Title

A Systematic Review of the Ways Schools Engage With Climate Change Adaptation

Journal

Wiley Interdisciplinary Reviews Climate Change, 17(4)

ISSN

1757-7780

Authors

Laub, Kaylee

Pulver, Simone

Harlow, Danielle

et al.

Publication Date

2026-07-01

DOI

10.1002/wcc.70080

Peer reviewed

Wiley Interdisciplinary Reviews: Climate Change

WILEY

WIREs CLIMATE CHANGE

OVERVIEW OPEN ACCESS

A Systematic Review of the Ways Schools Engage With Climate Change Adaptation

Kaylee Laub | Simone Pulver | Danielle Harlow | Sarah Anderson

University of California, Santa Barbara, California, USA

Correspondence: Kaylee Laub (kayleelaub@ucsb.edu)

Received: 10 February 2026 | **Revised:** 18 June 2026 | **Accepted:** 29 June 2026

Chief Editor: Daniel Friess | **Academic Editor:** Chandni Singh

Keywords: climate adaptation | community | curriculum | infrastructure | justice | schools

ABSTRACT

How are schools engaging with adaptation to climate change? A systematic review of 85 publications reporting research on climate adaptation activities at schools serving students ages 5–18 identifies three pathways of engagement: (1) Schools are places for teaching and learning about climate change adaptation; (2) Schools experience climate hazards and implement adaptation responses on their buildings and grounds; and (3) Schools collaborate with the communities they serve, exchanging climate adaptation information and providing support during climate disasters. Research most often positions schools as teaching and learning environments, with substantially less attention given to schools' roles as managers of infrastructure and as members of their communities. Most publications focus on a single form of school engagement with climate adaptation; only two of the 85 publications reviewed recognize schools as simultaneously engaging in all three pathways. There is also limited attention to justice in the publications reviewed. More broadly, research on schools and climate adaptation is dispersed across multiple disciplines and publication outlets, with few attempts to create a cumulative body of knowledge. In combination, these characteristics of the research literature impede recognition of the multiple and potentially synergistic roles schools can play in climate adaptation. The review concludes with recommendations for the field, researchers, and schools to advance school-based climate adaptation activities across pedagogy, infrastructure, and community engagement.

1 | Introduction

Climate adaptation is widely recognized as a collective challenge that demands coordinated action across sectors, institutions, and scales of governance (Chu and Cannon 2021; Shi et al. 2016). Schools have significant potential to contribute to climate adaptation because of their positioning at the intersection of education, local government, and community life. First, schools offer curricular opportunities for climate change education. Educational opportunities to participate in community-engaged environmental stewardship build students' capacity to develop solutions (Monroe et al. 2019), alleviate eco-anxiety, and help students develop self-efficacy around climate change adaptation and mitigation (Pinsky et al. 2020; Schwartz et al. 2023; van Nieuwenhuizen et al. 2021). Second, schools function as more than educational institutions. At many schools, buildings and grounds are directly exposed to various climate hazards (Callahan et al. 2022), and students come to school with climate-related trauma, including dislocation due to wildfires or flooding, increased health concerns such as asthma, and feelings of eco-anxiety (Sanson et al. 2019). Third, schools already function as community hubs where diverse neighborhood populations feel like they belong and gather for performances, sports events, and graduations (Teo et al. 2022). The embeddedness of schools in communities has been leveraged to address a range of concerns. Research on "community schools," that is, schools that intentionally support communities through services and community engagement, documents their efficacy in areas such

as healthcare, housing assistance, and community education (Maier et al. 2017).

The goal of our review is to assess and synthesize existing scholarly research on schools and climate adaptation, delineating the prevalence, distribution, and types of school-connected climate adaptation activities. We focus on climate adaptation in human systems and define it as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities" (Intergovernmental Panel on Climate Change (IPCC) 2022). Adopting this broad definition of adaptation allows this review to capture the variety of ways that climate adaptation has been studied in school settings. Climate and its effects encompass both slow and fast climate impacts, such as gradual sea-level rise and severe events like extreme weather and flooding (Van Der Geest and Van Den Berg 2021). Adjustments can range from creating shade structures in anticipation of extreme heat days to developing early warning systems for fire and flooding. Climate adaptation may also have implications beyond short-term changes, driving the transformation of systems towards resilience and justice (Shi and Moser 2021). Engaging with climate adaptation can mean both implementing direct adaptation measures and learning about adaptation as a process.

Our study extends existing review efforts on schools and climate change in two ways. First, we foreground schools and climate *adaptation* in contrast to the bulk of the literature, which focuses on schools and climate *mitigation*. A recent scoping review of climate change education research found that fewer than a quarter of publications even referenced adaptation measures (Kranz et al. 2022). This mitigation-oriented emphasis is evident both in reviews focused on classroom-based climate instruction (Monroe et al. 2019; Nepraš et al. 2022; Radzi et al. 2022; Rousell and Cutter-Mackenzie-Knowles 2020) and in those examining climate-related changes to school infrastructure (Díaz-López et al. 2022). When adaptation does appear, it is typically treated as a secondary concern and paired with mitigation strategies (e.g., Abulibdeh 2024; Kranz et al. 2022; Radzi et al. 2022; Sibanda and Manik 2023).

Second, our review is informed by education research that recognizes the multiple levels at which schools engage with climate change and disaster risk resilience (e.g., Gibb 2016; Rahma et al. 2024). Gibb (2016) posits that climate change extends to "every aspect of school life…includ[ing] school governance, teaching content and methodology, campus and facilities management, as well as cooperation with partners and the broader communities" (p. 3). Likewise, Rahma et al. (2024) propose "a framework comprising schools, families, facilities, and external communities" and recognize that "[t]hese components work together to form a collaborative network of [disaster risk reduction] actions" (p. 12). Both draw on educational theories that frame schools as systems in themselves and as components of larger systems. Rahma et al. (2024) build on Bronfenbrenner's (1979) ecological systems theory, which identifies five nested systems that constitute a learning ecosystem. Gibb (2016) advocates for a "whole school approach," which emerged from the World Health Organization's Health Promoting Schools Framework (WHO 1996). A whole school approach aims to embed policies and practices throughout the entire school community, reaching every aspect of school life, from governance and teaching to facilities management and community partnerships (Cavanagh et al. 2024; Goldberg et al. 2019; Mogren et al. 2019). The key feature of both framings is that they extend school-based activities beyond classroom programming to include schools' social and physical environments, families and neighborhoods, local governments, and civic institutions.

Our review is structured to capture this breadth in aspects of school life potentially relevant to climate adaptation and thus extends the work of those who used a narrower lens and examined only a single, specific facet of schools and climate adaptation. Some, for example, focus only on the physical impacts of climate change on schools, encompassing infrastructure, attendance, and student well-being (Boon et al. 2011; Sheffield et al. 2017; Venegas Marin et al. 2024). Other reviews target their focus on adaptation education in early childhood settings (Spiteri 2023), the intersections between disaster education and adaptation (Fazeli et al. 2024; Rahma et al. 2024), or the multiple barriers to implementing adaptation education, often within particular regional contexts, including South Africa (Sibanda and Manik 2023) and East Africa (Apollo and Mbah 2021). While each of these publications provides valuable insights, none offers a comprehensive account of the diverse roles schools play in climate adaptation. Our approach seeks to characterize the full range of school-connected climate adaptation activities that have been studied. Only by adopting this broader lens can we identify areas of strength, as well as gaps, in the research literature.

2 | Methods

Following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement (Page et al. 2021), we conducted a systematic review starting with a keyword search in the Web of Science database with our search completed in October of 2024. Key words included climate adaptation (including cognates[1]) AND schools (including cognates[2]). In combination, these search terms identified 1653 unique publications. We note two potential limitations to this approach. First, the Web of Science database has a higher representation of natural science journals compared to journals in the social sciences and humanities (Stahlschmidt and Stephen 2020). Because much education research is characterized as social science, our choice of database may have skewed our results towards education research published in climate and environmental journals and away from climate research published in education journals. Second, our search criteria excluded articles that do not explicitly mention climate change. As a result, articles describing research on school educational initiatives related to hazards, such as wildfire or flooding, were only included if those hazards were explicitly linked to climate change.

