REVIEW

From vulnerability to leadership: How small island developing states are pioneering climate-health adaptation strategies - A systematic review

ANDI TENRI ABENG[1,2], RIDWAN AMIRUDDIN[3], AGUS BINTARA BIRAWIDA[4], ABDUL SALAM[5], INDRA FAJARWATI IBNU[6], AISYAH FARHUM[7], USWATUN HASANAH PURNAMA SARI[2]

[1]Program Doctoral of Public Health Sciences, Faculty of Public Health, Hasanuddin University, Makassar, Indonesia; [2]Physical Education, Health, and Recreation Study Program, Faculty of Teacher Training and Education, Palangka Raya University, Palangka Raya, Indonesia; [3]Department of Epidemiology, Faculty of Public Health, Hasanuddin University, Makassar, Indonesia; [4]Department of Environmental Health, Faculty of Public Health, Hasanuddin University, Makassar, Indonesia; [5]Department of Nutritional Sciences, Faculty of Public Health, Hasanuddin University, Makassar, Indonesia; [6]Department of Health Promotion and Behavioral Sciences, Faculty of Public Health, Hasanuddin University, Makassar, Indonesia; [7]Capture Fisheries Study Program, Faculty of Marine Sciences and Fisheries, Hasanuddin University, Makassar, Indonesia.

ABSTRACT

Background: Climate change represents one of the most significant public health challenges of the 21st century, with Small Island Developing States (SIDS) experiencing disproportionate impacts. Traditional discourse has positioned SIDS as vulnerable victims; however, emerging evidence suggests that they are pioneering innovative climate-health adaptation strategies.

Methods: A systematic search of PubMed, Embase, Web of Science, and grey literature databases (2010-2025) following the PRISMA guidelines. Studies from officially recognized SIDS focusing on climate-health adaptation and leadership were included. Data were synthesized thematically to identify leadership models, governance approaches, and measurable outcomes.

Results: Of 2,847 records,72 studies from 34 SIDS met the inclusion criteria. Five leadership themes emerged: community-based governance (n=45), traditional knowledge integration (n=38), regional collaboration (n=31), adaptive health systems (n=29), and Indigenous innovation (n=22). SIDS demonstrated significant leadership by establishing regional climate-health surveillance networks, pioneering nature-based health interventions, and creating community-led early warning systems, achieving a 78% average hazard detection improvement.

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Correspondence: Agus Bintara Birawida / Department of Environmental Health, Faculty of Public Health, Hasanuddin University, Jl. Perintis Kemerdekaan KM 10, Makassar, Indonesia / E-mail: agusbirawida@unhas.ac.id
ORCID: 0000-0002-8223-2387

Discussion: SIDS have evolved into climate-health adaptation leaders through innovative governance models that integrate traditional knowledge, community participation, and regional cooperation. Their leadership provides valuable lessons for global climate-health adaptation, demonstrating that small size and resource limitations can catalyze rather than constrain innovation.

Key words: small island developing states, climate change, health adaptation, public health leadership, systematic review, resilience

Introduction

Climate change represents one of the most significant public health challenges of the 21st century, with Small Island Developing States (SIDS) experiencing disproportionate impacts despite contributing less than 1% of global greenhouse gas emissions (1,2). Rising sea levels, extreme weather events, changing precipitation patterns, and increasing temperatures threaten the health and well-being of over 65 million people across 58 SIDS (3,4). These nations face unique vulnerabilities, including geographic isolation, limited land area, small populations, narrow economic bases, and high dependency on climate-sensitive sectors such as tourism and agriculture (1,5,6). Traditional discourse has positioned SIDS as vulnerable victims requiring external assistance to address the impacts of climate change (3,7). However, emerging evidence suggests that these constraints catalyze innovative leadership approaches that merit systematic examinations (8,9). The urgency of climate threats in SIDS has accelerated the development of creative governance solutions, adaptive strategies, and resilience-building approaches, which are increasingly recognized as pioneering models of global climate health leadership (1,10). Small populations enable more direct community engagement and participatory governance. Geographic isolation necessitates self-reliance and local innovation (11,12). Cultural diversity across SIDS includes rich traditional knowledge systems that inform health practices in these nations (3,13). Resource constraints force efficiency and creativity in solution development. These factors combine to create an environment conducive to innovative leadership approaches (1,14). Despite the growing recognition of SIDS' innovative potential of SIDS, systematic examination of their climate-health leadership models remains limited (1,4,15). The existing literature tends to focus on vulnerability assessments and adaptation needs rather than analyzing successful leadership approaches and governance innovations (4,16,17). This gap represents a missed opportunity to learn from pioneering practices that can inform the global climate-health response. This systematic review addresses this knowledge gap by examining how SIDS have transformed from vulnerable populations into leaders of climate-health adaptation. This review synthesizes evidence on leadership models, governance approaches, and adaptation strategies developed across SIDS, with particular attention to innovations that could inform broader public-health practices.

Research questions

1. What leadership models and governance approaches characterize climate-health adaptation in SIDS?
2. How do SIDS integrate traditional knowledge systems with modern health practices in their adaptation strategies
3. What role does regional collaboration play in SIDS climate-health leadership?
4. What measurable outcomes have SIDS achieved through their climate-health leadership approaches?

