Asia Pacific Academy of Science Pte. Ltd.

Sustainable Social Development 2026, 4(1), 8519.
https://doi.org/10.23812/ssd8519

Article

Adaptive governance for mangrove resilience: Systematically reviewing policy pathways and livelihood linkages in global research (1989–2025)

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CITATION

Zhang F, Mohd Idris ND, Abdullah SA. Adaptive governance for mangrove resilience: Systematically reviewing policy pathways and livelihood linkages in global research (1989–2025). Sustainable Social Development. 2026; 4(1): 8519. https://doi.org/10.23812/ssd8519

ARTICLE INFO

Received: 19 March 2026
Revised: 13 April 2026
Accepted: 13 April 2026
Available online: 23 April 2026

Abstract: Mangrove ecosystems are an important source of ecological benefits and support livelihoods at the coastline, but the governance systems often cannot compromise conservation and socio-economic requirements. This systematic review looks at the way the scientific literature relates the relationships between mangrove conservation and local livelihoods and governance, especially adaptive governance frameworks. Bibliometric mapping and qualitative synthesis were used to analyze 45 Web of Science Core Collection studies that focused on governance. The results show that it is a rapidly developing and interdisciplinary area, yet one that is thematically lopsided. Whereas there is a well-researched understanding of ecological processes, ecosystem services and livelihood outcomes, there is no adequate integration of their governance aspects which includes power relations, institutional coordination and adaptive learning. Though conservation-livelihood trade-offs are generally recognized, there are not effectively dealt with by effective institutional mechanisms. New financial strategies such as blue carbon risk enhancing the existing inequalities with weak governance frameworks. It is pointed out in the review that a paradigm shift is required in the form of switching to adaptive governance that directly controls trade-offs, fair sharing of costs and benefits and responsive to changing socio-ecological dynamics.

Keywords: mangrove conservation, sustainable livelihood, adaptive governance

1. Introduction

The mangrove forests are one of the most important socioecological systems, which provide a broad spectrum of ecosystem services, which interacts both locally, regionally, and globally. These services encompass carbon sequestration, also known as the so-called blue carbon, coastal amenities against storm surge and erosion, fisheries nurseries, and conserving biodiversity [1]. Mangrove has additional ecological value since it is an important source of livelihood of millions of people in coastal areas of the tropical and subtropical areas, especially low- and middle-income countries. Mangrove ecosystems are important in the ecotourism and ecosystem restoration programs because coastal communities depend on their ecosystems to provide livelihoods through small-scale fisheries, fuelwood, timber harvesting, honey productions, and diversified livelihoods [2]. Mangroves are situated in the ecological and socioeconomic nexus of these intertwined ecological and socioeconomic functions that make them quintessential social-ecological systems (SES) where ecosystem dynamics and human well-being are closely related.

Although they are valued, mangrove ecosystems have continually been destroyed due to the continued anthropogenic influence. The rapid growth in aquaculture, creating infrastructure on coastal areas, agricultural transition, and urbanization have

caused mangroves to be lost at unprecedented rates worldwide, with climate change adding to this stress due to rising sea level, intensifying storms, and intrusion of salinity [3]. The immediate, commonly imbalanced impacts of such ecological degradation on local livelihoods are direct, disproportionately impacting the small scale, resource dependent households, which have limited adaptive capacity. Mostly in the context of conservation interventions aimed at stopping the loss of mangroves, the problem of conservation has imposed new social contradictions when access to traditional resources is limited, and livelihood demands are not appropriately divided into parts, which weaken both social equity and conservation effectiveness [4].

Mangrove ecosystems are also becoming part of the world system of blue carbon and are considered important in the mitigation of climate change because of their outstanding ability in long-term carbon storage. Recent research points to the fact that mangroves accumulate carbon per unit area, disproportionately higher than that of terrestrial forests, making them the focus of climate solutions based on nature, as well as carbon management strategies in the world. In addition to their ecological importance, mangroves contribute to the coastal livelihoods, fisheries, aquaculture, and resource-based economies [5,6], thus, connecting the ecological sustainability of the environment with the socio-economic sustainability. Although there is cumulative research on the mangrove ecosystems, distribution of research on the studies is still discreet in thematic areas. Although the ecological processes, the storage of carbon and the ecosystem services have been studied widely, the governance aspects especially on the aspect of institutional coordination, power relations and adaptive decision making have been left relatively disjointed [7]. Such aspects have recently been covered by scholarship; but interrelation between governance, livelihoods and ecological dynamics have not yet been systematically studied but are localized and situation-specific.

Conventionally, top-down and centralized conservation systems of mangroves have dominated which have focused on ecological conservation at the expense of local knowledge systems, customary institutions, and livelihood priorities. These control and management interventions have been found to mostly assume an ecological stability and predictable human behaviors that are increasingly less true in the dynamic coastal ecology [8]. As the empirical statistics show, such type of strategies typically leads to low compliance rates, low potential of enforcing them and undesirable social and environmental effects like competition over resources and the displacement of livelihood [9]. Community-based and participatory management has taken a center stage with respect to participatory management, decentralization and shared decision making, e.g. co-management arrangements [10]. Even though these strategies represent a necessary step beyond exclusionary conservation, they are more likely to fail to address uncertainty, power relationships and cross-scale relations that characterize mangrove SES.

The research which has been conducted on the mangrove has largely been associated with the shifting global policy agendas which have been undergoing high rates of growth. International agreements such as the Ramsar Convention, Convention on Biological Diversity and 2030 Agenda on sustainable development made mangroves their first line ecosystems to be preserved and a form of mitigation measure in climate change. Although these frameworks have managed to mobilize money and

interest in science, they have also influenced the nature of research to favor those outcomes that are globally quantifiable in terms of habitat area, carbon stocks, and valuation of ecosystem services, rather than those that are socio-economically embedded in the location. Such a policy-based research agenda has yielded what is arguably termed as funding echoes whereby the science agenda is bound by the international policy demands at times to the detriment of subtle involvement of local livelihoods, institutional capacity and governance realities.

