning · Place-based policies · Bibliometric · Citation link · Text mining
Introduction

Over the past decades, the resilience concept became an eye-catcher in many science domains, from psychology to engineering or disaster management, from ecology and environmental sciences to economics and sociology, and from regional science to urban planning. Meanwhile, the resilience concept itself has undergone various profound changes in meaning, academic relevance and practical applicability (Wilson, 2017). Often seen as a ‘competitor’ for the more politically embedded concept of sustainable development, resilience has become a popular concept in uncertain times. We live in a ‘risk society’ (Beck, 1992), as the globalized world is more and more subject to profound changes and various threats, while the environmental and social balance is continuously challenged and is becoming increasingly fragile. Resilience is becoming a novel framework that may provide the bridge between emergency, competitiveness, intelligent technologies and long-term sustainability.

There is a wealth of definitions of resilience in various disciplines. Initially, from a technical point of view, it was defined as the capacity of a system to resist perturbations and to return to an equilibrium after a disturbance (Pimm, 1984; Petrişor et al., 2016). The concept attracted much attention in the 1970s when the ecological approach was introduced by Holling (1973) who defined resilience as the amount of disturbance that a system can absorb without shifting to a different state. The major difference, namely the transition to consecutive multiple-equilibrium states, was adopted later-on by social (Adger, 2000), social-ecological (Wilkinson, 2011) and economic approaches (Rose, 2004; Simmie & Martin, 2010; Jabareen, 2013; Goschin & Constantin, 2021), including an evolutionary perspective on complex (adaptive) systems. Therefore, the concept became focused not just on efficiency and predictability (as in the engineering approaches), but rather on persistence when confronting change and unpredictability (Holling, 1996) which brings resilience very close to the better-known concept of sustainability (Rega & Bonifazi, 2020).

In the spatial sciences, resilience has also succeeded in becoming a major systemic objective and a keyword. Territories are subject to an increasingly higher number of threats – both natural and human-induced (Wilson, 2012) - that manifest themselves differently in different areas. Spatial resilience allows the evaluation of place-specific consequences of various shocks, but it also integrates the analysis of consequent resistance, adaptation and transformation of the territory to these inherent perturbations. Within the sustainability framework, the resilience concept highlights that a territory should be prepared for innovative or intelligent transformations. Acknowledging the “normality” of expected and unexpected perturbations, the concept of resilience also addresses phenomena from both temporal and spatial points of view, as changes and consequent risks occur in the short, medium and long term at all scales from local to global. Even though the spatial perspective on resilience is already well-documented for a long time, the use of resilience thinking in territorial planning is rather recent (Magoni, 2017). The first studies on resilience were exclusively local or regional in
nature. Nowadays, several studies take into consideration global scale, as world-scale challenges (climate change, invasive species, rapidly spreading diseases such as COVID-19, geopolitical changes etc.) make resilience/adaptation plans and strategies extremely important.

The present paper addresses various particular challenges aiming, on the one hand, to analyse what researchers study in the area of spatial and territorial planning and what are the main outcomes. On the other hand, it provides an assessment of the convergence or gap between the territorial, administrative, institutional or political needs and the alternatives and opportunities given by the spatial/territorial dimension of resilience. The evolution over time of this rather new approach and also future directions and perspectives are tested in our study from this viewpoint. In brief, the objectives of our approach can be summarised as follows: (i) highlight and measure by bibliometric analysis the concept of resilience in relation to spatial/territorial planning; (ii) review the main identified directions of resilience studies from a spatial/territorial viewpoint; (iii) evaluate the normative relevance of current research and identify future research perspectives.

To attain these objectives, the present study is organized in four parts. After the present introduction, there is a methodological section (Section 2), followed by the presentation of the results that comprise the bibliometric and content analysis, including a meta-analysis (Section 3), and a concluding discussion on the normative relevance and the perspectives related to spatial/territorial resilience in planning safe, meaningful and sustainable places (Section 4).

**Methodology**

To obtain an integrated perspective on the scientific impact and relevance of the resilience concept, on the key trends and progress in the literature on resilience-based approaches in spatial and territorial planning and also to highlight future directions in the area, we conducted an in-depth analysis using a mix of review methods, capitalising on the strengths of each method: a bibliometric analysis, a content analysis and a meta-analysis. For the bibliometric analysis, we retrieved from Thomson ISI/Clarivate Analytics (only the Core Collection) and SCOPUS all papers integrating spatial and territorial resilience approaches. The searches and analyses were concentrated on the topics of Spatial resilience, Territorial resilience, Spatial planning AND Resilience, Territorial planning AND Resilience, so as to identify, over time, the literature in the area over the last three decades (1990–2020). For the over 7000 publications that resulted from our search (6391 focused on spatial analysis and 613 on territorial resilience), we performed a structured assessment of the resilience approach integration in the scientific production focused on spatial and territorial resilience, highlighting the dynamics (in absolute and relative terms) of the scientific production (Annex 2 - Table 2 and Figs. 6, 7, 8, 9); the specific topics by discipline (Figs. 1, 2, 3) in a comparative perspective; the scientific impact and relevance of the research integrating a resilience approach; the main journals where the articles were published (Annex 2 - Fig. 11), and the geographical distribution of the scientific production (Annex 2 – Fig. 10.).
Fig. 1  The Prisma diagram flow applied to the current study

Fig. 2  The number of papers taken into account in the overall bibliometric analysis (December 2020)
We next selected the papers (120) included in the Prisma Flow method (Moher et al., 2009) for deciding on the studies to be included in the content analysis and the meta-analysis, following the four steps of the diagram: identification, screening, eligibility and inclusion in the qualitative analysis (Fig. 1). Within the content analysis, we reviewed first the title, the abstract and the list of keywords, following the Neff and Corley co-word analysis (Neff & Corley, 2009) for identifying the main topics of interest in spatial vs. territorial planning. Based on citation analysis (Aksnes et al., 2019), we selected next the 30 most cited articles from all records, as well as the most relevant articles of the last 3 years from both databases. A set of additional
20 papers were identified as relevant from other sources (outside Clarivate or SCOPUS database).

