

Original Article

Climate and health in Asia: a scoping review of vulnerability and community adaptation

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Abstract

Introduction: Climate change intensifies environmental risks across Asia, disproportionately affecting vulnerable populations and exacerbating health disparities. However, evidence on community adaptation strategies and the integration of health dimensions into adaptation policies remains fragmented. This scoping review aimed to map climate-sensitive health risks, evaluate the equity and effectiveness of community adaptation measures, and examine theoretical frameworks for vulnerability assessments across Asia.

Methodology: Guided by the PRISMA-ScR checklist, this scoping review analyzed 21 peer-reviewed studies on climate-health interactions and adaptation strategies in Asia published between 2008 and 2024. Data were systematically charted and synthesized thematically.

Results: Five cross-cutting themes emerged: physical and socioeconomic exposure, gender-related vulnerability, community-based and informal adaptation, climate-related health impacts, and institutional and policy gaps. Adaptation strategies rely heavily on community-led practices with limited attention to gender and health in national plans. The review also highlights challenges to equity in community adaptation and critiques existing vulnerability frameworks. This review underscores the need for justice-oriented, integrated approaches to climate and health.

Conclusions: This review underscores the importance of integrating community knowledge and gender-sensitive approaches into climate-health frameworks. Strengthening health systems and formalizing local adaptation practices are essential for reducing inequities. Future research should adopt longitudinal and interdisciplinary perspectives to capture long-term health outcomes and policy implementation barriers in rapidly urbanizing environments.

Key words: Asia; climate change; community adaptation; health disparities; scoping review; vulnerable population.

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Introduction

Climate change represents a major global challenge that profoundly impacts environmental systems and human health [1]. In particular, low- and middle-income countries in tropical Asia, including South, Southeast, and East Asian regions, are increasingly vulnerable to climate-related hazards such as extreme heat, flooding, increased precipitation, and sea-level rise [2,3]. These environmental changes have contributed to rising disease burdens and increased community vulnerability, including increased water contamination, inadequate sanitation, forced displacement, and deteriorating access to basic services [4,5].

The adverse health effects are evident: higher rates of waterborne diseases (e.g., cholera and diarrhea), vector-borne diseases (e.g., dengue and malaria), and airborne diseases (e.g., influenza and tuberculosis). These impacts, shaped by changes in temperature, precipitation, and air quality, also lead to nutritional deficiencies and disruptions in critical healthcare services [6,7]. Noncommunicable diseases, such as

hypertension and cardiovascular disorders, are also affected by factors like heat stress, food insecurity, and limited access to healthcare [8,9]. Incorporating these conditions into vulnerability and adaptation (V&A) assessments provides a more comprehensive understanding of climate-health risks in Asia.

Governments, alongside national and international institutions, have adopted various climate adaptation measures to reduce population exposure and increase resilience in response to these growing dangers. These efforts include early warning systems, climate-resilient infrastructure, and community-based adaptation (CBA) programs, particularly in flood-prone and coastal areas [10,11]. Implementation is frequently fragmented, top-down, and inadequately adapted to local socioeconomic and ecological circumstances [12,13]. Additionally, several adaptation initiatives fail to incorporate health vulnerability factors into climate planning, thereby limiting their effectiveness for the most vulnerable groups.

Vulnerability is a foundational concept in climate adaptation research, defined as a population's

susceptibility and limited capacity to respond to adverse climate-health outcomes [14]. Evaluating exposure, sensitivity, and adaptive capability, formal V&A assessments are now increasingly employed to guide national policies and risk management plans [15]. These evaluations are used in diverse regions, including Ghana [16] and South Africa [17], and their implementation in Asia is also becoming evident. Nepal's 2022 V&A assessment evaluated climate-sensitive diseases, including dengue, diarrheal illnesses, and heat-related illnesses, and provided localized profiles and recommendations for integrating health into national climate adaptation planning [18]. Likewise, Japan's 2021 Health National Adaptation Plan (HNAP) outlined cross-sectoral initiatives to mitigate the health impacts of heat stress, vector-borne diseases, and extreme weather, emphasizing inter-ministerial coordination [19].

Despite these advances, Asia's demographic diversity, rapid urbanization, and severe climate vulnerability necessitate region-specific health adaptation plans. Significant research gaps exist in understanding how climate-sensitive disease burdens, particularly infectious diseases, interact with local adaptation techniques and vulnerability measures. While national and subnational V&A assessments are present, infectious disease epidemiology rarely integrates into broader climate-health frameworks. There is also a lack of synthesized evidence on how communities adapt to these emerging risks.

This scoping review has three objectives: (1) identify climate-sensitive health issues throughout Asia's geographical areas; (2) analyze the efficacy and equity of community adaptation measures; and (3) critically examine theoretical frameworks for vulnerability assessments. By connecting these analytical areas, we provide a policy-relevant summary to inform climate-resilient healthcare systems, while uncovering previously overlooked connections between resilience capacity, gender equality, and governance institutions in rapidly urbanizing contexts.

