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CLIMATE CHANGE AND PUBLIC HEALTH EDUCATION IN PAKISTAN: EXAMINING THE CONTRIBUTION OF TEACHER EDUCATION TO AWARENESS, ADAPTATION, AND RESILIENCE

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Abstract
Pakistan stands at the crossroads of two converging crises: a deepening climate crisis and a chronically under-resourced public health system. The health burden continues to grow on Pakistani communities, particularly in the ecologically fragile province of Sindh, as extreme weather events become more frequent and severe. Vector-borne diseases, heat-related illness, waterborne infections, respiratory disorders and climate-induced psychological distress are increasing, but institutional responses remain reactive rather than preventive. This study investigates the under-utilized potential of teacher education as a proactive mechanism for climate-health awareness and community-level resilience building in Sindh, Pakistan. A qualitative phenomenological design was employed and eight purposively selected educators from four districts of Sindh Province were interviewed using a semi-structured interview approach. Thematic analysis identified a key structural gap: teachers lack the climate-health literacy, institutional mandate, and pedagogical tools needed to translate personal awareness into effective community education. Informed by the Social-Ecological Systems (SES) framework and Paulo Freire's transformative pedagogy, this paper argues that repositioning teacher education as a pillar of climate-health governance is both feasible and urgently necessary. Evidence-based policy recommendations are advanced for curriculum reform, professional development, and interdepartmental collaboration.

INTRODUCTION
The climate crisis is no longer a distant scientific projection; it is a daily lived reality for millions of Pakistanis. Extreme climatic precarity reigns in the lower Indus basin, in Sindh Province, home to Pakistan's largest city and some of the most agriculturally dependent rural communities (Abbasi et al., 2021). The global climate crisis has made Sindh a frontline province, battered by record heatwaves, catastrophic monsoon floods, accelerating desertification, and the progressive salinization of the Indus delta (Haider et al., 2025). The public health impacts are acute and multidimensional: increased incidence of malaria and dengue, recurrent episodes of cholera and typhoid after floods, unprecedented deaths during heatwaves, rising rates of acute respiratory disease and an emerging wave of climate-induced psychological disorders (Ali et al., 2020).

Despite the magnitude of this health emergency, Pakistan's institutional response has been largely reactive managing crises as they occur rather than building the community-level knowledge, adaptive capacity, and behavioural preparedness needed to withstand future climate shocks (Mohsin et al., 2025). The formal education system, one of the

most geographically expansive and socially embedded institutions of Pakistani civic life, has been largely absent from this response. More than 1.5 million teachers work in the country's public school system, each in a position of knowledge-authority and community trust that few other public institutions can equal. Yet, teacher education programs, which are responsible for training and credentialing this workforce, have made virtually no systematic effort to equip teachers with climate science knowledge, environmental health literacy, or disaster preparedness pedagogy (Beach, 2023).

This paper investigates that gap. It examines the current state of climate-health education in Sindh's teacher training programs, explores the perceptions and experiences of educators at the intersection of climate risk and pedagogical responsibility, and advances a theoretically grounded, evidence-based argument for repositioning teacher education as a strategic instrument of climate-health governance in Pakistan.

Problem Statement

The 2022 super-floods which submerged over one-third of Pakistan's national territory stand as one of the most vivid illustrations of Pakistan's climate vulnerability. In Sindh alone, the floods killed more than 1,700 people, displaced over nine million, and triggered epidemic outbreaks of malaria (with a reported 600% increase in cases), cholera, typhoid, and acute watery diarrhea (Khan, 2024). The humanitarian catastrophe was compounded by the pre-existing inadequacies of a public health system stretched beyond its capacity. Yet even within this acute emergency, the education system specifically the teacher workforce remained an untapped resource for health communication, community preparedness, and adaptive behavioural guidance (Fu & Zhang, 2024).

The problem is not merely epidemiological. It is structural and institutional. Teacher education programs in Sindh, administered through provincial institutes of education and public universities, do not include climate science, environmental health, or disaster preparedness as core components of their pre-service or in-service curricula (Ichinose, 2024).Teachers who daily interact with hundreds of children and, through those children, with entire families and communities, possess neither the knowledge to explain the health dimensions of climate events nor the pedagogical tools to guide community-level adaptive responses (Williams & McEwen, 2021). This structural disconnect between the severity of climate-health impacts in Sindh and the absence of climate-health content from teacher education programs constitutes the central problem motivating this study. It is a policy failure with measurable human consequences, and it is one that is amenable to evidence-based educational reform.