After excluding duplicates (papers included in both spatial and territorial topics) the total number of articles taken in the screening phase was 121. After the qualitative analysis of the abstracts and the keywords, 60 articles were eliminated as not being relevant to our topic (coming from very specialised research areas such as nanotechnologies or without a clear focus on resilience and its spatial/territorial dimension). Finally, 61 articles were included in the content analysis. Combining essentially quantitative and qualitative methods (Mayring, 2015; Khirfan et al., 2020), the content analysis allowed the identification of the main disciplines, the key thematic areas in the resilience-based approaches in spatial and territorial research, and an assessment of the co-occurrence between the different topics and the major trends in the literature. The analysis was performed using Atlas.ti software.

Finally, we conducted a review through a meta-analysis of the three research directions identified, through a content analysis, as the most relevant in the literature: (i) territorial/spatial systems resilience; (ii) space as a component of resilience and (iii) resilience measures by targeted indicators. Our meta-analysis included only 30 articles, while only 20 of them were considered important for identifying future trends of resilience inclusion in planning-related research. Furthermore, supplementary sources were used to emphasize the most prominent ideas that were included in the overall analysis.

The main subjects highlighted in the meta-analysis were: resilience and territorial/spatial systems, types of resilience in territorial research, resilience and territorial capital, scale (panarchy) and adaptive cycle, resilience in planning (urban, regional, national, global) etc. This systematic approach provided a set of insightful discussions and conclusions on the state-of-art and perspectives of resilience approaches in spatial and territorial planning.

Results

Results of the Bibliometric Analysis

The bibliometric analysis uses papers published in high-quality journals indexed in ISI Clarivate and/or Scopus databases. We note a ratio of 10 to 1 in frequency between spatial and territorial approaches, which confirms the fact that territorial resilience is a much more recent and yet less consistent concern in planning studies, while spatial resilience, especially in ecological studies, is a long-term research area. A specific place is taken by urban resilience studies that involve both spatial and territorial approaches and have shown an exponential growth in the last two decades (Fig. 2 and Annex 2 - Table 2).

Spatial resilience appears to be more frequently used in the literature than territorial resilience. In absolute terms, the number of papers on spatial resilience started to increase in the late 1990s and surpassed one hundred in both ISI and SCOPUS databases in 2009. In the last ten years, the increase was exponential, the total number of the published article on this topic being more than 500 after 2017 and around 800.
in 2020. Territorial resilience as a topic appears to be much less common, although the temporal patterns of the occurrence are more or less similar: from a lower but significant number (more than 10) after 2010, to more than 50 after 2017 and almost 100 in 2020 (Annex 2 – Fig. 6). Nevertheless, when analysing the growth rate, one can notice that both topics have a similar trajectory, with small variations. Moreover, in the last 8 years, it seems that territorial resilience started to have an even higher growth rate than spatial resilience (Annex 2 – Fig. 7).

A rather similar overall dynamic pattern can be observed by including resilience in spatial and territorial planning studies. A consistent number of papers on spatial resilience planning (more than ten per year) started after 2008 and, eight years later, the number has grown to more than 100. Territorial planning papers integrating resilience appeared several years later (2014–2015) and have not surpassed 15 papers per year (Annex 2 – Fig. 8). Taking into account the share of publications in each year from the total number of articles focusing on spatial and territorial resilience in planning, the growth rates in the last 10 years turn to be more or less similar, with even a relatively higher positive trend for the territorial approaches (Annex 2 – Fig. 9).

By looking at the specific domains of interest for resilience-centred papers included in the analysis, one can notice that for both spatial and territorial resilience, in general, and in the planning field, most of the papers are included in the environmental science and ecology domain. This is the case for more than 45% of the 6391 papers focused on spatial resilience and more than 30% of the 613 papers on territorial resilience (Fig. 3a and b). Spatial resilience was included as a topic also in other domains related to the dominant one: Biodiversity Conservation, Marine Freshwater Biology, Water Resources, Geography, Geology, but also Engineering (9.51%) and, to a lesser extent, Computer Science, Urban Studies and Public Administration. In the case of spatial planning, the only domains with more than 10% of the share of all included papers were: Urban studies (13.19%), Geography (11.17%), Public Administration (11.70%) and Science Technology (11.70%). On the other hand, territorial planning is more related to Geography (21.17%) and social and economic sciences (Business Economics, Public Administration, Urban Studies, Social Sciences). The planning related papers are also dominated by Environmental Science and Ecology (35%) and - with an equal share - by Urban Studies, Geography and Science Technology (18–19%). Meanwhile, in analysing the main journals publishing papers on spatial and territorial resilience and planning, it is noteworthy that apart from the high number of occurrences in highly cited journals such as Sustainability (where both areas are covered), there is a clear divide between the two approaches. Firstly, spatial resilience and planning are more published in journals related to ecology and landscape management, also in relation to natural hazards. Secondly, territorial resilience and planning are addressed by more heterogeneous journals related to land use, ecology and urban management (Annex 2 – Fig. 11).