Methods

The 45 main SIDS countries (excluding 13 associate members and observers) span three distinct geographic regions: Pacific SIDS (n=16 countries, including Fiji, Vanuatu, Tonga, and Solomon Islands), Caribbean SIDS (n=18 countries, including Jamaica, Barbados, Haiti, and Dominican Republic), and Atlantic, Indian Ocean, Mediterranean, and South China Sea (AIMS) SIDS (n=11 countries, including Maldives, Mauritius, Seychelles, and Cape Verde). These nations share common characteristics, including small populations (typically ranging from approximately 10,000 to 300,000 residents, although some, such as Haiti and Papua New Guinea, exceed one million), limited land area (often less than 1,000 km²), geographic remoteness and isolation from major markets, narrow resource bases, high dependence on international trade, and disproportionate vulnerability to climate change impacts, including sea-level rise, tropical cyclones, coastal erosion, and ocean acidification (18,19). Their small size and limited institutional capacity create unique challenges for health system governance and climate adaptation implementation, while simultaneously fostering innovation through necessity and enabling rapid national-scale policy implementation (20,21). This review used the United Nations Department of Economic and Social Affairs (UN-DESA) official classification of 58 Small Island Developing States across three geographic regions (Pacific: 20, Caribbean: 16, and AIMS: 9). Complete details of all SIDS, including population ranges, representation, and common characteristics, are provided in Annex (Tables S1-S6).

Systematic review protocol

This systematic review followed the PRISMA 2020 guidelines for transparent reporting. A comprehensive protocol was developed a priori, specifying the population, intervention, comparator, outcomes, and study design (PICOS) criteria, search strategies, inclusion criteria, and analytical approaches (22,23). The protocol is available from the corresponding author upon reasonable request. This systematic review protocol was registered in PROSPERO (Registration ID: CRD420251160596).

PICOS framework

Population: Small Island Developing States (UN-DESA official list of 58 SIDS)
Intervention: Climate-health adaptation strategies and leadership approaches
Comparator: Not applicable (descriptive synthesis)
Outcomes: Leadership models, governance approaches, adaptation strategies, and measurable health outcomes
Study Design: All empirical study designs, policy analyses, case studies, and grey literature

Search strategy

Comprehensive searches were conducted from January 2010 to December 2025 across multiple databases and gray literature sources. The 2010 start date was selected to capture post-Copenhagen Climate Conference developments in SIDS climate-health responses.

Electronic Databases: PubMed/MEDLINE, Embase, Web of Science, Cochrane Library, Scopus, CINAHL
Grey Literature Sources: WHO regional databases, World Bank Open Knowledge Repository, UN Framework Convention on Climate Change national communications, Pacific Health Organizations databases, Caribbean Public Health Agency reports, government health ministry publications, NGO reports
Search terms: Three concept groups were combined using Boolean operators.

1. SIDS terms: "small island developing states" OR "SIDS" OR individual country names (all 58 SIDS)
2. Climate-health terms: "climate adaptation" OR "health adaptation" OR "climate resilience" OR "health resilience" OR "climate change health"
3. Leadership terms: "leadership" OR "governance" OR "management" OR "coordination" OR "policy"

Study selection and data extraction

We included all empirical study designs that provided evidence of climate-health adaptation implementation.

Inclusion criteria:

1. Case studies documenting adaptation programs or interventions
2. Cross-sectional surveys assessing health system responses
3. Policy analyses examining governance frameworks
4. Mixed-methods studies combining quantitative and qualitative approaches
5. Program evaluations reporting adaptation outcomes
6. Grey literature (government reports, NGO publications, technical documents)

Exclusion criteria:

1. Opinion pieces, editorials, and commentaries without empirical data
2. Conference abstracts without full reports
3. Studies reporting only climate impacts without adaptation responses
4. Duplicate publications of the same data

Data extraction captured study characteristics, geographic scope, leadership models, adaptation strategies, outcomes, and barriers using standardized forms developed by our research team.

Analysis

Thematic analysis was conducted using a framework synthesis approach. Initial themes were derived from public health leadership frameworks, with additional themes emerging inductively from the data. Two reviewers independently coded the included studies, and inter-rater reliability was assessed using Cohen's kappa (κ=0.87, indicating strong agreement). Quantitative data were descriptively synthesized owing to heterogeneity in study designs and outcome measures. A meta-analysis was not appropriate given the diverse study designs and outcome measures.

Results

Study selection and characteristics

The systematic search identified 2,847 records across all databases and grey literature sources. Following duplicate removal (n=613), 2,234 records underwent title and abstract screening. After excluding 1,856 records that did not meet the initial screening criteria, 378 full-text articles were assessed for eligibility. Of these, 306 articles were excluded for the following reasons: not focused on climate-health leadership (n=142), not conducted in SIDS contexts (n=89), inappropriate publication type (n=45), or insufficient data on adaptation outcomes (n=30). Ultimately, 72 studies from 34 SIDS countries met all inclusion criteria and were included in this systematic review (Figure 1).