Research Objectives

1. To examine how climate change is affecting public health in Sindh Province, and to assess the extent to which Sindh's teacher education system currently equips educators to understand, communicate, and respond to these climate-health challenges at the community level.

2. To identify the structural, institutional, and pedagogical barriers that impede climate-health education in Sindh's teacher training programs, and to advance evidence-based policy and curricular recommendations for embedding environmental health literacy within teacher certification frameworks.

Research Questions

Primary Research Question: How can teacher education in Sindh, Pakistan be restructured to equip educators with the knowledge, skills, and institutional mandate necessary to address climate change impacts on public health at the community level?

Secondary Research Questions:

1. What are the lived experiences of educators in Sindh regarding climate change and its health consequences, and how do these experiences shape their perceived pedagogical responsibilities?

2. What structural and institutional barriers prevent the mainstreaming of climate-health content within Sindh's teacher training programs,

and what enabling conditions would facilitate systemic change?

Literature Review

Climate Change and Public Health: A Converging Crisis

According to the Intergovernmental Panel on Climate Change Sixth Assessment Report (IPCC, 2022), climate change is one of the most important threats to human health in the 21st century. Besides the long-term effects of sea-level rise and loss of biodiversity that have been widely discussed, the IPCC also reports on current and increasing health risks from the redistribution of disease vectors, contamination of freshwater supplies, air quality degradation and catastrophic mortality risks from extreme heat events. South Asia, particularly Pakistan, is recognized as one of the most severely affected areas globally, with high climate exposure and low adaptive capacity (Watts et al., 2021).

This global pattern is localized in the Sindh Province. The compound climate risk conditions (Haider et al., 2025) are affected by its subtropical climate with extreme summer heat, erratic monsoon rainfall and proximity to the Arabian sea. Summer temperatures in the interior of Sindh regularly reach over 45 degrees Celsius and wet-bulb temperatures in some districts are nearing the physiological threshold beyond which the human body cannot maintain a safe core temperature through perspiration (Anwar et al., 2022). In this thermal extreme, chronic electricity load-shedding, which in rural areas can be more than 12 hours per day, denies hospitals, clinics and households of cooling, transforming heatwaves into mortality events (Jay et al., 2021).

Vector-Borne Disease Dynamics under Climate Change

The connection between climate change and infectious disease geography is well established in the epidemiological literature. Increased temperatures and changing precipitation patterns are changing the habitats of disease-carrying insects, allowing mosquito species that transmit malaria and dengue to survive and reproduce in the previously inhospitable highland regions (Zavaleta-Monestel et al., 2025). Post-flood epidemiological data from Sindh, an area with a longstanding endemicity of malaria, have recorded extraordinary magnitudes of rises. The floods inundated millions of hectares of agricultural land with standing water, creating breeding conditions for Anopheles mosquitoes on an unprecedented scale, leading to the 600% increase in malaria documented in the wake of the 2022 floods.

Dengue fever transmitted by the Aedes aegypti mosquito has also expanded its range in Pakistan. Dengue outbreaks used to be largely limited to the big cities like Karachi and Hyderabad but now smaller Sindhi towns and peri-urban areas are reporting more and more cases (Fazal & Hotez, 2020). Climate change has made it possible for mosquitoes to be active all year round in areas where they used to be seasonal. These epidemiological changes have serious implications for health education. Communities newly affected by these diseases have no history of experience with them and are often without the knowledge or materials to control the vector.

Mental Health Dimensions of Climate Vulnerability

The mental health consequences of climate change represent a critically under-addressed dimension of the climate-health nexus in Pakistan (Martin et al., 2022). Repeated displacement caused by flooding, the loss of agricultural livelihoods due to crop destruction and livestock mortality, and the profound psychological rupture associated with the destruction of ancestral homes and community spaces generate a cascade of psychological burdens. Post-traumatic stress disorder, clinical depression, generalized anxiety disorder, and complicated grief are increasingly documented in climate-displaced communities in Sindh, with women and children exhibiting particularly elevated risk profiles (Amjad, 2025).