Taking into consideration the distribution of authors’ affiliations, some consistent geographical differences can be noticed between spatial and territorial approaches related to resilience (Annex 2 - Fig. 10). Spatial resilience studies were published mainly by researchers from the USA, Australia and the UK, i.e. more than 58% of the total number of papers related to this topic, followed by papers from China.
Most of the papers that particularly analyze spatial resilience from a planning perspective were written by authors from the same countries (with more than 25% from the USA), with a lesser representation from China (6,28%), but also with a significant contribution of researchers from Italy and The Netherlands (more than 8% each). On the contrary, territorial resilience is mainly “a European concept” used mostly by Italian affiliated authors (24%), but also by researchers from France (12,1%) and Spain (10,6%). The USA, the UK or Canada have all less than 10% of the total number of authors analyzing territorial resilience. Italian affiliated authors analyzing territorial resilience from a planning perspective are by far more prominent—37,12% of all papers, followed at distance by Spanish authors (11,36%). This information on Italy shows a high concern for practical reasons: Italy faces higher threats than most European countries in relation to earthquakes risk and climate change-related hazards that need to be addressed from a planning perspective, especially in cities.

The most consistent resilience items were systemic resilience and development resilience which was targeted by most of the selected papers (Fig. 4). Secondly, risk management and qualitative approaches of resilience (resilience measurement) also included papers focused on ecological approaches, but adding also, more vigorously, the economic and social-ecological dimensions. Finally, the more general approaches, i.e. spatial and temporal ones, are considered as a transversal field included in all other types of approaches.

The by far most dominant number of approaches in resilience studies originate from ecology, while social-ecological and economic approaches are more recent, but also consistently present. Social resilience itself is still a niche area, although becoming more prominent in recent years.

Based on these four resilience fields, in the second part of this study three main relevant directions of present and future research were identified and assessed from a content-analysis perspective:

- resilience of spatial/territorial systems remains the main direction of resilience research integrating traditional systemic approaches of ecological resilience and social-ecological systems, but also more recent resilient development studies;
- approaches that integrate space as a component of resilience - such as connectivity, accessibility or spatial distribution - influence resilience capacity or, in some cases, vulnerabilities in a territorial context. The scale also differentiates resilience and creates complex effects of spatial synergies, simultaneities or oppositions (e.g. adaptive cycles and panarchy models);
- an indicators-based approach of resilience highlighting the territorial difference in preparedness, response and adaptation is viewed either as a process (resilience capacity) or as an outcome (resilience performance).

The co-occurrences statistics (Table 1) show some significant relations between all these main resilience domains. One can distinguish systemic resilience as the most “durable” and “resilient” field with a connection towards all the other fields from more specific and classic approaches centred on ecological resilience to social-ecological and economic approaches that are applied in risk management.
Fig. 4 Sankey diagram – The main approaches of spatial dimensions of resilience

Table 1 Co-occurrence statistics

|                                | Territorial systems resilience | Space - a component of resilience | Resilience indicators |
|--------------------------------|--------------------------------|-----------------------------------|-----------------------|
|                                | count  | coeff. | count  | coeff. | count  | coeff. |
| SYSTEMIC RESILIENCE            | 4109   | 0.75   | 1897   | 0.34   | 1988   | 0.35   |
| RISK MANAGEMENT                | 1785   | 0.31   | 1081   | 0.25   | 1146   | 0.26   |
| DEVELOPMENT RESILIENCE         | 2736   | 0.47   | 1892   | 0.41   | 2353   | 0.55   |
| RESILIENCE MEASUREMENT         | 1691   | 0.29   | 1503   | 0.39   | 1950   | 0.55   |
and development studies and are also often based on integrative indicators-based assessments.

The indicator-based assessments of resilience highlight, from a planning perspective, the need for operationalization. Resilience was, for a long time, either a small domain within larger ecological approaches or a very broad theoretical umbrella for studies in different areas that included this concept more as a metaphor and a theoretical background than as an instrument leading to operational results.

Lastly, in overall resilience studies, space plays a central role and becomes a driver of resilience or vulnerability that can and should be measured and addressed. Connectivity, accessibility, spatial morphology and landscape structure are major topics that imply a clear empirical perspective on the drivers of change and recovery after a certain perturbation. Acknowledging all these long-term trends in resilience studies from a spatial and territorial perspective, one can conclude that spatial/territorial planning is very much influenced by these new developments. This influence however, is very recent (Rega & Bonifazi, 2020) and still needs fit-for-purpose adjustments.

The analysis of the most common terms in the literature shows major differences between spatial and territorial approaches in planning (see Fig. 5).

Spatial resilience is still very much linked to the initial ecological resilience studies of ecosystem management/planning, but also to the more systemic ecological and social-ecological approaches linked to climate change. The words that have the highest frequencies in the selected papers on spatial resilience connected to the above-mentioned notion are: “climate” (0.39%), “management” (0.32%), “ecological” (0.31%), “change” (0.31%), “ecosystem”, “resilience”, “planning”, “ecology”, which also appear in most of the articles. Some keywords are dominant in some papers, but are not present in other papers at all, a fact showing a certain degree of science specialization. For example, “species” (0.43%) has the highest frequency, but also appears in 80% of the papers, while “marine”, “forest” and “landscape” appear in less than 50% of the selected papers. Other keywords that appear in (almost) all papers are: “spatial”, “area”, “natural”, “system”, “environmental”, “scale”, “time” or “impacts”.

