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Integrating the Food-Energy-Water Nexus into Development Planning: A Literature Review on Collaborative Governance

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Abstract: The increasing complexity of global crises and escalating resource vulnerabilities demand cross-sectoral policy integration. The Food-Energy-Water (FEW) Nexus approach has been adopted in Indonesia as a strategic agenda within the National Medium-Term Development Plan 2025-2029 to achieve self-sufficiency targets. Responding to the challenge of institutional fragmentation during its implementation, this study aims to examine the landscape of collaborative governance within FEW Nexus-based development planning by mapping thematic trends, network patterns, and discussions from previous literature. This study applies a systematic literature review to 68 reputable journal articles from the Scopus database, published between 2016 and 2025, with data extracted and visualized using bibliometric analysis. The findings reveal that while research on nexus integration and governance is continuously growing, a disconnect persists between governance approaches and technical modeling—both quantitative and qualitative—within decision support systems. Furthermore, there is a notable gap in the literature specifically addressing national-scale collaborative action planning in Indonesia. Empirically, the study also finds that the implementation of the nexus approach is frequently hindered by sector mismatches, data asymmetry, and public sector dominance. Therefore, dismantling sectoral egos through inclusive and participatory planning, alongside strengthening the data-sharing ecosystem, are absolute prerequisites for building cross-level policy coherence to address the complexities of the FEW nexus.

Keyword: Collaborative Governance, Development Planning, Food-Energy-Water Nexus

INTRODUCTION

The Water-Food-Energy (WFE) Nexus has emerged as a foundational paradigm in contemporary sustainability discourse, reflecting the intrinsic interdependencies between three of the world's most vital resource sectors (Yupanqui et al., 2025). As global populations expand and climate volatility intensifies, the security of one sector can no longer be achieved in isolation. Traditional, "siloed" management strategies—where water allocation, agricultural production, and energy generation are planned independently—often result in cross-sectoral friction and unintended environmental degradation (Benitez & Dhakal, 2026).

The Global Risks reported by the World Economic Forum (2011) identifies the Water-Food-Energy (WFE) Nexus as an interconnected web of global risks that continues to escalate due to demographic trends and the climate crisis. The report emphasizes how population growth drives a surge in demand for water, food, and energy, while the impacts of the climate crisis simultaneously disrupt the production capacity and supply chains of these commodities, thereby threatening societal well-being. This high level of interdependence is empirically evident: the agricultural sector accounts for 70% of global water use, the industrial sector utilizes approximately 75% of its water consumption for energy production, food production and its supply chains consume nearly 30% of global energy, and roughly 90% of global power generation requires large-scale water resources (Sivakumar, 2021). The relational complexity within the WFE Nexus inherently underscores the escalating systemic vulnerability regarding the future availability of these vital commodities.

At its core, the Nexus approach recognizes that interventions in one domain frequently precipitate trade-offs or synergies in others (Allouche, 2024). For instance, the transition to bioenergy may bolster energy security while simultaneously straining water supplies and competing for arable land. Conversely, integrated wastewater treatment can provide nutrient-rich irrigation and biogas, illustrating the potential for circularity. Consequently, the WFE Nexus serves as a functional lens for identifying these complexities, moving beyond technical efficiency toward a holistic model of resource security (Ramírez-Márquez & Ponce-Ortega, 2023).

In Indonesia, the agenda to achieve self-sufficiency in food, water, and energy represents a strategic political commitment within the government's national development plan for the 2025-2029 period. These targets will be realized through the Water-Food-Energy (WFE) Nexus approach—hereafter referred to as the Food-Energy-Water (FEW) Nexus in this article—as outlined in the National Medium-Term Development Plan 2025-2029. Specifically, the medium-term development plan document mandates the application of this approach to reach the development targets set under National Priority 2.

However, the operationalization of the Nexus requires more than just technical integration; it demands a shift in development planning toward collaborative governance. Collaborative governance represents a multi-level institutional arrangement where state actors, private industries, and civil society engage in collective decision-making (Van Gestel & Grotenbreg, 2021; Sicilia et al., 2016). By fostering cross-sectoral dialogue, this governance model seeks to mitigate power asymmetries and align the divergent priorities of stakeholders.