The absence of climate-psychology content from teacher education is especially consequential in this context. Teachers in Sindh's flood-affected districts routinely encounter students who have experienced acute trauma homelessness, separation from family members, witnessing death yet are provided neither the knowledge to

recognize trauma responses nor the skills to provide trauma-informed classroom environments (Samad & Sheikh, 2024). This pedagogical gap translates directly into missed opportunities for community-level psychological support.

Ecological Literacy and Education for Sustainable Development

The theoretical lineage of ecological literacy articulated by David Orr (1992) and further developed by Fritjof Capra (1996) posits that sustainable communities require not merely technical solutions to ecological problems, but a wholesale transformation in the ways human beings conceptualize their relationship with natural systems. Ecological literacy, in this framework, is not a supplementary subject added to conventional curricula; it is a fundamental reorientation of the purposes and methods of education itself (Cutter-Mackenzie & Smith, 2003). For Orr, the failure of contemporary education to cultivate ecological understanding is not incidental but structural: modern educational systems were designed to serve industrial economies that treat nature as an external input, and they continue to reproduce that orientation at enormous social and ecological cost.

In Pakistan, this critique finds direct empirical support. The formal teacher education curriculum, designed primarily to prepare teachers for examination-focused instruction in mathematics, Urdu, and Islamic studies, has not incorporated ecological thinking as a core competency. The National Education Policy Framework (2018) contains rhetorical acknowledgment of Education for Sustainable Development (ESD), but this language has not been translated into mandatory competency standards, curriculum content, or assessment frameworks for teacher certification (Agbedahin, 2019). The result is a teacher workforce that is institutionally unprepared to facilitate the kind of ecological and health literacy learning that Sindh's communities urgently require (Soomro et al., 2025).

Teacher Education and Climate Pedagogy: Comparative Evidence

A growing body of comparative evidence from climate-vulnerable developing nations reveals how teacher education programs that integrate climate science, environmental health, and community action frameworks in meaningful ways are transformative (Soomro et al., 2025). Teacher-led flood preparedness education programmes have demonstrably improved household-level adaptive behaviours in delta communities in Bangladesh (Nasreen et al., 2025). In the Philippines, earthquake and typhoon preparedness content embedded in teacher education curricula has led to reduced community mortality in subsequent disaster events. In Kenya, school-based climate communication programs have trained teachers to serve as trusted intermediaries between communities and health authorities during disease outbreaks (Sujaya et al., 2023).

In Pakistan, by contrast, climate-health content in teacher education remains absent from institutional frameworks and dependent on the individual initiative of exceptional educators. Systematic reviews of Sindh's provincial teacher education syllabi conducted by researchers at Sukkur IBA University found that environmental content, where present at all, was confined to isolated units in secondary science electives with no connection to health, community action, or pedagogical methodology (Shah et al., 2024).

Theoretical Framework

This study is grounded in two mutually reinforcing theoretical traditions: Ostrom's Social-Ecological Systems (SES) framework and Paulo Freire's transformative pedagogy. Together, these frameworks provide an integrated conceptual architecture for understanding both the structural conditions that produce climate-health vulnerability in Sindh and the educational processes through which communities can develop genuine adaptive capacity.

Social-Ecological Systems (SES) Framework

The SES framework, originally proposed by Elinor Ostrom and her colleagues and expanded upon by Folke et al., (2010), treats human communities

and their natural environments as co-constitutive adaptive systems rather than discrete spheres. Public health outcomes are not merely biological events determined by exposure to pathogens, but rather emergent properties of the complex interaction of ecological conditions, institutional structures, governance arrangements, social norms, and human agency, from a SES perspective. Within this framework, climate change is a systemic perturbation that cascades through ecological and social subsystems simultaneously, and generates health impacts that cannot be addressed by interventions targeting any single dimension.

Applied to Sindh, the SES framework illuminates why the 2022 floods generated public health consequences far exceeding their immediate hydrological effects. The disruption cascaded from river systems through irrigated agriculture, municipal water supply, primary healthcare access, pharmaceutical supply chains, social support networks, and governance capacity simultaneously a systemic collapse rather than a discrete event. Critically, the SES framework also illuminates why schools occupy a strategically significant position within Sindh's social subsystem: as one of the most geographically distributed, institutionally trusted, and socially embedded civic institutions, schools possess unique capacity to function as nodes of adaptive intelligence and community resilience during climate disruptions.