Methodology

The methodological framework of this scoping review adhered to [20] and was enhanced by [21], following PRISMA Extension for Scoping Reviews (PRISMA-ScR) principles [22]. The objective was to systematically map and synthesize empirical evidence on the interlinkages between climate-related exposures, health outcomes, and community-level adaptation strategies in Asia. Given Asia's unequal climate vulnerability, which includes eight of the ten nations

most threatened by climate-related health concerns [14], the evaluation targeted community-level adaptation methods to guide equity-focused policy responses.

This scoping review protocol was registered on the Open Science Framework (OSF) on August 8, 2025 (<https://osf.io/z9yse>). Since this review synthesized data from previously published studies, ethical approval or informed consent was not required. All data were anonymized and publicly accessible, in accordance with institutional guidelines for secondary research.

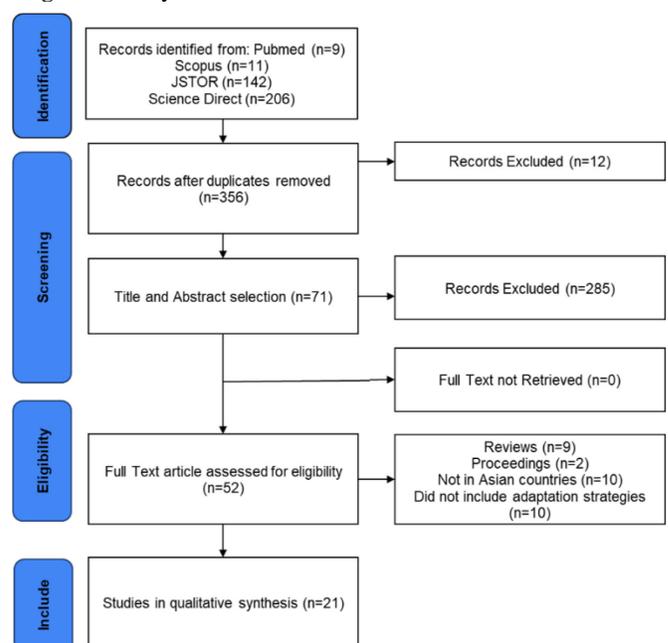
Eligibility criteria

Studies were included if they met the following criteria: (1) were conducted in Asian countries, (2) examined the links between climate change and public/child health outcomes or community adaptation, and (3) addressed vulnerability, climate risk exposure, or adaptation responses. Studies were excluded if they were non-peer reviewed, written in a language other than English, or lacked a combined focus on health and adaptability.

Excluding non-English publications may omit region-specific insights, and omitting gray literature (e.g., local policy documents, NGO reports) may underrepresent grassroots adaptation strategies. These constraints were necessary for the feasibility and consistency of data extraction.

The review spanned the period from 2008 to 2024. It was chosen to capture developments in literature following the Intergovernmental Panel on Climate

Figure 1. Study selection flowchart.



Change (IPCC) Fourth Assessment Report (AR4) 2007 to capture the surge in adaptation research and span developments before and after the Paris Agreement (2015), including insights from the IPCC AR5 (2014) and AR6 (2021–2022).

Information Sources

Several central databases were searched extensively for relevant literature: PubMed, Scopus, JSTOR, and ScienceDirect, covering studies published up to March 2025. The search combined MeSH terms and free-text keywords, which included: ((Child OR Infant) AND (Risk Factor OR Climate Change OR Environmental Risk Factors) AND (Diarrhea OR Rotavirus) AND (Adaptation to Climate Change)). Grey literature was excluded to ensure methodological consistency across databases. Duplicates were deleted from the search results before screening.

Selection Process

Three authors (ID, KA, and DHT) independently selected studies. The Rayyan web-based tool [23] was employed to facilitate blinded screening and conflict tracking throughout the study. After the titles and abstracts were examined, a full-text assessment of potentially pertinent research was conducted. Conflicts

were settled through iterative debate until agreement was reached, with a third scientist (DH) arbitrating any unresolved cases. Additional exclusions were made during the full-text review and data extraction when studies did not meet the inclusion criteria.