Regardless of the increasing amount and complexity of mangrove science, science-policy implementation gap has continued to be clear in most coastal settings. The quality of ecological knowledge often does not provide positive or equitable social and policy outcomes because of a lack of institutional capacity, division of government, and political lack of incentives to enforce ecological information. This gap is especially high in the mangrove regimes where national or international policies are made but then applied locally in conditions of resource scarcity, competing livelihood needs and informal tenure systems. Consequently, it happens that governance interventions frequently tend to fail not due to the lack of scientific knowledge, but due to institutional and political limitations that limit their implementation.

To overcome these shortcomings, the possibility to have governance regimes that are able to accommodate complexity, ignorance and change with time has been increasingly advanced by scholars. On this note, adaptive governance has come into the limelight, with the emphasis on learning, flexibility in institutions, polycentricity and inter-scale and sectoral collaboration [11]. Adaptive governance focuses on the evolutional ability of institutions and actors to act on inputs of social-ecological systems by engaging in a process of iterative learning and adaptation as opposed to following preset rules or set management strategies. It is based on this line of thinking that adaptive co-management and co-adaptive governance systems have been suggested as a way to balance conservation goals with livelihood sustainability by incorporating ecological information, stakeholder involvement and processes of adaptive learning [12].

Although adaptive governance has become increasingly prominent in the environmental governance theory, it has been applied unevenly and disjointedly in the mangrove conservation and livelihood literature. The available literature tends to be case-specific by either concentrating on ecological or livelihood outcomes and there is little incorporation with governance. Concepts of governance are often used normatively as opposed to being operationalized empirically and there are limited systematic evaluations of how adaptive governance frameworks are working in various mangrove settings. In addition to this, the accelerated growth in mangrove-related scholarship in the disciplines has not been accompanied by extensive endeavors to map the intellectual landscape of the field, thematic development and gaps in knowledge, especially to do with governance-livelihood nexus.

On a conceptual level, this research is based on the social-ecological systems (SES) approach and the implications of the polycentric governance theory that focuses on cross-scale dynamics, institutional heterogeneity, and co-development of ecological and social dynamics. It is on the foundation of this theoretical approach that conservation of mangroves and local livelihoods are not understood as two distinct policy domains, but as parts of a complex system of governance, which is defined by

institutional structure [13], power relations and flexibility. To make this theoretical view operational, the research uses the two-method approach. Firstly, Bibliometric analysis of the publications indexed in Web of Science Core Collection is conducted to trace a trend of development of mangrove conservation and local livelihoods studies in terms of time, thematic framework, and knowledge groups. The current research trends are quantitatively described in this discussion and the views regarding governance are put in contextual relation to general knowledge. Second, the targeted systematic review will involve a collection of studies that do not only explicitly discuss adaptive governance, but also address the conceptualization and application of governance frameworks in its practiced contexts in regard to the conservation and livelihood outcomes of mangroves [14]. This combination of complementary methods will help this study to contribute to theoretical knowledge in adaptive governance in social ecological mangrove systems, understand the key gaps in research, and shape more sustainable and equitable conservation and livelihood policy choices.

2. Methodology

To investigate the patterns of research, thematic arrangement, governance outlooks systematically in studies concerning mangrove-livelihood, this research uses a two-phase of analytical design [15], combining bibliometric mapping with a qualitative in-depth review of literature on governance-oriented studies. The method allows not only a macro-level view of the landscape of knowledge but also a more in-depth discussion of the way governance structures, especially adaptive governance, have been defined as well as implemented. In **Figure 1**, the overall methodology workflow is integrated to include bibliometric mapping, as well as qualitative synthesis.

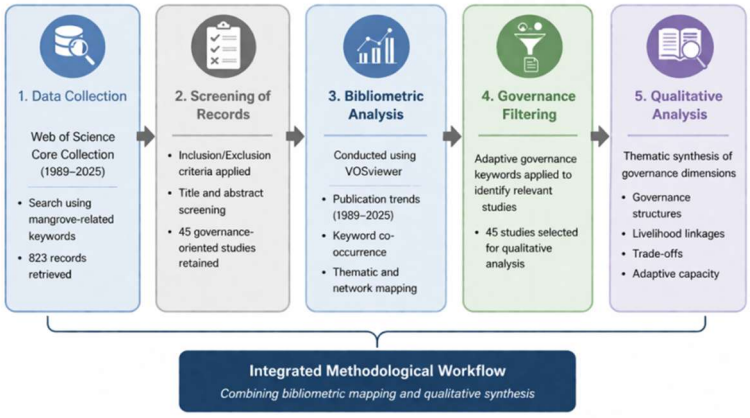

Figure 1. Methodological flow of the study.

2.1. Data source and literature retrieval

The Web of Science (WOS) Core Collection was searched thoroughly due to the fact that it is the most widely known database with high-quality and well-established indexing requirements and the broad coverage of high-quality, peer-reviewed journals in the fields of environmental science, ecology, geography, and social science. WOS was chosen to make bibliometric analysis analytically consistent and comparable.

Although WOS fails to represent the grey literature and some regionally oriented journals, it still has a standardized set of data which is specifically appropriate in mapping intellectual structures and research patterns at the field level.

The search strategy employed Boolean operators to structure the retrieval process. The operator "OR" was used to include synonymous or related terms (e.g., mangrove OR mangroves), while "AND" was applied to combine ecological and livelihood dimensions, ensuring thematic relevance.