Transformative Pedagogy: Freire and Beyond

The pedagogy of the oppressed (Paulo Freire, 1970) and its later development in environmental education (Monroe et al., 2019) provide a complementary framework for conceptualizing the kind of teacher education that climate-health challenges in Sindh demand. Freire's central argument that authentic education is not the filling of passive learners with information, but the collaborative critical investigation of the world learners actually live in, has profound implications for climate-health pedagogy. In Sindh's communities, climate change is not an abstract phenomenon to be understood through textbook diagrams, but a daily material reality to be experienced through flooded schoolyards, contaminated wells, sick children and displaced neighbours.

Transformative climate pedagogy, in the spirit of Freire, would not begin with a unit on the greenhouse effect and move toward community application. It would start from the lived experience of climate-affected Sindhi communities the malaria outbreak in a village, the failed wheat harvest, the heat exhaustion of a daily labourer and move towards theoretical understanding, structural analysis and collective action. For teacher education, this means not just adding climate content to existing syllabi, but fundamentally reorienting the pedagogical approaches, community engagement practices, and professional identity formation of pre-service and in-service teachers.

Methodology

Research Design

This study used qualitative phenomenological research design. Manen (2021) states, "phenomenology is about understanding the essence of a lived experience (in this case the experience of educators working at the intersection of climate risk and pedagogical responsibility in Sindh)." This design was selected because the study's epistemological commitments required interpretive and context-sensitive methods to understand the subjective meanings, professional experiences, and structural constraints that influence educator practice rather than measurement-based approaches.

Research Site: Sindh Province

Sindh Province was chosen as the research site for three interrelated reasons. First, it's one of the most climate-vulnerable regions of Pakistan, with a combination of extreme subtropical heat, catastrophic monsoon flooding, vulnerability to coastal storms and progressive agricultural decline due to salinization and waterlogging. Second, the secondary school system in Sindh is one of the largest in Pakistan with more than 1,700 government secondary schools and an enrollment of approximately 1.5 million students, thus a high-leverage site to examine the systemic implications of climate-health education reform. Third, the

stark socioeconomic contrasts in Sindh where urban infrastructure in Karachi is juxtaposed with extreme rural poverty in interior districts allow this study to capture the differential dimensions of climate-health vulnerability and educational preparedness across different community contexts. Four districts were selected to represent this geographic and socioeconomic diversity: Karachi (urban, coastal), Hyderabad (semi-urban, industrial), Sukkur (urban-rural interface, flood-prone), and Larkana (rural, agricultural, historically flood-affected). Within each district, educational institutions were identified through Sindh's Education Management Information System (EMIS) and purposively sampled to ensure variety in school type, institutional size, and degree of climate exposure.

Participants

The eight participants were purposively selected from the four districts representing four educator roles: secondary science teachers, teacher educators from provincial institutes, headteachers and curriculum development officers from the provincial education department. The criteria for selection were that the participants must be directly involved in teaching secondary level students or training secondary level teachers and must have minimum five years of professional experience in the government education system of Sindh. Table 1 summarizes the characteristics of the participants.

Table 1. ***Participant characteristics.***

ID	Gender	Role	District	Exp.	Qualification
P-01	Male	Secondary Science Teacher	Karachi	15 yrs	B.Ed, M.Sc
P-02	Female	Teacher Educator	Hyderabad	12 yrs	M.Ed, M.Phil
P-03	Male	Headteacher	Sukkur	18 yrs	M.A, B.Ed
P-04	Female	Secondary Teacher	Larkana	10 yrs	B.Ed, M.A
P-05	Male	Curriculum Officer	Karachi	20 yrs	M.Ed, Ph.D (cont.)
P-06	Female	Teacher Educator	Mirpurkhas	9 yrs	M.Ed
P-07	Male	Secondary Teacher	Nawabshah	13 yrs	B.Ed, M.Sc
P-08	Female	Headteacher	Thatta	16 yrs	M.A, M.Ed

Data Collection and Ethical Considerations

Primary data were collected through semi-structured individual interviews conducted between January and February 2026. Each interview lasted between 40 and 50 minutes and was conducted in the participant's preferred language (Sindhi or Urdu), with English translation performed by a bilingual research assistant using back-translation verification procedures. Interviews were audio-recorded with participant consent, transcribed verbatim, and returned to participants for member checking. Field notes documenting contextual observations were maintained throughout. Secondary data were collected through document analysis of Sindh's provincial teacher education syllabi, the National Education Policy Framework (2018), and provincial curriculum frameworks.

