



Transformative Resilience: An Overview of Its Structure, Evolution, and Trends

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Abstract: Transformational resilience is at the forefront of academic and policy initiatives on sustainable development, climate adaptation, and disaster risk reduction as a result of successive and complex changes in global dynamics. While the literature on transformative resilience is growing, there is no comprehensive analysis of its trends and development. This paper aims to close this knowledge gap by presenting a multifaceted bibliometric overview of transformative resilience literature, revealing its trends, focus areas, transitions, and intellectual foundations. This is based on 415 Web of Science-indexed articles published between 1996 and 2021. According to the findings, the concept has developed primarily around four key presentive domains: vulnerability and climate change adaptation, urban and regional disaster resilience, sustainability management and institutional transformation, and COVID-19. While priorities and subjects of research have evolved over time, key concepts such as resilience, adaptation, and climate change have recurred. Influential authors and documents from three interrelated resilience schools, including sustainable development, climate change adaptation, and disaster risk reduction, have shaped the field's intellectual foundations. We contend that a greater variety of contexts is required to facilitate transformative resilience's investigation, description, and experimentation.

Keywords: transformative resilience; transformative adaptation; sustainable development; climate change; disaster risk reduction; bibliometric analysis

1. Introduction

Resilience has been an influential concept in development, disaster risk reduction, and climate change adaptation research and policy over the past decades [1–3]. Despite its complex intellectual basis, resilience has often been conceptualized and operationalized in three distinct but interconnected capacities: conservative coping adaptation, reformative incremental adaptation, and fundamental transformative adaptation [4–9].

Conservative coping adaptation denotes the inherent capacities of urban systems, including circumstances of basic urban infrastructures and services [10,11], quality of buildings [12], settings, norms, and instruments of planning systems [9,13–16], as well as established institutional networks and resources [4,17]. These capacities support the robustness level of urban systems and predispose them to perform routinely. However, reported evidence asserts that counting on only reactive coping characteristics can form path dependencies [4], enhance trade-offs [18], and generate unforeseen conflicts [19].

Reformative incremental adaptation concentrates on learning processes and mediumterm adjustments to indigenous or exogenous drivers of change by combining shortterm reactive coping characteristics with medium-term gradual capacities to gradually



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Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). facilitate existing measures and provide adaptive pathways for urban systems in times of uncertainty [9,19–21]. Examples include project-oriented participation of underlying actors in decision-making processes [8], strengthening existing planning instruments with risk-sensitive standards such as building codes [13,22], as well as moderate improvements in buildings qualities and critical infrastructures to enhance their adaptability [23,24], amongst others. However, some studies argue that an over-emphasis on reformative adaptive capacities may result in contrasting outcomes [25], deepen inherent vulnerabilities [26], and yield maladaptive development trajectories [4,27].

To address these challenges, literature on resilience necessitates a paradigm shift in resilience planning and practice from reformative incremental adjustments to fundamental transformative pathways that underpin mechanisms of change for sustainability and resilience [7,28–30]. In line with this, the policy narratives such as the UN agendas (e.g., the SDGs, the Paris Agreement, and the New Urban Agenda) and the science-policy reports (e.g., the SREX, the GAR, and the updated Global Research & Action Agenda) have also signified the necessity for system-based essential changes in resilience planning and practice.

Fundamental transformative capacity for resilience denotes "the capacity of individuals and organizations to be able to both transform themselves and their societies in a deliberate, conscious way" [29]. According to Wolfram [31], transformative capacity focuses on understanding how urban systems can reshape and transit toward a more sustainable form and function. Transformative capacity also calls for the creation of innovations and novelties in resilience theories and their incorporation into practice [19]. Thus, deliberate transformative capacity advocates for a mindset change in existing resilience paradigms and mandates new mechanisms to drive the shift toward a more sustainable and resilient future.

While transformative resilience literature is rapidly growing, it remains an intricate construct with little contextualization, conceptualization, and operationalization. Existing research on transformative adaptation for resilience is either focused on single sectors such as governance [9,19], infrastructures [32,33], planning [34,35], or linked to small case studies with specific shocks or stresses such as flooding [36,37], drought [38], or hurricane [39]. Transformative resilience, by nature, is a context-dependent concept, and the significance of a special focus (transformative resilience to what) and capacity (transformative resilience of what) can differ in different contexts and scales. In addition, the concept is multi-faceted and includes a diverse range of disciplines, which either limit the development of a more solid transformative resilience concept or provide a comprehensive assessment of urban transformative resilience discourses. Therefore, the fragmented knowledge base of the concept makes it difficult to map all forms of knowledge and analyze the various aspects of transformative resilience.

Existing attempts on this evolving concept include systematic review papers on analyzing directions and aspects of transformative resilience [2,40,41] and particular article reviews on framing new frameworks, dimensions, and methods [19,31,42,43]. However, recent studies on urban sustainability and resilience highlight that traditional systematic reviews are inadequate to fully map the current trend and evolution of a relevant field since they often focus on small sample sizes, specific topics, and short-term periods [17,44,45].