The topic-based advanced search strategy has been used to carry out the search, which searches article title, abstracts, author keywords, and Keywords Plus. The keyword search involved ecosystem- and livelihood-related terms, and Boolean operators in the following way:

TS = mangrove (OR mangroves) (OR coastal wetland) TS = livelihood (OR livelihoods) (OR subsistence) (OR income generation) (OR resource dependence).

The identification of keywords was made based on pilot searches in order to achieve a tradeoff between inclusiveness and relevance so that both socioeconomic and ecological aspects of mangrove social-ecological systems are covered. Even though other terms like coast wetland may also involve non mangrove systems, further screening was done to ensure that records that remained did so to the context of mangroves. There was no limit in terms of time of publication. The date of the search is January 23 rd 2026.

There were not imposed any time limitations, however, it can be observed that analytical focus is evidence of substantive emergence of livelihood- and governance-oriented research, which accelerated after the late 1990s.

The keyword strategy was aimed at balancing inclusiveness and specificity of analysis. The search did not attempt to fully cover the socio-economic terminology but focused on those terms that were most closely linked to mangrove-based livelihood this ensured that conceptual consistency and interpretability with further bibliometric analyses.

2.2. Construction and screening of the dataset

The first search registered 951 records. As is usual in bibliometric practices, document type screening was done to eliminate document types other than research articles that have been peer-reviewed to eliminate non-original and substantive scholarly contributions. Consequently, 823 articles were accepted as the main dataset to be analyzed as articles. To eliminate over-representing secondary interpretations and provide consistency in the analysis, other types of documents such as editorials, conference proceedings, book reviews, and notes were not included.

Clear inclusion and exclusion criteria were used to increase the methodological transparency and reproducibility. The studies were incorporated in case they were peer-reviewed research articles that dwelled on the interactions of mangrove and livelihood in the social-ecological systems. Non research documents like editorials, conference proceedings, book chapters and review notes were omitted to maintain consistency in the analysis. The screening was performed in three steps, namely title screening, abstract screening and full-text screening, which helped to eliminate irrelevant records, determine the relevance of the records in terms of theme and verify

eligibility of the records on the basis of governance and livelihood criteria. This is a systematic procedure that makes the process of dataset selection clear and repeatable.

The dataset represents the empirical foundation of the study of the trends of publications, their thematic structure, and partnerships existing in the sphere of researches on mangrove-livelihood issues.

2.3. Bibliometric analysis

Bibliographic records were all exported in plain text format and loaded in visualization and network analysis VOSviewer. The bibliometric element of the given research was originally aimed at analyzing three tasks, which were as follows: to trace the increase in the number of publications with time, to visualize thematic organization of the literature, to trace temporal dynamics in the application of keywords. These analyses underlie the methodology of the results which have been given in the Sections 3.1–3.3.

The trend analysis of publications was done by the count of publications annually, which deems how the research output varies over time. This discussion gives a descriptive account of how the study of mangrove livelihood has evolved and puts time into perspective of thematic studies.

The thematic organization in the literature was investigated by performing keyword-based analyses. Keywords Plus and author keywords were also removed and cantered before analyses. Highly generic terms inherent to the search strategy (e.g., mangrove, livelihoods), methodological descriptors, and the geographically specific keywords were omitted to prevent the effects of dominance and analytical noise. The other keywords were then utilized to build a co-occurrence network of the thematic relationships in the literature [16].

In case of key word co-occurrence analysis, a filtering frequency of five was used but this was to reduce the frequency of rare keywords and improve understanding. Among the extracted keywords, the ones that were below the threshold were saved to be used in creating the network. To each retained key word, VOSviewer computed the total link strength which is defined as the overall strength of the co-occurrence links of the key word with other key words in the network. These measures provided the basis in the interpretation of thematic patterns that followed.

In order to determine the thematic groupings in the co-occurrence network, the clustering algorithm of VOSviewer was used with the default parameter configuration. The size of clusters was selected to achieve a compromise between the clarity of analysis and inclusiveness of themes. The clusters that result are an analytical mechanism of analyzing and arranging the prevailing research themes in the results section.

Besides that, an overlay visualization was created depending on the mean year of publication of the keywords. Such visualization aids the analysis of temporal trend in the use of the keywords without assuming certain developmental trends. The overlay analysis offers methodological support to examine how they change in terms of thematic focus over time, as reported in Section 3.3.

All these bibliometric processes combine to provide a systematic and internally consistent methodology of analyzing the scale, structure, and time scale of mangrove-

livelihood studies, but all substantive interpretation is left to the results section.

2.4. Identification of governance-oriented studies

On the basis of the first bibliometric archive, a second-tier filtering was carried out to select studies that specifically address the issue of governance approaches to the problem of mangrove conservation and local livelihood. This refinement was done through topic-based advanced search strategy, which is in line with the first retrieval process of scanning the article titles, abstracts, author keywords and Keywords Plus.

The search based on governance used the query below:

TS = adaptive governance or collaborative governance or co-management or community-based management or participatory governance.

This search was done in the already identified mangrove-livelihood dataset in order to guarantee thematic relevance and analytical consistency. The chosen terms related to governance denote analytically related but conceptual differently distinct ways of addressing collective action and resource governance. Among them, adaptive governance became the major version of integrative analytical prism towards further qualitative synthesis.

This narrowing down produced a subsample of 45 papers which directly cover the issues of governance mechanisms and of institutional arrangements in mangrove-livelihood contexts. The comparatively small sample of the governance-oriented studies is indicative of the fact that the governance research in this area is emerging and fragmented, and not by the weakness of the review design.

2.5. Qualitative analysis of governance systems

To perform the qualitative synthesis, a set analytical framework with four dimensions was used. Instead of following one of the existing models of governance, these dimensions were synthesized inductively and deductively out of the common focal points of analysis in the literature of environmental governance and the social-ecological systems, where governance is traditionally studied through institutional positioning, conservation-livelihood interactions, adaptive capacity, and distributional outcomes. This framework was even formulated in a manner that it is able to encapsulate the essence of the ways of how the governance processes are talked about in terms of resource-dependent social-ecological systems but at the same time is flexible enough to cover divergent empirical situations.