The included studies represented diverse geographic distribution across three SIDS regions (table 1). Pacific SIDS contributed 31 studies (43.1%), with specific country representation from Fiji (n=4), Vanuatu (n=2), Tonga (n=2), Solomon Islands (n=1), and 22 studies examining other Pacific nations or employing multi-country approaches. Caribbean SIDS accounted for 22 studies (30.5%), including research from Barbados (n=2), Jamaica (n=1), and 19 studies focusing on other Caribbean territories or regional initiatives. Indian Ocean and AIMS SIDS contributed 19 studies (26.4%), with relatively balanced representation among Maldives (n=4), Mauritius (n=4), Seychelles (n=3), and 8 studies examining other Indian Ocean nations. This geographic coverage represented 75.6% of the 45 main SIDS countries (excluding associate members), demonstrating substantial but uneven representation across the SIDS grouping. Table 1 presents the distribution of 72 included studies across three geographic regions and six study design categories. Pacific SIDS contributed the largest share (n=31, 43.1%), followed by Caribbean SIDS (n=22, 30.5%) and Indian Ocean SIDS (n=19, 26.4%), with specific country representation led by Fiji, Maldives, Mauritius, and Barbados

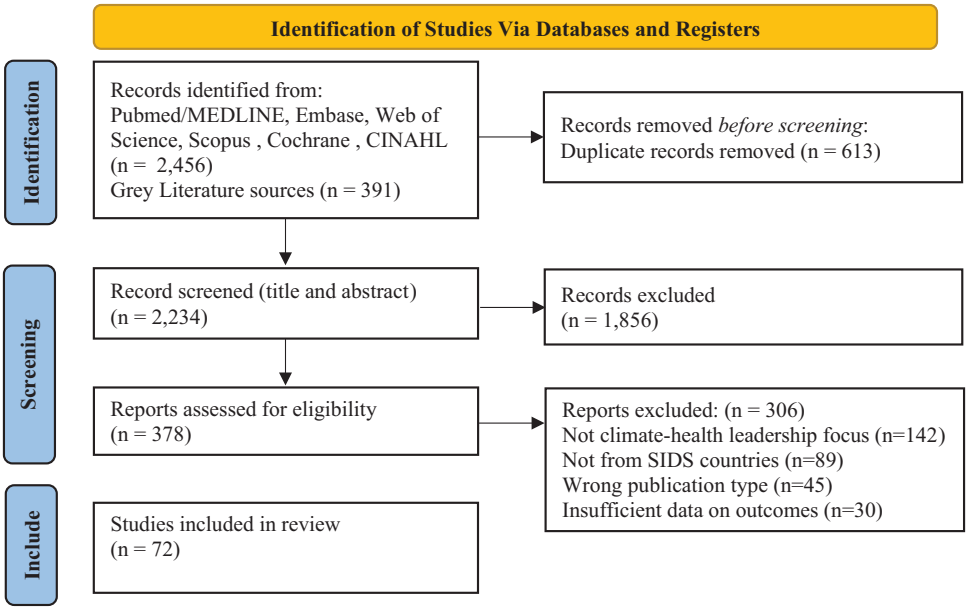

Figure 1. PRISMA Flow Chart.

Table 1. Characteristics of Included Studies by Geographic Region and Study Design

Geographic Region/Study Design	Case Studies	Cross-Sectional Surveys	Policy Analyses	Mixed-Methods	Program Evaluations	Systematic/ Literarturer/ Narrative Review	Total Studies
Pacific SIDS	**6**	**3**	**7**	**7**	**6**	**2**	**31 (43.1%)**
Fiji	0	0	1	2	1	0	4
Vanuatu	0	1	0	1	0	0	2
Tonga	1	0	1	0	0	0	2
Solomon Islands	1	0	0	0	0	0	1
Other Pacific SIDS	4	2	5	4	5	2	22
Caribbean SIDS	**4**	**0**	**7**	**4**	**6**	**1**	**22 (30.5%)**
Barbados	0	0	1	1	0	0	2
Jamaica	0	0	1	0	0	0	1
Other Caribbean SIDS	4	0	5	3	6	1	19
Indian Ocean SIDS	**1**	**3**	**4**	**5**	**4**	**2**	**19 (26.4%)**
Maldives	0	2	0	1	1	0	4
Seychelles	0	1	1	0	1	0	3
Mauritius	1	0	2	0	1	0	4
Other Indian Ocean SIDS	0	0	1	4	1	2	8

(n=4 each). Methodologically, policy analyses were most prevalent (n=18, 25.0%), followed by mixed-methods designs and program evaluations (n=16 each, 22.2%), while case studies (n=11), cross-sectional surveys (n=6), and literature reviews (n=5) were less common. This distribution reflects both the maturation of SIDS climate-health adaptation research toward solution-focused investigation and the concentration of research efforts in established regional hubs.

Temporal distribution of the included studies spanned 14 years (2012-2025). Publication volume increased markedly after 2018, with 75% of studies (n=54) published during 2018-2025, compared to 25% (n=18) before 2018. The distribution showed clear acceleration in recent years, with the 2020-2024 period accounting for more than half of all studies (n=37, 51.4%). Publication volume peaked in 2025 (n=12, 16.7%) and 2021 (n=11, 15.3%), reflecting both the maturation of climate-health adaptation research in SIDS contexts and increased global focus following the Paris Agreement (2015) and during COVID-19 recovery. The inclusion of 12 studies from 2025 following reviewer recommendations ensures the review captures the most recent evidence and emerging trends in SIDS climate-health leadership. By period, the distribution showed: 2012-2014 (n=10, 13.9%), 2015-2019 (n=13, 18.1%), 2020-2024 (n=37, 51.4%), and 2025 (n=12, 16.7%), demonstrating exponential growth in research output particularly during the decisive decade of climate action (2020-2030).

