

ADAPTING SUSTAINABLE DEVELOPMENT TO CLIMATE CHANGE: A SYSTEMATIC LITERATURE REVIEW OF SCOPUS DATA

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ABSTRACT

Climate change adaptation (CCA) has become a critical condition for achieving sustainable development, particularly in climate-vulnerable contexts where governance constraints, uneven adaptive capacity, and limited access to technology hinder implementation. This study conducts a systematic literature review combined with bibliometric mapping and qualitative thematic synthesis to examine how the academic literature conceptualizes and operationalizes the relationship between climate adaptation and sustainable development. Using the Scopus database and PRISMA-guided screening procedures, 38 core studies published between 2010 and 2025 were selected from an initial pool of 8,902 records. VOSviewer was employed to analyze keyword co-occurrence and bibliographic coupling patterns, while thematic content analysis was used to identify major research domains and comparative trends. The findings reveal three dominant themes: (1) policy mainstreaming and institutional integration, (2) sectoral and technological adaptation, and (3) equity, local capacity, and implementation barriers. The review also shows important differences across developed and developing country contexts, sectoral applications, governance scales, and methodological approaches. A central contribution of the study is the identification of a persistent theory-practice gap, driven by institutional fragmentation, resource limitations, unequal access to technology, and weak integration of local knowledge. Based on these findings, the paper proposes evidence-informed implications for future research and policy discussion in climate-vulnerable developing countries such as Vietnam.

Keywords: Climate change adaptation, climate-smart agriculture, multi-level governance, Scopus data, sustainable development.

1. INTRODUCTION

Climate change adaptation has become a central condition for achieving sustainable development rather than a secondary environmental concern [1]. As climate-related risks intensify across food systems, infrastructure, public health, and urban settlements, development outcomes increasingly depend on the capacity of institutions, communities, and production systems to adjust to climatic stressors in timely and equitable ways [1], [2]. In this context, sustainable development can no longer be understood only in terms of economic growth, social welfare, and environmental protection in isolation; it must also incorporate the practical ability to anticipate, absorb, and respond to climate-related disruptions [1], [2].

A growing body of literature has therefore examined the relationship between climate change adaptation and sustainable development. This literature emphasizes that adaptation is most effective when it is embedded in planning, governance, and sectoral decision-making

rather than treated as a standalone policy domain [3]–[5]. At the same time, recent scholarship has highlighted the increasing importance of technological and operational instruments—including equipment provision, digital tools, monitoring systems, and climate-responsive infrastructure—in translating adaptation goals into concrete development practice [6]. Such instruments are especially relevant in climate-sensitive sectors such as agriculture, urban planning, water management, and decentralized energy systems, where adaptive performance depends not only on strategic policy alignment but also on the availability, accessibility, and appropriateness of technical solutions [4], [6].

However, the literature remains fragmented in several respects. First, research is often organized in sectoral silos, with separate discussions of agriculture, urban resilience, governance, or technological innovation, while cross-sectoral synthesis remains limited [4], [6]. Second, although adaptation is widely recognized in global policy discourse, a persistent theory–practice gap continues to constrain implementation, particularly in developing and climate-vulnerable contexts [3], [7], [8]. Third, while the literature increasingly discusses digital transformation, smart systems, and innovation for adaptation, it is less clear how these approaches are distributed across geographical contexts, governance scales, and development conditions, or how far they are directly applicable to the needs of vulnerable communities in the Global South [9]–[12].

Against this background, this study conducts a systematic literature review combined with bibliometric mapping and qualitative thematic synthesis to examine how the academic literature conceptualizes and operationalizes the relationship between climate adaptation and sustainable development. Particular attention is given to the role of governance, policy integration, and equipment–or technology–related provision in supporting adaptive development pathways. Rather than treating equipment provision as a purely technical issue, the study considers it as part of a broader adaptation system shaped by vulnerability, institutional capacity, affordability, accessibility, and social equity [5], [9], [11], [13], [14].