In this respect, the analysis was based on four dimensions of analysis, namely: (i) the positioning of governance on the mangrove-livelihood systems; (ii) the interactions and trade-offs between the conservation goals and the livelihood practices; (iii) the features of institutional design in terms of adaptability and learning; and (iv) the links between governance interventions and the distributional and power-related outcomes. These dimensions were employed as the analytical lenses to put the extracted information into order and to make systematic comparisons across the studies. The coding was performed repeatedly, and the chosen articles were reviewed several more times to provide homogenous interpretation of the content associated with governance across dimensions.

In order to maximize the reproducibility, the research adhered to a systematic

procedure comprising of database choice (Web of Science Core Collection), pre-defined search terms, definite inclusion and exclusion criteria, and uniform data analysis procedures with VOSviewer software. The search took place on January 23, 2026, which means that the dataset construction process and the analysis workflow can be repeated by future researchers.

3. Bibliometric mapping of mangrove–livelihood research

To give a logical information on the study of the conservation of mangrove and local livelihoods as a discipline, this section outlines the current literature through the bibliometric mapping of the literature. The analysis will determine the prevailing research themes, patterns of co-occurrence between keywords, and collaboration networks by tracking the patterns and trends of publications, the temporal pattern of the research topic, and the intellectual organization in general. Instead of providing a review of the individual studies, this mapping intends to present broad trends and biases in the research focus, thus, providing a contextual basis to the further detailed analysis of the governance-related views.

3.1. Development and time increase of the literature

The bibliometric analysis revealed 823 articles on the conservation of the mangrove and local livelihood in the Web of Science Core Collection. A nonlinear upward trend of temporal distribution of publications shows a definite increase in the past thirty years. Between 1989 and the late 1990s production of research was extremely slow with only scattered publications and this is indicative of an initial stage whereby mangrove studies were largely controlled by the biophysical conservation and resource management viewpoints. The publication output was relatively low as depicted in **Figure 2** until the early 2000s after which there was slow growth and a steep growth after 2010. The trend is associated with the increased global attention to ecosystem services, environmental protection in the fight against climate change, and the study of blue carbon.

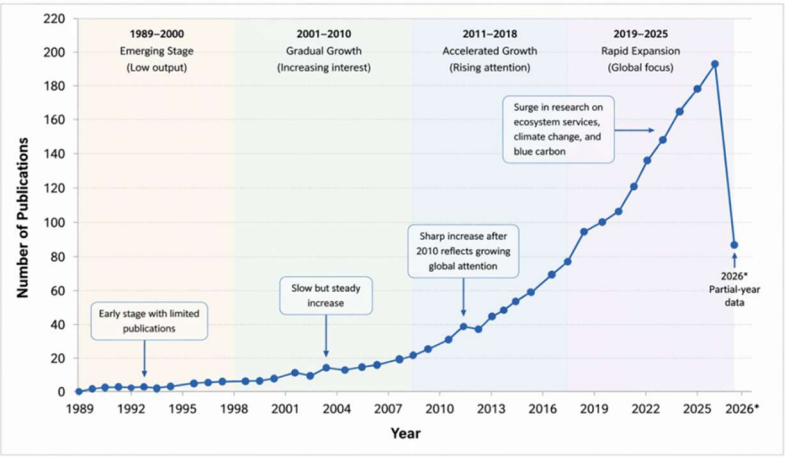

Figure 2. Trends in the annual publication in mangrove-livelihood studies (1989–2026). The figure shows the temporal trend of the scientific production, with a steep rise after 2010.

Note: 2026 data are partial-year publications.

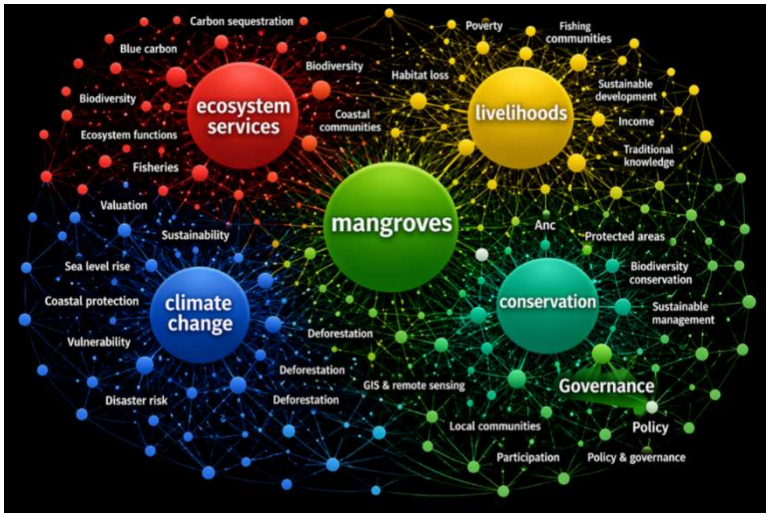

Figure 3. Keyword co-occurrence network showing the thematic structure of mangrove–livelihood research.

It is possible to distinguish several thematic clusters around this center, though they are all connected and different. A management-based cluster focuses on the ideas of coastal management, co-management, community organization, knowledge and sustainability to depict high applied and practice-based interests in decision making process, implementation situations and long-term governance of resources. Also allied to this core is a conservation-oriented cluster, organized around biodiversity, under preservation, restoration, deforestation, and carbon related themes, as to the reiteration of ecological protection and restoration in the mangrove studies.

Another yet distinct climate change cluster is pegged on the keywords of climate change, sea level, vulnerability, adaptive capacity and mitigation. The cluster also reflects an increasing academic interest in the risks and adaptation issues in coastal and mangrove ecosystems that have to do with climate, but the cluster retains a close connection to land-use, forest dynamics, and biomass-related studies.