Ansell and Gash (2008) highlight essential principles in the implementation of collaborative governance, which include initiation by public agencies, the inclusion of non-governmental actors, and the active involvement of participants in the decision-making process. Furthermore, Emerson et al. (2012) argue that a primary driver necessitating this approach is the existence of complex social issues, commonly referred to as "wicked problems." Building on this, Ratner (2012) explains that collaborative governance engages stakeholders to ensure diverse perspectives are represented, establish shared goals, build commitment to specific roles and actions, monitor progress toward targets, and ultimately manage the sustainability of the collaboration itself.

In the context of development planning, a collaborative Nexus framework is essential for achieving the United Nations Sustainable Development Goals (SDGs). It ensures that policy objectives—such as poverty alleviation and climate resilience—are not undermined by sectoral competition. This background establishes that the integration of Nexus thinking into collaborative governance structures is not merely a theoretical preference but a pragmatic necessity for navigating the socio-ecological challenges of the 21st century.

This study systematically explores previous scientific literature regarding the FEW Nexus and its intersection with collaborative governance. The objective is to provide a

comprehensive overview of how collaborative governance operates within FEW nexus-based development by examining thematic trends, evolutionary developments, the characteristics of collaborative networks, and the prevailing narratives within the field. Additionally, this study examines how collaborative governance fosters food, energy, and water resource security, particularly through collaborative development planning. Ultimately, this research aims to contribute to the strengthening of institutional frameworks and the national planning system in navigating the complexities of the nexus.

METHOD

This study employs the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to conduct a systematic literature review of existing research on collaborative governance within FEW Nexus-based development planning. The PRISMA framework facilitates a transparent review process, clearly articulating the research rationale, the methodologies applied, and the resulting findings (Page et al., 2021). Ultimately, the application of this framework is intended to enhance the overall quality and rigor of the study's outcomes.

Search Strategy

This systematic literature review was conducted through an online search of journal articles within the Scopus electronic database, encompassing publications from 2016 to 2025. Scopus was selected as the primary data source due to its reputation as a highly credible and widely utilized repository for peer-reviewed literature. Furthermore, its selection was justified by a preliminary assessment indicating a limited volume of existing reviews on this specific intersection, ensuring the retrieved articles closely align with the targeted research context. This study maps the thematic focus and spatial scope of existing literature concerning collaborative governance, development planning, and the FEW Nexus. The specific search query utilized for article retrieval was as follows: (TITLE-ABS-KEY ("collaborative governance" OR (collabora* AND (govern* OR plan* OR develop*)) OR indonesia) AND TITLE-ABS-KEY (food AND energy AND water AND nexus)). This Boolean string was executed simultaneously to retrieve articles explicitly containing the terms food, energy, water, and nexus in conjunction with collaborative governance. The query was strategically designed to capture broad collaborative elements, accommodate relevant variations in governance terminology (such as governing, planning, or developing), and specifically identify previous research situated within the Indonesian context.

Criteria Application

The initial search query yielded a total of 252 articles. These results subsequently underwent a screening process based on their titles, keywords, and abstracts. Articles were excluded based on the following criteria: publication outside the 2016–2025 period (31 articles), languages other than English or Indonesian (4 articles), non-final journal article formats (93 articles), and a lack of relevance to the research topic (56 articles). Following this screening phase, 68 articles remained. Among these, 59 articles were published in highly reputable journals classified as Q1 under the SCImago Journal Rank (SJR), while the remaining 9 articles belonged to Q2 journals. Given this high standard of journal rankings, no further data exclusion was necessary. Full-text documents for the remaining articles were then retrieved from their respective online databases. The retrieval process confirmed that all 68 articles were fully accessible. Consequently, these 68 documents proceeded to the final analysis stage. An illustration of the article search and screening flow is presented in Figure 1.