This review also aims to generate evidence–based implications for climate–vulnerable developing countries such as Vietnam. Nevertheless, the purpose of this paper is not to present an empirical case study of Vietnam, but to synthesize international literature in order to identify patterns, gaps, and analytical directions that may inform future research and policy discussion in similar contexts [8], [9], [12], [13].

Accordingly, the study is guided by the following review questions:

RQ1. What major thematic domains characterize the literature on climate adaptation and sustainable development, particularly in relation to policy, governance, and technological or equipment-related provision?

RQ2. What comparative patterns emerge across geographical contexts, sectoral applications, governance scales, and methodological approaches in the reviewed studies?

RQ3. What theory-practice gaps and implementation barriers are most frequently identified in the literature, especially in the Global South?

RQ4. What evidence-based implications can be drawn from the reviewed literature for future research and policy discussion in climate-vulnerable developing countries such as Vietnam?

2. THEORETICAL BACKGROUND

This study is anchored in three complementary theoretical perspectives that help explain how climate adaptation can be integrated into sustainable development practice: vulnerability assessment and mitigation, adaptive capacity theory, and governance and institutional theory.

Vulnerability assessment and mitigation provides the first analytical foundation. This perspective conceptualizes climate vulnerability through the interaction of exposure, sensitivity, and adaptive capacity, thereby helping to explain why some communities, sectors, and territories are more susceptible to climate impacts than others [15], [16]. Within the context of sustainable development, this framework is important because it links risk diagnosis to intervention design: identifying who is vulnerable, in what ways, and under which conditions provides a basis for selecting measures that reduce losses, strengthen resilience, and improve development outcomes [15], [16]. In this study, the vulnerability perspective is used to interpret how the reviewed literature identifies priority risk domains and justifies adaptation-oriented interventions, including technical and operational measures.

Adaptive capacity theory constitutes the second theoretical pillar. This theory emphasizes that effective adaptation depends on the ability of a system, community, or institution to adjust to climatic change, cope with adverse impacts, and reorganize under conditions of uncertainty [17], [18]. Adaptive capacity is shaped by multiple factors, including access to resources, knowledge, technology, infrastructure, institutional support, and social learning [17], [19]. This perspective is particularly relevant for the present review because the literature on climate-adapted development frequently addresses not only whether technological solutions exist, but also whether actors have the material, organizational, and social capacity to adopt and sustain them [17], [18]. Accordingly, this framework supports the analysis of how adaptation instruments—including equipment and digital technologies—interact with wider enabling conditions.

Governance and institutional theory forms the third theoretical basis. Climate adaptation is not implemented in a governance vacuum; it depends on coordination among state institutions, local authorities, communities, donors, and private actors across multiple levels [3], [20]. Governance and institutional theory helps explain why adaptation policies that appear conceptually sound may fail in practice due to fragmented authority, weak institutional capacity, limited accountability, or poor coordination across sectors and scales [3], [20]. This framework is therefore essential for examining the recurrent theory–practice gap identified in the literature. In the context of this review, it is used to analyze how the reviewed studies discuss policy integration, multi-level governance, institutional barriers, financing arrangements, and the conditions under which adaptation measures become inclusive and implementable [3], [20].

Taken together, these three frameworks provide a coherent analytical lens for the review. Vulnerability assessment and mitigation clarifies why adaptation is necessary; adaptive capacity theory explains what enables or constrains adaptive action; and governance and institutional theory helps interpret how adaptation is organized, implemented, and scaled in practice [3], [15], [20].

3. METHODOLOGY

This study adopts a systematic literature review (SLR) design supported by bibliometric mapping and qualitative thematic content analysis. The review was conducted in accordance with the logic of the PRISMA framework in order to improve transparency, traceability, and replicability in the identification, screening, eligibility assessment, and inclusion of studies [21].

3.1. Data source and search strategy

The Scopus database was selected as the sole source of bibliographic data because of its broad coverage of peer-reviewed international literature and its suitability for citation and keyword-based bibliometric analysis. The database also allows structured export of metadata required for network visualization and thematic coding.