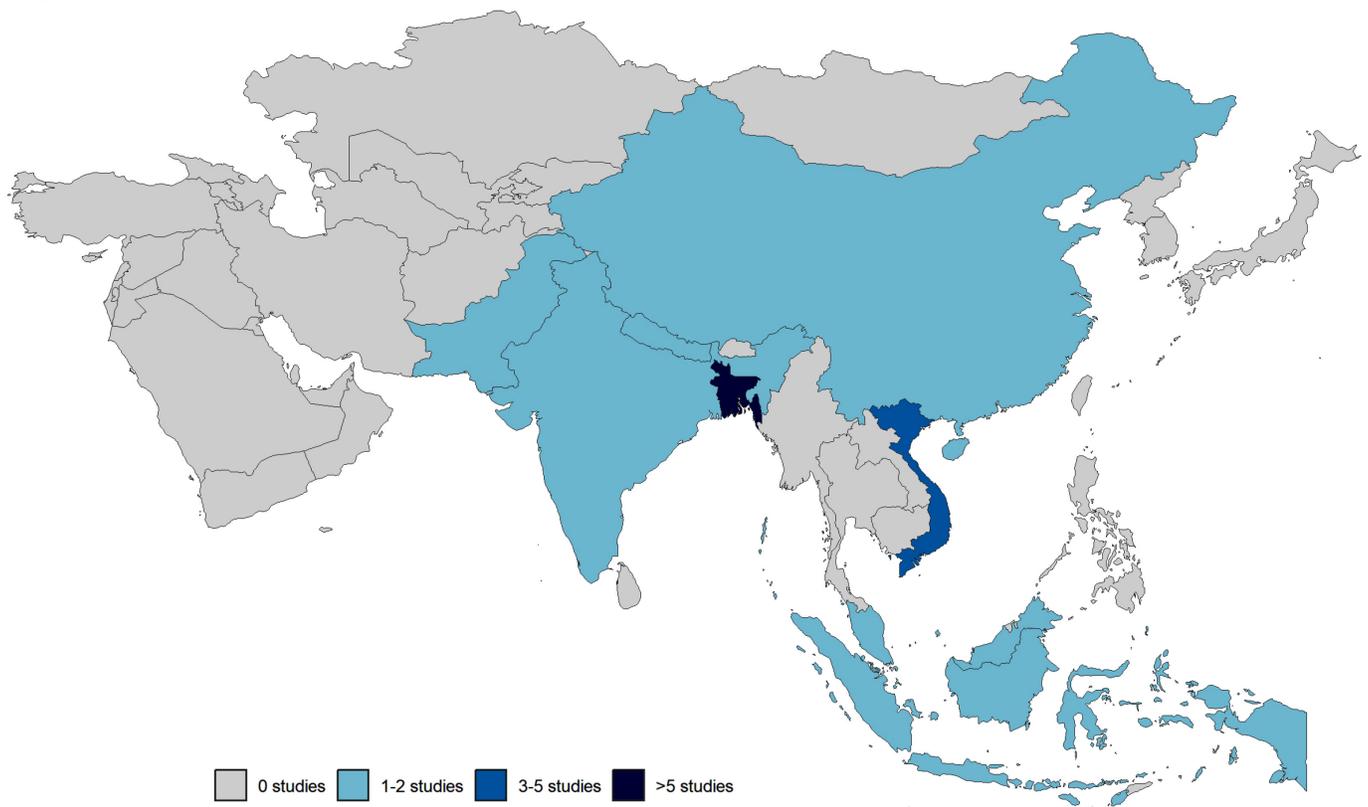
Data Charting

A structured data charting form was developed in Microsoft Excel to extract key information from each included study systematically. This form aligned with the review objectives and captured: author and year of publication, country of study, study aim, target population, health outcomes, adaptation strategies, key findings, reported limitations, and recommendations. The data were independently charted by three authors (ID, KA, and DHT), and any discrepancies were resolved through consensus among RP and TEBS. The extracted data were then summarized descriptively and synthesized thematically.

Synthesis

Thematic analysis of the included studies revealed five overarching themes related to the interaction between climate change, health impacts, and community adaptation strategies in Asia: (1) physical and socioeconomic exposure; (2) gender-related

Figure 2. Geographic distribution of included studies in Asia.



vulnerability; (3) community-based and informal adaptation; (4) climate-related health impacts; and (5) institutional and policy gaps.

Results

There were 356 records found across four databases. After screening titles and abstracts, removing duplicates, and assessing the full texts against predefined eligibility criteria, 21 studies were included in the final review. The PRISMA flowchart (Figure 1) visually summarizes the article selection process, clearly showing the number of records identified, screened, excluded, and included at each review stage.

Study Characteristics

The final analysis included 21 papers that fulfilled the inclusion criteria. Figure 2 shows that the studies were in eight Asian countries in three regions: South Asia (ten articles in Bangladesh, two each in India and Pakistan, and one in Nepal); Southeast Asia (three in Vietnam, one each in Indonesia and Malaysia); and one in East Asia (China). The high concentration of studies in South Asia, particularly in Bangladesh, indicates a significant research focus on climate-induced health hazards and vulnerability in this region. However, this geographic distribution reveals substantial research gaps in other areas, such as Central Asia, the Gulf countries, and small island states, which have different climatic and health systems.

An increase in academic interest in the relationship between climate change, health outcomes, and adaptation measures in the region is evident from publications spanning 2008 to 2024. Most of the research has been conducted over the past decade, consistent with the growing scholarly and policy focus on climate resilience.

Research on the link between climate and health in Asia utilized various methods, as detailed in Table 1. Of the 21 studies, nine used quantitative, six used qualitative, and six used mixed methods (combining

surveys, secondary data, and community participation). Most studies were community-based, highlighting the challenges of evaluating climate adaptation and vulnerability across diverse settings, as methodologies varied across countries. Bangladesh used mixed methods, reflecting its broad climate-health research agenda. China and Malaysia primarily used quantitative designs. Indonesia and Nepal each contributed a single study.

A review of 21 studies revealed diverse perspectives on climate-related health vulnerabilities and community adaptation strategies across Asia. A thematic synthesis identified five domains: (1) physical and socioeconomic exposure, (2) gender-related vulnerability, (3) community-based and informal adaptation, (4) climate-related health impacts, and (5) institutional and policy gaps.