Against this background, bibliometric analysis is widely applied to unpack the evolutionary aspects of urban resilience and unfold its emerging areas [17,44,46,47]. It aims at providing two important but interrelated benefits [48]. First, it provides insights into a diverse range of interpretation criteria relevant to scholars, references, journals, organizations, and countries that have underpinned the contextualization, conceptualization, and operationalization of a specific field [17]. Second, the bibliometric analysis contributes to the science mapping of a field by revealing the knowledge structure, areas of focus, and thematic and sub-thematic evolution [45]. Although some papers have attempted bibliometric reviews of urban resilience in general [17,46,47,49], or climate change adaptation in particular [44,50], a bibliometric analysis of urban transformative resilience is missing. By using a bibliometric analysis, therefore, this paper attempts to reveal the intellectual bases of transformative resilience literature by addressing the following core questions:

- 1. How has transformative resilience positioned at the forefront of global initiatives on sustainable development, disaster risk reduction, and climate change adaptation?
- 2. Which nations and organizations play the most active roles in defining and shaping transformative resilience paradigms?
- 3. Which disciplines have served as the foundation for transformational resilience discourses across time, sectors, and contexts?
- 4. What has changed in transformational resilience pathways throughout time, and what will be the crucial emphasis area in the future?

The remainder of this paper is organized as follows to answer these questions. Section 2 shows the utilized materials and methods and states the inclusion and exclusion criteria for the analysis. Section 3 presents the findings and discussions relevant to guiding questions. In the last section, we conclude the assessment and give some proposals for further work.

2. Research Methods and Materials

Transformative resilience has attained traction in policy and research, with 50–70 articles being published on this topic per year. The growing body of literature on this topic necessitates a review of the field's collective developments and tracking the present state of knowledge in this area. To ensure quality reporting for the systematic review, we applied the PRISMA checklist. The checklist, which can be accessed at http://prisma-statement.org/PRISMAstatement/checklist.aspx (accessed on 7 September 2021), has 27 items and 4 consecutive steps, including identification, screening, eligibility, and inclusion, designed to assist authors in conducting better systematic reviews (see Figure 1).



Figure 1. Procedures for literature search and selection.

Web of Science (WOS) was used to acquire the necessary data for the bibliometric analysis. This database has been noticeably used in relevant studies [45,47,51–53]. It contains over one billion cited reference connections and rich bibliometric data collected over the previous decades that enable researchers to implement various analyses in bibliometric software tools (i.e., VOSviewer). We designed a wide search string to enable the inclusion of numerous appropriate documents on transformative urban resilience in our analysis. The specific search string was searched in either the title, abstract, or keywords: TS = ((("resilient" OR "resilience") NEAR/10 ("transformative" or "transformational" or "evolutionary")) OR ("transformative adaptation" OR "transformational adaptation")). This search string considers different variants of terms related to transformative adaptation and resilience, such as transformative resilience, evolutionary resilience, and transformative adaptation, that are commonly used in the literature. On 28 September 2021, we conducted a literature search for an infinite period, yielding 789 records. We then scrutinized the titles and abstracts of all retrieved records to include or exclude them based on three inclusion criteria. These were relevant to the contexts of climate change, urbanization dynamics, and natural hazards; our focus on urban/local scales; and our concentration on multi-faceted constructs within urban systems, including water, food, energy, healthcare, supply chain, planning, and leadership.

Therefore, we excluded those documents that are not appropriate for urban transformative resilience. For example, relevant records to medical and agricultural disciplines were hindered from the database. This procedure yielded 415 documents (see Table 1). The "Full Record and Cited References" of these documents were downloaded to be used as input information for our bibliometric analysis and science mapping with VOSviewer. The application can be attained for free at https://www.vosviewer.com (accessed on 18 September 2021). Analysis of word co-occurrences, citations, co-citations, and bibliographic coupling were the primary uses of VOSviewer in this review study. The research period was split into two sub-periods (1996–2015 and 2015–2021). The opening year was 1996 because the first relevant article indexed in the WOS was published this year. Furthermore, 2015 was chosen as a landmark year since several policy narratives, such as the UN agendas (e.g., SFDRR, the SDGs, the Habitat III), which have affected transformational science and practice, were published in that year. Separate analyses were carried out to reveal the thematic direction over each period.