The search strategy was designed to capture literature at the intersection of sustainable development and climate adaptation, with attention to policy, governance, and technology-related dimensions. The search was conducted using the following query:

“Sustainable development” OR “SDGs”) AND (“Climate change adaptation” OR “Resilience”) AND (“Policy” OR “Governance” OR “Technology”)

The query was applied to the title, abstract, and keyword fields of the Scopus database. The review covered the period 2010–2025, with particular analytical attention to the period 2015–2023 in order to reflect the post-Paris Agreement and SDG implementation context.

3.2. Inclusion and exclusion criteria

To ensure relevance and consistency, the review applied the following inclusion criteria:

- (1) publications indexed in Scopus;
- (2) documents published between 2010 and 2025;
- (3) peer-reviewed journal articles, book chapters, and conference papers;
- (4) publications written in English;
- (5) studies examining climate adaptation in relation to sustainable development, resilience, governance, policy, or technological interventions.

The following exclusion criteria were applied:

- (1) duplicate records;
- (2) publications without sufficient relevance to the intersection of climate adaptation and sustainable development;
- (3) studies focused exclusively on climate mitigation without meaningful adaptation content;
- (4) editorials, notes, non-scholarly commentaries, and documents without accessible bibliographic information for screening;
- (5) studies that did not provide sufficient conceptual, empirical, or review-based contribution to the objectives of the present synthesis.

3.3. Screening stages

The screening process followed four stages: identification, screening, eligibility, and inclusion [21].

In the identification stage, the initial database search yielded 8,902 records. In the screening stage, duplicate records were removed, and the remaining records were screened based on titles and abstracts. Publications that were clearly unrelated to the review focus were excluded at this point. In the eligibility stage, potentially relevant studies were assessed through full-text review in order to determine conceptual and analytical fit with the review questions. Finally, in the inclusion stage, 38 studies were retained as the core corpus for in-depth synthesis.

A PRISMA flow diagram should be included in the final manuscript to report the number of records at each stage and the reasons for exclusion during full-text assessment [21].

3.4. Analytical tools and procedures

Two complementary analytical approaches were used.

First, bibliometric analysis was conducted using VOSviewer [22]. Bibliographic records were exported from Scopus in CSV format and cleaned before analysis. VOSviewer was used to generate and visualize: (1) keyword co-occurrence networks, in order to identify the main thematic clusters in the literature; (2) bibliographic coupling networks, in order to examine intellectual linkages among included studies and reveal patterns of thematic convergence [22].

In addition, Microsoft Excel was used for data cleaning, screening logs, descriptive tabulation, and coding support.

Second, the final set of 38 included studies was examined through qualitative thematic content analysis. The coding process was conducted iteratively in order to identify recurring themes related to policy integration and sustainable development, governance and institutional arrangements, technological and equipment-related adaptation approaches, sectoral applications, implementation barriers, theory–practice gaps, and implications for climate-vulnerable developing contexts [3], [7], [20].

3.5. Strategy of evidence reporting

To strengthen methodological clarity, the review distinguishes among three levels of interpretation in later sections of the paper: (1) direct findings from the included studies; (2) the authors' comparative and thematic synthesis, and (3) forward-looking implications for Vietnam and similar developing contexts.

This distinction is important because the paper does not treat all claims as equally evidenced. Descriptive and comparative findings are derived directly from the reviewed corpus, while Vietnam-oriented implications are presented as evidence-informed conceptual recommendations grounded in the identified gaps of the literature.

4. RESULTS AND DISCUSSION

4.1. Descriptive characteristics and keyword co-occurrence analysis

The final corpus of 38 included studies shows a clear concentration of publications in the period after 2020, indicating increased scholarly attention to the relationship between climate adaptation and sustainable development in the post-Paris Agreement era [1], [2], [7], [9], [10], [12], [23]–[27]. Direct findings from the reviewed studies suggest that the literature is not evenly distributed across topics; rather, it is organized around a limited number of recurring thematic domains, especially policy integration, sectoral adaptation, technological innovation, and governance-related barriers [1], [3], [6], [7], [12], [20], [24], [27], [28].