The abstracts were then reviewed by Authors 1 and 2 to select the subset of publications that met two inclusion criteria. The first inclusion condition was that the abstracts needed to explicitly mention schools that served children from approximately ages 5 to 18 years old. Specifically, we were looking for abstracts that mentioned that the study took place at a school site or involved the participation of the school (e.g., teachers, students, or

administration) within the context of the study. The second inclusion condition required that abstracts address adaptation to climate change. We excluded publications that focused on climate mitigation, that is, the reduction of greenhouse gas emissions. We also excluded publications that focused on disasters not connected to climate change, such as earthquakes. Authors 1 and 2 jointly reviewed several abstracts to achieve shared understanding of the inclusion criteria, independently assessed the remaining abstracts, and discussed abstracts where assessing the inclusion criteria was difficult. Publications that were review publications, non-English language, behind paywalls for university researchers, and without abstracts were also excluded. The full text of the remaining 101 publications was then read. At this stage, we identified a third inclusion criterion: the research had to position schools as playing an active role in relation to climate adaptation. This means that we excluded publications that mention schools and climate adaptation but position schools only as places to access young research subjects, without discussing the roles of schools in climate adaptation. In total, 16 additional publications were excluded because, following a full text analysis, they did not meet the inclusion criteria. The selection process resulted in a total of 85 publications included in this systematic literature review (see Figure 1 for an overview of the publication identification and selection process).

Through an iterative process of reading the full text of a subset of publications and identifying and refining key themes, we developed a codebook to assess the prevalence and distribution of key pathways of schools' engagement with climate adaptation. As a research team, we each independently coded the same 15 publications and collaboratively reconciled codes to develop our final codebook. We then independently coded an additional 15 publications to assess interrater reliability. We achieved an interrater reliability of 0.91 using Gwet's AC1 (Gwet 2008). Once we achieved interrater reliability, we divided the remaining 55 publications among the research team to independently code.

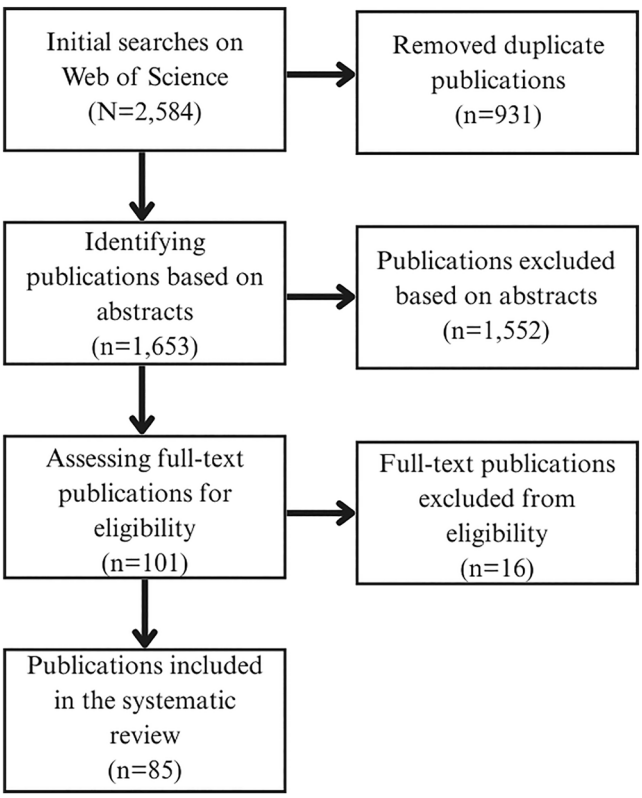


FIGURE 1 | Publication identification and selection process.

The first parent code in our codebook describes how schools are positioned in relation to climate change adaptation. Three primary pathways by which schools engage with climate adaptation were coded as: (1) Experiencing and adapting to climate hazards; (2) Teaching and learning about climate adaptation; and (3) Supporting community climate adaptation. For each publication, we also coded four additional features of the research: the focus of the data collected; the focus of the intervention (if applicable); the focus of the evaluation (if applicable); and, the focus of the recommendations offered. The 13 potential areas of focus were: school grounds, school buildings, teacher knowledge/perceptions, teacher practices, teacher training, student knowledge/perceptions, student behaviors, community knowledge/perceptions, community action, community training/learning, curriculum formal, curriculum informal, and policy. A final code indicated whether a study explicitly mentioned that the research concerned justice, diversity, underserved communities, communities with low socioeconomic standing, Indigenous communities, and/or Indigenous Traditional Ecological Knowledge. Descriptive statistics were also compiled for the 85 publications, including publication year and outlet, type of research (i.e., real-time empirical, conceptual, modeling, methodological), research methods, climate/disaster hazard focus, level of schooling (i.e., primary/elementary or secondary), geographic location of the school, and school/community demographics (see Appendix A for the complete codebook and Appendix B for the complete list of publications included).

A core limitation of our approach (and of much of the review literature on this topic) is the focus on academic publications. Our analysis documents the prevalence and distribution of *research* on climate change adaptation activities in schools rather than of the *activities* themselves and likely underreports what is happening in practice. Moreover, we highlight that the schools that are the focus of the reviewed research publications are not representative of all schools. There is no comprehensive, international database of school-based activities centering on climate adaptation, so the research literature provides a best available secondary data source. Another research approach would be to catalog school-connected climate adaptation activities in either climate or education planning and policy documents (e.g., Goritz and Kolleck 2024). However, such an approach would also provide only secondary data regarding school-based climate adaptation activities.

3 | Results

3.1 | Overview of Included Publications

Publications focusing on schools and climate adaptation first appeared in 2010. The number of publications then grew steadily, with rates peaking in 2020 and 2021 (Figure 2). The 85 publications included in the review constitute a very fragmented research literature, spread across 64 different publication outlets, with four publications as the maximum for any single publication outlet. Outlets with three or four included articles are the journals *Environmental Education Research* (4), *International Journal of Disaster Risk Reduction* (4), *International Journal of*

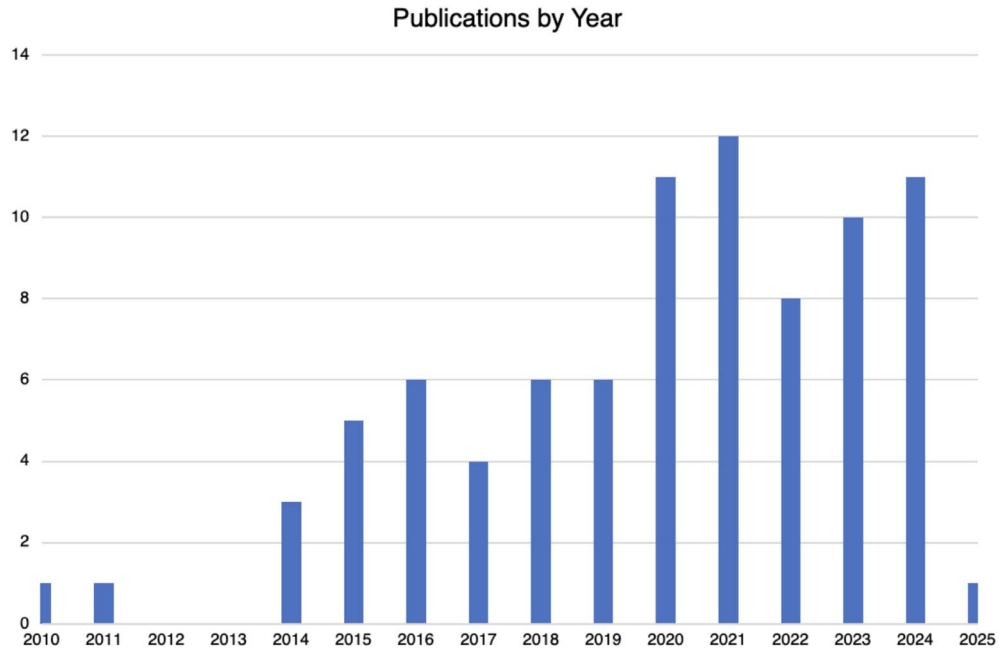


FIGURE 2 | Number of publications by year.