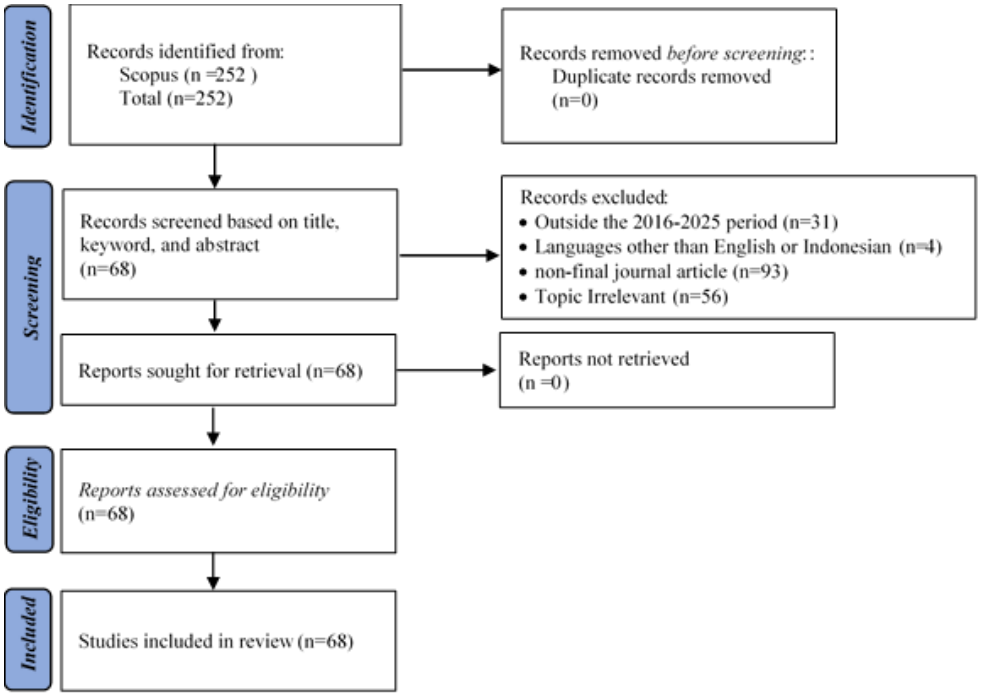

Figure 1. Stages of the Literature Search and Screening Process

RESULTS AND DISCUSSION

Publication trends

The metadata analysis of the 68 relevant references using VOSviewer software reveals that "collaborative governance" belongs to the red cluster (see Figure 2). Besides a direct connection to the "food-energy-water nexus" terminology within the same cluster, collaborative governance is also directly linked to the "water-energy-food nexus" in the green cluster.

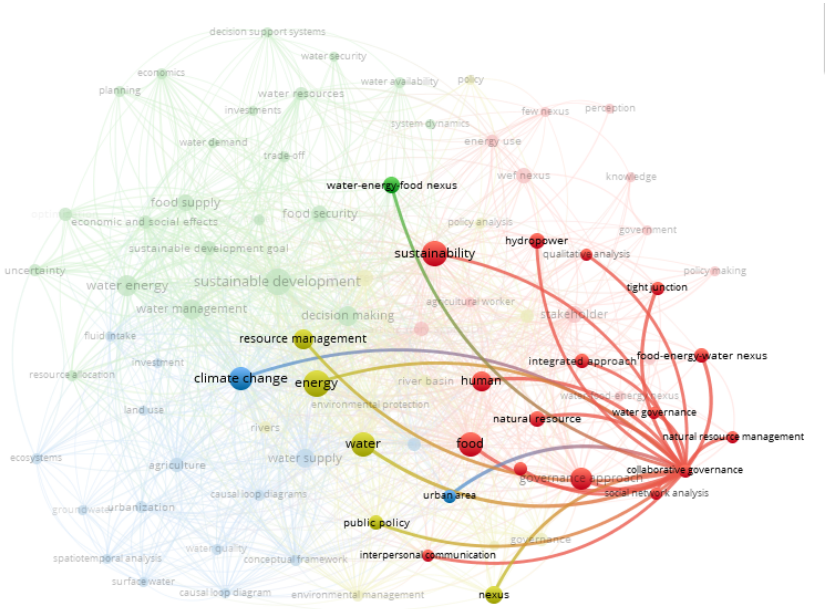

Figure 2. Network Visualization
Source: Authors' VOSviewer analysis of keyword

From the nexus perspective, both the Food-Energy-Water Nexus and Water-Energy-Food Nexus terminologies are connected to topics such as sustainability and natural resource

management. Furthermore, collaborative governance emerges as a critical node associated with governance approaches, public policy, and integrated approaches. This clearly demonstrates the inherent integration of nexus discussions with collaborative governance frameworks. Additionally, collaborative governance is linked to "climate change" in the blue cluster, alongside "resource management" and "public policy" in the yellow cluster. This visual pattern indicates that the literature surrounding ecological issues emphasizes the necessity of resolving these challenges through cross-sectoral governance and appropriate policy-driven resource management.