Territorial resilience is more linked to social-economic systems, but also includes a variety of approaches from ecological and social development to systemic social-ecological centred papers. Therefore, the most common words both as total frequency and occurrence in most of the selected papers are “urban” (1366–0.76%), “city/cities” (1038 occurrences in 22 papers), “planning” (949–0.53%), “social” (858–0.48%), “areas” (782–0.43%), “resilience” (713–0.40%), “development” (680–0.38%), “system” (598–0.33%), but also “change”, and “natural”, “area” or “local” (also frequent in spatial resilience planning studies). Other words have a high overall frequency, but are included in a smaller number of papers (in our selection) such as “food” (743 occurrences in 17 papers), “vulnerability” (589 occurrences in 17 papers), and “landscapes” (494 occurrences in 24 papers).

Overall, our bibliometric analysis shows clear patterns and trends for spatial and territorial approaches of resilience studies that were first very much divided – one towards ecology and the other related to disaster management studies and social-economic analysis. Recently, the two approaches seem to converge, so that territorial
Fig. 5 Word clouds 1) spatial resilience & planning; 2) territorial resilience & planning; 3) spatial and territorial resilience & planning; taking into account a) total frequency; B) frequency in no. of selected papers
perspectives are included in ecosystem management papers while spatial resilience becomes a syntagma that is very much used in urban or human geography and economic studies.

**Bibliographic Review: A meta-Analysis**

The bibliometric analysis from the previous section has to be placed in a wider context and, also, has to be complemented by an in-depth analysis of the actual implications of spatial/territorial approaches of resilience for shaping social-ecological and social-economic systems by planning, development and territorial policies. We analyse here – as mentioned above - three main research frameworks that include resilience as a main concept and instrument for spatial and territorial planning: the systemic perspective, space as a component of resilience, and the role of spatial/territorial indicators in measuring resilience.

**Systems Approach of Spatial and Territorial Resilience**

Spaces and territories are systems within systems (Berry, 1964) - therefore, a complex integrative spatial approach is needed when discussing resilience. The first extensive work related to the spatial component of resilience was published by Cumming (2011) who also adopts a very comprehensive systems approach to resilience. Cummings states that spatial resilience is primarily induced by the internal organisation of the system of reference. Therefore, there are spatially relevant properties (the morphology of the system, e.g. shape, size etc.), the boundaries of the system, the position of the elements within the system, but also the spatial variation of internal states (regime shifts, succession stages, transitions) that are to be considered. For example, Biggs et al. (2018) created a database of social-ecological systems considering their regime shifts to provide a platform for comparison of drivers, feedbacks, impacts and potential management options in different areas all over the world.

Secondly, external elements can also shape the adaptive capacity of the system. In this sense, one may refer to the context (background), the market (influence area of the system), connectivity (accessibility and fluency in communication with other relevant systems), spatial feedbacks, but also to modularity (compartmentalization and discontinuities can also make systems more resilient). Understanding the role of structural and functional components of managed systems may contribute to increasing their resilience (Allen et al., 2014; Angeler et al., 2016).

An essential concept emerging for the spatial configuration of resilience is “spatial subvention(s)/subsidies” that refer to the results of regulation mechanisms imposed by spatial configurations that depend on the position of the system in the proximity of certain privileged areas in terms of natural and human resources, a technical endowment which can be diffused to the interest area (Cumming, 2011). Some scholars even define spatial resilience as the capacity of buffering and renewal, which depends on the areas that are in the proximity of the territory affected by disturbance (Nyström & Folke, 2001; Nyström et al., 2000). Allen et al. (2016) exemplify spatial subsidies indicating the sandstorms fertilizing low productivity soils
elsewhere. These spatial externalities imply that the resilience of a system can affect the resilience of other systems at the same scale or at a different scale. Therefore, it is important to consider the feedbacks and interactions that are implied by different changes (Magoni, 2017). Nevertheless, spatial resilience does not only depend on internal and external attributes of the systems, but is also an emergent characteristic, viz. the ability of the system to undertake change while maintaining the core attributes and identity. It depends on the dynamic systemic thresholds, but also on the memory and the potential to learn and adapt (Istrate et al., 2015).

In ecological resilience studies, spatial resilience is considered highly important for operationalization and quantification of resilience in landscape ecology (Allen et al., 2016; Rescia & Ortega, 2018). Landscapes are dynamic spatially and temporally complex systems; therefore, understanding the role of spatial patterns and spatial variation can produce important advances in this field. Moreover, applying certain spatial principles and concepts that have been developed in landscape ecology to social-economic context or even to cultural landscapes (Ianos et al., 2014), is useful to designing more resilient, complex systems.

An ecosystem-based and place-based approach of marine spatial planning is proposed by Crowder and Norse (2008) by taking into account heterogeneity and connectivity (networks of biogeochemical flows) from a system perspective that also includes human-environment interactions to accomplish the goal of preserving biodiversity and ecosystems’ functions integrity. Foley et al. (2010) even introduce four resilience-inducing principles of marine spatial planning: maintaining or restoring native species diversity, habitat diversity and heterogeneity, key species and connectivity. Consequently, when transferred to cities and territorial planning, it can be stated that spatial heterogeneity can determine system function at any scale (Pickett et al., 2004).

The broader systemic view would integrate the complexity of society and economy (within social-ecological systems) using as a tool the concept of territorial resilience. The metabolism of cities is better understood by using the framework of resilience as a complex adaptive system that suffers rapid or slow changes that are controlled and directed towards different complex territorial, topographic and social-economic components (Salvati & Serra, 2016).