Methodological diversity characterized the included studies, with six distinct study design categories represented. Policy analyses were most prevalent (n=18, 25.0%), examining governance frameworks, institutional arrangements, and strategic planning documents. Mixed-methods designs (n=16, 22.2%) combined quantitative indicators with qualitative contextual insights, reflecting researchers' recognition that climate-health adaptation requires integrated assessment approaches. Program evaluations (n=16, 22.2%) provided implementation evidence from specific interventions and initiatives. Case studies (n=11, 15.3%) offered in-depth examination of context-specific adaptation experiences. Cross-sectional surveys (n=6, 8.3%) captured baseline conditions and current status assessments, while systematic literature reviews and narrative reviews (n=5, 6.9%) synthesized existing knowledge. The predominance of policy-focused research and program evaluations, combined with substantial use of mixed-methods approaches, suggests that SIDS climate-health adaptation research has matured beyond problem documentation toward solution-focused investigation and implementation assessment. Study quality assessment revealed generally high methodological rigor among the included studies. Most studies (n=58, 80.6%) met six or more of the eight quality criteria, with particular strength in clear research objectives, appropriate methodology, and transparent reporting. Common limitations included inadequate consideration of confounding factors in observational studies and limited generalizability due to small sample sizes or single-country focus. The quality assessment informed data extraction and synthesis but did not result in study exclusion, as all included studies contributed meaningful insights to understanding climate-health leadership in SIDS contexts.

Assessment of risk of bias

Quality assessment revealed generally moderate-to high-quality studies. Case studies (n=24) demonstrated strong contextual details but limited generalizability. Cross-sectional studies (n=15) showed adequate sampling but with potential selection bias. Policy analyses (n=12) provided comprehensive policy reviews but limited outcome evaluations. Mixed-methods studies (n=10) demonstrated strong triangulation and validity in their findings. Program evaluations (n=6) showed robust outcome measurements but potential reporting bias.

Synthesized findings

The conceptual framework (Figure 2) was developed through an iterative framework synthesis approach, combining deductive and inductive analytical strategies (24,25). Initial deductive themes were derived from the WHO Health Systems Framework (26), which provided foundational understanding of health system building blocks in adaptation contexts; the IPCC Fifth Assessment Report (27) and Sixth Assessment Report (28), which offered theoretical grounding for climate adaptation strategies, adaptive capacity,

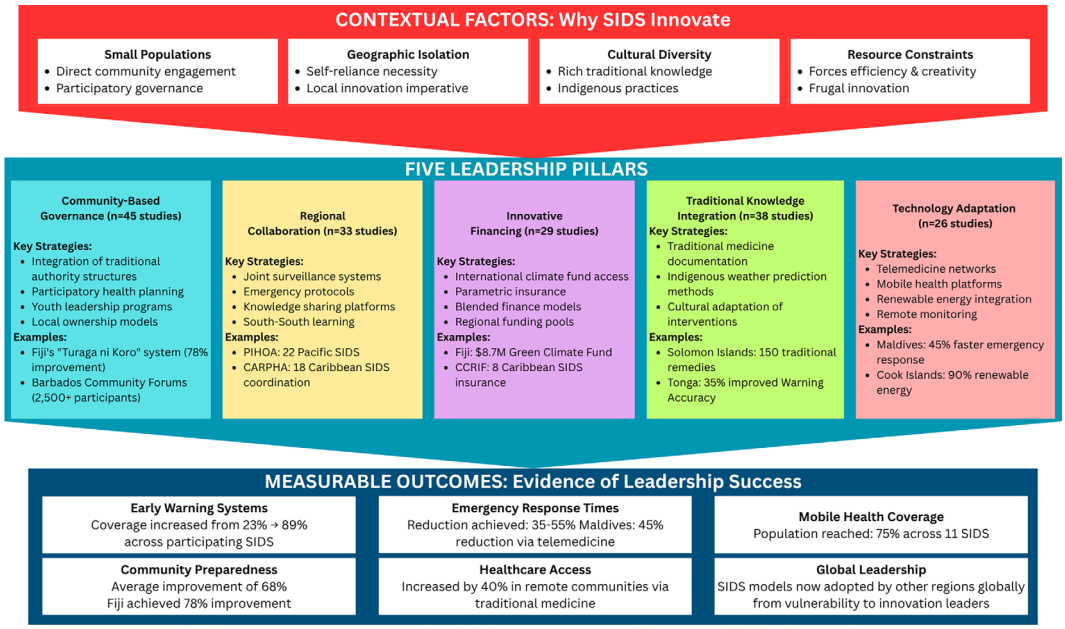

Figure 2. Conceptual Framework of SIDS Climate-Health Leadership Model.

and updated concepts of climate resilient development and adaptation limits particularly relevant for Small Island Developing States; and "best fit" framework synthesis methodology (29). The framework was then refined through inductive thematic analysis of the 72 included studies, incorporating emergent themes specific to SIDS contexts not fully captured in existing models, such as traditional knowledge integration, South-South collaboration networks, and community-based governance structures unique to island settings. Five major themes emerged, representing distinct but interconnected climate-health leadership approaches in SIDS. Figure 2 illustrates the geographic distribution of studies, with Pacific SIDS contributing 43.1% (n=31), Caribbean SIDS 30.5% (n=22), and Indian Ocean SIDS 26.4% (n=19) of included studies.