Conversely, the visualization also reveals a lack of cross-disciplinary connections directly linking collaborative governance to broader themes within the green cluster, such as sustainable development, decision-making, planning, and decision support systems. Methodologically, the visualization indicates that collaborative governance tends to be more strongly associated with qualitative analysis. It lacks direct connections to technical modeling terms found in the blue and green clusters, such as causal loop diagrams, spatiotemporal analysis, system dynamics, or optimization.

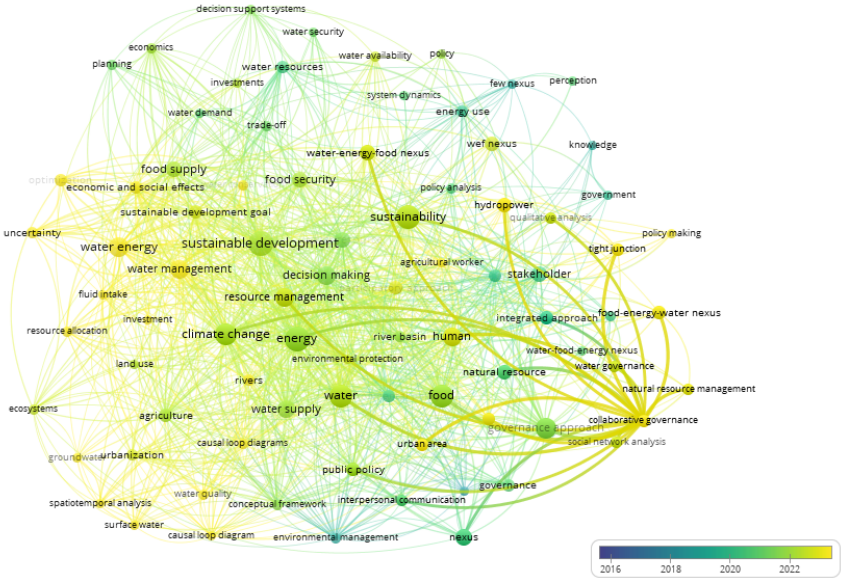

Figure 3. Overlay Visualization
Source: Authors' VOSviewer analysis of keyword

In the overlay visualization (see Figure 3), the "collaborative governance" node is highlighted in a bright yellow hue, indicating its more recent publication timeline. This signifies the emergence of a growing research trend between 2016 and 2025 that explores the food-energy-water nexus through the lens of collaborative governance. Furthermore, the topic of collaborative governance has co-evolved alongside issues of "uncertainty" and "economic and social effects," which similarly display bright yellow coloring. Although these three nodes lack direct links to one another, they remain interconnected through the mediating topics of "sustainable development" and "governance approach."

The density visualization of the search results, as illustrated in Figure 4, reveals that "collaborative governance" is situated in an area of relatively low density. This condition suggests that there is still considerable room for further development of collaborative governance as a supporting approach for integrating the food, energy, and water nexus.