| Categories | 1996-2015 | | 2015–2021 | | Total | |
|--------------------------------|-----------|----|-----------|-----|-------|------|
| | Ν | % | Ν | % | Ν | % |
| Publications | 96 | 23 | 319 | 77 | 415 | 100 |
| Document types | | | | | | |
| Article | 74 | 70 | 266 | 84 | 340 | 81.9 |
| Proceeding paper | 9 | 12 | 18 | 6 | 27 | 6.5 |
| Review | 8 | 11 | 34 | 10 | 42 | 10.1 |
| Book chapter | 5 | 8 | 1 | 0.3 | 6 | 1.4 |
| Subject areas | | | | | | |
| Environmental sciences ecology | 36 | 38 | 145 | 45 | 181 | 44 |
| Geography | 9 | 9 | 32 | 10 | 41 | 10 |
| Business economics | 8 | 8 | 26 | 8 | 34 | 8 |
| Urban studies | 4 | 4 | 24 | 8 | 28 | 7 |
| Public administration | 5 | 5 | 23 | 7 | 28 | 7 |
| Other areas | 34 | 35 | 69 | 22 | 103 | 24 |

Table 1. Outline of publications on transformative resilience from Web of Science datasets split into two-time spans: Early (1996–2015) and latest (2015–2021).

| Categories | 1996–2015 | | 2015-2021 | | Total | |
|---|-----------|-----|-----------|----|-------|------|
| | Ν | % | Ν | % | Ν | % |
| Journals | | | | | | |
| Sustainability | 0 | 0 | 22 | 7 | 22 | 5 |
| Environmental science policy | 2 | 2.8 | 13 | 4 | 15 | 4 |
| Global environmental change | 6 | 6.2 | 11 | 3 | 17 | 4 |
| International journal of disaster risk reduction | 0 | 0 | 11 | 3 | 11 | 3 |
| Other journals | 88 | 91 | 262 | 82 | 350 | 84 |
| Country | | | | | | |
| USA | 25 | 26 | 102 | 32 | 125 | 30 |
| Australia | 19 | 20 | 50 | 16 | 70 | 17 |
| England | 14 | 15 | 56 | 18 | 70 | 17 |
| Germany | 4 | 4 | 29 | 9 | 34 | 8 |
| Canada | 4 | 4 | 27 | 8 | 31 | 7 |
| Other countries | 30 | 31 | 55 | 17 | 85 | 20 |
| Funding agencies | | | | | | |
| National Science Foundation NSF | 13 | 38 | 39 | 35 | 48 | 36 |
| European Commission | 5 | 15 | 31 | 28 | 34 | 25.6 |
| UK Research Innovation UKRI | 16 | 47 | 24 | 22 | 34 | 25.6 |
| "National Natural Science" "Foundation of China NSFC" | 0 | 0 | 17 | 15 | 17 | 12.8 |
| Most published authors | | | | | | |
| Folke C | | | | | 6 | |
| Ziervogel G | | | | | 5 | |
| Colloff MJ | | | | | 5 | |
| Wamsler, C | | | | | 5 | |
| Most cited authors | | | | | | |
| Adger, N | | | | | 201 | |
| Folke, C | | | | | 182 | |
| Pelling, M | | | | | 177 | |

Table 1. Cont.

Source: authors.

3. Results and Discussion

3.1. Publication Trends

Figure 2 is a Pareto chart indicating the transformative resilience publications trend for 1996–2021. Since the publication of the first paper in 1996, about 415 papers have so far been published on this subject based on the Web of Science search. This figure demonstrates an irregular publication trend, with the number of publications increasing exponentially since 2015. Based on the cumulative percentage line, about 50% of publications were disseminated in the last three years. The study years (1996–2021) are classified into two suberas based on the development speed of publication directions. The initial era encompasses the years from 1996 to 2015, when the publication speed was slow and fluctuated. In sum, only 53 (13% of the sample) papers were published in this period. One explanation of this background is that the term transformation has not been well-positioned in international policy and scientific discourses on "development, climate adaptation, and disaster risk reduction" [2]. Despite some underlying academic efforts in characterizing transformation and the associated necessities to navigate the shift toward fundamental transformative resilience [23,24,54–56], many resilience initiatives have been limited to the understanding of the concept as reactive absorptive coping or moderative incremental adaptive capacities



aiming at managing the impacts of disasters or changes, and gradually streamlining available standards and adjusting to keep the continuity of systems, respectively [57].

Figure 2. Year Pareto chart for transformative resilience publications for 1996–2021. Note that the literature search was done in early October 2021, and more publications are expected to be published this year.

In the second period (2015–2021), the adoption of the landmark UN agendas of the "Sustainable Development Goals2 [58], the "Paris Agreement" [59], and the "New Urban Agenda" [60] highlighted the vital need for fundamental changes in development trajectories, climate change adaptation pathways, and disaster risk reduction strategies. The discourses on transformation have also been supported by UN science-for-policy reports such as the "IPCC's Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" (SREX) [61] and the "UNISDR's 2015 Global Report on DRR (GAR)" [62]. Therefore, by re-positioning transformation in resilience science and policy discourses, the number of related documents increased drastically, with 362 papers being published (87% of the sample) in the second period.