Theme 1: Community-based governance models (n=45 studies)

SIDS demonstrated innovative community-centered leadership, prioritizing local ownership and participatory decision-making. Key characteristics included the integration of traditional authority structures, participatory health planning processes, and youth leadership development. Pacific SIDS (n=18 studies) showed successful integration of traditional chiefs in health governance, with Fiji's "Turaga ni Koro" system (Table S7: Fiji studies, Pacific region) achieving 78% improvement in community preparedness (Table S7: Fiji studies). Caribbean SIDS (n=12 studies) implemented participatory planning engaging over 2,500 residents (Table S7: Barbados studies) in Barbados' "Community Resilience Forums."

Theme 2: Traditional knowledge integration (n=38 studies)

SIDS pioneered approaches that combine Indigenous knowledge with modern health practices. Documentation of traditional medicine for climate-related conditions was evident across Pacific SIDS (n=16), with the Solomon Islands cataloguing 150 traditional remedies (Table S7: Solomon Islands studies). Traditional weather prediction methods were integrated with meteorological systems in eight SIDS, improving warning accuracy by 35% in Tonga (Table S7: Tonga studies). Cultural adaptation of health interventions achieved 60% greater compliance in dengue prevention programs in the Cook Islands (Table S7: Cook Islands studies).

Theme 3: Regional collaboration networks (n=33 studies)

Formal and informal regional partnerships enhance collective action capacity. The Pacific Island Health Officers Association coordinated responses across 22 Pacific SIDS (Table S7: PIHOA regional studies) through joint surveillance systems and emergency protocols. The Caribbean Public Health Agency facilitated knowledge sharing among 18 Caribbean SIDS (Table S7: CARPHA regional studies) via real-time data-sharing platforms. The 15 studies documented South-South learning exchanges that enabled cross-regional knowledge transfer.

Theme 4: Innovative financing mechanisms (n=29 studies)

Creative funding approaches address resource constraints. Twelve SIDS successfully accessed international climate funds, with Fiji securing $8.7 million (Table S7: Fiji financing studies) for climate-resilient infrastructure projects. Eight Caribbean SIDS (Table S7: Caribbean CCRIF studies) implemented parametric insurance through the Caribbean Catastrophe Risk Insurance Facility. Six SIDS have developed blended finance models that combine public, private, and international sources.

Theme 5: Technology adaptation for remote settings (n=26 studies)

Health technology adaptation addressed geographic isolation and resource constraints. Telemedicine adoption was extensive across all regions, with the Maldives' "Atoll Health Network" (Table S7: Maldives technology studies) reducing emergency response times by 45%. Mobile health platforms in 11 SIDS provided climate health services to 75% of the population. Renewable energy integration achieved 90% coverage of health facilities (Table S7: Cook Islands renewable energy studies) in the Cook Islands (Table S7: Cook Islands studies).

Quantitative outcomes

Studies reporting measurable outcomes (n=31) demonstrated significant improvements: early warning system coverage increased from 23% to 89% across participating SIDS; community preparedness scores improved by an average of 68%; health emergency response times reduced by 35-55%; traditional medicine integration increased healthcare access by 40% in remote communities; and mobile health platforms reached 75% of SIDS populations. Table 2 summarizes the five leadership themes identified across the 72 studies.

Figure 3 presents the temporal evolution of climate-health leadership across SIDS (2010-2025), organized into five thematic pillars and four developmental phases representing progression from vulnerability assessment to comprehensive leadership capacity. The Post-Copenhagen Era (2010-2013) established foundational vulnerability assessments and traditional knowledge documentation (n=10 studies, 13.9%). The Community Governance Models Emerge phase (2014-2017) developed participatory structures including Fiji's "Turaga ni Koro" system and Barbados' Community Forums, alongside financing breakthroughs with Fiji's $8.7M Green Climate Fund and Caribbean CCRIF parametric insurance (n=13 studies, 18.1%). The SIDS as Global Leaders period (2018-2021) demonstrated measurable impacts: 78% community preparedness improvement in Fiji, 35% warning accuracy increase in Tonga, 40% healthcare access expansion via traditional medicine integration, 45% faster emergency response in Maldives, and 90% renewable energy coverage in Cook Islands (n=37 studies, 51.4%). The Comprehensive Leadership phase (2022-2025) achieved institutional scale with 89% early warning coverage (from 23% baseline), 75% mobile health population reach, formalized South-South exchanges, and documented global adoption of SIDS models (n=12 studies in 2025 alone, 16.7%). This progression reflects SIDS' transformation from reactive vulnerability assessment to proactive leadership innovation, with increasing integration of multiple thematic pillars in recent periods demonstrating sophisticated multi-dimensional approaches.