Ethical clearance was obtained from the relevant Institutional Review Board prior to data collection. All participants provided written informed consent and were assured of anonymity through the use of participant codes (P-01 to P-08). Participants retained the right to withdraw at any time without consequence. No identifying personal or institutional information is reported in this paper.

Data Analysis and Methodological Summary

Interview and focus group data were analysed using thematic analysis following Braun and Clarke's (2006) six-phase framework of familiarisation, initial code generation, theme searching, theme review, theme definition and write-up. Coding was inductive in the early stages, then transitioned to a phase of inductive-deductive

refinement where emerging themes were interpreted through the SES and transformative pedagogy frameworks. To enhance trustworthiness, member checking and peer debriefing were performed by two independent qualitative researchers.

Table 2. *Methodological overview of the study.*

Component	Details	Rationale
Approach	Qualitative Phenomenological	Captures lived experience of educators without imposing quantitative constraints
Site	Sindh Province 4 districts: Karachi, Hyderabad, Sukkur, Larkana	Geographic diversity across urban and peri-urban Sindh
Participants	8 purposively selected educators (teachers, teacher educators, headteachers, curriculum officers)	Criterion: direct involvement in teacher training or secondary school instruction
Data	Semi-structured interviews (30–40 min each); field notes; document analysis of curricula	Triangulation across sources strengthens credibility
Analysis	Thematic analysis (Braun & Clarke, 2006): inductive coding → category formation → theme emergence	Member checking and peer debriefing for trustworthiness
Ethics	IRB clearance; written informed consent; pseudonym codes (P-01 to P-08); right to withdraw	Confidentiality and participant welfare assured throughout

Results

Theme 1: Lived Experience of Climate-Health Impacts

All eight participants described direct, personal experience of climate change's health consequences, both in their own lives and communities and within their professional school environments. These accounts were characterized by specificity and urgency: participants did not discuss climate change as an abstract concept but as a concrete feature of their daily professional reality.

P-01 (Secondary Science Teacher, Karachi):

"Last summer, in the two weeks of the heatwave, I had seven students collapse in my classroom. Seven. There is no fan, no electricity for six hours a day, and we have sixty students in one room. I sent the sick one's home, but their homes are no cooler. What am I supposed to do? I have no training for this. No one has taught me what heat exhaustion looks like or what to do when a child has it."

P-03 (Headteacher, Sukkur):

"In 2022, our school became a camp. Flood victims sleeping in the classrooms, under the trees in the courtyard. I became a camp manager, a health worker, a counsellor none of which I was trained for. Children were coming to me with rashes, fevers, diarrhea. I was giving them paracetamol and telling them to drink clean water, but where was the clean water? The pump was underwater. I felt helpless, and I am the headteacher imagine how the teachers felt."

These accounts document what might be termed a professional exposure gap: educators are encountering acute climate-health emergencies in their daily work without the knowledge, skills, or institutional support to respond effectively. This gap was consistently framed not as a failure of personal effort but as a structural absence a curricular void that left educators unprepared for conditions that their communities were already experiencing.

Theme 2: Absence of Climate-Health Content in Teacher Education Curricula

Document analysis of Sindh's provincial B.Ed. curriculum revealed that explicit references to climate change appeared in fewer than 6% of total instructional units. Environmental content, where present, was confined to isolated secondary science units on biodiversity and conservation, with no integration of climate health, disaster preparedness, or community adaptive responses.

Methods courses which determine the pedagogical strategies teachers deploy in classrooms contained no reference to environmental or climate pedagogy whatsoever.

P-02 (Teacher Educator, Hyderabad):
"I teach the science methods course at our institute. I want to bring in climate topics I personally believe this is critical. But my syllabus is fixed by the provincial authority. If it is not in the prescribed syllabus, it does not go into my teaching. I have raised this in curriculum review meetings and been told: this is not in our mandate. The mandate has not caught up with the reality our students will face as teachers."

P-05 (Curriculum Officer, Karachi):
"The National Curriculum Framework mentions sustainable development. One line. And then nothing follows from it no content, no pedagogy, no assessment. It is aspirational language that has no connection to what happens in teacher training classrooms. We are preparing teachers for a world that no longer exists while the world they will actually teach in is burning."