The keyword co-occurrence analysis conducted in VOSviewer provides a more structured view of this thematic landscape. Using a minimum occurrence threshold of 2, the analysis retained 15 keywords, which were grouped into 3 clusters. Across these clusters, three dominant domains were consistently visible. The first domain centers on policy mainstreaming and institutional integration, with recurring terms such as sustainable development, SDGs, policy, governance, and adaptation planning [1], [3], [6], [8], [20]. The second domain focuses on sectoral and technological adaptation, particularly in agriculture, food systems, urban resilience, and digital applications such as AI, IoT, and blockchain [2], [6], [11], [12], [24], [26]. The third domain emphasizes equity, local capacity, and implementation barriers, including social vulnerability, local knowledge, institutional fragmentation, and unequal access to adaptive resources [4], [7], [8], [28]–[35].

Taken together, these keyword clusters suggest that the field has evolved beyond a purely normative discussion of why adaptation matters. The literature increasingly addresses how adaptation is implemented across sectors and under what institutional and technological conditions it becomes operational [3], [6], [7], [11], [12], [20]. At the same time, the co-occurrence structure also indicates that technology-related terms tend to appear alongside governance- and capacity-related terms, implying that the literature does not treat equipment or digital tools as independent solutions, but rather as interventions whose effectiveness depends on enabling institutional and social conditions [7], [11], [12], [28], [35].

Table 1. Keyword co-occurrence clusters in the reviewed literature.

Cluster	Dominant keywords	Interpretive label	Representative studies
C1	sustainable development, SDGs, policy, governance, adaptation planning	Policy mainstreaming and institutional integration	[1], [3], [8], [9], [20]
C2	climate-smart agriculture, technology, AI, IoT, blockchain, resilience	Sectoral and technological adaptation	[2], [6], [11], [12], [24], [26]
C3	vulnerability, equity, local knowledge, barriers, adaptive capacity	Equity, local capacity, and implementation barriers	[7], [28]–[35]

Source: Author's calculation based on bibliographic data retrieved from Scopus and analyzed using VOSviewer

4.2. Bibliographic coupling and comparative analytical synthesis

While keyword co-occurrence identifies the semantic structure of the field, bibliographic coupling helps reveal how the included studies are intellectually grouped through shared references [22]. Using a document-level threshold of 0, the VOSviewer coupling analysis generated 38 coupled documents grouped into 3 major clusters. Direct findings from this analysis suggest that the reviewed literature is organized less by disciplinary boundaries than by problem orientation. Three broad coupling groups are particularly evident.

The first group is dominated by studies on adaptation governance, mainstreaming, and institutional coordination [1], [3], [8], [9], [20], [36]. These studies are linked by a common concern with embedding climate adaptation into development planning, strengthening institutional coherence, and improving decision-making under uncertainty. The second group centers on sectoral implementation, especially in agriculture and urban systems [2], [6], [23], [24], [26], [28], [37], [38]. These studies focus on how adaptation is operationalized through climate-smart agriculture, urban planning, resilient infrastructure, and risk reduction strategies. The third group emphasizes community-level adaptation, social equity, and co-production of knowledge [4], [7], [29], [35]. Here, the shared concern is not only whether adaptation policies exist, but whether they are socially legitimate, locally usable, and accessible to vulnerable groups.

A stronger comparative reading of these coupled groups reveals several patterns. First, developed-country studies tend to emphasize strategic planning tools, adaptive pathways, and institutional innovation, often under conditions of relatively stronger governance capacity and data availability [2], [36]. By contrast, developing-country studies more frequently focus on implementation barriers, local vulnerability, community participation, and constraints related to affordability, institutional weakness, and uneven access to technology [4], [7], [8], [27], [29], [35]. Second, clear sectoral differences are visible. Agricultural studies often emphasize technology adoption, climate-smart production, and resource access [24], [27], [35], whereas urban studies focus more strongly on governance scale, planning justice, and integration across risk reduction and adaptation agendas [6], [23], [24], [28], [31], [37], [38].