From this perspective, especially in some rural systems, resilience capacity can increase if proper importance is given to resource endowments (resourcefulness), re-localization and diversification of production (adaptation), breaking-down the “technical-legislative barriers” that generate rigidity, creating self-reliance (modularity) but also the connection with the outside, enhancing the sense of community, also by strengthening social bonds and trust and through a high-quality education (Salvia & Quaranta, 2017).

Urban resilience is also analysed from different systemic perspectives by many scholars. At the first level, the engineering approaches emphasize the need to reduce vulnerabilities to disasters by enhancing resistance and robustness of physical infrastructure systems (Borsekova & Nijkamp, 2019). From a planning perspective, infrastructure must be planned to be safe (Ahern, 2011), so that it recovers quickly after a disruption. Nevertheless, the issue of relying upon a safe infrastructure could give planners a false sense of security that has to be considered (Sharifi, 2020).
second phase, based on evolutionary resilience, is more oriented towards adaptation-based approaches, based, on the one hand, on the main drivers of resilience (such as diversity, modularity, self-organization, adaptive capacity) and, on the other hand, on including a certain balance between two major perspectives. This is regularity imposed by the adaptive cycle for urban, regional and other territorial systems (i.e. the succession of exploitation, conservation, release and reorganization phases – each demanding different planning measure to tackle perturbations) and the unpredictability of future changes that should transform cities in complex systems who learn to live with risk while building “safe-to-fail” systems (Ahern, 2011) that do not suffer major losses when disturbed and not only bounce back, but also bounce forward (Sharifi, 2020).

From a systemic point of view, the proactive perspective of resilience is one of the most important emerging directions in the field. The “blessing in disguise” hypothesis highlights an ability that appears and develops when the system is subject to real or potential threat (Magoni, 2017; Koerniadi et al., 2016). Resilience is not just the capacity to resist, to maintain vital functions and identity, but also the capacity to go forward, to learn, to build back better, to become more efficient and more functional. This approach is not new in itself. In fact, in ecological resilience, studies are identifying the self-organizing processes that create a self-regenerating natural forest, but also natural regeneration in planted forests by promoting local genetic adaptation, creating spatial and temporal heterogeneity, sustaining local biodiversity and, finally, creating higher ecosystem resilience to future shocks (Chazdon & Guariguata, 2016).

**Space/Territory as a Component of Resilience**

The spatial variation of certain factors within a system influences, and is influenced by, the amount of resilience at different temporal and spatial scales (Cumming, 2011). The convergence between resilience analysis and spatial sciences such as geography and planning is very fruitful, as it allows the comparison between the patterns and the processes of resilience that range from the local level (communities, cities) to global scale (nations) (Berke et al., 2012; Berke et al., 2014; Frazier et al., 2013). These sciences have the scientific opportunity to make a multi-scale integration, given their analytical tools and intrinsic focus on place and spatial interactions (Cutter, 2016).

Concerning disturbances, the coping capacity which is a component of resilience depends on spatial characteristics of both disturbances and interest areas (that suffers from those disturbances). Such an approach is taken by Hessburg et al. (2015) who provide a framework for landscape restoration in case of forest fires for Inland Pacific United States identifying some spatially-induced principles of resilience to these perturbations. Similarly, at the global or regional level, numerous other papers analyse spatial differences in forest ecosystems resilience (e.g. Krumhansl et al., 2016; Kulakowski et al., 2017), spatial and temporal variation of the ecosystems resilience to marine heatwave (Frölicher et al., 2018), similar variations in plant water behaviour in the context of ecosystems resilience to drought (Konings & Gentine, 2017), in-stream conditions and ecosystems (Lake, 2000; Lake et al., 2012; Berke et al., 2014; Frazier et al., 2013). These sciences have the scientific opportunity to make a multi-scale integration, given their analytical tools and intrinsic focus on place and spatial interactions (Cutter, 2016).
A prerequisite to reorganise ecosystems after large disasters, spatial resilience takes sometimes the form of ecological memory, which corresponds, in the case of social-ecological systems, to place identity. It is found both inside and outside of the area of disturbance and should be included in ecosystem and biodiversity management (Bengtsson et al., 2003).

Meanwhile, spatial resilience refers to location, connectivity and the context for resilience as the spatial variation of characteristics and processes at different scale influence and is influenced by the resilience of the local systems (Cumming, 2011). To manage inherent turbulences, both functional and response diversity have to be sustained and enhanced at large scales and across scales. In ecological systems, this diversity is maintained by species existing and operating at different scales allowing ecological functions to be “borrowed” from one scale to another so that the affected systems will persist (Elmqvist et al., 2003). In all cases, scale is important, therefore including spatial hierarchies of social-ecological systems in landscape management is essential. Therefore, nce conditions and spatial-temporal variations can be addressed within a system of hierarchically organised sites by using the state-in transition model to refer to (Bestelmeyer et al., 2009).

Nevertheless, the spatial scale is a problem that has to be addressed very cautiously. In the case of biodiversity resilience to climate change, some uncertainties emerge from the need to scale up empirical observations from smaller spatial scales to predict larger-scale phenomena (Root & Schneider, 1995; Heller & Zavaleta, 2009). Another issue that also emerges in ecological resilience approaches to climate change, is “connectivity conservation”, which involves sustaining and building connected environments that enable species to move with the climate (Hodgson et al., 2009). In other approaches, a larger spatial spread of species such as migratory birds’ population can increase their resilience if environmental conditions change (Finch et al., 2017). By contrast, fragmentation of formerly continuous landscapes and consequent habitat loss affect the resilience of ecosystems. Smaller and isolated patches have different features and usually lower resilience when compared to continuous landscape (Debinski & Holt, 2000; Lindenmayer & Fischer, 2006).