Table 2 provides a thematic summary of these domains, highlighting key learnings and recommendations. The findings definitively show that marginalized groups, including low-income households, women, children, and displaced populations, bear disproportionate climate-related health risks. Local adaptation strategies are undervalued in formal policy processes. Recommendations across themes emphasize three key actions: strengthening community engagement, investing in public health infrastructure, and embedding equity-focused strategies into national adaptation planning.

The thematic synthesis is enhanced by supplementary material, which details specific study features. Supplementary Table 1 provides comprehensive study-level details, such as the country, study aim, population, method, and reported limitations. In the following subsections, each theme is presented with three layers of analysis: (i) a descriptive overview of the theme, (ii) identification of vulnerable groups most affected, and (iii) thematic richness through evidence from the included studies.

Table 1. An overview of the studies' publication methods and data sources.

Country	Quantitative method	Qualitative method	Mixed-method
Bangladesh	(Guimbeau <i>et al.</i> , 2024)	(Azad & Pritchard, 2023), (Jannat & Kusakabe, 2024) (Khan, 2022), (Roy <i>et al.</i> , 2022)	(Ashrafuzzaman, 2023), (Chowdhury <i>et al.</i> , 2020), (Hossain <i>et al.</i> , 2020), (Rakib <i>et al.</i> , 2017), (Shamsuddoha <i>et al.</i> , 2024)
China	(Zhong <i>et al.</i> , 2021)		
India	(Banerjee & Maharaj, 2020) (Rajkhowa & Chakrabarti, 2024)		
Indonesia		(Prana <i>et al.</i> , 2024)	
Malaysia	(V. L. H. Phung <i>et al.</i> , 2023)		
Nepal	(Paudel & Pant, 2020)		
Pakistan	(Yaseen <i>et al.</i> , 2023)	(Ullah <i>et al.</i> , 2024)	
Vietnam	(Kelly-Hope <i>et al.</i> , 2008); (D. Phung <i>et al.</i> , 2015)		(Pham <i>et al.</i> , 2020)

Table 2. Thematic synthesis of climate-related health vulnerabilities and community adaptation in Asia

Theme	Number of Studies (countries)	Key Findings	Recommendations
Physical and socio-economic exposure	5 (Bangladesh, India, Pakistan, Vietnam)	Climate hazards such as flooding, heatwaves, and salinity intrusion disproportionately affect poor households, smallholder farmers, and children. Limited infrastructure, poverty, and a lack of formal insurance are driving the issue.	It is essential to improve adaptive resources through infrastructure, livelihood diversification, social protection, and targeted support for climate-sensitive groups.
Gender-related vulnerability	4 (Bangladesh, Pakistan)	Women experience heightened vulnerability due to exclusion from planning, limited land and cash access, and gender-based violence in displacement contexts. They play central roles in household and community adaptation.	Promote gender-transformative adaptation. Enhance women's participation in decision-making. Strengthen gender-sensitive governance systems.
Community-based and informal adaptation	4 (Bangladesh, Indonesia)	Local strategies include salinity-resistant crops, floating gardens, water pond re-excavation, house elevation, and self-funded drainage. These informal practices are innovative, but they're often excluded from formal policy.	Recognize and integrate local practices into formal adaptation planning. Scale-up community-NGO partnerships to sustain grassroots innovation.
Climate-related health impacts	8 (Bangladesh, China, India, Nepal, Vietnam)	Climate change increases gastrointestinal infections, child morbidity, under-five mortality, and mental health stress among displaced people. Poor, rural, and coastal communities have increased health hazards.	Improve public health infrastructure, increase access to sanitation and clean water, and use multidimensional health vulnerability indices to inform policymaking.
Institutional and policy gaps	4 (Bangladesh)	Local knowledge and informal practices are frequently neglected in national policies. Weak institutional coordination limits the efficacy of climate migration planning and adaptation.	Encourage participatory, inclusive, and gender-sensitive governance; strengthen cross-sectoral cooperation; and incorporate local knowledge into national adaptation plans.

Physical and socioeconomic exposure

Flooding, heat waves, and saline intrusion have become recurring threats to livelihoods and human well-being in rural and urban areas across Asia. These risks are compounded by limited adaptive capacity, underdeveloped infrastructure, and persistent poverty, constraining communities' ability to respond effectively. Vulnerable groups include smallholder farmers, residents of flood-prone settlements, and rural households with limited access to emergency services. For instance, smallholder farmers in Vietnam's uplands experience significant income losses due to erratic rainfall and crop failures. Often, they lack access to formal insurance or financing [24]. Residents of flood-prone districts face repeated displacement, housing destruction, and income disruption [25,26]. In India, heat-related mortality disproportionately affects newborns in rural, low-income areas with limited access to cooling facilities and emergency care [27]. Furthermore, climate-driven temperature variability has been associated with reduced dietary diversity and food insecurity among children [28]. These findings underscore the intertwined nature of physical exposure and socioeconomic disadvantage in shaping climate vulnerability.