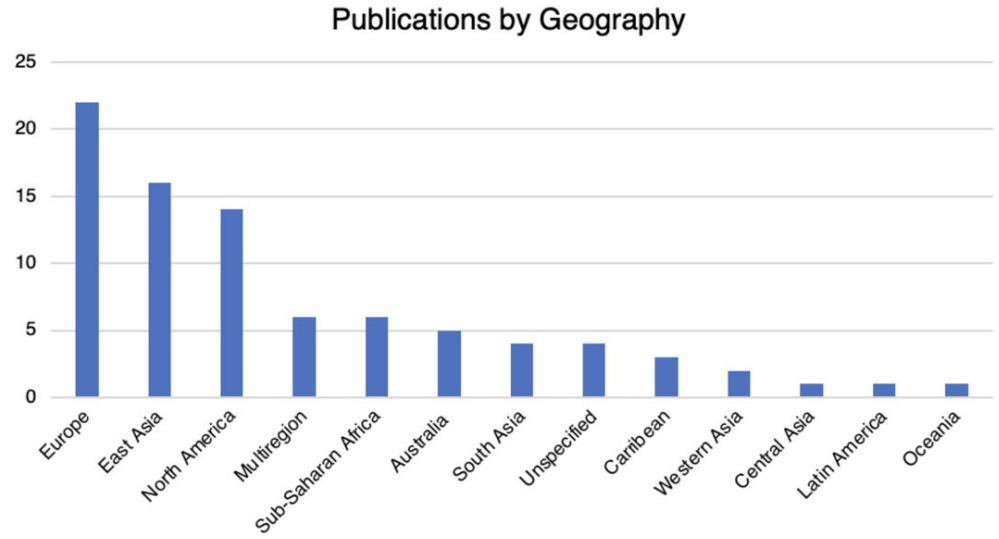


FIGURE 3 | Number of publications by geographic region.

Environmental Research (4), *Public Health* (4), *Sustainability* (4), *Building and Environment* (3), and *Science of the Total Environment* (3). The majority of included publications are journal articles (71, 83.5%), followed by book chapters (9, 10.5%) and conference proceedings (5, 5.9%).

The reviewed publications showcase that school engagement with climate adaptation is a global phenomenon, with the largest number of studies documenting activities in Europe (22, 25.9%), followed by East Asia (16, 18.8%) and North America (14, 16.5%) (Figure 3). Notably, 35 publications (41.2%) focus on schools in the Global South.[3] The majority of publications address climate change hazards in a general sense (24, 28.2%) or refer to multiple hazards (22, 25.9%). The most common single hazard focus is extreme heat (20, 23.5%), followed by flooding (8, 9.4%), sea level rise (4, 4.7%), extreme precipitation (3, 3.5%), wildfires (2, 2.3%), landslides (1, 1.2%), and drought (1, 1.2%).

Twenty-four publications (28.2%) focus on the secondary school level (ages 12–18), 23 (27.1%) on the primary/elementary school level (ages 5–11), and another 23 (27.1%) focus on multiple grade levels. Fifteen publications (17.6%) do not specify a specific grade level.

The research methods used across the publications reflect a balance of quantitative approaches (33, 38.8%), mixed methods (25, 29.4%), and qualitative approaches (20, 23.5%). Seven publications (8.2%) do not specify a methodology and were coded as "other." The majority of the publications present real-time empirical data (73, 85.9%). A total of 11 publications (12.9%) have a simulation component projecting future data, and only six publications (7.1%) were categorized as conceptual or theoretical papers. In 53 publications (62.4%), the research described includes some form of intervention, but only 42 publications (49.4%) have a component evaluating the intervention.

3.2 | Schools and Climate Adaptation

Three key roles emerged from our assessment of how schools engage with climate adaptation: (1) Schools are places to teach and learn about climate change adaptation; (2) Schools are sites experiencing and adapting to the physical impacts of climate change; and (3) Schools support climate adaptation in the communities they serve (Figure 4). The majority of reviewed publications (54, 63.5%) position schools as places of teaching and learning about climate change adaptation. Many of these publications offer curriculum assessments and recommendations or investigate students' knowledge of climate adaptation and risk perceptions. Just over a third of publications (31, 36.5%) investigate the physical relationship between schools and climate hazards, whether by assessing physical climate hazards, such as heat stress, or by evaluating infrastructural adaptations to school buildings and grounds. Finally, 22 of the reviewed publications (25.9%) have a community component. Most studies with a community component examine how schools extend their reach beyond the student population to include parents and the community. The community category also includes studies that assess the role schools can play as disaster relief centers (4, 4.7%). Only a handful of publications position schools as simultaneously playing more than one role.

3.2.1 | Schools as Places for Teaching and Learning About Climate Adaptation

The majority of the publications (54, 63.5%) position schools as sites of teaching and learning. Of these, 34 focus solely on schools' contributions to climate change adaptation through teaching and learning, while the remaining 20 highlight multiple roles: learning and community (15), learning and physical impacts (3), and learning alongside both community and physical impacts (2). Among the 34 publications focused exclusively on teaching and learning, most (28) address the knowledge and perceptions of climate adaptation of students (12), teachers (11), or both (5). Other topics include curriculum (7), education policy (5), teacher practices (4), and student behavior (4). In terms of research methods and data, most publications (49 of 54, 90.7%) are empirical analyses focusing on existing data.

Knowledge gaps are a consistent theme across publications that track students' and teachers' knowledge and perceptions about climate adaptation. For example, Schrot et al.'s (2019) survey of high school students in Austria and Italy documented confusion about mitigation and adaptation prior to a curricular intervention. Likewise, pre-service teachers in rural Australia were shown to have significant knowledge gaps related to the impacts of climate change (Boon 2015), although it must be noted that this survey was conducted over 10 years ago.

Another common topic across this set of publications is experiential and action-oriented learning (e.g., Caprari et al. 2024; Leckey et al. 2021; Neset et al. 2020; Pickering et al. 2021; Schlaepfer-Miller et al. 2023; Trejo-Rangel et al. 2023; van der Plank et al. 2024). These studies all focus on how to foster active engagement and critical thinking through hands-on projects. For example, Schlaepfer-Miller et al. (2023) profiled the Climate Garden 2085 project, in which students studied the impacts of climate change on plant species in greenhouses that simulate varying climate scenarios. Yan et al. (2023) studied students in California who collected forest data to

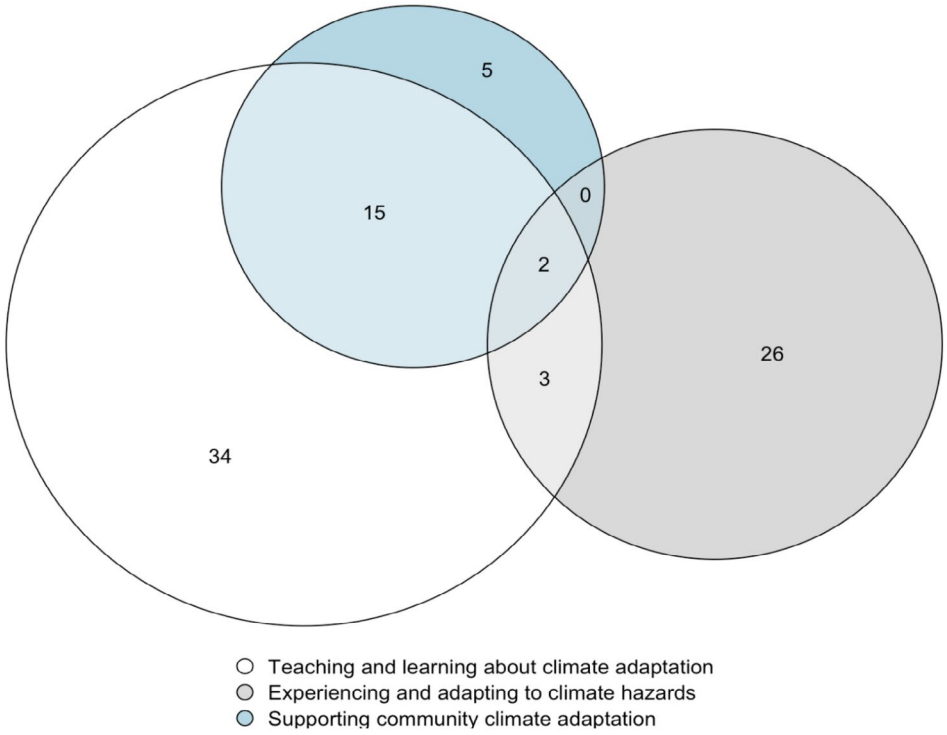


FIGURE 4 | Number of publications focusing on the three key roles played by schools in relation to climate change adaptation.

understand wildfire management in a California region that had recently experienced wildfires. Through this activity, the students developed complex systems-thinking skills. Neset et al. (2020) evaluated a game that engaged high school students in Sweden with the opportunity to limit the impact of climate hazards.