Simultaneously, a livelihood-based cluster is livelihood-focused, rural livelihoods, and income inequality, alleviation of poverty, access to land, and sustainable livelihood approaches. It is closely related to management and sustainability-related clusters, which means that the problem of livelihood is most commonly discussed in the terms of development-oriented and resource-use approach, and not as an independent socio-economic phenomenon. The concepts related to the ecosystem, such as mangrove forest and ecology can be found in this cluster, which implies that livelihoods tend to be reflected in connection with the state of ecosystem and the availability of resources.

Although these are the key areas of research, which are concurrent, the integration of these domains is not even. The keywords related to livelihood have a high density of internal relations but a low number of direct links to the governance-related concepts like institutions, policies and rights that are located on the outskirts or bridging points in the net. In the same manner, terms related to governance are also used, but there is a tendency to connect conservation and management clusters with them, and the relations between them and livelihood outcomes are relatively low. Such structural arrangement implies that ecological, climatic, and livelihood aspects are

often dealt with simultaneously, as opposed to entirely combined governance-livelihood analytical models. Thus, the mangrove-livelihood research knowledge structure is defined by high-thematic clustering based on the established areas, and a general lack of cross-domain integration, especially between the processes of governance and livelihood dynamics.

3.2. Change in the themes of research over time

Riding on the structural trends that are observed in the keyword co-occurrence network, an overlay visualization was used to visualize the temporal development of the key research themes in the mangrove-livelihood literature (**Figure 4**). Through the overlay analysis, which visualizes the mean year of publication of the high-frequency keywords, it is possible to see the theme of the maturation of the field and the changing scientific and policy priorities over time.

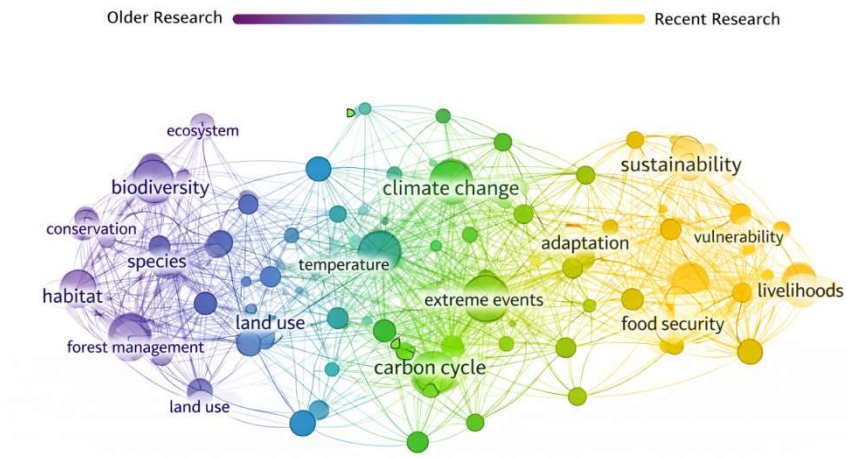

Figure 4. Overlay visualization of keyword evolution over time in mangrove–livelihood research.

Previous studies are characterized by ecologically oriented and biophysical keywords and the keywords biodiversity, conservation, forest, habitat, estuary, and fishers are mostly used in older years of publications. These words are concentrated on the periphery of the overlay map and are dense in the foundational layer, which means that the initial scholarly attention was devoted to ecological degradation, species protection, and conservation of resources in mangrove ecosystems. At this stage human aspects were predominantly depicted in the terms of the types of resource-use as opposed to the actual livelihood or governance models.

Since the end of the 2000s to the middle of the 2010s, the thematic focus expanded with the emergence of ecosystem services and climate-related ideas. The keywords, which include ecosystem services, climate change, resilience, vulnerability, sea level, and adaptation, have more recent year average publication and have been placed at progressively mainstream positions in the network. It is a conceptual transition of the connection between ecological roles and human gains, exposure to

risks, and adaptability in coastal social-ecological systems. It is interesting to note that livelihoods emerge more prominently at this stage, and they tend to co-exist with ecosystem service valuation, poverty, and food security, which means the increasing awareness of mangrove-dependent livelihoods.

The latest average year of publication is on the keywords of governance, policy, and institutional processes, such as governance, participation, policy, institutions, blue carbon, and nature-based solutions, in the latest stage of the literature. Such terms are apt to pile towards the peripheries or to connect between the established thematic areas and not to hold central structural positions. Their comparative late development and less strong integration imply governance views have been added on slowly and many times as supplements to an already existing ecological or service-based approach, rather than as the driving force of analysis.

Throughout the phases, the management is in a consistently central location with an intermediate mean of publication years, which highlights its place as a continuous integrative notion between the ecological conservation, livelihood issues, and the new governance discussions. Nevertheless, the general temporal trend is the thematic layering and not the complete conceptual convergence. Though the ecological and service-based paradigms have been gradually broadened with new themes to the research agenda, the intellectual structure of the field remains dominated by the old ones.

Combined with the above imbalance analysis, the overlay analysis supports the trend of imbalance found in Section 3.2: despite the fact that the mangrove-livelihood research area has shifted to be more of a conservation-oriented sphere, in terms of ecosystem service engagement, climate adaptation, and governance, integrative governance approaches are at the margins. This temporal sequencing point to a major disconnection between the increasingly complex socio-ecological issues on the one hand, and the slower integration of the governance-focused analysis methods on the other hand.

3.3. Placing adaptive governance in the bibliometric space

A specific search of 823 papers by the means of the key-word adaptive governance provided the result of 45 studies to evaluate how adaptive governance is positioned in this body of literature. The rather limited identified publications, along with their outer location on the keyword co-occurrence network, indicate that adaptive governance is a poorly networked concept in the overall mangrove-livelihood research field.