Gender-related vulnerability

Gender influences the distribution of climate risks by affecting exposure and adaptive capacity. In many Asian countries, women, particularly those in rural and climate-affected areas, face compounded

vulnerabilities due to social norms, unequal access to resources, and exclusion from formal decision-making processes. Vulnerable groups include climate-displaced women, female-headed households, and women in informal settlements who have limited legal and economic protections. In Bangladesh, for example, women are excluded from formal planning and resource allocation, yet play essential roles in flood caregiving and community adaptation [29]. Studies also show that climate-displaced women experience increased gender-based violence and social marginalization, particularly in overcrowded informal settlements [30,31]. Social norms of male dominance further restrict women's access to land, credit, and safe spaces, thereby constraining their ability to respond to environmental shocks [32]. Despite these constraints, women often spearhead household-level adaptation strategies, underscoring the need for gender-transformative approaches in climate policy and practice.

Community-based and informal adaptation

In diverse Asian regions, communities have developed informal adaptation strategies to address climate risks, often compensating for inadequate institutional support. These strategies are crucial for vulnerable groups, including smallholder farmers in hazard-prone rural areas, low-income urban households, and marginalized coastal communities that experience frequent flooding and saltwater intrusion. In coastal Bangladesh, for example, local strategies include cultivating salinity-resistant crops, creating

floating gardens, and re-excavating ponds for storing freshwater [33]. In Indonesian cities, households have elevated their homes, financed drainage improvements, and organized community-based disaster committees to reduce flood impacts [34]. While these initiatives demonstrate local innovation and resilience, their exclusion from formal adaptation frameworks limits their scalability, sustainability, and long-term integration into policy [25,35].

Climate-related health impacts

Climate variability poses significant health risks, disproportionately affecting impoverished populations, young children, and displaced individuals. Vulnerable groups include internally displaced persons (IDPs) in flood-affected regions, coastal populations exposed to salinity intrusion, and households in areas with limited health infrastructure and resources. In Bangladesh, for example, IDPs are at an increased risk for mental distress, waterborne infections, and restricted access to healthcare facilities [36]. Salinity intrusion in coastal areas has been linked to adverse health outcomes in early life [37]. In China, a multidimensional health vulnerability score has been developed to assess combined risks by accounting for health service accessibility, socioeconomic status, and environmental hazards [38]. Additional studies document that climate change increases the incidence of enteric diseases [39], elevates morbidity among young children [28,40], and contributes to higher under-five mortality rates in resource-poor areas [41], thereby imposing substantial health and adaptation costs due to climate-related health risks [42]. These outcomes underscore the urgent need to address climate change as a public health concern, where adaptive capacity hinges on the availability of health infrastructure, sanitation systems, and social protection measures.

Institutional and policy gaps

There is a persistent disconnect between top-down climate adaptation policies and the needs of vulnerable communities, which undermines the effectiveness of interventions. The most affected populations include marginalized rural households, climate migrants, and communities that rely on informal adaptation practices. National adaptation frameworks often overlook local knowledge systems and community-led innovations, reducing policies' relevance and long-term impact [33,35]. In Bangladesh, for example, research has highlighted the need for inclusive, gender-sensitive governance structures that facilitate participatory planning [43]. Gaps in institutional coordination are

evident in national development plans addressing climate migration, where fragmented responsibilities hinder coherent responses [44]. Without mechanisms to integrate local insights and strengthen cross-sectoral collaboration, adaptation strategies risk remaining misaligned with community priorities and perpetuating existing vulnerabilities.

Discussion

This scoping review analyzed the effects of climate change on health outcomes and community-level adaptation, particularly for vulnerable populations, by combining empirical studies across Asia. The thematic analysis revealed five interrelated categories: physical socioeconomic exposure, gender-related vulnerability, community-based and informal adaptation, climate-related health impacts, and institutional and policy gaps. These themes highlight the effects of social and structural inequities and environmental exposure on climate vulnerability.

The findings revealed that the ability to adapt is unevenly distributed across social and regional lines, despite climatic hazards, including heatwaves, salinity, and floods, being major risk drivers. Marginalized groups, such as women, displaced people, smallholder farmers, and informal workers, face compound vulnerabilities due to poverty, inadequate infrastructure, and limited access to official support systems. These results align with another study's view, which contends that vulnerability is a product of historical, economic, and political processes rather than a neutral state [45].

The review acknowledged that vulnerability is unequally distributed by gender and socioeconomic level, and displacement status is one of its main contributions. Research conducted in Bangladesh and Pakistan has shown that women often face increased domestic violence, limited mobility, and limited financial resources during and after climate shocks. According to these results, adaptive responses are substantially shaped by gender roles and disparities [26,32]. These results are consistent with feminist political ecology theories, which stress that adaptation must consider the power dynamics that shape the control and access to resources [46,47].

Gender becomes a crucial vulnerability indicator for adaptive activity. Women were often the first to respond to caregiving and household adaptation during climatic shocks, but were not included in formal decision-making. To address systemic power imbalances, a combined approach that acknowledges both agency and vulnerability aligns with perspectives

on gender-transformative practices. These approaches aim to integrate women into existing systems and to change the structures and beliefs that perpetuate inequality [48]. The experiences of displaced populations also demonstrate a form of double exposure or compounded vulnerability, whereby the consequences of climate change further hurt those already disadvantaged by poverty or violence [49]. In addition to physical exposure, sociopolitical marginality should be included in adaptation assessments.