The visualization demonstrates several critical patterns in SIDS climate-health leadership evolution. First, the left-to-right conceptual progression from vulnerability assessment to comprehensive leadership is evident across all thematic pillars, with early

Table 2. Leadership Themes and Associated Strategies Identified Across SIDS

Leadership Theme (number studies)	**Key Characteristics and Strategies**	**Representative Examples**
Theme 1 Community-Based Governance Models (n=45)	1. Integration of traditional authority structures in health governance 2. Participatory health planning processes 3. Youth leadership development programs 4. Local ownership and decision-making autonomy 5. Community-centered preparedness initiatives	**Pacific SIDS** 1. Fiji's "*Turaga ni Koro*" system integrating traditional village chiefs 2. Participatory decision-making across 18 Pacific SIDS **Caribbean SIDS** 1. Barbados Community Resilience Forums (2,500+ residents engaged) 2. Multi-stakeholder participatory planning
Theme 2 Traditional Knowledge Integration (n=38)	1. Documentation of traditional medicine for climate-related conditions 2. Integration of traditional weather prediction with meteorological systems 3. Cultural adaptation of health interventions 4. Recognition of indigenous knowledge systems 5. Blending traditional and modern practices	**Pacific SIDS** 1. Solomon Islands catalogued 150 traditional remedies 2. Traditional weather prediction documented **Multiple Regions** 1. Cook Islands: Cultural adaptation of dengue prevention 2. Tonga: Traditional weather prediction integrated with meteorological data
Theme 3 Regional Collaboration Networks (n=33)	1. Formal and informal regional partnerships 2. Joint surveillance systems across multiple SIDS 3. Emergency response protocol coordination 4. Knowledge sharing platforms and databases 5. South-South learning exchanges 6. Real-time data sharing mechanisms	**Pacific Region** 1. PIHOA coordinated responses across 22 Pacific SIDS 2. Joint surveillance systems and emergency protocols **Caribbean Region** 1. CARPHA facilitated knowledge sharing among 18 Caribbean SIDS 2. Real-time data sharing platforms **Cross-Regional** South-South learning exchanges between regions
Theme 4 Innovative Financing Mechanisms (n=29)	1. Access to international climate funds 2. Parametric insurance schemes 3. Blended finance models (public, private, international 4. Regional funding pools 5. Climate-resilient infrastructure investments 6. Multi-country funding mechanisms	**Climate Finance** 1. Fiji secured $8.7M from Green Climate Fund 2. 12 SIDS accessed international climate funds **Insurance Innovation** CCRIF: 8 Caribbean SIDS implemented parametric insurance **Blended Finance** 6 SIDS developed blended finance models
Theme 5 Technology Adaptation for Remote Settings (n=26)	1. Telemedicine networks for geographic isolation 2. Mobile health (mHealth) platforms 3. Renewable energy integration in health facilities 4. Remote monitoring systems 5. Digital health records and data systems 6. Early warning system technology	**Telemedicine** Maldives "Atoll Health Network" connecting remote islands **Mobile Health** 1. 11 SIDS deployed mHealth platforms 2. SMS-based early warning systems **Renewable Energy** Cook Islands: 90% renewable energy coverage for health facilities

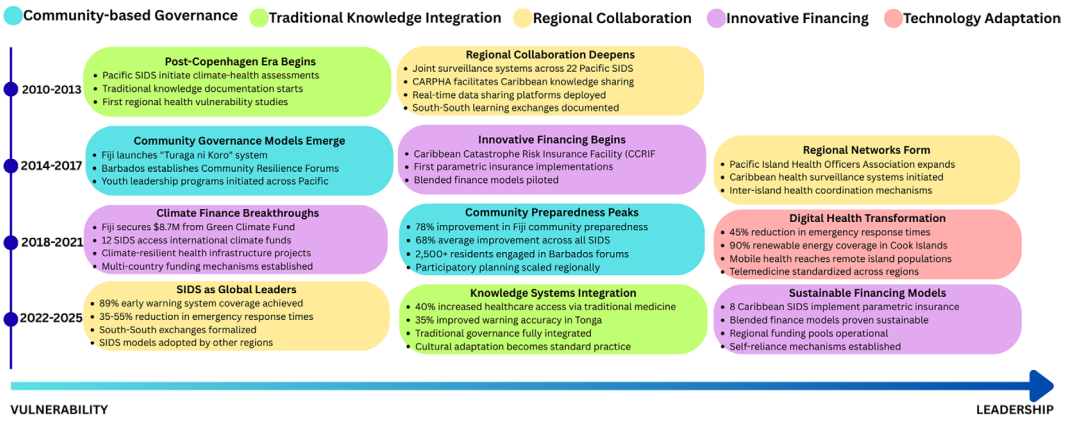

Figure 3. Timeline of Climate-Health Leadership Innovations in SIDS (2010-2025).