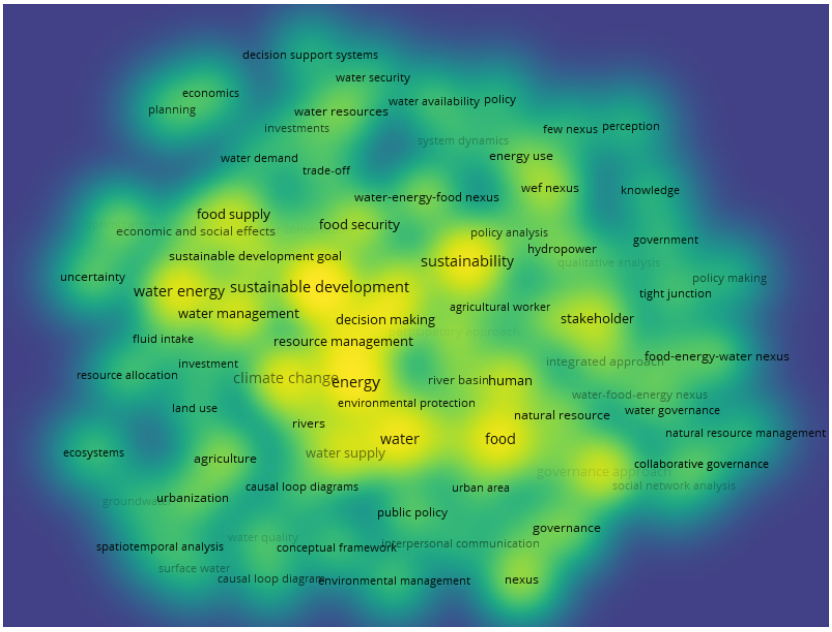

Figure 4. Density Visualization
Source: Authors' VOSviewer analysis of keyword

Frequency distribution of articles by year

Based on the publication trend graph from 2016 to 2025 (see Figure 5), research on this topic demonstrates positive growth, as illustrated by the upward-sloping dashed trendline. Nevertheless, the volume of publications experienced a significant decline in 2020, coinciding with the global disruption caused by the COVID-19 pandemic. The subsequent surge in 2025 and the overall positive trendline strongly align with the overlay visualization findings in Figure 3. This serves as empirical evidence reinforcing the argument that the study of collaborative governance within this context is far from obsolete; rather, it possesses a compelling academic urgency that is increasingly relevant today.

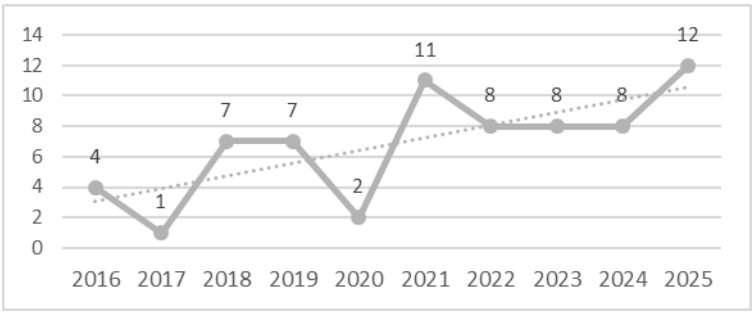

Figure 5. Publication Trends Over Time

Frequency distribution of articles by Locus and Focus

An analysis of the research locus reveals that the United States is the most frequent study location for this topic, accounting for 11 studies. Meanwhile, Indonesia serves as the focus for three studies, one of which is a cross-national collaboration with South Korea. China ranks second as the most frequent research locus, sharing similarities with several cross-national studies that predominantly focus on river basins and other water-related regions. The geographical distribution of these previous studies is illustrated in Figure 6.

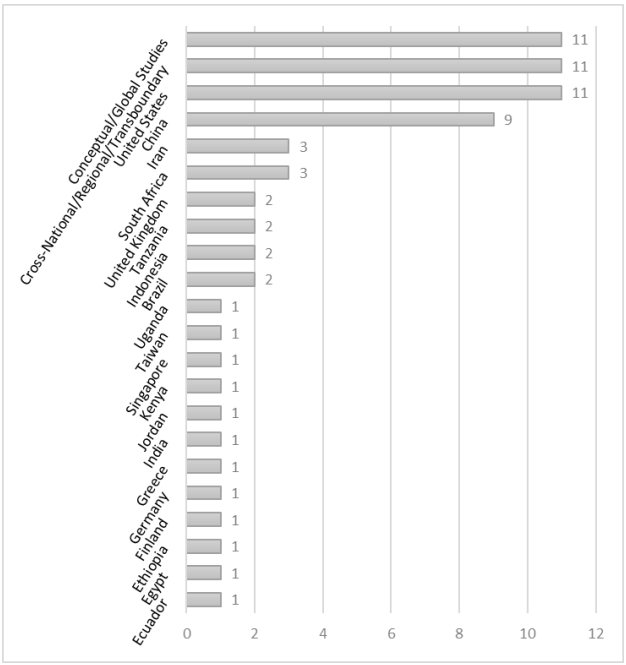

Figure 6. Number of Previous Studies by Research Locus

Drawing upon the diversity of thematic focuses and study loci identified in the search results, the 68 reviewed articles are classified in Table 1. The research topics are categorized into five primary themes: Decision-Making Frameworks/Tools, Development Planning, Collaborative Action and Stakeholder Engagement, Governance and Policy Frameworks, and Collaborative Governance. Additionally, the studies are grouped according to their geographical scope: Local, National, International, and Global/Conceptual. The "collaborative governance" cluster specifically designates studies that explicitly utilize thsis widely recognized terminology, drawing on foundational frameworks such as those articulated by Ansell and Gash (2008), Emerson et al. (2012), and Ratner (2012).