Teaching and learning about climate hazards and adaptation is often presented alongside or integrated with disaster risk reduction (DRR) or disaster education (e.g., Li et al. 2022; Nahayo et al. 2018; Nurdin et al. 2017; Pickering et al. 2021; Selby et al. 2020; Shah et al. 2020; Ueda et al. 2014, 2016; Yildiz et al. 2024; Zhong et al. 2021). For example, two publications by Ueda et al. (2014, 2016) described work in Vietnam developing a general DRR program. Others focused on reducing the risk of specific disasters, such as Shah et al.'s (2020) research on flood disaster resilience education in Pakistan. Many of the publications that position schools as sites for teaching and learning frame climate hazards as a general category (16) or address multiple climate hazards (17). Only 19 publications focus on a single climate hazard, with extreme heat and flooding being the most common focus (4 publications each).

Studies assessing teaching and learning about climate adaptation provide both baseline data and generate information that could later inform curricular innovations or policy changes. For example, Bofferding and Kloser (2015) implemented pre- and post-tests to show that middle and high school students in California, U.S., were developing a stronger understanding of the difference between climate mitigation and adaptation compared to earlier years, although they still lacked a strong understanding of adaptive responses. Working with school teachers in the Kalutara district in Sri Lanka, Rupasinghe and de Silva Weliange (2024) found that 23% of the sample had poor knowledge of climate adaptation but over 60% of their participants were in favor of adaptation and mitigation action. Thirty-three publications (61.1%) analyze an intervention in the teaching and learning space, over half of which are curriculum interventions in either formal classrooms (16) or informal settings (5). Twenty-five of the interventions were evaluated for their effectiveness. As a group, the publications offer a range of future recommendations related to teaching and learning about climate adaptation, focused on formal (32) and informal (12) curriculum, policy (14), teacher training (8), and community action (8).

3.2.2 | Schools Experiencing and Adapting to Climate Hazards

Moving beyond teaching and learning, a second cluster of publications positions schools as directly affected by climate change. The most commonly assessed climate hazard in this domain is extreme heat, but publications also focused on vulnerability to flooding and other hazards. Publications in this domain investigate how current or projected future physical changes impact or will impact school buildings (10), grounds (4), both (3), and student and/or teacher perceptions, knowledge, and behavior related to climate impacts and adaptation actions (9). The starting point of many projects was to document the vulnerability of school infrastructure and student groups to changing climates. For example, Heberger et al. (2011) detailed the number of schools that are vulnerable to coastal flooding due to future sea-level rise in California. Likewise, Park, Behrer, and Goodman (2020) quantified the negative impact of projected increases in the number of hot school days on learning in the United States. Other authors offered tools for use in adaptation planning, such as developing and testing methods to visualize vulnerability to heat and floods (Opach et al. 2020), to characterize the greenness of schoolyards (van den Bogerd and Maas 2024), and to simulate school infrastructure (Baba, Cheong, et al. 2026; Baba, Ge, et al. 2023).

Publications in this domain also identify and evaluate adaptation responses. A high proportion of publications (18) go beyond assessing vulnerability and test potential adaptation interventions, both in the technical realm and policy solutions. The majority assess interventions to retrofit buildings for projected future increased temperatures. For example, Sanz-Mas et al. (2024) demonstrated how passive cooling interventions, like roof insulation and sun protection on windows, enhanced student comfort, while Lanza et al. (2023) assessed how temperature and shade structures on playgrounds affected the physical activity of students. Policy solutions are also examined. For example, Kerr et al. (2019) demonstrated that compliance with pre-season heat acclimatization guidelines reduced exertional heat illness events among American high school football athletes. The general conclusion across publications is that technical and policy interventions have been effective under a range of climate scenarios and in varied political and social settings.

The publications focused on the direct effects of climate change rarely refer to the other roles played by schools. Only five of the 31 publications in this category also consider schools as places for teaching and learning about climate adaptation or recognize the roles schools can play in supporting community climate adaptation.

3.2.3 | Schools Supporting Community Climate Adaptation

The third key way in which schools are positioned in the climate adaptation research literature is as community-connected institutions. Of the publications reviewed, 22 (27.1%) introduced a community component. Our definition of community is expansive, including intergenerational efforts by students to involve parents and other family members in climate adaptation learning and activities (Li et al. 2022; Manalo et al. 2016; Walker et al. 2025), as well as initiatives engaging neighbors (Davies and Hügel 2021; Meyer et al. 2018), community elders (e.g., McNamara and Westoby 2016), and government officials (Verlie and Blom 2022). The review reveals two broad types of climate adaptation initiatives connecting schools and communities: those focused on information exchange (18), those positioning schools as disaster relief centers (3), and one publication that includes both.

Information sharing is the primary mode of interaction between schools and communities. Information can flow from both the school to the community and the community to

the school. For example, a 2017 school-based intervention to build capacity to respond to heatwaves in China asked students to spread knowledge on climate change and health impacts to their families (Li et al. 2022). Likewise, Caluwaerts et al. (2021) documented how high schools facilitated data collection that led to more accurate climate monitoring to inform community climate adaptation. Some programs had a very targeted community audience (e.g., Manalo et al.'s (2016) research on rice farmers in the Philippines), while others focused on educating the public-at-large, through events at neighborhood institutions such as malls, libraries, or houses of worship (e.g., Lock 2019; Pickering et al. 2021). Information also flowed from communities to schools. For example, the Torres Strait Islander communities' seasonal calendar project (McNamara and Westoby 2016) brought community elders together with primary/elementary school teachers and their young students to document traditional ecological knowledge on a public mural. The Lentes en Cambio Climatico (LECC) filmmaking program (Leckey et al. 2021) empowered secondary students to interview community members about their climate adaptation experiences and create films that document local knowledge of climate impacts.

Beyond information exchange, publications in this domain also center on schools as relief centers in the face of climate-related disasters. Only four publications (4.7%) highlight this aspect of school-community interactions, and all focus on schools in Asia (China, Indonesia, Pakistan, and Thailand). More specific research topics within this domain include preparing schools as shelters, engaging schools as participants in disaster management planning organized by local communities, and using schools as conduits for emergency notifications aimed at parents and families. Two of the four publications present frameworks for school climate-disaster preparedness: Dania et al. (2022) reported on a survey of teachers and administrators at a village school in Thailand related to the school's capacity to serve as a safe space during disasters, and Shah et al. (2020) created a four-component framework for assessing school preparedness and resilience. Notably, none of the publications identify schools as the initiators of school-community climate adaptation programs. The school-community connections reported on were most often initiated by university researchers who created climate adaptation curricula/initiatives with a community or service-based learning component. Non-governmental organizations (NGOs) were also identified as initiating programs connecting students and community members. These included local environmental organizations (Krasny and DuBois 2019; Lock 2019; Selby et al. 2020), international NGO networks (Chineka and Yasukawa 2020; Dueñas I Cid and Ochoa I Cañigueral 2016), and research institutes (Manalo et al. 2016). In one case, the leadership of a small town in Alaska initiated a project and selected the school as a demonstration site to test the efficacy of selective logging and wood-based energy generation as a wildfire adaptation strategy (Cost 2015). Likewise, disaster preparedness programs were initiated by local and regional government agencies (Sakurai et al. 2018; Shah et al. 2020; Wu et al. 2019) and an NGO (Lassa et al. 2023).

The reviewed publications centered on school-community engagement tend to be descriptive and not evaluative. Only nine publications include an evaluation component, and of these, only three include a quantitative element to the evaluation. These are low rates of evaluation compared to the publications with a learning or physical infrastructure focus.

3.3 | Schools Playing Multiple Roles Related to Climate Adaptation

The majority of publications position schools in a single role (63, 74.1%), and only 20 publications discuss multiple forms of engagement.[4] Of these, all include a focus on schools as learning environments and then introduce either a community element (15) or a physical infrastructure element (3). Only two publications include all three roles for schools (again, see Figure 4).