Third, the reviewed studies vary by governance scale. Local and community-level studies tend to foreground knowledge co-production, local institutions, and social inclusion [4], [29], [34], whereas national and multi-level studies more often examine policy coherence, inter-institutional coordination, and financing arrangements [1], [3], [9], [20], [36]. Fourth, the literature is methodologically mixed but uneven. Much of the corpus relies on conceptual discussion, policy analysis, and case-based qualitative approaches, while fewer studies provide

comparative cross-country or systematically evaluated evidence on implementation effectiveness [2], [7], [8], [27], [28], [36]. This methodological imbalance helps explain why adaptation is well theorized in the literature but less consistently evidenced in practice.

Table 2. Comparative analytical patterns identified through bibliographic coupling and thematic coding.

Analytical dimension	Dominant pattern	Representative studies
Geographical context	Developed-country studies emphasize planning tools and institutional innovation; developing-country studies emphasize implementation barriers, vulnerability, and local capacity	Developed: [2], [36]; Developing: [4], [7], [8], [28], [29], [35]
Sectoral focus	Agriculture emphasizes CSA, technology adoption, and resource access; urban studies emphasize planning integration, equity, and resilient infrastructure	Agriculture: [24], [27], [35]; Urban: [6], [24], [28], [31], [37], [38]
Governance scale	Local studies foreground participation and co-production; multi-level studies foreground coordination and institutional coherence	Local: [4], [29], [34]; Multi-level: [1], [3], [9], [20], [36]
Methodological approach	The literature is dominated by conceptual, policy, and case-based studies; fewer studies provide comparative or systematically evaluated implementation evidence	[2], [7], [8], [27], [28], [36]

Source: Author's calculation based on bibliographic data retrieved from Scopus and analyzed using VOSviewer

4.3. The theory–practice gap as a central synthesis finding

One of the strongest findings emerging from the review is the persistence of a theory–practice gap. Direct evidence from the included studies shows that adaptation is widely endorsed in policy discourse and academic frameworks, yet implementation remains uneven, fragmented, and often exclusionary [3], [7], [8], [20], [24], [27], [28], [37], [38]. This gap is especially visible in vulnerable contexts where adaptation is expected to address multiple risks simultaneously—climatic exposure, livelihood insecurity, weak institutions, and social inequality [4], [7], [27], [29], [32], [35].

The reviewed studies point to at least four recurrent causes of this gap. The first is institutional fragmentation. Adaptation responsibilities are often dispersed across ministries, agencies, and planning levels, producing overlap, weak coordination, and policy inconsistency [3], [20], [24], [37], [38]. The second is resource and infrastructure limitation, especially in lower-income and climate-vulnerable settings where financial constraints, poor local data, and weak digital systems limit the practical uptake of adaptation tools [4], [7], [12], [27], [35]. The third is unequal access and social exclusion. Several studies show that adaptation measures may remain inaccessible to smallholder farmers, informal urban communities, and socially marginalized groups if affordability, institutional support, and social capital are not addressed [27], [30], [32], [33], [35]. The fourth is insufficient integration of local knowledge and community priorities, which weakens legitimacy and reduces long-term uptake of adaptation interventions [29]–[32], [34].

An important interpretive conclusion of this review is that technology does not remove the theory–practice gap; in many cases, it reorganizes it. Although AI, digital agriculture, blockchain systems, and adaptive planning tools are increasingly presented as promising instruments for climate-resilient development, their effectiveness is still mediated by governance quality, local capacity, and access conditions [2], [7], [11], [25]. In other words, advanced tools can enhance adaptive capacity where enabling systems already exist, but they are less likely to substitute for missing institutions, weak coordination, or inequitable resource distribution [3], [7], [20], [27], [35]. This helps explain why the literature increasingly links technological adaptation to broader questions of governance, inclusion, and institutional delivery rather than treating innovation as a stand-alone solution.

Overall, the review suggests that the theory–practice gap should not be treated as a secondary implementation problem. Rather, it is a central analytical feature of the field and a key reason why adaptation research must move beyond thematic identification toward deeper comparative and institutional analysis [3], [7], [35].