3.2. Core Subjects, Journals and Authors

As of September 2021, 415 studies have been published that are relevant to transformative adaptation or transformative resilience, relying on the terms considered by authors in titles, abstracts, and keywords (Table 1). The analyzed publications largely comprise academic journal articles (N = 340; 81.9%) while also containing proceeding papers (N = 27; 6.5%), reviews (N = 42; 10.1%), and book chapters (N = 6; 1.4%). Based on the WOS database, the main subject areas belong to environmental studies (N = 181; 44%), geography (N = 41; 10%), business economics (N = 34; 8%), urban studies (N = 28; 7%), and public administration (N = 28; 7%). As the analysis indicates, the vast majority of literature relates to social-environmental studies, indicating that enhancing transformative resilience is a case to challenge the established systems that undermine environmental, social, and economic sustainability [29].

Most of the published literature comes from the United States (N = 125; 30%), followed by the United Kingdom (N = 70; 17%), Australia (N = 70; 17%), Germany (N = 34; 8%), and Canada (N = 31; 7%; Table 1). Figure 3 indicates that other significant contributions to the literature belong to Italy, the Netherlands, Norway, Spain, France, and South Africa. Accordingly, the principal players of transformative resilience discourses are three Global North countries, the USA, the UK, and Australia, and the contribution of Global South countries has been negligible. The closest research collaboration also belongs to the top three countries. Although the evidence of social-environmental inequalities and vulnerabilities supporting the need for a paradigm shift in resilience planning and practice are dominant in the Global South, the applicability of the developed concepts, tools, and indicators of transformative resilience in the Global North to cities in the Global South is still a challenging issue. This is because transformative resilience by nature is a highly context-dependent term that necessitates the development of evidence-based and inclusive approaches [8,63]. The funding agencies of the field are the four institutions from the USA (National Science Foundation), EU (European Commission), UK (UK Research Innovation), and China (National Natural Science Foundation of Chania), indicating that transformative resilience discourses demand shifting unjust socio-political relations as well as processes within which they developed and delivered [64].



Figure 3. Dominant countries and their interconnections in the transformative resilience literature. The size of nodes represents the digit of publications, and the density of links and different colors display to what extent these countries are interconnected.

The journals that have published the most papers on this topic include "Sustainability" (N = 22; 5%), "Global Environmental Change" (N = 17; 4%), "Environmental Science & Policy" (N = 15; 4%), and "International Journal of Disaster Risk Reduction" (N = 11; 3%; Table 1). The leading organizations are Stockholm University (N = 10; 2.4%), University of Cambridge (N = 10; 2.4%), University of Melbourne (N = 10; 2.4%), Monash University (N = 10; 2.4%), and Arizona State University (N = 9; 2.1%). The most published authors are Carl Folke (N = 6), Gina Ziervogel (N = 5), Matthew Colloff (N = 5), and Christi Wamsler (N = 5) (Table 1). These are distinguished researchers in the field of resilience and its associated concepts, including adaptive and transformative capacities to steer the paradigm shift toward more sustainability and resilience concerning growing uncertainties and changes in world dynamics.

3.3. Research Subject Areas and Their Transformation

3.3.1. Subject Areas

Co-occurrence analysis is a technique that utilizes terms used in the title, abstracts, and keywords to demonstrate major topics and their linkages within a certain study subject [65]. We used the VOSviewer software's term co-occurrence analysis to identify important topic areas and priority research themes in urban transformative resilience literature. The most popular items between 1996 and 2021 were "resilience" (N = 170; 10%), "adaptation" (N = 150; 9%), "climate change" (N = 122; 7%), and "vulnerability" (N = 78; 5%) (Table S1). The arrangement and links between the dominant terms enable us to reveal and group concepts that are strongly related in the selected literature. The analysis highlighted four primary clusters (Figure 4). The node size represents the frequency of keywords. The thickness of the links between nodes is proportional to the strength of connections between them. As Figure 4 displays, some other terms such as institutions (N = 62, 3.8%), policy (N = 61, 3.7%), management (N = 55, 3.2%), and transformation (N = 52, 3%) also represent high values of occurrence, indicating that they are considered as enabling forces of transformative pathways to navigate the paradigm shift toward fundamental transformative resilience in the relevant discourses [66–69]. Similarly, the high link strength of these terms reveals that they are considerably interconnected to other keywords. The most popular keywords, including resilience, adaptation, policy, management, and institutions, are placed close to the edges of the clusters, commenting that they cut across all themes. This is because transformative resilience is a multidisciplinary and multifaceted concept calling for an intentional shift in institutional structures and planning mechanisms to predispose cities to transform themselves against uncertain circumstances. [8,29].