Connectivity is one of the main spatial attributes that can enhance resilience, or, in some cases can create vulnerabilities. Creating functional networks might be a prerequisite for survival. Janssen et al. describe three network characteristics relevant for resilience: centrality (existence of key nodes), the density of links and reachability of nodes from each other. Nevertheless, they did not find any direct connectivity-resilience relation (Janssen et al., 2006). Some scholars argue that the connectivity principle can impact variability in ecological systems (which can also be transposed in the human-dominated systems). For instance, Almany et al. (2009) use a spatial analysis of the Great Barrier Reef Marine Park to analyse the potential trade-off between connectivity and biodiversity.

The relationship between accessibility and resilience can also be studied from the viewpoint of interconnected dynamic human-dominated systems; therefore, accessibility can become a factor of resilience or, on the contrary, fragility (Reggiani, 2012. Östh et al., 2018), in post-crisis/disaster context (Dutozia & Voiron-Cancio, 2018), e.g. regarding critical infrastructure and basic services (Bănică
et al., 2017) or a more balanced context integrated within the perspective of smart cities’ framework (Zhu et al., 2020).

Maintaining the reference state of the more stable systems also depends on the spatial and temporal scale, on the species considered and other intrinsic properties of each reference area (Grimm & Wissel, 1997). Overall, the appropriate spatial resolution has to be identified, so that different measures are taken at different scales to assure the persistence of species and ecosystems services (Heller & Zavaleta, 2009). Some important research challenges emerge from the need for clarifying the feedbacks of interlinked social-ecological systems: to differentiate the ones that build resilience from those which cause vulnerability, to integrate into a common framework the matches and mismatches across scales and to adequately put into light the characteristics that create adaptive capacity (Folke, 2006). In managing different disasters, different spatial and timeframe policies are needed. For example, earthquakes and floods need emergency approaches targeted to specific areas, whereas climate change needs long-term global scale policies (Pizzo, 2015).

Mismatches between different scales of social or ecological processes and the institutions that are responsible for their management can induce a decrease in social-ecological resilience, including the mismanagement of natural resources and a decrease in human quality of life. Therefore, it is important to discover tools to diagnose spatial mismatching (Cumming et al., 2006). One way to do so is by mosaic governance that can be sensitive to diversity and dynamics of active citizenship, which aligns with local informal networks and across scales, which highlights a distinctive spatial dimension of environmental government (Buijs et al., 2016; Buizer et al., 2016).

The interactions across spatial and temporal scales are included within the panarchy model of nested adaptive renewal cycles (Gunderson & Holling, 2002). In this already classic model, resilience becomes a self-organizing process that is sustained by spatial and temporal scales above and below those taken into account for the system in focus. Panarchy explains why complex systems create and benefit from crisis, by both persisting and innovating at the same time (Holling, 2004). The approach is theoretically attractive, but rather difficult to operationalize in the case of different systems.

In social-economic systems, spatial networks, applied in a variety of domains, can be analysed from the viewpoint of their resilience. The main directions include scale, interdependent networks, optimal spatial networks, connection with socio-economic indicators, the evolution of transportation and spatial networks, urban studies (Barthelemy, 2011). From a systems perspective, urban resilience studies are mainly focused not only on institutional and management of urban areas (Polonenko et al., 2020) but, moreover, on land use design and planning and infrastructure development (Voghera & Giudice, 2019; Sharifi, 2020), this second category emphasising the morphological and social-spatial aggregates as intrinsic attributes of resilient cities. Also, resilience can address dynamic ‘spatial’ processes which involve mobility and multiple interactions (such as urban-rural, transboundary relation, migration) which can be also sources of vulnerability (Béné et al., 2014).
Measuring Resilience - Spatial/Territorial Indicators

Measuring resilience is indispensable for decision-makers, therefore including clear ways to measure and quantify resilience at different scales is still an important task to be accomplished (Gharai et al., 2018). Meanwhile, spatial and territorial resilience, which implies the adaptation and transformation of a complex co-evaluative system, is influenced by many phenomena that are difficult to measure (Davoudi et al., 2012).

In spatial economy, the resilience is already a well-established domain that also succeeds in introducing and applying methodologies and tools from an engineering or evolutionary viewpoint, and to adopt indicators of spatial-economic resilience, but scholars still consider that new developments are needed in from theoretical viewpoint to ground the diversity of empirical studies (Reggiani et al., 2002; Modica & Reggiani, 2015; Goschin & Constantin, 2021).

In planning cities for disaster resilience, specific indices that include spatial relations between components of urban environment and form, and responsivity/adaptive capacities of cities, are sometimes proposed, but further research is still needed (Masnavi et al., 2019). Cutter (2016) addresses the heterogeneous landscape of disaster resilience by assessing two categories of assessments: (i) attributes and assets of resilience (economic, social, environmental, infrastructure) and (ii) capacities (social capital, community functions, connectivity, planning). In addition, from a practical point of view, indicators for emergency and urban security planning are highly important (Coaffee & Rogers, 2008; Coaffee, 2013). The resilience indicators integrate increasingly social, economic and institutional dimensions assessed in both spatial and aspatial conditions (Rafieian et al., 2011).

Community and regional development also need assessments that are based on various dimensions of resilience that have spatial outcomes and have to be included in spatially differentiated domains, e.g. housing and built environment, infrastructure and services, land-use and tenure, natural environment, economy (Sherrieb et al., 2010; Rogers, 2013; Welsh, 2014; Serban & Ianos, 2015; Zebrowski, 2016; Benedek & Lembcke, 2017; Botezat et al., 2021). Sturgess (2015) highlights the importance of moving from simple characteristics-based approaches to resilience capacity indicators. The characteristics-based approaches have a circular logic as resilience is measured using features that are considered to be key elements of resilience, while not considering the impact of shocks.