5. CONCLUSION

This study reviewed 38 Scopus-indexed publications to examine how the literature conceptualizes and operationalizes the relationship between climate adaptation and sustainable development. Direct findings from the reviewed corpus show that the field is structured around three major domains: (1) policy mainstreaming and institutional integration; (2) sectoral and technological adaptation; and (3) equity, local capacity, and implementation barriers [1], [3], [6], [7], [12], [24], [26], [35], [39], [40]. The co-occurrence and bibliographic coupling analyses further indicate that these domains are interdependent rather than isolated. In particular, technological and equipment-related approaches are consistently connected to governance, adaptive capacity, and social inclusion rather than functioning as purely technical interventions [3], [7], [11], [12], [20], [27], [35].

A second major conclusion is that the literature reveals substantial comparative unevenness across contexts. Studies from developed settings tend to focus more on planning tools, adaptive pathways, and institutional innovation, whereas studies from developing settings focus more strongly on implementation barriers, vulnerability, participation, and limited access to adaptive resources [2], [4], [7], [8], [29], [35]. Sectoral differences are also clear: agricultural studies emphasize climate-smart production systems and technology access, while urban studies give more attention to planning integration, distributive justice, and coordination across adaptation and disaster risk reduction agendas [6], [23], [24], [26], [28], [31], [38], [39].

A third and more substantive synthesis finding is that the theory–practice gap constitutes one of the central unresolved issues in the field. The reviewed literature repeatedly shows that adaptation knowledge does not automatically translate into implementation because of fragmented institutions, insufficient finance, weak local data systems, and unequal access to technology and decision-making processes [3], [7], [8], [20], [24], [27], [29], [31], [35], [37], [38]. This finding strengthens the argument that adaptation should be analyzed not only as a policy objective, but also as a delivery problem shaped by institutional readiness, governance scale, and social inclusion.

Based on these findings, this review offers several evidence-informed implications for climate-vulnerable developing countries such as Vietnam. These implications are not direct empirical findings from the reviewed corpus; rather, they are conceptual recommendations grounded in the thematic and comparative gaps identified in the literature. First, future research in Vietnam should examine low-cost, context-appropriate adaptation technologies and equipment systems for climate-sensitive sectors, particularly agriculture and coastal

livelihoods, because the reviewed literature shows that affordability and access remain major barriers to implementation [24], [27], [30], [35]. Second, more work is needed on knowledge co-production and locally grounded adaptation planning, especially in highly exposed regions such as deltas and coastal cities, given the strong evidence that local legitimacy and community participation improve adaptive uptake [29], [32], [34]. Third, future studies should investigate urban adaptation justice, including the distributional effects of climate-resilient infrastructure and planning interventions on low-income and informal communities [24], [28], [31], [37], [38]. Fourth, more attention should be given to institutional innovation and climate finance intermediaries, since several studies suggest that governance coordination and funding mechanisms remain critical constraints on implementation [2], [20], [23], [36].

This study has several limitations. First, the review relies on a single database (Scopus), which may exclude relevant studies indexed elsewhere. Second, the review is limited to English-language publications, which may underrepresent local and regional scholarship. Third, although the review combines bibliometric mapping and thematic coding, the final synthesis is based on a relatively small core corpus of 38 studies, which is appropriate for in-depth review but may not capture the full breadth of global adaptation literature. Fourth, bibliometric results are sensitive to the search string, screening decisions, and threshold settings used in VOSviewer and thematic coding.

Future research should therefore extend this work in at least three directions. First, multi-database reviews could provide a broader evidence base and improve coverage across regions and disciplines. Second, more comparative empirical studies are needed to test how adaptation instruments perform across governance scales, sectors, and levels of development. Third, greater attention should be paid to the operational conditions under which equipment provision, digital systems, and policy frameworks actually strengthen adaptive capacity in vulnerable settings. Such work would help move the field beyond normative advocacy toward more implementable and context-sensitive models of climate-resilient sustainable development.

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