The review highlighted the creativity of informal and community-based adaptation techniques, such as elevated housing, floating agriculture, water pond management, and informal flood-proofing [33,34,37]. Studies in Portugal, where communities have traditionally used localized, experienced knowledge systems to adjust to environmental stressors, are consistent with these grassroots responses [50].

Although these measures are effective, their infrequent inclusion in national adaptation planning suggests a technocratic bias in policy frameworks prioritizing infrastructure-based solutions [35,51]. Neglecting informal adaptation perpetuates a top-down strategy that undervalues the agency of local actors, especially women and informal settlers. This review reinforces calls for effective CBA to be formally recognized, adequately funded, and integrated into national strategies [52].

This review emphasized that climate change is a growing public health emergency. During displacement or following extreme disasters, vulnerable populations are more susceptible to waterborne illnesses, malnutrition, and mental health stress. One of the biggest dangers to health in the twenty-first century is climate change [4,53]. The continued absence of integration between health systems and climate adaptation policies in vulnerable, neglected areas indicates an urgent need for adaptation planning that considers health.

Several studies identify health as an underexplored but critical dimension of climate vulnerability. Evidence from Bangladesh illustrates how salinity intrusion and displacement lead to malnutrition, diarrheal disease, and psychosocial stress, particularly among children and low-income urban communities [36,37]. These results are consistent with an expanding amount of research that views climate change as a significant public health emergency [13,54].

Additionally, integrating multidimensional health vulnerability indices makes a complex analysis that links infrastructure, socioeconomic conditions, and

environmental exposure possible [38]. As a result, the adaptation policy needs to be revised to prioritize the health sector, rather than treating it as an afterthought.

One major obstacle to successful adaptation is the continuation of institutional neglect and policy fragmentation. National plans are frequently implemented in ways that are distant from local reality, even while they theoretically accord with international frameworks such as the Paris Agreement [35,44]. According to studies, bureaucratic inefficiencies, conflicting mandates, and the exclusion of marginalized voices from planning procedures are common problems with adaptation efforts.

As a result of this broader governance failure, sectors including health, the environment, and disaster management are not adequately coordinated, and reactive, siloed, adaptive planning is ill-equipped to address compound vulnerabilities [51]. On the other hand, the review advocates for a move toward decentralized, multi-level, and participatory governance systems that empower local actors, incorporate local knowledge, and encourage context-specific solutions to increase resilience [55].

This scoping review summarized findings from 21 empirical studies in Asia, revealing the complex relationship between exposure, marginality, and adaptive responses. Unlike sector-specific or hazard-based assessments, this review used a multidimensional lens to highlight the interconnectedness of vulnerability by examining the intersection of gender, displacement, health, and informality. Beyond reaffirming established climate–health linkages, the study offers new insights by framing gender as a structural determinant of access to health and livelihood changes, rather than merely a marker of vulnerability. The review also identifies and documents various community-led adaptation strategies outside formal policy frameworks, underscoring the importance of local practices in building resilience.

This study redefined adaptation as a social and political process influenced by identity, power dynamics, and institutional contexts. It sheds light on under-explored aspects, including gender-based violence and the mental health impacts of climate change, especially in informal and peri-urban areas. The review builds on prior studies by offering a justice-oriented perspective that emphasizes integrating community-led practices into governance and adaptation agendas.

Despite providing important insights, this review had several limitations that should be acknowledged. First, its geographic scope was limited to eight Asian

countries, and more than two-thirds of the evidence is from South Asia. This overrepresentation might limit the transferability of the findings to underrepresented regions, such as Central Asia, the Gulf countries, and small island states, which have distinct climate–health dynamics. Second, most of the included studies had short- to mid-term designs with limited longitudinal data, which constrains our understanding of the sustainability of adaptation measures. Third, restricting the search to English-language peer-reviewed publications may have excluded relevant evidence documented in other languages or captured in gray literature, including community-led initiatives. Fourth, although the review was updated through March 2025, it might not entirely reflect recent climate events and rapidly evolving policies. Finally, some vulnerable groups beyond gender and displacement received less analytical attention, indicating a need for more inclusive perspectives. These limitations highlight the need for future research to expand its geographic and linguistic scope, adopt interdisciplinary and longitudinal approaches, and integrate non-academic evidence to capture the full spectrum of climate-health adaptation in Asia.

Conclusions

This scoping review revealed that climate change in Asia exacerbated environmental hazards and reinforced socioeconomic inequalities, disproportionately affecting marginalized groups. After synthesizing evidence from 21 studies, five cross-cutting themes emerged: physical and socioeconomic exposure; gender-related vulnerability; community-based and informal adaptation; climate-related health impacts; and institutional and policy gaps. These themes highlight the interplay between social structures and climate-related risks. Although local communities demonstrate innovation and resilience, structural inequities and fragmented governance often hinder adaptation outcomes. Advancing transformative and sustainable adaptation requires integrating climate and health systems into national adaptation plans and measures promoting equity, participatory governance, and justice-oriented responses.

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Conflict of interest

No conflict of interest is declared.

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Annex – Supplementary Items**Supplementary Table 1.** A summary of the selected papers.