The first (green) cluster in our analysis contains terms related to "vulnerability to climate change" [70,71], which is often linked with the "climate change adaptation" concept [64,72] in the context of climate-induced hazards, including drought [38,73], food security [74,75], and global warming [72,76]. This cluster can be linked to the *social-ecological discourse of resilience* that defines transformation as radical policy and structural changes of social-ecological systems (SESs) to establish new trajectories for SESs and secure the maintained "well-being" of humans and the ecosystem services [54,77–79].

The second (red) cluster consists of terms that are centralized around the resilience of urban [80,81] and regional [82,83] systems by focusing on innovative [84,85], dynamic [86,87], and evolutionary [55,88] perspectives to reduce the impacts of natural or climate-induced disasters or crises [89–91]. This cluster is mainly related to the *disaster risk reduction (DRR) discourse of resilience* that conceptualizes transformative adaptation as radical policy and structural changes of urban and regional systems to outline new strategies and capacities and deliver justice, equity, and long-term development [23,24,56].

The third (blue) cluster analysis comprises terms that emphasize sustainability transformation of [92–94] of institutions [95–97] and management [98,99] structures in transformative resilience planning and practice. This cluster can be connected to the *sustainable development discourse of resilience* that links transformation to the institutional arrangements and governance structures of existing risk management systems. The main focus is to develop new frameworks, knowledge, and science to improve decision-making processes and adaptive governance pathways that enable the transition toward disaster risk reduction, long-term resilience, and sustainable communities in the context of increasing complexity and uncertainty associated with global environmental change [29,79,100].

The fourth (yellow) cluster is an emerging theme in transformative resilience discourses that only contains a few terms related to community resilience [101,102] in the context of COVID-19 and its associated challenges [103–105].



Figure 4. The term co-occurrence analysis output map.

3.3.2. Transformation of Research Subjects over Time

To detect the subject emphasis change, we used a separate term co-occurrence analysis by dividing the dataset into two sub-periods. The first group includes the research conducted from 1996 to 2015 (N: 53, 13%). The second group encompasses a greater number of studies published from 2015 to 2021 (N: 362, 87%). Overall, the three terms, "resilience," "adaptation," and "climate change," have been the most frequently co-occurred keywords in both periods. As Figure 5a shows, institutions, transformation, and vulnerability have been other highly emphasized keywords in the first period (1996–2015), indicating that the literature has started to embed resilience as adaptive and system-based thinking into institutional settings to challenge or redress underlying drivers of vulnerability. The first period can be divided into two sub-periods: the genesis (1996–2000) and development

(2000–2015). In the genesis phase (1996–2000), adaptation is the most used term for the concept of resilience that appears in multiple disciplines, such as complex systems, sustainability, and urban scale risks [106–108]. In the development phase (2000–2010), the literature distinguishes between adaptive and transformative capacities for resilience and gravitates to the transformation of multiple systems and institutions via bounce-forward frameworks and approaches [54,109,110]. Nevertheless, the field was still in its infancy during the first period, and only a few underlying themes emerged in the analysis. Overall, the first period includes those narratives that have mainly focused on improving the resilience of complex socio-ecological systems such as cities by adaptation measures to drive the required transformation for medium to long-term resilience (green cluster). Another focus area has been examining the vulnerability of different systems (e.g., ecosystems, communities, land, etc.) by analyzing institutional arrangements, frameworks, and management to handle the challenges posed by climate change (red cluster). However, transformational pathways for capacitating policy and decision-makers to guide the transition toward disaster risk reduction and long-term resilience are limited (blue cluster).

In the second period (2015–2021), the number of publications and the thematic focus of the field increased remarkably (Figure 5b). As mentioned, research concerning resilience (N = 149, 13%), adaptation (N = 132, 9.7%), and climate change (N = 108, 7.7%) have been the priority subject areas of the literature during this period. While institutions and transformation were the fourth and fifth frequent terms in the first period, they were replaced with vulnerability and policy terms in the second period, indicating the entanglement of the concept of vulnerability with the vision of fundamental transformative resilience and the articulation of the field in policy documents [24,111,112]. New priority research topics emerged in this period to underpin a fundamental change in transformative resilience thinking and planning, making it more just [113], evolutionary [114], and inclusive [115]. With more research being published, the intellectual foundation of the field augmented, and new themes with high centrality values emerged. By addressing the resilience of what question (conceptualization), the field started to embrace new concepts to challenge the established development and risk management trajectories and develop transformational mechanisms to lead to innovative practices toward sustainable resilience [116,117]. Similarly, complex and successive changes in world dynamics transferred the field to new contexts (contextualization). For instance, the COVID-19 pandemic placed cities across the world at the forefront of disaster reduction and appeared as an emerging research priority for transformative resilience discourses [103,118]. In addition, research on transformative resilience has been enriched by capacity and performance-based frameworks (operationalization) to link its grand theories to ground-level evidence of which interventions should be considered to build and boost fundamental transformative resilience [12,119,120]. In addition, research on transformative resilience has been enriched by capacity and performance-based frameworks (operationalization) to link its grand theories to ground-level evidence of which interventions should be considered to build and boost fundamental transformative resilience. As expected, the structure and distribution of key topics in this cluster are compatible with the patterns of the whole period. However, some keywords were repositioned from the blue (Sustainable development transformation) to the red cluster (Transformative DRR). One explanation of this trend is that transformative resilience narratives are increasingly considered as a boundary object not only in the science-practice interface but also between multiple academic disciplines, sectors, and scales [46,121].