Tabel 1. Distribution of Study Loci and Thematic Focuses

Geographical Scope	Decision-Making Frameworks/Tools	Development Planning	Collaborative Action and Stakeholder Engagement	*Governance and Policy Frameworks*	*Collaborative Governance*
Local	1, 2, 5, 7, 10, 11, 18, 20, 26, 30, 35, 38, 39, 42, 44, 47, 48, 51, 56, 67	11, 13, 35, 42, 44, 47	10, 13, 18, 20, 24, 26, 30, 32, 35, 44, 47, 48, 51, 56, 64, 67	13, 32, 35, 39, 44, 48, 64	13, 32, 35, 39
National	9, 15, 17, 19, 21, 23, 28, 30, 31, 33, 37, 46, 52, 55, 63	6, 9, 13, 15, 17, 21, 23, 31, 34, 37, 40, 46, 49, 52, 57, 60	3, 4, 6, 9, 13, 15, 21, 28, 30, 33, 34, 49, 55, 57, 60, 63	3, 4, 6, 9, 13, 15, 19, 28, 33, 34, 49, 55, 57, 60, 63	4, 13, 15
International	8, 9, 10, 14, 16, 25, 36, 40, 50, 53, 54, 58, 62, 65, 68	9, 14, 25, 36, 50	8, 9, 10, 16, 36, 40, 50, 54, 58, 62, 65, 68	9, 16, 50, 58	
Conceptual/ Global	12, 22, 27, 29, 41, 43, 45, 59, 61, 66		12, 41, 45, 61, 66		

Note

1. Tan et al., 2025
2. Zhou et al., 2025
3. Ningi et al., 2025
4. Brown et al., 2025
5. Sun et al., 2025
6. Chemura et al., 2025
7. Huang et al., 2025
8. Xu et al., 2025
9. Nikolaidis et al., 2025
10. Djenontin et al., 2025
11. Mashaal et al., 2025
12. Rozhkov et al., 2025
13. Jones-Crank, 2024
14. Ma et al., 2024
15. Jones-Crank, 2024
16. Mooren et al., 2024
17. Ni dan Chen, 2024
18. Shahmohammadi et al., 2024
19. Suda et al., 2024
20. Uslu et al., 2024
21. Mondal et al., 2023
22. Ioannou & Laspidou, 2023
23. Yin et al., 2023
24. Markazi et al., 2023
25. Muhirwa et al., 2023
26. Zellner et al., 2023
27. Okonkwo et al., 2023
28. Arcoverde et al., 2023
29. Khan et al., 2022
30. Alamanos et al., 2022
31. Wang et al., 2022
32. Jones dan White, 2022
33. Samadi-Foroushani et al., 2022
34. Adom et al., 2022
35. Jones-Crank et al., 2022
36. Zhong et al., 2022
37. Raub et al., 2021
38. Li et al., 2021
39. Jones dan White, 2021
40. Wang et al., 2021
41. Radini et al., 2021
42. Purwanto et al., 2021
43. Arenas et al., 2021
44. Ferrari et al., 2021
45. Zhuang et al., 2021
46. Mabhaudhi et al., 2021
47. de Carvalho et al., 2021
48. Kharanagh et al., 2020
49. Paim et al., 2020
50. Salmoral et al., 2019
51. Purwanto et al., 2019
52. Wicaksono dan Kang, 2019
53. Zhou et al., 2019
54. Colloff et al., 2019
55. Marttunen et al., 2019
56. Heitmann et al., 2019
57. Stein et al., 2018
58. Harwood, 2018
59. Cai et al., 2018
60. Pardoe et al., 2018
61. Schwanen, 2018
62. Knox et al., 2018
63. Hoolohan et al., 2018
64. White et al., 2017
65. Howarth dan Monasterolo, 2016
66. Wolfe et al., 2016
67. Fowler & Shi, 2016
68. 68. King & Carbajales-Dale, 2016

Discussion

Table 1 illustrates the distribution of thematic focuses and geographical scopes across the reviewed literature concerning the FEW Nexus, particularly its intersection with collaboration, governance, and development planning. The synthesized studies collectively highlight a pressing need for cross-sectoral collaboration to enhance outcomes and scale up sustainable development efforts through the FEW Nexus approach. Nevertheless, the majority of existing research is heavily concentrated within the "Decision-Making Frameworks/Tools" category, which predominantly addresses technical aspects and relies on quantitative modeling.