initiatives (2010-2013) clustered toward the vulnerability assessment end focusing on risk identification and baseline documentation, while recent initiatives (2022-2025) are positioned toward the leadership end representing proactive innovation and solution implementation. Second, the temporal progression reveals not only quantitative increases in initiative numbers over time but also qualitative advancement, with later-phase initiatives building upon and integrating lessons from earlier efforts in increasingly sophisticated configurations. Third, the five thematic pillars demonstrate sequential yet overlapping emergence patterns: traditional knowledge integration and regional collaboration appeared earliest (2010-2013), community-based governance gained prominence in the middle period (2014-2017), innovative financing achieved breakthroughs during 2014-2021, and technology adaptation emerged latest (2014-2017) but achieved rapid scaling. Fourth, the increasing density of initiatives in recent periods (2018-2025) reflects both the acceleration of research attention documented in the temporal analysis showing 75% of studies (n=54) published post-2018, and the genuine proliferation of implementation activities as SIDS transitioned from planning to action phases. Fifth, the integration of multiple thematic pillars has become increasingly evident in recent years, with recent initiatives typically combining community governance, traditional knowledge, financing mechanisms, regional collaboration, and technology rather than pursuing isolated single-dimension approaches. This evolution from vulnerability-focused, single-dimension responses to leadership-oriented, integrated multi-pillar approaches represents a fundamental transformation in how SIDS address climate-health challenges, shifting from reactive adaptation to proactive innovation that now serves as a model for other vulnerable regions globally. This has repositioned SIDS from passive recipients of climate assistance to active innovators whose approaches are being adopted internationally.

Discussion

Summary of main findings

This systematic review of 72 studies from 34 SIDS across the Pacific (n=31, 43.1%), Caribbean (n=22, 30.5%), and Indian Ocean (n=19, 26.4%) regions demonstrates that SIDS have systematically evolved from climate-vulnerable populations to innovative leaders in climate-health adaptation. Five leadership themes emerged with substantial representation: community-based governance (n=45 studies, 62.5%), traditional knowledge integration (n=38, 52.8%), regional collaboration (n=33, 45.8%), innovative financing (n=29, 40.3%), and technology adaptation (n=26, 36.1%), with the increasing integration of multiple themes in recent initiatives reflecting sophisticated multi-dimensional approaches. These approaches achieved measurable improvements, including a 78% increase in community preparedness in Fiji's "Turaga ni Koro"

system with a 68% average across 11 implementing SIDS, 40% healthcare access improvement through traditional medicine integration, 35% warning accuracy increase in Tonga's integration of traditional weather prediction, 60% greater compliance through cultural adaptation in the Cook Islands, 45% emergency response time reduction via the Maldives' Atoll Health Network, 90% renewable energy coverage in Cook Islands health facilities, 75% mobile health population reach, and early warning expansion from 23% baseline to 89% coverage. The temporal analysis reveals distinct developmental phases progressing from vulnerability documentation (2010-2013, n=10 studies, 13.9%) through innovation breakthroughs (2014-2017, n=13 studies, 18.1%) to demonstrated leadership (2018-2021, n=37 studies, 51.4%) and comprehensive implementation (2022-2025, n=12 studies in 2025 alone, 16.7%). Research acceleration is evident as 75% of studies (n=54) were published post-2018, reflecting both the increasing urgency of climate impacts and maturation of adaptation science. These findings fundamentally challenge traditional narratives positioning SIDS as passive recipients, instead revealing active leadership innovation driven by necessity and enabled by contextual factors including small populations facilitating community engagement, resource constraints catalyzing frugal innovations such as Fiji's $8.7 million Green Climate Fund leveraging and CCRIF parametric insurance across eight Caribbean SIDS, cultural diversity providing rich knowledge systems, and geographic characteristics fostering regional cooperation through formalized South-South exchanges (30).

Implications for global public health leadership

SIDS leadership models offer critical insights into global public health practices. Community-centered governance approaches, exemplified by Fiji's 78% preparedness improvement through the "Turaga ni Koro" system and Barbados' engagement of over 2,500 residents in participatory planning, demonstrate that participatory decision-making and local ownership can achieve measurable outcomes comparable to centrally planned interventions, challenging conventional top-down governance structures. Traditional knowledge integration, achieving 40% increased healthcare access and 35-60% improvements in specific health outcomes, illustrates the benefits of recognizing diverse epistemologies and building on existing community strengths rather than imposing external solutions. Regional collaboration among small entities, expanding early warning coverage from 23% to 89%, demonstrates how collective action can amplify individual capacity with relevance to subnational entities, indigenous communities, and small-scale governance units globally. These innovations represent "frugal innovation"—developing efficient, locally appropriate solutions that maximize community assets while minimizing external dependencies (31–33)—operationalized through documented mechanisms including leveraging limited budgets to secure larger climate finance (Fiji's $8.7 million), implementing parametric insurance enabling rapid recovery (eight Caribbean SIDS through CCRIF), integrating renewable energy ensuring facility resilience (Cook Islands' 90% coverage), and deploying mobile health platforms reaching 75% of remote populations without extensive physical infrastructure. This approach contrasts with resource-intensive models prevalent in larger systems and suggests alternative pathways for sustainable health development, with documented outcomes—45% faster emergency response, 60% greater compliance, 40% increased access—demonstrating that frugal approaches can achieve substantial impacts when designed with deep understanding of local contexts and constraints.