How much these publications go beyond listing multiple roles to analyzing how activities across roles can reinforce each other varies considerably. The two publications that position schools as playing all three roles (Shah et al. 2020 and Verlie and Blom 2022) offer an instructive comparison. Shah et al. (2020) acknowledged the multiple roles played by schools but did not frame them as interacting. Specifically, they analyzed education sector resilience in the face of flood disasters in Pakistan and developed an education sector resilience index. The 60 variables used to create the index address the physical impacts of floods on school buildings, training for teachers and students, and the relationships between schools and communities. While these are all presented as contributing to overall resilience, the authors did not explore, for example, how adapting to physical impacts could be the basis of a classroom lesson or how the community could be included in training programs for teachers and students. In contrast, Verlie and Blom (2022) showed how learning, physical impacts, and community engagement interact and overlap. Their analysis of the bushfires in Australia during the summer of 2019/2020 documented the effects of smoke pollution on physical learning environments, classroom conversations, and student activism to support affected communities and challenge political leaders. The authors proposed an integrative framework centered on the concept of "climatic-affective 'atmos-fears'" to examine how the bushfires and smoke, and the political discourses that were entangled with them, affected classroom climates and student engagement (Verlie and Blom 2022, 622).

The cross-domain synergy most often recognized in the reviewed publications is between the curricular and community roles of schools. The 17 publications in this group, including the two publications that consider all three domains, are aligned in their conclusion that learning in the classroom is enhanced when it is grounded in a particular community context (e.g., Leckey et al. 2021; Walker et al. 2025). Likewise, communities benefit from school-based initiatives, for example, gaining access to community-specific climate hazard data (e.g., Davies and Hügel 2021; Krasny and DuBois 2019; Meyer et al. 2018) and adaptation resources (e.g., Manalo et al. 2016; Pickering et al. 2021). The five publications that identify schools both as sites for teaching and learning about climate adaptation and as adapting to climate hazards also offer examples of synergies. Lanza et al. (2021) explored how heat impacts can reduce students' interactions and connection with nature, which, in turn, adversely affects classroom and learning behavior. In their

conceptual overview, Brown et al. (2023) emphasized the importance of designing physical contexts for learning about climate change and climate adaptation that promote active engagement and constructive coping.

3.4 | Schools and Just Climate Adaptation

A key motivation for this review was to explore what the research literature suggests about the potential role of schools in promoting just climate adaptation. We used an expansive definition of justice, including explicit mentions of justice, as well as related concepts, such as diversity, underserved communities, historically marginalized communities, and Indigenous communities and Indigenous Traditional Ecological Knowledge. In order to be coded as addressing justice concerns, the text of a publication had to make explicit mention of this aspect of the study. We recognize that some publications not coded as mentioning justice are informative about underserved communities or contribute to knowledge about justice and schools in climate adaptation. Only 16 publications (18.8%) explicitly mention justice considerations, and few offer sufficient details about the context of the study to contribute to a structured understanding of how schools' engagement with climate adaptation might differ in ways that address justice for more vulnerable populations. Among the publications that address justice, some explicitly focused on the effects of an intervention on a given population (e.g., marginalized youth; Davies and Hügel 2021), but fully half of the 16 publications coded as mentioning justice considerations offer only an implicit mention of implications for vulnerable communities. Geographically, these studies have a wide but sparse geographic coverage, with only a few studies conducted in developing countries (e.g., Bangladesh). Those with intentional designs to address inequitable impacts or target vulnerable populations primarily focused on income differences; though one study examined storytelling in a community of migrants (Walker et al. 2025), and another evaluated climate impacts by race (Heberger et al. 2011). Several studies emphasized the role of traditional ecological knowledge, and one employed participatory action research in collaboration with environmental justice organizations (Meyer et al. 2018).

4 | Discussion and Recommendations

The reviewed research literature underscores that some schools are already active contributors to climate adaptation. The schools analyzed engage in climate adaptation primarily through teaching and learning activities but also by modifying school infrastructure and facilitating community climate adaptation. By situating schools within interconnected systems of learning, infrastructure, and community governance, our findings highlight both the potential breadth of existing school-connected adaptation efforts and the missed opportunities created by fragmented research and practice. We identify four areas for improvement: consolidating across this research literature, building an evidence base for effective interventions, recognizing synergies across domains of school engagement, and attending to just climate adaptation. In each of these areas, focused attention can accelerate the synthesis of knowledge about curricular, infrastructural, and community climate adaptation strategies and support a more vibrant community of practice across schools.

One significant weakness of the research literature on schools and climate adaptation is its fragmentation. Relevant publications are spread across multiple journals and rarely reference or build on one another. Even the terminology used is an obstacle to synthesis. Some researchers discussed schools' roles in climate change adaptation as "disaster risk reduction," while others framed it as "climate change education." The result is a knowledge landscape of mostly stand-alone research and exploratory studies. To support consolidation, future studies should aim to build bodies of work. The use of shared frameworks and more consistent terminology would encourage cumulative knowledge building. Developing agreed-upon definitions that bridge fields such as disaster risk reduction, resilience, and climate adaptation would facilitate synthesis and comparison across studies. Likewise, creating dedicated platforms—such as special journal issues, research networks, or collaborative databases—could help consolidate findings, promote cross-referencing, and support a more coherent research agenda.

Second, advancing research centered on schools and climate adaptation will require more evidence-based evaluation. As with adaptation research more broadly (e.g., Hansen et al. 2023; Hansen et al. 2025), there is limited assessment of the impact and effectiveness of school-related adaptation programs and interventions. Just under 50% of the reviewed publications include an evaluation component. Publications focused on community are least likely to include an evaluation component (9 of the 22 publications, 40.9%), compared to 15 of the 31 publications (48.4%) focused on physical impacts and 25 out of 54 publications (46.3%) focused on teaching and learning. We recommend that researchers prioritize longitudinal and comparative studies that build on prior work and assess the effectiveness of specific interventions, with the recognition that generalizability, particularly across geography, will always be hampered by the need to customize climate adaptation education and activities to the local context.

Third, our review documents siloed research attention to the three primary domains of school climate adaptation activity. We note that this may, in part, be an artifact of the research process and not characteristic of activities in schools. Pre-identified research objectives and restrictions on interactions with human subjects focus and narrow research attention. We hypothesize that more integration across domains is occurring in schools than is being documented in the research literature and encourage scholars to investigate and report on synergies across the three domains. For example, there are opportunities for researchers to document how interactions across domains enhance the effectiveness of interventions. Community engagement has been shown to enrich environmental curricula in ways that benefit both students and communities (Monroe et al. 2019). More broadly, schools can feature in research not as isolated sites of intervention but as institutional actors embedded in local adaptation systems, and scholars who address a wider set of concerns related to schools and climate adaptation can multiply returns on the effort needed to build collaborative relationships with schools.

Fourth, we note that justice arises relatively infrequently in the publications reviewed and recommend a more explicit research

focus on schools as potential partners in advancing just climate adaptation. Schools play a complex role in communities. They are embedded in social, environmental, and governing networks and often hold a special place as trusted social institutions (Trust for Civic Life 2025). This makes schools a potentially powerful node for community climate adaptation. Schools can function as access points for resources, information, and services related to emergency preparedness and climate-resilient infrastructure, in ways that directly benefit vulnerable populations. They are also well positioned to connect marginalized and historically underserved communities to local adaptation planning processes. In order to advance research and synthesize knowledge related to the role of schools in just climate adaptation, we encourage more community-engaged research that elevates the voices of students, educators, families, and community partners in historically underserved areas. Researchers and educators must consider whose knowledge is valued, whose voices are heard, and who benefits from adaptation initiatives.

These four areas of improvement related to academic research on schools and climate adaptation also have direct implications for schools themselves. However, the starting point of any recommendations aimed at school administrators and teachers must be to recognize that they are already navigating competing demands on their time, resources, and attention. Proposed activities must fit within existing time and resource demands or must be supported by communities, governments, or external funders who can provide appropriate resources to teachers and administrators. With that constraint in mind, for schools that want to begin engaging with climate adaptation, we recommend starting local. Climate adaptation is, at its core, a local challenge, with place-specific risks and hazards. We also encourage schools to explore synergies across their adaptation activities. Changes to school infrastructure (e.g., planting trees to provide shade) can provide teachers and students with opportunities to tie learning about climate change adaptation to implementing adaptive strategies in school buildings and on school grounds. We urge administrators to communicate with their teaching staff about building and grounds decisions and changes made on campuses. Schools can also be a catalyst for community climate adaptation. They can leverage their roles as collaborators within communities to connect people outside of formal learning spaces, thereby bringing awareness and information about climate adaptation.

The reviewed publications offer additional, more specific recommendations. They reveal a rich and growing landscape of climate adaptation curricula, ranging from classroom-based instruction to hands-on, community-driven learning experiences, as well as novel climate adaptation technologies for school buildings and grounds. Most suggestions relate to formal curriculum (33 publications, 38.8%), followed by policy (26, 30.6%), buildings (20, 23.5%), and community engagement (10, 11.8%). However, these ideas and recommendations too often fail to travel beyond the contexts in which they were created. Building stronger channels for sharing work between the academy and schools and across schools could significantly amplify its reach and impact.