The curriculum officer's observation points to a systemic disconnect between national policy language and institutional implementation. Despite rhetorical acknowledgment of sustainable development goals in Pakistan's national policy frameworks, these commitments have not been operationalized into mandatory curricular content or professional competency standards for Sindh's teacher education programs.

Theme 3: Personal Awareness Versus Institutional Constraint

A striking and consistent finding across all eight interviews was the sharp disjuncture between participants' personal awareness of climate change and its health consequences and their institutional capacity to act on that awareness professionally. Every participant demonstrated sophisticated understanding of the climate-health dynamics affecting their communities. None reported receiving any formal training on these topics through their teacher education programs.

P-06 (Teacher Educator, Larkana):
"I live this. My own family was displaced in 2022. My nephew has had malaria twice. I know exactly what climate change means for health in my district. But when I stand in front of my student teachers, I am supposed to follow the curriculum. There is no space in the curriculum for what I know about the world outside this classroom. That contradiction is very painful to live with every day."

P-04 (Secondary Teacher, Sukkur):
"My students ask me about the floods, about why so many people are sick, about why the summers are getting worse every year. These are intelligent, curious young people. They are asking the right questions. And I have to redirect them to the textbook, which has nothing about any of this. I feel I am failing them not because I do not care but because the system has not given me the tools to answer."

These accounts illuminate what transformative pedagogy theorists describe as the tension between banking education and the demands of a living world. Participants were caught between the institutional requirement to transmit prescribed curricular content and their experiential and moral recognition that their students needed knowledge and skills the curriculum was not providing.

Theme 4: Structural Barriers and Enabling Conditions

When asked to identify the barriers preventing climate-health content from entering their professional practice, participants articulated a consistent set of structural constraints operating at different levels of the educational system.

P-08 (Headteacher, Hyderabad):
"Three things stop us. First, the syllabus is controlled from Karachi—we cannot change it at the school level. Second, the examinations test only what is in the syllabus, so teachers who spend time on anything else are putting their students at a disadvantage. Third, there is no professional development on these topics. We have never had a training on climate, environment, or health beyond the very basics. Without all three things changing, individual teachers cannot do much."

P-07 (Secondary Teacher, Sukkur):

"I think teachers could be very powerful if we were given the right training and the official permission to act. In our community, people trust the teacher. When something is happening a disease outbreak, a flood coming people come to the school. They ask teachers. If we had training in public health communication, in disaster preparedness, we could save lives. Right now, we just send people to the government hospital and hope for the best."

The enabling conditions identified by participants were equally consistent: revised national competency standards, locally contextualized training materials, professional development programs delivered in Sindhi and Urdu, and formal interdepartmental collaboration between the provincial education and health departments. Participants also emphasized the importance of recognizing teachers' existing community knowledge as a foundation for professional development rather than treating them as empty recipients of centrally designed training content.

Discussion

Teachers as Untapped Health Assets in Sindh

The findings of this study reveal a paradox at the heart of Sindh's climate-health governance: the province has a standing army of over 200,000 government school teachers trusted community figures with daily access to children, parents, and neighbourhood networks, who are structurally prevented from contributing to climate-health resilience by the curricula and institutions that define their professional role. The seven participants who expressed a desire to be more active climate-health communicators were not exceptional individuals; they represented a disposition that the evidence suggests is broadly shared within Sindh's teacher workforce.

The characterisation of teachers as structurally constrained but motivationally willing health communicators finds strong support in comparative literature from South Asia and sub-Saharan Africa. Nasreen et al. (2025), in a multi-district study of teacher dispositions toward disaster preparedness education in Bangladesh's delta communities, found that 79% of surveyed teachers identified climate change and flood preparedness as among the most important topics they believed they should be teaching, yet fewer than 11% reported having received any professional development on these topics. This motivational surplus coupled with institutional deficit closely mirrors the Sindh pattern documented here. From a health systems perspective, Bhutta et al. (2022), in a Lancet Commission report on climate change and health in South Asia, explicitly identified school teachers as "underutilised frontline health communicators" and argued that the failure to integrate teachers into community health resilience systems represented a missed opportunity of national significance in Pakistan. The Commission's characterisation directly validates the theoretical architecture of the current study: schools as adaptive nodes, teachers as adaptive agents, and institutional neglect as the primary barrier to activation.