Many of these indicators are reversed vulnerability indicators; vulnerability is a concept that was utilized for a longer time and has a broader conceptual and methodological basis (e.g. Chang et al., 2015), but to be effective, a resilience approach to planning should have a larger perspective that goes beyond the actual susceptibility of places affected by shocks.

The relation between resilience and spatial social disparities is not linear, but rather more complicated. Therefore, resilience can increase spatial and social disparities as land use planning for adaptation may lead to greater inequality. For instance, some researchers argue that urban adaptation interventions can increase incidences of social, spatial and environmental injustices (Anguelovski et al.,
These injustices may have to be addressed by nested multi-level indicators that should also integrate cross-scale interactions (Béné, 2018).

**Discussions and Conclusions. Normative Relevance and Future Research Agenda**

In the last decade, resilience became a very popular concept, tending to replace sustainability as a reference framework (Rega & Bonifazi, 2020) in the development strategies and policies. Nevertheless, the integration of the resilience approach in spatial and territorial planning is recent and uncompleted. The literature highlights an important gap between the theory and practice (Brunetta & Caldarice, 2019; Assumma et al., 2020), despite important advances in the development of theories and methodologies for assessing the resilience of different socio-economic systems and the fact that territorial resilience became very important for the planning of socio-ecological systems at different scales.

Current placed-based resilience approaches are only broadly integrated in the spatial planning strategies, which seldom remain “territorial blind” (Brunetta & Caldarice, 2019), without a real reference to the territorial characteristics. Certainly, this is mainly due to the fact that, despite theoretical developments, the concept of resilience remains a “fuzzy and contested” concept (Salata & Yiannakou, 2020). Some authors have long drawn attention to its low relevance to spatial planning and its utility was consistently debated by some scholars (Davoudi et al., 2012). The latest studies maintain a lack of consensus in defining resilience and its characteristics, in measuring the resilience of a system, while spatial planning lacks clear and feasible tools to ensure the transposition of resilience-based theories into concrete measures and policies (Salata & Yiannakou, 2020).

However, in the face of the prospect of an increasing exposure to a more complex society and unexpected risks and stressors, a growing interest from academics and policy makers in developing resilience and policy solutions based on the resilience’s theories can be observed. Compared to current trends in the literature, we anticipate a strengthening of the role of resilience as an appropriate concept to understand the vulnerabilities and ability of systems to react, adapt and overcome while maintaining balance and function in optimal parameters, without affecting sustainable development objectives. However, taking into account on the one hand, the current state of knowledge and, on the other hand, the current theoretical, methodological and normative limits of place-based resilience approaches, we consider that some major research axes will result from already confirmed trends, in particular:

1. The development of integrated, multidimensional models including in a common framework the environment/territory, the economy, the social capital and networks, institutions, governance, political instruments, etc. (Kim & Marcouiller, 2019) within multi-scale, multilevel and multi-actors assessments, considering the space-sensitive dimensions of resilience and the key role of the people and the stakeholders. Such a trend, already existing in the literature, has not been associated with methodological developments to ensure the integration of these
components into replicable and policy-relevant models, and new approaches have not been reflected in the dynamics of development policies and spatial and territorial planning strategies. We anticipate that the literature will aim to gain a clearer normative dimension and move from theoretical approaches based on models, to research leading to the integration of resilience in evidence-based policies.

2. The attempt to enforce the concept by strengthening the evolutionary perspective. For spatial and territorial planning, the first challenge will be to integrate an “evolutionary adaptation approach” taking into account specific territorial aspects. Concepts such as “capacity building” (Kim & Marcouiller, 2019); bouncing forward (Zhang et al., 2019); transformative capacity; adaptive resilience, evolutionary resilience; community capacity (Weichselgartner & Kelman, 2015), prosilience (Bogardi & Fekete, 2018) will need to be increasingly integrated into spatial and territorial planning. Bouncing-forward and enhancing functionality by better territorial design is an increasingly strong emerging positive perspective concerning disasters, ordinary perturbations and stresses creating adapted and adaptable places (Rega & Bonifazi, 2020). Antifragility is probably the most consistent concept that addresses the limits of resilience. Proposed by Taleb (2012), the concept can be applied (complementary to resilience) to spatial systems that not only withstand and recover from a shock but also benefit from it and thrive afterwards. There are at present emerging approaches in this field, focusing on the antifragility of the built environment and urban form (Sartorio et al., 2021), antifragile ecosystems (Equihua et al., 2020) and antifragile planning (Blečić & Cecchini, 2020).

3. Integration of the latest societal challenges such as climate adaptation, environmental crisis, digital transformation, social inequalities, technological revolution, urban concentration and segregation and others (Brunetta & Caldarice, 2019). For example, spatial planning will need to have replicable models that integrate challenges of climate adaptation and environmental sustainability (especially in the context of the high EU ambitions regarding the Green Deal). Meanwhile, the development of research in the field and the strengthening of the societal dimension in the resilience models will be needed to increase the place-sensitive character of the spatial and territorial planning policies and actions.

4. Strengthening the spatial dimension of resilience in spatial-temporal frameworks, integrating a dynamic perspective and a space-sensitive approach is another important research path. Such models will increase the integration of the territorial characteristics in the planning and policies based on the resilience theories and methods and will contribute to the identification of the emerging and pro-active solutions for a specific context, considering the growing interest in including a strong resilience approach in the spatial sensitive-based policies. The tendency is towards a socio-ecological, integrative approach to resilience, to develop an “integrative spatial and temporal framework” in resilience approaches for integrated resilience solutions, as already confirmed by the literature (Kim & Marcouiller, 2019).