Fragmented, siloed, and too often content to document single interventions at one school, the field must move towards cumulative knowledge, built on shared frameworks and terminology, and tested through longitudinal and comparative studies. Strengthening conceptual coherence, building an evidence base for effective interventions, fostering opportunities to leverage climate adaptation efforts across domains, and prioritizing community-engaged and justice-oriented research and practice are necessary to realize the potential of schools as key nodes in local adaptation systems. Absent such collective commitment, schools risk remaining peripheral to the broader climate adaptation enterprise.

Author Contributions

Kaylee Laub: project administration, data curation, methodology, formal analysis, writing – original draft, writing review and editing, visualization. **Simone Pulver:** conceptualization, supervision, methodology, formal analysis, writing – original draft, writing – review and editing. **Danielle Harlow:** methodology, formal analysis, writing – original draft, writing – review and editing, visualization. **Sarah Anderson:** methodology, formal analysis, validation, writing – original draft, writing – review and editing.

Funding

This material is based upon work supported by the U.S. National Science Foundation under Grant Number 2334340. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the U.S. National Science Foundation.

Conflicts of Interest

Dr. Simone Pulver is a WIREs CC Domain Editor. The remaining authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Endnotes

[1] Cognates for climate adaptation include: *climate adaptation, climate change, climate change adaptation, climate, climate resilience, adaptation to climate, climate-smart adaptation, adaptation strategy, environment, global warming, disaster risk, disaster risk reduction, resilience, sustainability, or climate resilience*.

[2] Cognates for school include: *community school, green school, climate change education, environmental education, climate change curriculum, global warming education, climate change lesson, K-12 school, school hub, environment lesson, youth participatory action research, lesson on environment, teacher, or student*.

[3] As defined by the Evidence Synthesis Infrastructure Collaborative (ESIC) (*Memo: Definition of Global South*, n.d.).

[4] We note that the dominance of research on one type of adaptation activity may be an artifact of the demands of academic research and not characteristic of activities in schools themselves. Research often encourages a narrow focus, and studying more than one role at a time presents real challenges. A study of school infrastructure and a study of classroom learning, for example, requires fundamentally different approaches.

References

Abulibdeh, A. 2024. "Towards Zero-Carbon, Resilient, and Community-Integrated Smart Schools and Campuses: A Review." *World Development Sustainability* 5: 1–16.

Akkose, G., C. Meral Akgul, and I. G. Dino. 2021. "Educational Building Retrofit Under Climate Change and Urban Heat Island Effect." *Journal of Building Engineering* 40: 102294. https://doi.org/10.1016/j.jobe.2021.102294.

Allen, L. B., and K. Crowley. 2017. "Moving Beyond Scientific Knowledge: Leveraging Participation, Relevance, and Interconnectedness for Climate Education." *International Journal of Global Warming* 12, no. 3–4: 299–312.

Apollo, A., and M. F. Mbah. 2021. "Challenges and Opportunities for Climate Change Education (CCE) in East Africa: A Critical Review." *Climate* 9, no. 6: 93. https://doi.org/10.3390/cli9060093.

Ashraf, S. A., and M. Faruk. 2018. "Children's Perspective on Adaptation to Heat Waves and Heavy Precipitation in Dhaka, Bangladesh." *Procedia Engineering* 212: 768–775. https://doi.org/10.1016/j.proeng.2018.01.099.

Baba, F. M., K. C. T. Cheong, H. Ge, et al. 2026. "Comparing Overheating Risk and Mitigation Strategies for Two Canadian Schools by Using Building Simulation Calibrated With Measured Data." *Journal of Building Performance Simulation* 19, no. 1: 67–85. https://doi.org/10.1080/19401493.2023.2290103.

Baba, F. M., H. Ge, R. Zmeureanu, and L. (L.) Wang. 2023. "Optimizing Overheating, Lighting, and Heating Energy Performances in Canadian School for Climate Change Adaptation: Sensitivity Analysis and Multi-Objective Optimization Methodology." *Building and Environment* 237: 110336. https://doi.org/10.1016/j.buildenv.2023.110336.

Bardsley, D. K. 2017. "Too Much, Too Young? Teachers' Opinions of Risk Education in Secondary School Geography." *International Research in Geographical and Environmental Education* 26, no. 1: 36–53. https://doi.org/10.1080/10382046.2016.1217075.

Bidassey-Manilal, S., C. Y. Wright, T. Kapwata, and J. Shirinde. 2020. "A Study Protocol to Determine Heat-Related Health Impacts Among Primary Schoolchildren in South Africa." *International Journal of Environmental Research and Public Health* 17, no. 15: 5531. https://doi.org/10.3390/ijerph17155531.

Bofferding, L., and M. Kloser. 2015. "Middle and High School Students' Conceptions of Climate Change Mitigation and Adaptation Strategies." *Environmental Education Research* 21, no. 2: 275–294. https://doi.org/10.1080/13504622.2014.888401.

Boon, H. J. 2015. "Climate Change Ignorance: An Unacceptable Legacy." *Australian Educational Researcher* 42, no. 4: 405–427. https://doi.org/10.1007/s13384-014-0156-x.

Boon, H. J., L. H. Brown, K. Tsey, et al. 2011. "School Disaster Planning for Children With Disabilities a Critical Review of the Literature." *International Journal of Special Education* 26, no. 3: 223–237.

Bronfenbrenner, U. 1979. *The Ecology of Human Development: Experiments by Nature and Design*. Harvard University Press.

Brown, A., S. Collado, G. W. Evans, and J. E. Loebach. 2023. "Designing Learning Environments for Promoting Young People's Constructive Coping With Climate Change." In *Advances in Child Development and Behavior*, vol. 65, 169–198. Elsevier. https://doi.org/10.1016/bs.acdb.2023.05.005.

Callahan, C., L. Dunlap, M. Gallarza, R. Spriggs, and V. K. Turner. 2022. *Protecting Californians With Heat Resilient Schools*. UCLA Luskin Center for Innovation.

Caluwaerts, S., S. Top, T. Vergauwen, et al. 2021. "Engaging Schools to Explore Meteorological Observational Gaps." *Bulletin of the American Meteorological Society* 102, no. 6: E1126–E1132. https://doi.org/10.1175/BAMS-D-20-0051.1.

Caprari, G., R. D'Onofrio, R. Cocci Grifoni, P. Pellegrino, L. Simionato, and E. Trusiani. 2024. "Landscape, Environmental Sustainability, and Climate Instability—The EDUSCAPE Project: University Research for Innovation in School Education." *Sustainability* 16, no. 2: 790. https://doi.org/10.3390/su16020790.

Cavanagh, M., C. McDowell, U. O. Connor Bones, L. Taggart, and P. Mulhall. 2024. "The Theoretical and Evidence-Based Components of Whole School Approaches: An International Scoping Review." *Review of Education* 12, no. 2: e3485. https://doi.org/10.1002/rev3.3485.

Chineka, R., and K. Yasukawa. 2020. "Intergenerational Learning in Climate Change Adaptations; Limitations and Affordances." *Environmental Education Research* 26, no. 4: 577–593. https://doi.org/10.1080/13504622.2020.1733494.

Chinowsky, P., A. Schweikert, and C. Hayles. 2014. "Potential Impact of Climate Change on Municipal Buildings in South Africa." *Procedia Economics and Finance* 18: 456–464. https://doi.org/10.1016/S2212-5671(14)00963-0.

Chu, E. K., and C. E. Cannon. 2021. "Equity, Inclusion, and Justice as Criteria for Decision-Making on Climate Adaptation in Cities." *Current Opinion in Environmental Sustainability* 51: 85–94.

Cost, D. S. 2015. "The Role of Public Education in Governance for Resilience in a Rapidly Changing Arctic." *Ecology and Society* 20, no. 3: art29. https://doi.org/10.5751/ES-07757-200329.

Dania, M., W. Inpin, R. Juwitasari, Y. Miyake, Y. Takeuchi, and T. Maki. 2022. "The Production of Safety School Space From Climate Disasters in Doi Mae Salong Forest, Upland Northern Thailand." *Forestry and Society* 6, no. 2: 763–788. https://doi.org/10.24259/fs.v6i2.20739.