Combined with the bibliometric patterns, it suggests a field with high growth and thematic diversification, where there are large concentrations of literature about ecological processes and ecosystem services and livelihood outcomes. Contrarily, the concepts that revolve around governance, especially those that focus on institutional flexibility, learning, and adaptive decision-making fall to the periphery or transitional zone to the rest of the thematic framework. This trend is an indication that governance views are yet to become primary organizing factors in literature.

Although bibliometric analysis is useful in mapping the breadth, design and thematic dispersion of study, it cannot be used to capture conceptualization and

application of governance structures in the study of any individual work. In this regard, the next section transcends the quantitative mapping towards a specific qualitative review of the available publications on governance matters, taking special care of how adaptive governance is to be offered and implemented in empirical mangrove-livelihood settings.

4. Adaptive governance in mangrove–livelihood systems

4.1. Governance positioning in mangrove–livelihood systems

In the studies reviewed, it can be considered that governance is more than a pertinent variable influencing the relationships between mangrove conservation and the livelihoods of the local communities. Nonetheless, it is unevenly and fragmented in terms of its analytical positioning in the literature. A significant share of the literature uses an instrumental approach to governance, with a primary emphasis on particular management arrangements, including community-based management, co-management, or protected-area governance, as an effective tool to enhance conservation performance while responding to livelihood demands [17–19]. In this framing, it is customary to perceive governance as a kind of institutional mechanism or a policy instrument, instead of a process that changes and is rooted in more comprehensive social-ecological processes.

The livelihoods in such works are generally conceptualized as a product or effects of governance interventions or limitations that have to be addressed in the attainment of conservation goals instead of aspects that are constitutive, influencing governance processes, decision-making priorities, and institutional arrangements. Consequently, the issue of governance has been relatively marginal to the analytical plane, secondary to ecological or managerial issues [20]. A relatively small literature uses the relational approach, which posits governance as a part of larger social-ecological systems and focuses on the way institutions, actors, and knowledge systems interact [21]. These works point to the historicity and social relations of governance arrangements as well as the cross-scales in determining these arrangements, thus, transcending instrumental interpretation. However, even in this strand, governance is more commonly defined in an empirical than theoretically conceptualized forms as a temporally evolving mediator of conservation-livelihood relationships. On the whole, the literature demonstrates a trend of considering governance as a key issue that is not yet analyzed well and is not properly incorporated into the mangrove-livelihood studies.

4.2. Regulating conservation-livelihood trade-offs

One of the themes that can be traced throughout the reviewed literature is the trade-offs between the conservation goals and the local livelihood practices of the mangroves. Such trade-offs are usually recorded as to do with access limitation, conservation zoning, restoration projects, and regulatory interventions that have a direct impact on livelihoods like fishing, harvesting, aquaculture, and collection of resources [22]. The negative livelihood effects of conservation measures are in most instances identified to have triggered tension, conflict or diminished compliance. These tensions are often responded to with governance approaches which are

understood as mitigation strategies instead of being mechanisms to explicitly regulate trade-offs. The most frequent strategies are the promotion of alternative livelihoods, benefit-sharing schemes and participatory planning exercises to balance between livelihood losses or to increase the domestically acceptable nature of conservation interventions [23]. Although these measures can minimize conflicts that arise in the short term, they tend to view the trade-offs as technical or distributive issues that can be dealt with through pragmatic approaches.

Few studies directly investigate how governance arrangements organize conservation-livelihood trade-offs over time, such as setting of priorities, beneficence of certain interests and how alternative values are negotiated between different groups of actors [24]. In spite of the fact that the frameworks of ecosystem services are often used to align the conservation goals with the concept of livelihood benefits in a conceptual way, they often tend to aggregate the benefits and ignore distributional conflicts. Therefore, the trade-offs are more frequently recognized and provisioned than are managed systematically as contentious and dynamic governance issues [25].

4.3. Adaptive capacity and institutional design

There is an increasing use of adaptive capacity in the mangrove governance literature, especially as a reaction to climate change, environmental variability, and the increasing uncertainty of the coastal social-ecological systems [26]. Allusions to flexibility often underline the necessity of flexible institutions, involvement of stakeholders, and incorporation of several bodies of knowledge in the process of conservation and management. Nevertheless, the adaptive governance is not a common coherent analytical framework that is employed throughout the reviewed studies. Rather, adaptive factors, such as participation, incorporation of local knowledge, or institutional flexibility, are frequently addressed independently, without a systematic interest in the learning processes, feedback, or prolonged institutional change [27]. Consequently, it tends to assume adaptability based on the institutional traits or policy intentions instead of studying them empirically based on the dynamics of governance and decision making. The explicit use of the adaptive governance or social-ecological systems framework is relatively underrepresented in the literature [28]. This limits the capacity of the existing research to measure how institutions react to changing conservation-livelihood trade-offs through time and how power relations, cross-scale relations and structural constraints determine adaptive capacity. Adaptive capacity is therefore commonly viewed as a desired quality as opposed to being a process of governance with empirical foundation.

4.4. Distributional performance and lopses of power

The distribution outcomes are extensively documented in the reviewed articles, especially in the framework of gender dynamics, uneven access to resources, and livelihood stratification among communities that depend on mangroves [29]. All these studies show that conservation and management interventions create unequal benefits and costs across social groups that can either add on the inequalities independently or generate new forms of marginalization. Although this has been the focus of empirical attention, the power asymmetries underlying distributional outcomes have seldom

been investigated in a systematic manner. Even though some research papers point to the exclusion or limited inclusion of vulnerable populations, such as women, small-scale fishers, or socially marginalized households [30], the power relations are usually viewed as background factors and not as the main mechanisms of governance that determine the nature of decision-making. Consequently, distributional inequalities are recorded descriptively, but disanalytically without connection with the governance structures and the institutional design. This further solidifies the division between the issue of social equity and the analysis of conservation governance [31], and thus, limits the ability of the literature to consider how the power relations influence the outcome of conservation-livelihood and limit the ability to respond through adaptive governance.