Various decision support tools have been developed to facilitate the analysis of trade-offs and synergies within the nexus. For instance, methods like multi-level chance-constrained fuzzy programming (MCFP) have been employed to manage the WEFE nexus in Central Asia under uncertain conditions (Ma et al., 2024). Similarly, a control-theory approach has been applied to establish a trustworthy and responsible decision-making framework (Uslu et al., 2024), while the System of Systems Engineering (SoSE) framework has been proposed to design sustainable, cross-sectoral solutions (Heitmann et al., 2019). Furthermore, decision-making tools such as system dynamics are utilized to develop computer simulation models capable of analyzing future resource security, feedback loops, and sectoral interconnections. Conversely, Social Network Analysis (SNA) is employed to map the power dynamics among actors within the nexus (Kharanagh et al., 2020; Samadi-Foroushani et al., 2022; Wicaksono dan Kang, 2019). There are also visualization tools; the Nexus Discovery Map, for example, enables academic collaboration and the spatial identification of nexus projects (Arenas et al., 2021). Alongside this, Concept Maps of Nexus Interactions serve as visual and conceptual instruments that complement actor networks and infrastructure diagrams. Despite these methodological advancements, the real-world implementation of these tools remains limited, frequently hindered by obstacles such as data availability (Wicaksono & Kang, 2019; Radini et al., 2021).

From a development planning perspective, adopting the nexus approach requires tools capable of simulating dynamic intersectoral interactions. System dynamics models have been developed to simulate FEW security at both local (Purwanto et al., 2021) and national (Wicaksono & Kang, 2019) levels, assisting planners in evaluating policy impacts on resource security. In China, a "coupling coordination degree" framework was employed to analyze the performance of the FEW nexus in the Yellow River Basin, revealing spatial patterns and the driving factors of coordination (Yin et al., 2023). However, integrating the nexus into national development planning is frequently hampered by a lack of institutional coordination and resource constraints, as evidenced in South Africa (Adom et al., 2022) and Tanzania (Pardoe et al., 2018). In Tanzania, intersectoral collaboration within the nexus tends to occur through ad hoc projects, yielding limited success in fostering stronger, long-term sustainable relationships. Conversely, in India, sub-national coordination progressed from an "intermediate" to a "good development" stage between 2011 and 2021. This improvement was driven by collaboration and cooperation through an approach that integrated the Sustainable Development Goals (SDGs) to manage spatial and temporal imbalances (Mondal et al., 2023). Therefore, an adaptive and multi-scalar planning approach is essential to effectively internalize the various considerations inherent in the nexus.

Research categorized under "Collaborative Action and Stakeholder Engagement" highlights how stakeholder participation in knowledge co-creation demonstrably enhances the relevance and acceptability of nexus solutions. In Uganda, for example, Collaborative Learning Schools (CLS) successfully facilitated knowledge exchange across diverse actors—including academics, practitioners, and farmers—to generate actionable policy solutions (Djenontin et al., 2025). In the other hand, Social Network Analysis (SNA) in Iran revealed that the power dynamics within nexus governance remain largely dominated by the public sector, characterized by weak intersectoral linkages (Kharanagh et al., 2020). Empirical evidence from Arizona further illustrates that "sector mismatch" acts as a primary barrier to collaboration, underscoring the need to deliberately cultivate trust and mutual benefits (Jones & White, 2022). To address such challenges at the local level, participatory approaches like Group Model Building (GMB) have been employed. For instance, a collaborative initiative in Karawang utilized these participatory methods to engage stakeholders in mapping the causal loops of the FEW security nexus, thereby fostering shared understanding and commitment (Purwanto et al., 2019). Furthermore, King and Carbajales-Dale (2016) assert that comprehending the scope and types of metrics utilized by various actors—ranging from the project to the global level—is crucial for incentivizing their engagement. By deciphering actor motivations through economic and life-cycle metrics, the complexities of the FEW nexus can be translated into a universal language accessible to all stakeholders. This approach moves beyond tokenistic participation, sparking genuinely inclusive dialogues and collaborations. Ultimately, these multifaceted engagement strategies are designed to bridge disparate priorities and build community capacity through mechanisms such as living labs and causal diagrams.