Davies, A. R., and S. Hügel. 2021. "Just Adapt: Engaging Disadvantaged Young People in Planning for Climate Adaptation." *Politics and Governance* 9, no. 2: 100–111. https://doi.org/10.17645/pag.v9i2.3892.

Dawkins, L. C., K. Brown, D. J. Bernie, et al. 2024. "Quantifying Overheating Risk in English Schools: A Spatially Coherent Climate Risk Assessment." *Climate Risk Management* 44: 100602. https://doi.org/10.1016/j.crm.2024.100602.

de Lara, K. A. 2017. *Contextualization and Localization: Acceptability of the Developed Activity Sheets in Science 5 Integrating Climate Change Adaptation*, 20–24. Proc Proceedings of the International Conference on Climate Changem. https://doi.org/10.17501/iccc.2017.1103.

Díaz-López, C., A. Serrano-Jiménez, K. Verichev, and Á. Barrios-Padura. 2022. "Passive Cooling Strategies to Optimise Sustainability and Environmental Ergonomics in Mediterranean Schools Based on a Critical Review." *Building and Environment* 221: 109297. https://doi.org/10.1016/j.buildenv.2022.109297.

Dong, J., Y. Schwartz, I. Korolija, and D. Mumovic. 2023. "The Impact of Climate Change on Cognitive Performance of Children in English School Stock: A Simulation Study." *Building and Environment* 243: 110607. https://doi.org/10.1016/j.buildenv.2023.110607.

Dong, J., Y. Schwartz, I. Korolija, and D. Mumovic. 2024. "Unintended Consequences of English School Stock Energy-Efficient Retrofit on Cognitive Performance of Children Under Climate Change." *Building and Environment* 249: 111107. https://doi.org/10.1016/j.buildenv.2023.111107.

Dueñas I Cid, D., and L. Ochoa I Cañigueral. 2016. "Climate Change and Health Related Challenges as a Trigger for Educational Opportunities to Foster Social Knowledge and Action." In *Climate Change and Health*, edited by W. Leal Filho, U. M. Azeiteiro, and F. Alves, 297–312. Springer International Publishing. https://doi.org/10.1007/978-3-319-24660-4_17.

Eichinger, M., M. Bechtoldt, I. T. M. Bui, et al. 2022. "Evaluating the Public Climate School—A School-Based Programme to Promote Climate Awareness and Action in Students: Protocol of a Cluster-Controlled Pilot Study." *International Journal of Environmental Research and Public Health* 19, no. 13: 8039. https://doi.org/10.3390/ijerph19138039.

Fazeli, S., M. Haghani, M. Mojtahedi, and T. H. Rashidi. 2024. "The Role of Individual Preparedness and Behavioural Training in Natural

Hazards: A Scoping Review." *International Journal of Disaster Risk Reduction* 105: 104379. https://doi.org/10.1016/j.ijdrr.2024.104379.

Feinstein, N. W., and K. J. Mach. 2020. "Three Roles for Education in Climate Change Adaptation." *Climate Policy* 20, no. 3: 317–322. https://doi.org/10.1080/14693062.2019.1701975.

Gibb, N. 2016. *Getting Climate-Ready: A Guide for Schools on Climate Action. United Nations Educational, Scientific, and Cultural Organization (UNESCO).*

Giezen, M., and V. Pellerey. 2021. "Renaturing the City: Factors Contributing to Upscaling Green Schoolyards in Amsterdam and the Hague." *Urban Forestry & Urban Greening* 63: 127190. https://doi.org/10.1016/j.ufug.2021.127190.

Goldberg, J. M., M. Sklad, T. R. Elfrink, K. M. G. Schreurs, E. T. Bohlmeijer, and A. M. Clarke. 2019. "Effectiveness of Interventions Adopting a Whole School Approach to Enhancing Social and Emotional Development: A Meta-Analysis." *European Journal of Psychology of Education* 34, no. 4: 755–782. https://doi.org/10.1007/s10212-018-0406-9.

Goritz, A., and N. Kolleck. 2024. "Education in International Climate Pledges – Identifying Education Framings in Countries Nationally Determined Contributions (NDCs)." *Environmental Education Research* 30, no. 11: 1949–1969. https://doi.org/10.1080/13504622.2024.2340504.

Guler, S. D., S. Sotelo, and M. Iwabuchi. 2022. "Tekniverse: Towards a Connected Future for Sensors, Education, and Action: Fostering Environmental Literacy With IoT and Physical Computing." *Interaction Design and Children*: 583–589. https://doi.org/10.1145/3501712.3535291.

Gwet, K. L. 2008. "Computing Inter-Rater Reliability and Its Variance in the Presence of High Agreement." *British Journal of Mathematical and Statistical Psychology* 61: 29–48. https://doi.org/10.1348/000711006X126600.

Haida, C., A. K. Chapagain, W. Rauch, M. Riede, and K. Schneider. 2019. "From Water Footprint to Climate Change Adaptation: Capacity Development With Teenagers to Save Water." *Land Use Policy* 80: 456–463. https://doi.org/10.1016/j.landusepol.2018.02.043.

Hansen, L. J., K. N. Braddock, and D. A. Rudnick. 2023. "A Good Idea or Just an Idea: Which Adaptation Strategies for Conservation Are Tested?" *Biological Conservation* 286: 110276. https://doi.org/10.1016/j.biocon.2023.110276.

Hansen, L. J., D. A. Rudnick, K. N. Braddock, et al. 2025. "Are Climate Change Adaptation Strategies Working? A Call to Expedite Learning." *Conservation Science and Practice* 7, no. 6. https://doi.org/10.1111/csp2.70060.

Haraha, M., and J. Ernawati. 2014. *A Cognitive Analysis of Residents With Regard to Community-Based Flood Management*. Vol. 13, 219. IWA Publishing.

Heberger, M., H. Cooley, P. Herrera, P. H. Gleick, and E. Moore. 2011. "Potential Impacts of Increased Coastal Flooding in California due to Sea-Level Rise." *Climatic Change* 109, no. S1: 229–249. https://doi.org/10.1007/s10584-011-0308-1.

Heracleous, C., A. Michael, A. Savvides, and C. Hayles. 2021. "Climate Change Resilience of School Premises in Cyprus: An Examination of Retrofit Approaches and Their Implications on Thermal and Energy Performance." *Journal of Building Engineering* 44: 103358. https://doi.org/10.1016/j.jobe.2021.103358.

Hviid, C. A., D. Zukowska-Tejsen, and V. Nielsen. 2020. *Cooling of Schools – Results From a Demonstration Project Using Adiabatic Evaporative Cooling With Harvested Rainwater.* Vol. 172. E3S Web of Conferences. https://doi.org/10.1051/e3sconf/202017202003.

Intergovernmental Panel on Climate Change (IPCC), ed. 2022. "Annex I: Glossary." In *Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C Above Pre-Industrial Levels in Context of Strengthening Response to Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*, 541–562. Cambridge University Press. https://doi.org/10.1017/9781009157940.008.

Kabir, M. I., M. B. Rahman, W. Smith, M. A. F. Lusha, and A. H. Milton. 2015. "Child Centred Approach to Climate Change and Health Adaptation Through Schools in Bangladesh: A Cluster Randomised Intervention Trial." *PLoS One* 10, no. 8: e0134993. https://doi.org/10.1371/journal.pone.0134993.

Kerr, Z. Y., J. K. Register-Mihalik, R. R. Pryor, et al. 2019. "The Association Between Mandated Preseason Heat Acclimatization Guidelines and Exertional Heat Illness During Preseason High School American Football Practices." *Environmental Health Perspectives* 127, no. 4: 047003. https://doi.org/10.1289/EHP4163.

Kranz, J., M. Schwichow, P. Breitenmoser, and K. Niebert. 2022. "The (Un)Political Perspective on Climate Change in Education—A Systematic Review." *Sustainability* 14, no. 7: 4194. https://doi.org/10.3390/su14074194.

Krasny, M. E., and B. DuBois. 2019. "Climate Adaptation Education: Embracing Reality or Abandoning Environmental Values." *Environmental Education Research* 25, no. 6: 883–894. https://doi.org/10.1080/13504622.2016.1196345.

Langenheim, N., M. White, N. Tapper, S. J. Livesley, and D. Ramirez-Lovering. 2020. "Right Tree, Right Place, Right Time: A Visual-Functional Design Approach to Select and Place Trees for Optimal Shade Benefit to Commuting Pedestrians." *Sustainable Cities and Society* 52: 101816. https://doi.org/10.1016/j.scs.2019.101816.