Figure 5. The results of term cooccurrence analysis for each period. Link thickness reflects link strength, while node size is related to term frequency. Additionally, various colors indicate groups of phrases that frequently occur together.

3.4. Literature Foundations

3.4.1. Leading Sources

We used "co-citation" analysis to find out how the underlying knowledge base of the transformative resilience field has been shaped. This analysis was performed by selecting the lowest number of citations per record to 100 in VOSviewer. Accordingly, we analyzed the cited reference list of 28 journals that have contributed to the development and evolution of transformative resilience discourses within the relevant literature (Figure 6).



Figure 6. Most leading sources in transformative resilience literature. Node size is proportional to the number of publications, and link thickness reveals the strength of connections between the journals. In addition, different colors refer to clusters of closely linked journals.

The most cited journals are "Global Environmental Change" (848 citations), "Ecology and Society" (683 citations), "Proceedings of the National Academy of Sciences of the United States of America" (PNAS) (389 citations), and "Climatic Change" (328 citations). This indicates that the number of publications in the relevant top journals (Table 1) is not necessarily in line with the quality impacts of these journals on the field. For instance, while Sustainability is ranked as the first journal concerning the number of publications, its total citation (166 citations) ranks the journal as the 11th in terms of contributing to the development and evolution of transformative resilience. As Figure 6 shows, the central cluster (red) consists of those influential journals that contributed to the development of transformative resilience paradigms within the vulnerability and climate change adaptation discourses. Research published in high-impact multidisciplinary journals such as "Nature," "Science," and "Proceedings of the National Academy of Sciences of the United States of America" (blue cluster) indicates the diversity of journals publishing on transformative resilience. Furthermore, interdisciplinary journals, such as "Progress in Human Geography," "Urban Studies," and "Cambridge Journal of Regions, Economy, and Society" (blue clusters), have had a keen interest in analyzing how and to what extent existing conditions and rapid changes in urban and regional systems open up or constrain opportunities for transformative resilience.

3.4.2. Leading Documents

We also used "co-citation" analysis to reveal the most important articles that have underpinned the development and evolution of transformative urban resilience literature. There is a handful of guiding papers that have attained citations more than 50 times (Table 2). The most influential paper is by Kates et al. [24], which concentrates on transformational adaptation to climate change when incremental adaptation measures are insufficient. The next most influential paper is Holling [122], which has often been considered the first conception of the term resilience in the ecological literature. Pelling's book [23] on the need for the transition toward transformative resilience through significant change in social and political relations at urban scales is the next most influential paper. Similarly, O'Brien [56] is another one highlighting the importance of deliberate transformation (instead of incremental adaptation) as a response to global environmental change. Davoudi [55] is also a distinguished reference that focused on the evolutionary resilience of complex socio-ecological systems, including governance and planning systems. Furthermore, Folke [54] is the next important document in this list that has focused on the adaptive management approach for responding to ecosystem changes (Table 2).

Table 2. Most influential documents of transformative resilience discourses.

| Influential Documents | Authors/Year | Highlighted Terms | Transformative Resilience Discourse | Target of Transformation |
|---|----------------------|---|--|---|
| "Transformational adaptation when incremental adaptations to climate change are insufficient." "Adaptation to climate change: From resilience to transformation." "Global environmental change II: From adaptation to deliberate transformation." | [24] [23] [56] | Adaptation Climate Change Vulnerability | Disaster risk reduction (DRR) | Urban and regional resilience |
| "Resilience and Stability of Ecological Systems" "Resilience: The emergence of a perspective for social-ecological systems analyses." | [122] [54] | Resilience Systems Crisis | Social-ecological systems (SES) | Climate change adaptation |
| "Resilience: A Bridging Concept or a Dead End?" | [55] | Institutions Management Sustainability | Development | Sustainability management and institutional transformation |