5. Discussion

The results of this research indicate that there is an exploding but structurally imbalanced literature on the mangrove-livelihood systems. Bibliometric analysis shows a significant increase in the number of publications since 2010, reflecting growing global interest in ecosystem services, climate adaptation, and sustainable development. Nevertheless, even with this growth, the concepts related to governance are loosely embedded in the general knowledge framework [32]. The co-occurrence analysis of keywords shows that terms related to governance, including institutions, policy, and participation, are located at the periphery of the network and have few direct relationships with livelihood clusters. In addition, among the 823 studies analyzed, most of them are not focused on governance mechanisms, suggesting that governance is not a developed analytical dimension, but an organizing framework. This implies that governance is often recognized, but it is seldom operationalized in empirical studies. In spite of these shortcomings, the literature has excellent empirical contributions in the ecological and livelihood sectors [33]. The fact that the innovations in governance can be effective in mediating the conservation-livelihood trade-offs is further evidenced by the empirical findings of various contexts of the coastlines, provided that they are well-designed and executed. The experiences of community-based mangrove management in Indonesia have shown that the value of local participation and decentralized decision-making can be useful in recovering ecology and resilience of livelihoods, particularly in regard to sustainable aquaculture and ecosystem based income diversification. Similarly, co-management systems in Bangladesh, where local communities collaborate with government institutions, have demonstrated improved resource access, reduced conflict, and enhanced adaptive capacity in vulnerable coastal areas. The positive relationships between participatory models of coastal governance in the Philippines and better compliance, better ecosystem protection and fairer allocation of benefits have been linked to the inclusion of local knowledge systems and collaboration of multiple stakeholders in decision-making. These examples highlight that governance cannot be seen only as a contextual aspect but as a key mechanism that defines the nature of conservation. This suggests that governance structures must be actively aligned across institutional levels to effectively respond to dynamic livelihood and ecological needs. of the studies mention the success of community-based management and co-management strategies in

enhancing conservation and local involvement, especially in the Southeast Asian and South Asian setting. These examples suggest that properly implemented governance innovations can contribute to ecological sustainability and livelihood resilience.

5.1. Governance as an analytical dimension of periphery but necessity

The bibliometric analysis shows that the governance-related concepts are usually either peripheral or bridging concepts of the network of key-words co-occurrences, as opposed to being a central organizing theme. This form of organization implies that governance is often brought in as a backdrop of context or as a detail of implementation and not as a prime element of analysis that underpin conservation-livelihood relations. This finding is supported by the qualitative synthesis indicating that numerous empirical studies recognize that governance issues are a fact, but fail to systematize how institutional arrangements, decision making and power relations play out in mediating socio-ecological outcomes [34]. This is indicative of a wider analytical weakness, in which processes of governance are recognized but not conceptualized and compared in relation to contexts rigorously [35]. Such concepts as the participation, co-management and policy coordination are observed in a variety of case studies. Nevertheless, they are hardly incorporated in consistent governance systems that can draw parallels to why such interventions produce different livelihood and conservation effects in different contexts. Consequently, the field of governance is still underdeveloped analytically in comparison to the practical relevance in the development of the mangrove social-ecological system.

5.2. Regulating conservation-livelihood trades-offs

Conservation-livelihood trade-offs can be considered one of the most common and regular issues throughout the reviewed literature. The qualitative synthesis however, as well as the bibliometric patterns itself, point to the fact that these trade-offs are described more than governed. Although livelihood effects are sometimes conceptualized as effects of conservation efforts, governance interventions are evaluated largely on the basis of ecological efficiency or the success of the project implementation. There is still very little explicit consideration of the ways through trade-offs are bargained, fought and institutionalized over time [36]. This means that the process of governance that determines these trade-offs is yet to be sufficiently explored especially in the context of negotiation, power relations and long term institutional frameworks. This trend represents an expanded analytical divide between the ecological and socio-economic worlds. Trade-offs are usually discussed as technical allocation issues instead of the results of political processes and institutional decision-making even in the cases when ecosystem services frameworks are adopted to couple the functions of mangroves with human benefits [37]. As a result, livelihoods are often placed as either obstacles to conservation or as the benefactors of effective interventions, as opposed to being considered as constitutive conditions that inform the governance priorities, legitimacy and adaptation.

5.3. Adaptive governance: aspiration and constraints

The concept of adaptive governance has become more visible in the literature as

a possible remedy to uncertainty and social complexity in the ecological context of mangrove systems. The qualitative synthesis shows an increasing interest on flexibility, learning, and flexible arrangements in terms of community-based and co-management. Nonetheless, the bibliometric evidence also shows that adaptive governance has been loosely attached to the fundamental thematic framework of the field, which implies that its implementation has been uneven and superficial in most cases [38]. Most research appeals to the notion of adaptive governance as an abstract concept though not operationalizing its main principles in empirical research [39]. Specifically, iterative learning, feedback integration, and cross-scale coordination are not in the few investigated longitudinally or across the level of governance. The learning processes, feedback mechanisms and institutional change are common terms that are seldom looked at on long term basis or even at different levels of governance. In addition, adaptive governance is not seen as a power-based and controversial process, but as a normative ideal. Adaptive governance can perpetuate the existing institutional asymmetries instead of changing them without explicitly tackling who sets the priorities of adaptation, the knowledge upon which that priority is based, and the redistribution of power.