Author (Year)	Country	Study Aim	Target Population	Key Learning	Recommendation	Limitation
Pham <i>et al.</i> (2020)	Vietnam	To assess the vulnerability of smallholder farmers facing flash floods and landslides	Households in the poor upland regions of Vietnam	Income disparities, environmental pressure, inadequate water management infrastructure, and weak community networks amplify climate vulnerability among farmers.	Enhancing capacity through literacy and diversification programs, formalizing land tenure, and integrating localized disaster plans with health-environment measures.	Limited generalizability to regions and the selection of the indicators used to assess vulnerability
Ashrafuzzaman <i>et al.</i> (2023)	Bangladesh	To examine local community-based adaptation strategies in coastal Bangladesh	Coastal communities	Community-NGO partnerships enable salt-tolerant farming and other adaptation strategies to increase resilience against climate hazards.	An integrated community-based adaptation to strengthen local adaptive practices to ensure socioeconomic and environmental sustainability	Lacks long-term data on institutional durability.
Azad & Pritchard (2023)	Bangladesh	To investigate women's roles in adaptive capacity and flood resilience	Rural flood-prone communities in Bangladesh	Women in rural Bangladesh underpin flood resilience through their human, social, and financial capital, but lack formal recognition.	Formally recognize women's disaster roles through empowering women and incorporating women's contributions into formal disaster planning and evaluation.	Qualitative design limits statistical generalizability.
Chowdhury <i>et al.</i> (2020)	Bangladesh	To assess climate change impacts and health adaptation needs of internally displaced people (IDPs)	Internally displaced households (IDPs)	Climate migrants face financial constraints and limited access to healthcare information.	Improve the financial capacity of affected households and ensure access to healthcare information.	A cross-sectional survey design cannot capture longitudinal health outcomes.
Roy <i>et al.</i> (2022)	Bangladesh	To examine the socio-environmental impacts of sea level rise in coastal Bangladesh and evaluate the effectiveness of locally-led, community-based adaptation (CBA) strategies.	Coastal communities	Communities are adapting to climate change through farming measures, non-farming practices, and internal migration, but they lack policy integration.	Local knowledge, social capital, flexible institutional support, and increased recognition of CBA in national climate policies	Limit the generalizability of the outcomes to other regions with different environmental and socioeconomic contexts.
Rajkhow & Chakrabarti (2024)	India	To investigate how climate variability affects the variety of foods consumed by young children	Children aged 6-23 months	Maternal education mitigates climate-driven child malnutrition.	Prioritizing maternal education and rural infrastructure	Using pooled cross-sectional data makes it challenging to establish causal relationships.
Yaseen <i>et al.</i> (2023)	Pakistan	To determine how flood risk affects household-level economic losses and vulnerability in a rural area of Khyber Pakhtunkhwa.	Rural flood-prone communities in Khyber Pakhtunkhwa	Households with higher vulnerability scores suffer significantly more agricultural and non-agricultural losses, indicating greater risks.	Prioritize the development of early warning systems and construct flood-resistant homes in high-risk areas.	It is conducted in a single district and at a single point in time, but it does not fully incorporate the influence of cultural and social factors.
Hossain <i>et al.</i> (2020)	Bangladesh	To examine the effects of extreme climate-induced floods on livelihoods and coping mechanisms in the Char Village.	Residents of flood-prone Char Village	Floods significantly undermine the livelihoods in Char Village by causing income loss, thus weakening households' capacities to respond to flooding events.	Policymakers must prioritize focused interventions, such as capacity building, road construction, and employment facilities, to break the cycle of vulnerability.	The research is predominantly qualitative, supplemented by quantitative data, which might restrict the ability to generalize the findings broadly.
Shamsuddoha <i>et al.</i> (2024)	Bangladesh	To explore the gendered impacts of climate-induced hazards and their	Women in climate-vulnerable areas of the southwest coast of Bangladesh	Coastal women face reproductive health issues and a destroyed primary income source	Diversifying livelihood options, integrating women into healthcare and social protection,	Limited engagement with male household members prevented analysis of intra-