5. Considering that the planning based on resilience “must be understood as the responsibility of everyone” (Di Lodovico & Di Ludovico, 2018) and that resilience requires “a joint work of all actors” living and working in a community...
(Pirlone et al., 2020), policymakers will be interested in new governance patterns conducting to resilient development and planning of cities (Assumma et al., 2020). From this perspective, we expect a growth rate of research focused on governance patterns based on citizen science research and active involvement of key local actors in decision-making for place-based resilience planning. Recent works also refer to reflexive urban governance and people’s empowerment from the viewpoint of transformative and anticipatory resilience, using knowledge, social innovation and digital technology as facilitators (Moghadas et al., 2022; Zeng et al., 2022).

Place-based policies applied at various levels need to preserve local identity, knowledge and diversity, historical heritage and other valuable structures and functions related to local communities. In this regard, effective resilient planning will be based on: co-management governance, involving all users in the decision-making process by establishing strong connections between them, adaptive management i.e. learning by doing to deal with uncertainty and also adaptive co-management. This combination promotes a flexible resource management system allowing to learn from actions and use the information in the cooperation process of stakeholders (Plummer & Armitage, 2007).

This framework can create not just safe places, but also meaningful places, addressing, from a bottom-up perspective that complements top-down institutional decision mechanisms, not just safety and risk prevention, but also development issues, creating inclusive places, improving capacity and connectedness to build sustainable places and social capital in both urban (Mirti Chand, 2018) and rural communities (Salvia & Quaranta, 2017).

Resilience is designed as the cross-boundary concept between natural and social science. Spatial and territorial resilience are partially interchangeable, but there are also differences between the two. Spatial resilience is a concept and a tool originally used more in natural sciences (mainly ecology), while territorial resilience is predominantly an emerging concept in sciences that are more related to human society (social, economic, urban). Including resilience within all planning processes can positively influence the quality of life by increasing security, the number of resources available (even more than necessary i.e. redundancy), connectivity and accessibility, modular and polycentric approaches, learning, improving the quality of human resources and territorial innovation. Resilience is still difficult to operationalize, as successful approaches are difficult to be generalised and transposed in other contexts. Besides their site and context-specific features, such approaches need also a detailed “resolution” of data, not only spatially but also temporally which is usually not present in official statistics.

In conclusion, space is a main driver of resilience, but there is no single recipe for spatial or resilient territorial planning. Therefore, resilience is, by nature, place-specific and this perspective should be included in all policies and planning measures to become an effective framework and instrument.
Authors’ Contributions (Optional: Please Review the Submission Guidelines from the Journal whether Statements Are Mandatory) All authors contributed to the study conception, design, and writing. Data collection, content analysis and the meta-analysis was performed, in the first stage, by Alexandru Bănică and then adjusted and completed by Gabriela Pascariu and Peter Nijkamp. All authors read and approved the final manuscript.

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Annex 1 – Research areas and corresponding key words used for coding in Atlas.ti

Five areas of interest were identified and certain keywords were used as codes for each category (four horizontal and one transversal i.e. spatial-temporal approaches):

- SYSTEMIC RESILIENCE: ecology, ecosystems, socio-ecological systems, regime shift, change, habitat, system, transition, feedback, diversity, community/communities, species, conservation, protection, restoring
- SPATIAL-TEMPORAL APPROACHES: landscape, transition, state, regime, connectivity, accessibility, panarchy, adaptive cycles, scale, space, spatial, territorial
- DEVELOPMENT RESILIENCE: territory, regions, regional, development, economic, social, environmental, sustainable development, sustainability, planning, design, smart, policies, policy, measures, actions, strategy, governance, institutions
- RISK MANAGEMENT: vulnerability, exposure, risk, resistance, response, coping, recovery, adaptation, adaptability, transformation, reconstruction, security, disaster, crisis, catastrophe, climate, emergency services.
- RESILIENCE MEASUREMENT variables, indicators, index, capacity, factors, drivers, performance, outcome, process, spatial, territorial.

Annex 2 Figures and tables - illustrating the bibliometric analysis
Table 2  The papers related to spatial and territorial resilience and planning taken into account in current study

|                               | Spatial resilience | Spatial planning AND Resilience | Territorial resilience | Territorial planning AND Resilience |
|--------------------------------|--------------------|---------------------------------|------------------------|-------------------------------------|
| **No. of papers (ISI)**       | 5060               | 940                             | 463                    | 132                                 |
| **No. of papers (SCOPUS)**    | 4833               | 959                             | 499                    | 145                                 |
| **Highly cited**              | 70                 | 13                              | 2                      | 0                                   |
| **Open access**               | 1950               | 381                             | 190                    | 190                                 |
| **Associated data**           | 119                | 9                               | 1                      | 1                                   |

Fig. 6  Multiannual occurrences of spatial resilience and territorial resilience as topics in ISI and SCOPUS articles

Fig. 7  Multiannual occurrences growth rate of spatial resilience and territorial resilience as topics in ISI and SCOPUS articles
Fig. 8 Spatial planning and resilience/territorial planning and resilience (number of articles)

Fig. 9 Spatial planning and resilience/territorial planning and resilience (% of the total number of articles)

**Declarations**

Conflicts of Interest/Competing Interests (Include Appropriate Disclosures) Not applicable.

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Consent for Publication (Include Appropriate Statements) Not applicable

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