However, by selecting the lowest number of citations per reference to 20, we obtained 34 influential papers that have been highly cited across 415 relevant publications on transformative resilience. Overall, three co-citation groups can be classified by mapping these most cited references. The first group mainly belongs to the social resilience school (e.g., "the University of Exeter and King's College London") that has highlighted the importance of transformative adaptation pathways for resilience (instead of reformative incremental adaptation) to the challenges generated by natural or climate-induced disasters or crises on urban and regional systems [23,24,56]. The argument is that urban and regional systems should adapt and transform themselves via a purposeful shift in institutional structures, governance mechanisms, and planning innovations against environmental uncertainties. The second group mainly consists of those influential publications from the socio-ecological (e.g., Resilience Alliance) school that views transformation as an integral part of resilience to drive the transition from the resilience of old to the resilience of the new [54,77,122,123]. The main narrative here is that urbanization, as currently formulated and implemented, is unsustainable and evolutionary approaches for resilience are needed to explore pathways for the deliberate transformation of complex social-ecological systems such as cities. Finally, the third group includes those publications related to the development school (e.g., "School of Architecture, Planning and Landscape, Newcastle University" and "Urban and Regional research center Utrecht, Utrecht University") that focus on the transformation of institutional arrangements and planning paradigms in the face of increasing complexities and uncertainties [55,124]. The central narrative is that

conventional development paths are inadequate to provide sustainable tracks for resilience, and evolutionary approaches are needed to guide spatial development.

3.4.3. Leading Authors

The final step in this section was exploring the most influential authors in underpinning and transforming the field. Using "co-citation" analysis and fixing the lowest number of citations per scholar to 30, the analysis identified 31 influential authors in three main clusters (Figure 7). The red cluster includes those influential authors from human geography that have focused on the conception and assessment of adaptive and transformative capacities for resilience to reduce disaster risks and vulnerability posed to human communities by natural hazards or climate change. The top three influential authors with at least three-digit citations (Adger, Pelling, and O'Brien) belong to this cluster. The green cluster consists of the influential authors from the socio-ecological (Holling, Folke, Berkes, and Walker) school of resilience that have highlighted the need for transformational adaptation of complex social-ecological systems since incremental adaptation is often insufficient because of the inherent and inevitable changes of these systems. Adaptive governance and management is a key concept for these authors for capacitating social-ecological systems to drive the required transition toward transformative resilience [24,54,123].



Figure 7. The most influential authors in the development and evolution of transformative resilience literature.

The blue cluster refers to those influential authors from sustainable development studies that have focused on defining and analyzing the evolutionary resilience of regional economy [124–126], political economy [112], and urban planning [55]. However, the term evolutionary resilience has been addressed by diverse pathways, including the adaptive cycle model from the panarchy theory [127], innovation and leadership [125], and dynamic interplay of reformative adaptive and fundamental transformative capacities [55].

4. Conclusions

Transformative resilience is a dynamic, multi-faceted, and place-specific concept, which necessitates unpacking its transition over time, sectors, and contexts. Therefore, this paper aimed to provide an overview of the transformative resilience discourses with an emphasis on four fundamental areas:

 Mapping publication trends and assessing underlying initiatives in the relevant literature highlighting the importance of the transition toward transformative resilience;

- Identifying central subject areas, lead sources, authors, and the relevant knowledge and expertise that have shaped the field;
- Revealing the intellectual bases of the field within various but interconnected disciplines;
- Examining the development and evolutionary backgrounds of the field over time.

Our results indicate that the majority of transformative resilience documents have been disseminated during 2015–2021 by a quick wave in the number of records since 2020. With rapid changes in global dynamics and the inability of dominant resilience approaches to steer safe, inclusive, and sustainable pathways, transformative resilience has risen to the forefront of international policy and academic initiatives on sustainable development, climate change adaptation, and disaster risk reduction in the post-2015. Therefore, the inclusion of transition and change in resilience research and policy narratives can be the main explanation and driver of this trend. In the academic literature, overwhelming empirical insights showed that trusting conservative coping and reformative adaptive capacities of resilience may generate contrasting outcomes, aggravate inherent vulnerabilities, and yield maladaptive pathways [4,7,29,128]. In policy literature, the UN agendas (e.g., the SDGs, the "Paris Agreement", and the "Habitat III") and the science-policy reports (e.g., the SREX and the GAR) signified the transformative capacities for resilience initiatives on urban and regional scales.

Our findings from "bibliometric" analysis indicated that existing studies on transformative resilience have mainly concentrated on environmental studies. Other important topics such as geography, business economy, urban studies, and public administration have gained much less attention within the literature. While much focus on environmental issues can be linked to the crucial necessity to embrace deliberate changes and implement sustainable strategies to respond to climate change [116], more diverse contexts are needed to facilitate the investigation, description, and experimentation of transformative resilience. For instance, governance and planning as the central components of global ambitions to drive the transition toward fundamental transformative resilience in the context of development, climate change, and natural disasters are among the main issues that are not well-represented in the analysis. Furthermore, the geographies of transformative resilience are unfair and often belong to the Global North, whereas the evidence of social-environmental inequalities and unsustainable development trajectories supporting the need for a fundamental shift in resilience planning and practice are dominant in the Global South. As an emerging concept, transformative resilience presents the opportunity to develop innovative local capacity-building theories and practices. These could progress the understanding of sustainable resilience development through their application within under-researched geographies such as cities in the Global South (Africa and Asia-Pacific) and through co-creative approaches in collaboration with marginalized and under-represented groups in local case studies.