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		implications on women's human rights in coastal regions.		during climate disasters.	and fostering sustainable adaptation	household power dynamics driving vulnerability.
Zhong <i>et al.</i> (2021)	China	To develop and validate indices measuring health vulnerability and adaptive (V&A) capacity to extreme weather events, the 2016 flood in Anhui province was used as a case study.	Flood-affected populations in Anhui Province	The health V&A indices are significantly associated with post-flood waterborne disease risks, highlighting the usefulness of V&A indices for assessing and forecasting public health risks.	Local governments should reinforce public health sensitivity and adaptive capacity through investments in infrastructure improvements, community-based health education, and enhanced early-warning systems to mitigate post-flood infectious diseases.	Incomplete variable coverage, lack of index data for long-term effects after flooding
Prana <i>et al.</i> (2024)	Indonesia	To explore how residents in North Jakarta informally adapt to recurring urban flooding and how such practices intersect with formal planning systems.	Urban residents in flood-prone informal settlements	Informal urban adaptations conflict with formal planning systems.	Authorities need to create planning policies that are inclusive and informed by community input.	Indigenous adaptations like stilt houses preserve homes but may limit economic diversification, which has not been critically examined.
Banerjee & Maharaj (2020)	India	To determine how heat exposure affects infant mortality and the potential for adaptation	Infants and young children	Heatwaves disproportionately kill infants in low-income districts.	Invest in rural healthcare infrastructure to reduce urban-rural disparities in heat resilience.	Data limitations on the cause of death prevent the study from directly examining the specific pathways linking high temperatures to infant mortality.
Paudel & Pant (2020)	Nepal	To estimate household-level health and climate adaptation costs and identify key health-related determinants in western Nepal.	Rural households exposed to climate-related hazards	Direct curative costs for health expenditure are the most significant expense of household income.	Expand health financing and prioritize climate adaptation in high-risk areas and income instability to reduce direct household healthcare burdens.	Catastrophic events and lost productivity were not considered, leading to underestimation of potential costs.
Phung <i>et al.</i> (2015)	Vietnam	To examine the link between ambient temperature and hospitalization rates among young children.	Children under 5 years in the Mekong Delta	Pediatric hospitalizations rise during heat waves.	Integrate real-time temperature alerts into healthcare systems to anticipate hospitalization surges.	Confounding factors that may alter the connection were not evaluated in the study.
Phung <i>et al.</i> (2023)	Malaysia	To investigate the correlation between daily temperature and under-five mortality, and examine how local factors shape vulnerability.	Under-five population in six regions in Malaysia	The M-shaped risk curve indicates higher mortality at moderate cold and heat extremes than the minimum mortality temperature.	Integrate climate-health monitoring into maternal and child health programs, focusing on tropical-specific vulnerabilities.	Using ambient temperature as a proxy for personal exposure may not accurately reflect exposure for young children who spend much time indoors.
Kelly-Hope <i>et al.</i> (2008)	Vietnam	To examine the temporal trends and climate associations of bacterial enteric diseases (e.g., cholera, typhoid) between 1991 and 2001.	The general population across multiple Vietnamese provinces	Temperature and rainfall were strongly linked to disease patterns	Strengthen early warning systems using temperature and rainfall forecasts to predict outbreaks and target coastal and flood-prone regions with water quality monitoring and sanitation programs during wet seasons.	Detailed data updates are needed to inform public health responses in today's changing climate.
Jannat & Kusakabe (2024)	Bangladesh	To explore women's participation in Community-Based Adaptation to Climate Change (CBACC) projects	Women in rural, climate-vulnerable communities	Women's participation in CBA activities is shaped by overlapping identities (ethnicity, religion, age, and education) and contextual factors.	Integrate CBA monitoring and evaluation to track participation gaps among groups and work with local leaders	A small qualitative sample risks overlooking broader demographic patterns and does not examine male perspectives or institutional power

Author (Year)	Country	Study Aim	Target Population	Key Learning	Recommendation	Limitation
Guimbeau <i>et al.</i> (2024)	Bangladesh	To estimate the impacts of rising ocean salinity on early-life health outcomes and identify adaptation mechanisms.	Infants and pregnant women in coastal areas	Ocean salinity significantly harms early childhood health, reducing height-for-age (HAZ) and increasing stunting prevalence.	to address history and culture in CBAs. Promote alternative agricultural practices to diversify revenue streams and invest in desalination technologies and crop varieties that can withstand salinity to maintain irrigation and livelihoods in coastal areas.	dynamics within NGOs. The focus on short-term impacts (exogenous salinity drift) limits understanding of long-term adaptation, and the analysis of migration is incomplete due to a lack of longitudinal data on displaced populations.
Khan (2022)	Bangladesh	To assess the livelihood challenges and WASH-related (Water, Sanitation, and Hygiene) hardships of climate-induced migrants in urban slums.	Climate migrants living in urban slums	Climate migrants in Khulna's urban slums face severe water scarcity, inadequate drainage, insufficient toilets, tube wells, and bathing facilities, which exacerbate health risks.	Integrated gender-responsive policies to minimize infrastructure gaps and empower migrants through skill development and income-generating training programs	Limited inclusion of the private sector or national-level policymakers in interviews narrows the scope of solutions.
Ullah <i>et al.</i> (2024)	Pakistan	To examine the social injustices women, face during climate-induced migration, focusing on marginalization and vulnerability.	Women residing in the rural areas of District Nowshera, Khyber Pakhtunkhwa, who experienced the 2022 flood.	Socio-cultural barriers and economic marginalization heighten women's exposure to social injustice, and climate migration exposes women to domestic violence.	Develop gender-inclusive climate policies ensuring women's participation in migration planning and disaster management.	Findings are specific to rural-coastal Pakistan; urban migration dynamics are understudied, and there is limited discussion of cross-border identities that may exacerbate vulnerability.
Rakib <i>et al.</i> (2017)	Bangladesh	Analyze gender and flood vulnerability using multivariate tools	Flood-prone rural communities in Bangladesh	Women undertake most of the flood-related activities but face systemic undervaluation of their contributions and endure heightened risks of violence, discrimination, and mental/physical insecurity during all flood phases.	Implement gender-sensitive disaster policies, recognize women's leadership in flood management, encourage women to lead local adaptation efforts, and ensure culturally appropriate solutions.	Lack of longitudinal data prevents assessment of participatory action to future skill management's long-term efficacy or cyclical poverty impacts.