In terms of Governance and Policy Frameworks, coherence and integration are paramount for managing the complex interactions within the FEW Nexus. A study in Kenya's Tana River Basin demonstrates that while water policies tend to foster synergies with other sectors, food policies frequently result in trade-offs; thus, cross-sectoral coordination is required to strengthen collective institutional frameworks (Suda et al., 2024). At the transnational level, nexus governance challenges stem from a lack of awareness regarding interdependencies, poor cross-border communication, and inadequate resource allocation (Mooren et al., 2024). In Brazil, although the Nationally Determined Contributions (NDCs) incorporate the nexus approach, the dominance of the agricultural sector hampers effective policy integration (Paim et al., 2020). Moving forward, strengthening institutional capacity and fostering stakeholder collaboration are critical for the successful implementation of this

approach. Specifically, Samadi-Foroushani et al. (2022) underscore the importance of evaluating the power distribution network structures within water governance institutions to formulate more effective and participatory implementation strategies. Additionally, Suda et al. (2024) advocate for the formation of a national task force to develop aligned and coherent policies. Ultimately, national policy frameworks must be deliberately designed to accommodate the intricacies of the nexus and drive multi-level collaboration.

Research on collaborative governance within the FEW Nexus context demonstrates that while collaborative frameworks at the national level can drive sustainability, their implementation frequently remains suboptimal at the local level (Jones-Crank, 2024b). A case study in Singapore reveals that although national-level collaborative approaches support sustainability, weak integration at lower tiers of government constrains the potential to fully achieve nexus objectives (Jones-Crank, 2024b). Conversely, research in the United States indicates that collaboration in urban resilience planning is driven more by the presence of governance mechanisms—such as policy coherence and stakeholder participation—than merely by the pressures of resource scarcity (Jones-Crank, 2024). Furthermore, Jones and White (2021) demonstrate that Social Network Analysis (SNA) can identify both barriers and opportunities for cross-sectoral collaboration by mapping stakeholder relationship structures. In this context, bridging actors play a crucial role in enhancing cohesion and trust within fragmented governance networks. Similarly, Jones-Crank et al. (2022) highlight significant variations in institutional capacity, emphasizing the critical need for enabling factors like policy coherence and inclusive participation. Moreover, the implementation of collaborative governance frequently encounters fundamental barriers. Jones and White (2022) identify structural and procedural "sector mismatches" as a primary impediment to collaboration. Consequently, efforts to build trust and ensure mutual benefits are essential prerequisites for overcoming these asymmetries and coordination challenges.

CONCLUSION

This review has not identified any previous studies that specifically address collaborative governance with a focus on collaborative action planning in development within the FEW Nexus context, particularly at the national scale in Indonesia. Furthermore, research analyzing collaborative governance within comprehensive and institutionalized national development planning processes concerning the FEW Nexus remains highly limited. The use of the collaborative governance concept in previous studies predominantly draws upon the frameworks established by Ansell and Gash, or Emerson and Nabatchi.

The analysis of existing literature regarding collaborative governance within the FEW Nexus has revealed several crucial findings: (1) strong support for the importance of collaborative governance and coherent policy frameworks across multiple tiers; (2) an emphasis on stakeholder participation and capacity building for the co-creation of knowledge; (3) the necessity of developing both quantitative and qualitative modeling tools to support planning processes; and (4) the identification of various institutional and technical opportunities and barriers during implementation.

A critical lesson for the public sector, drawn from this literature review, in supporting the achievement of self-sufficiency through the FEW Nexus approach and collaborative governance, is the imperative to dismantle sectoral egos and "silo" mentalities. Additionally, there is a clear need for substantive participatory planning and the strengthening of data-sharing ecosystems to function as accurate and adaptive decision support tools. Although the FEW Nexus approach is supported by various technical and quantitative models, its practical implementation remains severely hindered by institutional fragmentation, a lack of data integration, and sectoral egos (sector mismatches). Furthermore, the dominance of the public sector risks leaving the true potential of collaboration untapped. Consequently, the primary

challenge today is to build policy coherence across sectors and tiers of government, bridge the priority gaps among actors, and cultivate trust through active stakeholder participation.

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