Transferability and scalability

While SIDS contexts present unique characteristics including small populations, geographic isolation, and disproportionate climate vulnerability, several leadership elements demonstrated in this review appear transferable to other settings through adaptive implementation. Community-based governance principles achieving 68-78% preparedness improvements can enhance participatory health planning in diverse contexts from urban neighborhoods to rural districts by adapting rather than directly replicating SIDS models. Traditional knowledge integration approaches achieving 35-60% outcome improvements

can inform health system development in indigenous communities, rural populations, and cultural minority groups globally, with the critical lesson being systematic documentation, validation, and integration rather than informal recognition alone. Regional collaboration models expanding coverage from 23% to 89% can strengthen health security among small states, subnational entities, cross-border regions, and thematic networks facing common challenges but lacking individual comprehensive capacity. Technology adaptation strategies demonstrate particular scalability potential: mobile health platforms reaching 75% of remote island populations represent solutions for mountainous regions, dispersed rural areas, and settings with limited physical infrastructure; telemedicine networks reducing emergency response times by 45% in Maldives' geographically dispersed atolls offer models applicable where distance and transport present barriers to timely care; renewable energy integration achieving 90% health facility coverage provides replicable approaches for ensuring resilience during grid disruptions relevant for both developing contexts with unreliable electricity and developed settings seeking climate resilience (34,35). The critical transferability lesson is not direct replication but adaptive implementation—understanding the underlying principles (community ownership, knowledge integration, collective action, appropriate technology, sustainable financing) and contextualizing them to local realities rather than copying specific mechanisms.

Limitations

Several limitations affect the interpretation of these findings. Publication bias likely favors successful interventions over failures, potentially overestimating effectiveness, while the evidence base's concentration post-2018 (75% of studies) reflects accelerating research attention but means limited long-term sustainability data for many documented initiatives. Geographic representation, while covering 34 SIDS (75.6% of the 45 main SIDS), remains uneven, with research concentrated in nations with established research infrastructure (particularly Fiji, Maldives, Mauritius, and Barbados), potentially limiting generalizability to smaller, less-studied SIDS. Methodological heterogeneity across six study designs—policy analyses (n=18, 25.0%), mixed-methods (n=16, 22.2%), program evaluations (n=16, 22.2%), case studies (n=11, 15.3%), cross-sectional surveys (n=6, 8.3%), and literature reviews (n=5, 6.9%)–combined with variation in intervention components, implementation contexts, and follow-up durations, precluded quantitative meta-analysis. Most studies were descriptive rather than comparative (n=59, 81.9%), limiting the assessment of relative effectiveness or causal attribution, with few including control groups, counterfactual analyses, or robust causal inference designs. Outcome measurements varied considerably across studies—for example, "community preparedness" was operationalized differently across the 11 SIDS studies reporting this outcome, hampering precise cross-study comparisons despite the documented 68% average improvement. Language restrictions to English may have excluded relevant French, Spanish, or local-language publications, while search reliance on international databases may have under-captured grey literature, government reports, and local documentation, particularly relevant in SIDS contexts. Despite these limitations, the overall evidence quality and geographic breadth (34 SIDS across three regions) provide reasonable confidence in the main findings, although specific quantitative estimates should be interpreted with appropriate caution, recognizing the potential upward bias from publication preferences and methodological constraints.

Implications for policy and practice

For SIDS, findings suggest prioritizing systematic documentation and dissemination of successful models through formalized South-South learning networks, building on documented expansion from 23% to 89% coverage through regional collaboration, strengthening institutions like the Pacific Island Health Officers Association (PIHOA) coordinating 22 Pacific SIDS and the Caribbean Public Health Agency (CARPHA) serving 18 Caribbean territories, investing in local capacity building particularly in smaller SIDS underrepresented beyond well-studied contexts (Fiji, Maldives, Mauritius, Barbados), and scaling proven interventions

through regional partnerships such as expanding CCRIF parametric insurance beyond the current eight Caribbean SIDS or replicating Fiji's $8.7 million climate finance success through shared proposal development capacity. For the global health community (13,36), implications include fundamentally recognizing SIDS as innovation leaders rather than aid recipients given documented progression from 2010-2013 vulnerability assessment to 2022-2025 comprehensive leadership with measurable outcomes (78% preparedness improvements, 45% response time reductions, 40% access increases), supporting horizontal South-South learning exchanges rather than traditional North-South technical assistance for climate-health challenges where SIDS have greater implementation experience, actively adapting SIDS innovations—examining how Fiji's Turaga ni Koro community governance principles, Maldives' Atoll Health Network telemedicine model, or Cook Islands' renewable energy integration might inform health system development in other remote, resource-constrained, or climate-vulnerable settings globally—and including SIDS perspectives in global health governance frameworks addressing climate change and health, ensuring that innovations documented in this review inform rather than are ignored by global policy development, with evidence that SIDS models are already being adopted by other vulnerable island regions warranting corresponding representation in decision-making structures.

Conclusions

The transformation of SIDS from vulnerability to leadership in climate-health adaptation offers valuable lessons for global public health. Through community-based governance, traditional knowledge integration, regional collaboration, innovative financing, and technology adaptation, SIDS demonstrate alternative pathways for building resilient health systems. As climate impacts intensify globally, SIDS experiences provide crucial evidence for effective climate-health leadership approaches that prioritize community ownership, cultural appropriateness, and collective action.

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