5.4. Power, distribution, and politics of governance

One key conclusion that can be drawn out of the synthesis is that the problem of governance in mangrove-livelihood systems cannot be completely comprehended unless the aspect of power relation and the distribution outcome is also given consideration. Although the concerns of equity, gender, and participation are observed in some studies, they rarely feature in the overall studies on institutional design or policy effectiveness. This tendency is also reflected in the marginal positioning of the concept of governance in the bibliometric network since the ideas related to power are still loosely related to the prevalent ecological and livelihood topics [40]. The gap has significant implications on research and practice. Conservation interventions, even that associated with market-based tools like blue carbon, can create emergent modes of exclusion or concentration of benefits in case the governance structures cannot consider underlying imbalances in access, representation and decision-making authority [41]. The findings support the argument that conservation-livelihood trade-offs are not just some ecological or economic issue, but those are defined by the process of governance that defines the distribution of costs, benefits and risks among social groups.

5.5. Implications for future research

Combined, the discussion underscores a major conflict in the literature on mangrove-livelihood, namely that governance is deemed imperative, but has been theorized and empirically investigated inadequately. Based on the cumulative bibliometric and qualitative evidence, the next step in the field development is to go beyond the descriptive narratives of participation and management to the analytical models that would explicitly connect the field of institutional design, power relations, and adaptive capacity to conservation-livelihood outcomes [42]. Comparative and longitudinal studies are the way to go in the future to gain a clearer idea of the way in

which governance systems are changing in both contexts and scales, and how these changes affect ecological sustainability as well as livelihood resilience. This gap is important to identify the success of mangrove governance interventions not only by whether, but also by whom, under which conditions and at what price.

6. Conclusion

The article is a synthesis of the connection between conservation of mangrove, local livelihoods and governance by combining bibliometric mapping and qualitative analysis of the governance-focused research. The results indicate that there is a fast growing but asymmetrical body of literature which has been widely studied in ecological processes and the livelihood results, but has not been fully incorporated into coherent governance systems.

The review also notes that, in spite of the growing prominence of concepts like participation, co-management and ecosystem services, these concepts are usually implemented in piecemeal fashion, as opposed to being institutionalized as processes of dynamic governance that can handle the conservation-livelihood trade-offs. Consequently, livelihoods are often put in place as limitations or as the consequences of conservation, instead of as the constituent elements of the governance design and decision-making.

Moreover, the existence of trade-offs within mangrove social-ecological systems is demonstrated to be not only based on ecological uncertainty but also deeper governance issues, such as institutional fragmentation, unequal power interests, and the increased marketization of conservation through such mechanisms as blue carbon. Although adaptive governance is a well-known framework that has been generally well developed in theory, it is not developed in empirical studies; hence, it is constrained to solve such structural problems.

In general, this work highlights the necessity to move towards the integrative forms of governance that directly involve power relations, institutional coordination, and adaptive learning. Such directions should be developed to deliver socially just and ecologically friendly results in the conservation of the mangroves.

6.1. Policy recommendations

This review indicates that there are a number of policy priorities that can be used to improve the governance systems of the mangroves. To begin with, institutional fragmentation at governance levels must be solved by improving the inter-agency coordination and integrated policy frameworks. Second, distributional differences in the conservation performance should be subjected to the targeted intervention, including the formalization of the community-based tenure rights and the improvement of procedural protection to ensure equal participation.

Third, the adaptive governance must be operationalized in a way that leads to the institutional mechanisms that facilitate the continuous learning, feedback and flexibility in a process of decision. This involves instilling adaptive capacity in the structures of governance as opposed to it being a normative goal. Lastly, the policy on climate and blue carbon should include considerations of equity to avoid the strengthening of the current social and economic inequalities.

6.1.1. Operational responsibility

In order to improve the realistic application of adaptive governance, the institutional roles at the various levels of governance need to be well-defined. Local community-based organizations and local non-governmental organizations (NGOs) must be on the forefront in adopting adaptive practices through participatory interaction and assimilation of local knowledge systems. National governments have the role of putting in place enabling policy frameworks, enhancing institutional coordination, and enforcing regulations. At the global level, the capacity building, technical assistance as well as equal distribution of funds should be enabled by the climate finance strategies such as the blue carbon schemes and global environmental funds. It is important to explicitly define these roles in order to prevent the occurrence of the same institutional asymmetries as well as avert poor governance results.

6.2. Future research directions

The future research will include conducting an empirical study of the adaptive processes of governance and especially on the learning processes, redistribution of power and the institutional change in the long run. Also, there exist new frontiers like digital governance, data ownership, and the socio-economic effects of the carbon markets that should be researched to gain more insight into their effect on the mangrove-dependent communities.

Author Contributions: Conceptualization, FZ and NDMI; methodology, FZ; software, FZ; validation, FZ, NDMI and SAA.; formal analysis, FZ.; investigation, FZ; resources, FZ; data curation, FZ; writing—original draft preparation, FZ; writing—review and editing, FZ, NDMI and SAA; visualization, FZ; supervision, FZ and NDMI; project administration, FZ; funding acquisition, NDMI. All authors have read and agreed to the published version of the manuscript.

Funding: None.

Ethical approval: Not applicable.

Informed consent statement: Informed consent was obtained from all subjects involved in the study.

Acknowledgements: The author would wish to heartedly thank her supervisor who guided her, gave constructive remarks, and provided unending support throughout the whole process of research and writing the manuscript.

Declarations: Being generative AI and AI-assisted technologies declared in the preparation of the manuscript. To create and revise this manuscript, the author applied VOSviewer to perform bibliometric visualization, Douban and ChatGPT to clarify concepts and develop a framework and organize and refine ideas in the literature review section, Zotero GPT to organize text and refine it, and Grammarly and DeepL to proofread and edit the text. Once the tools were used, the author thoroughly reviewed and edited the contents, and fully assumes responsibility as far as the integrity, originality and accuracy of the final manuscript is concerned.

Conflict of interest: The authors declare no conflict of interest.

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