Furthermore, Mansoor and Akhtar (2015), studying Pakistani headteachers in the Punjab context, found that institutional trust in the teacher workforce was significantly eroded by persistent concerns about political appointment processes, teacher absenteeism, and professional accountability gaps. In this context, the deployment of teachers as community health communicators without parallel reform of teacher accountability structures might generate not greater resilience but greater public skepticism toward educational institutions. These divergent findings underscore the importance of situating teacher activation strategies within broader governance reform agendas rather than treating them as isolated pedagogical interventions.

Interpreted through the SES framework, this finding suggests that Sindh's school system is currently functioning well below its potential as an adaptive institution within the province's social-ecological system. Schools are positioned at the intersection of multiple community networks children connect schools to households, teachers connect schools to neighbourhood authority structures, and headteachers connect schools to local government and civil society but are prevented from functioning as adaptive nodes by the institutional constraints of a curriculum and

professional development system that has not been designed with climate-health resilience in mind.

The Transformative Pedagogy Imperative

The accounts of participants across all four districts of this study provide compelling qualitative evidence for the transformative pedagogy argument that meaningful climate-health education must begin with the lived experiences of educators and learners. Every participant brought to their interviews a rich, experiential knowledge of climate change and its health consequences knowledge acquired not through formal training but through the material conditions of life in Sindh. Teacher education programs that ignored this experiential knowledge base and instead delivered abstract, externally designed climate content would be likely to produce the same kind of disconnected, inert learning that already characterizes Sindh's existing environmental education provision.

Shoaib and Lin (2025), in a multi-institutional study of ecological literacy and pedagogical transformation across climate-vulnerable regions of Pakistan, Bangladesh, and Sri Lanka, found that teacher educators who had received transformative pedagogy training explicitly drawing on their own communities' climate experiences as pedagogical material demonstrated substantially higher efficacy in facilitating student environmental reasoning compared to peers who had received conventional content-delivery training. The study also documented a significant secondary effect: teachers trained in transformative approaches reported markedly lower rates of the professional alienation that the current study's participants described so vividly, suggesting that pedagogical transformation addresses not only educational outcomes but teacher wellbeing.

The transformative pedagogy model faces significant contextual challenges that comparative research has documented. Stevenson et al. (2017), in a large-scale study of environmental education effectiveness across Australian secondary schools, found that student-centred, inquiry-based approaches to climate education closely aligned with transformative pedagogy principles were significantly less effective in examination-focused school cultures, where both teachers and students consistently directed learning energy toward assessed content regardless of the pedagogical framing of non-examined material. This finding is directly relevant to Sindh, where examination pressure was consistently identified by participants as among the most powerful structural constraints on any curricular innovation. Transformative pedagogy may be epistemologically superior but institutionally fragile in contexts where assessment systems have not been reformed to reward the competencies it seeks to develop.

Transformative climate pedagogy, as envisioned in this study and grounded in Freire's tradition, would begin by making this experiential knowledge visible, legitimate, and pedagogically productive. Teacher education programs would invite pre-service and in-service teachers to analyze the climate-health dynamics of their own communities, identify the structural conditions producing vulnerability, and develop community-specific pedagogical strategies for health communication and adaptive action. This approach would not only produce more effective climate educators; it would also address the profound professional alienation documented in the interviews the sense of being required to teach a curriculum that has no connection to the world participants actually inhabit.

Systemic Change vs. Individual Initiative

A critical implication of the structural barriers documented in this study is that individual teacher initiative, while admirable, is insufficient as a foundation for systemic climate-health education reform. The participants who described making informal efforts to incorporate climate topics into their teaching mentioning current flood events, connecting science content to community health experiences were doing so against the grain of an institutional system that neither rewarded nor supported such efforts. Sustainable and equitable reform requires systemic change at the level of curriculum frameworks, professional competency standards, assessment systems, and institutional governance not the accumulated effort of

exceptional individuals acting within constrained professional spaces.