The study also analyzed the thematic focus of the field and its development over the study period (1996–2021). While adaptation was the most common concept to drive transformative resilience (often as incremental change) of complex socio-ecological systems during the genesis phase (1996–2000), the field often characterized transformation as a longterm change of urban systems in the context of natural and climate-induced hazards in the development phase (2000–2015). Positioning transformation in the UN policy agendas and science-for-policy reports increased the concept's popularity in the relevant literature in the second period (2015–2021). Overall, the analysis found that the transformative resilience concept has mainly matured around the four main thematic areas: vulnerability and climate change adaptation, urban and regional disaster resilience, sustainability management and institutional transformation, and the COVID-19 pandemic. These clusters indicate the prevalent focus areas and directions of the literature. Further study, for example, in the first cluster (vulnerability and climate change adaptation), might focus on a fundamental shift in conventional policies, strategies, and institutions that generate maladaptive pathways and pose spatial-temporal vulnerabilities in the context of global climate change. Similarly, research on urban and regional resilience (second cluster) may concentrate on mindset

changes with the possibility of developing a system lens that allows leaders and decisionmakers to recognize a boundary of opportunities and innovation for transformation in their contexts. Further study on the third category (sustainability management and institutional transformation) should focus on systemic methods that encourage the transition to sustainability in order to inform and enhance policy. This must increase understanding of management and institutional system discourses, structures, tools, and practices at various scales and settings. Although the fourth cluster (the COVID-19 pandemic) is a relatively new context for transformative resilience literature and includes a few terms in our study, additional research should be conducted to identify the leadership challenges, gaps, and innovation needs that have emerged from within the context of the COVID-19 pandemic with municipal and community stakeholders at various scales and locations.

Finally, we analyzed the intellectual base of the field to discover the theoretical foundations of different transformative resilience discourses within the literature. Findings indicated that the social-ecological school of resilience views transformation as the required concept to drive the transition from the resilience of the old to the resilience of the new. The influential authors of this discipline (Holling, Folke, Berkes, and Walker) highlight the vital need for fundamental transformative adaptation of complex social-ecological systems to the problems and implications of urbanization dynamics and its associated challenges, including soil and water degradation, inequality, global warming, and most importantly climate change. The social school of resilience defines transformation as the long-term structural changes of urban and regional systems instead of reformative incremental adaptation against natural and climate-induced hazards. The influential authors of this discipline (Adger, Pelling, and O'Brien) argue that urban and regional systems should adapt and transform themselves via a purposeful shift in institutional structures, governance mechanisms, and planning innovations against environmental uncertainties. The development school of resilience explains transformation as evolutionary pathways to disrupt unsustainable development pathways and enable planners and decision-makers to set new types of visions and missions. The influential authors of this discipline (Davoudi, Martin, and Mackinnon) stress the interconnection of development trajectories, climate actions, and disaster risk reduction and highlight the importance of multi-actor, cross-sectoral, and integrated approaches to capacitate urban systems to navigate the fundamental shift toward transformative urban resilience.

While transformative resilience manifests new motivations, discourses, and directions in the context of global changes, its conceptualization remains challenging. In contrast to other conceptions of resilience (conservative and reformative), transformative resilience lacks conceptualization efforts that facilitate the exploration and explanation of underlying capacities contributing to a fundamental shift of different systems toward long-term sustainability and resilience. Therefore, the extracted key terms in this paper can be an entry point for further research to conceptualize transformative resilience capacities and processes in different contexts of development, climate change, and natural disasters at different scales. The clustered key concepts in the relevant literature indicate what contributes to transformative resilience and what kinds of paths and interactions are required to build and enhance it.

Overall, this paper has contributed to a better understanding of the current state of transformative resilience research using bibliometric analysis. However, the findings from the bibliometric study must be interpreted with due care. Geographical biases, for example, are incorporated into database procedures and might affect the geographical representation of authors and institutions [44]. Another point is the inclusion and exclusion criteria for selecting sample studies. In this analysis, we only included those documents that were in the English language and relevant to the contexts of climate change, development, and natural hazards. Our focus has also been limited to documents that have an urban/local scale. Furthermore, the discipline chosen from the Web of Science library is determined by the author's interests and goals. Further research may encompass a wide variety of disciplinary areas. Finally, further research is needed to obtain more detailed information about

the various thematic groups and hotspots identified in this study. This may be achieved by using systematic review techniques to provide additional qualitative information, allowing us to grasp better the quantitative elements provided by bibliometrics analysis.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su142215267/s1, Table S1: The 71 most commonly used author keywords for research on transformative resilience. Table S2: The thematic focus transition. Table S3: Synonymous author keywords replaced prior to keyword analysis. Table S4: The publication trends.

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