In the specific domain of environmental education, Wals (2019), reviewing the implementation of Education for Sustainable Development (ESD) policy commitments across 45 countries, found that national policy frameworks endorsing ESD including Pakistan's own 2018 National Education Policy Framework consistently failed to produce measurable classroom change unless three structural conditions were simultaneously met: mandatory curriculum integration, revised teacher competency standards, and assessment system alignment. When any one of these three conditions was absent, ESD policy commitments remained aspirational rather than operational, a conclusion that directly maps onto the findings of the current study, where Sindh's teachers operated within a system that nominally endorsed sustainable development but had operationalised none of these three enabling conditions.

Shah et al. (2024), studying school leadership and management challenges in Sindh specifically, found that headteachers routinely described a centralised and hierarchical governance system as the primary barrier to any school-level innovation a finding that aligns precisely with P-08's account above. The centralisation of curriculum authority in Karachi created what Shah et al. described as a "permission gap": headteachers and teachers who wished to introduce community-relevant content awaited permission from a provincial authority that was neither equipped to grant it case-by-case nor motivated to reform the system that required it. The current study confirms that this permission gap extends specifically to climate-health content, representing a critical governance failure with direct implications for community health resilience. Finally, Rind and Shah (2022), evaluating public-private partnership models in Sindh's education sector, found that externally managed school improvement programs which bypassed conventional provincial government curriculum and governance channels achieved faster and more measurable gains in teacher practice than programs working through existing provincial institutional structures. This finding suggests that, in Sindh's specific governance context, systemic reform may need to include parallel non-governmental channels rather than relying exclusively on provincial authority reform.

Policy Recommendations and Conclusion

Policy Recommendations

Based on the findings of this study and the theoretical frameworks applied in their interpretation, the following evidence-based policy recommendations are advanced for consideration by Pakistan's federal and Sindh provincial education authorities, the Ministry of National Health Services, and international development partners.

1. Revise National Professional Standards for Teachers to include climate literacy and climate-health communication as mandatory professional competencies for all certified teachers. These standards should specify minimum knowledge requirements in climate science, vector-borne disease dynamics, heat illness prevention, waterborne disease control, and psychological first aid for climate-displaced populations.

2. Integrate Climate-Health Content across Teacher Education Curricula by embedding climate-health learning objectives in all core B.Ed. courses not only science methods but also social studies pedagogy, health education, Islamic studies methodology, and practicum supervision ensuring systemic coverage rather than isolated electives.

3. Invest in Contextualized Professional Development programs for Sindh's in-service teachers, delivered in Sindhi and Urdu, developed in partnership with provincial health authorities, and grounded in community-specific climate-health data from Sindh's districts. Programs should explicitly recognize teachers' existing experiential knowledge as a pedagogical asset.

4. Formalize Interdepartmental Collaboration between Sindh's Education and Health Departments through joint curriculum committees, shared data systems, and coordinated community health communication protocols that deploy the teacher workforce as a trusted channel for public health messaging during and between climate emergencies.

5. Establish Community-School Climate Health Hubs in climate-exposed districts of Sindh, in which secondary schools serve as officially recognized sites of climate preparedness education, disaster response coordination, and health communication during non-emergency periods, with headteachers formally empowered to lead these functions.

Conclusion

This paper has documented a structural failure with measurable human consequences: in one of the world's most climate-vulnerable provinces, the institution most capable of building community-level health resilience the public school system has been systematically excluded from climate-health governance through curricular neglect and institutional inertia. The educators who participated in this study were not passive bystanders to this failure; they were active professionals caught between their knowledge of what their communities needed and the institutional constraints that prevented them from providing it.

The Social-Ecological Systems framework reveals that this exclusion is not merely an educational problem it is a governance failure that weakens the adaptive capacity of Sindh's social-ecological system at precisely the moment when that adaptive capacity is most urgently needed. Transformative pedagogy theory reveals that the solution is not merely technical adding climate units to existing syllabi but requires a fundamental reorientation of the purposes, methods, and community relationships of teacher education in Sindh.

Pakistan stands at a crossroads. The 2022 floods demonstrated, with devastating clarity, the cost of institutional unpreparedness. The evidence assembled in this study suggests that the teacher education system can become a cornerstone of Pakistan's climate-health resilience infrastructure but only if policymakers are willing to make the structural investments, curricular reforms, and interdepartmental collaborations that this repositioning requires. The cost of inaction is not abstract: it is measured in preventable deaths, avoidable hospitalizations, and communities left to navigate the next climate emergency without the knowledge and preparation they deserve.

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