Lanza, K., M. Alcazar, C. P. Durand, D. Salvo, U. Villa, and H. W. Kohl. 2023. "Heat-Resilient Schoolyards: Relations Between Temperature, Shade, and Physical Activity of Children During Recess." *Journal of Physical Activity and Health* 20, no. 2: 134–141. https://doi.org/10.1123/jpah.2022-0405.

Lanza, K., M. Alcazar, D. M. Hoelscher, and H. W. Kohl. 2021. "Effects of Trees, Gardens, and Nature Trails on Heat Index and Child Health: Design and Methods of the Green Schoolyards Project." *BMC Public Health* 21, no. 1: 98. https://doi.org/10.1186/s12889-020-10128-2.

Lassa, J. A., A. Amri, Y. Tebe, B. Towers, and K. Haynes. 2023. "Exploring NGOs-Government Collaboration Strategies in Institutionalising Child-Centred Disaster Resilience and Climate Change Adaptation." *Progress in Disaster Science* 18: 100284. https://doi.org/10.1016/j.pdisas.2023.100284.

Leckey, E. H., M. K. Littrell, C. Okochi, I. González-Bascó, A. Gold, and S. Rosales-Collins. 2021. "Exploring Local Environmental Change Through Filmmaking: The Lentes en Cambio Climático Program." *Journal of Environmental Education* 52, no. 4: 207–222. https://doi.org/10.1080/00958964.2021.1949570.

Li, Y., B. Sun, C. Yang, et al. 2022. "Effectiveness Evaluation of a Primary School-Based Intervention Against Heatwaves in China." *International Journal of Environmental Research and Public Health* 19: 2532.

Lock, R. 2019. "From Academia to Response-Ability." In *Climate Change and the Role of Education*, edited by W. Leal Filho and S. L. Hemstock, 349–362. Springer International Publishing. https://doi.org/10.1007/978-3-030-32898-6_19.

Maier, A., J. Daniel, J. Oakes, and L. Lam. 2017. *Community Schools as an Effective School Improvement Strategy: A Review of the Evidence*. Learning Policy Institute.

Manalo, J. A., K. P. Balmeo, J. C. Berto, F. M. Saludez, J. D. Villaflor, and A. M. Pagdanganan. 2016. "Integrating Climate-Smart Rice Agriculture Into Secondary-Level Curriculum: Lessons From Three High Schools in The Philippines." *Springerplus* 5, no. 1: 1592. https://doi.org/10.1186/s40064-016-3238-6.

Mavrogianni, A., and D. Mumovic. 2010. "On the Use of Windcatchers in Schools: Climate Change, Occupancy Patterns, and Adaptation Strategies." *Indoor and Built Environment* 19, no. 3: 340–354. https://doi.org/10.1177/1420326X09341507.

McNamara, K. E., and R. Westoby. 2016. "Intergenerational Sharing of Indigenous Environmental Knowledge in the Torres Strait." In *Geographies of Global Issues: Change and Threat*, edited by N. Ansell, N. Klocker, and T. Skelton, 463–482. Springer Singapore. https://doi.org/10.1007/978-981-4585-54-5_6.

Meyer, M. A., M. Hendricks, G. D. Newman, et al. 2018. "Participatory Action Research: Tools for Disaster Resilience Education." *International Journal of Disaster Resilience in the Built Environment* 9, no. 4/5: 402–419. https://doi.org/10.1108/IJDRBE-02-2017-0015.

Mogren, A., N. Gericke, and H.-Å. Scherp. 2019. "Whole School Approaches to Education for Sustainable Development: A Model That Links to School Improvement." *Environmental Education Research* 25, no. 4: 508–531. https://doi.org/10.1080/13504622.2018.1455074.

Monroe, M. C., R. R. Plate, A. Oxarart, A. Bowers, and W. A. Chaves. 2019. "Identifying Effective Climate Change Education Strategies: A Systematic Review of the Research." *Environmental Education Research* 25, no. 6: 791–812.

Nahayo, L., L. Li, G. Habiyaremye, et al. 2018. "Extent of Disaster Courses Delivery for the Risk Reduction in Rwanda." *International Journal of Disaster Risk Reduction* 27: 127–132. https://doi.org/10.1016/j.ijdrr.2017.09.046.

Nepraš, K., T. Strejčková, and R. Kroufek. 2022. "Climate Change Education in Primary and Lower Secondary Education: Systematic Review Results." *Sustainability* 14, no. 22: 14913. https://doi.org/10.3390/su142214913.

Neset, T.-S., L. Andersson, O. Uhrqvist, and C. Navarra. 2020. "Serious Gaming for Climate Adaptation—Assessing the Potential and Challenges of a Digital Serious Game for Urban Climate Adaptation." *Sustainability* 12, no. 5: 1789. https://doi.org/10.3390/su12051789.

Nguyen, H. T., H. T. Le, and L. B. Connelly. 2021. "Weather and Children's Time Allocation." *Health Economics* 30, no. 7: 1559–1579. https://doi.org/10.1002/hec.4264.

Nurdin, N., I. Rafliana, S. Hidayati, R. S. Oktari, and R. Djalante. 2017. "Integrating Disaster Risk Reduction and Climate Change Adaptation Into School Curricula: From National Policy to Local Implementation." In *Disaster Risk Reduction in Indonesia*, edited by R. Djalante, M. Garschagen, F. Thomalla, and R. Shaw, 213–234. Springer International Publishing. https://doi.org/10.1007/978-3-319-54466-3_8.

Opach, T., E. Glaas, M. Hjerpe, and C. Navarra. 2020. "Vulnerability Visualization to Support Adaptation to Heat and Floods: Towards the EXTRA Interactive Tool in Norrköping, Sweden." *Sustainability* 12, no. 3: 1179. https://doi.org/10.3390/su12031179.

Page, M. J., D. Moher, P. M. Bossuyt, et al. 2021. "PRISMA 2020 Explanation and Elaboration: Updated Guidance and Exemplars for Reporting Systematic Reviews." *BMJ* 372, no. 160. https://doi.org/10.1136/bmj.n160.

Parham, M. 2022. "Returning to Normal? 'Building Back Better' in the Dominican Education System After Tropical Storm Erika and Hurricane Maria." *Disasters* 46, no. S1: S128–S150. https://doi.org/10.1111/disa.12536.

Park, N.-E., S.-U. Choe, and C.-J. Kim. 2020. "Analysis of Climate Change Education (CCE) Programs: Focusing on Cultivating Citizen Activists to Respond to Climate Change." *Asia-Pacific Science Education* 6, no. 1: 15–40. https://doi.org/10.1163/23641177-BJA00004.

Park, R. J., A. P. Behrer, and J. Goodman. 2020. "Learning Is Inhibited by Heat Exposure, Both Internationally and Within the United States." *Nature Human Behaviour* 5, no. 1: 19–27. https://doi.org/10.1038/s41562-020-00959-9.

Pickering, C. J., E. Guy, Z. Al-Baldawi, L. McVean, S. Sargent, and T. O'Sullivan. 2021. ""I Believe This Team Will Change How Society Views Youth in Disasters": The EnRiCH Youth Research Team: A Youth-Led Community-Based Disaster Risk Reduction Program in Ottawa, Canada." *Canadian Journal of Public Health* 112, no. 5: 957–964. https://doi.org/10.17269/s41997-021-00486-8.

Pinsky, E., A. P. S. Guerrero, and R. Livingston. 2020. "Our House Is on Fire: Child and Adolescent Psychiatrists in the Era of the Climate Crisis." *Journal of the American Academy of Child and Adolescent Psychiatry* 59, no. 5: 580–582. https://doi.org/10.1016/j.jaac.2020.01.016.

Radzi, S. N. F., K. Osman, and M. N. Mohd Said. 2022. "Progressing Towards Global Citizenship and a Sustainable Nation: Pillars of Climate Change Education and Actions." *Sustainability* 14, no. 9: 5163. https://doi.org/10.3390/su14095163.

Rahma, A., D. Mardiatno, and D. R. Hizbaron. 2024. "Developing a Theoretical Framework: School Ecosystem-Based Disaster Risk Education." *International Research in Geographical and Environmental Education* 33, no. 1: 6–23. https://doi.org/10.1080/10382046.2023.2214041.

Raines, K., and J. M. Fitchett. 2024. "Exploring the Risk of Heat Stress in High School Pre-Season Sports Training, Johannesburg, South Africa." *International Journal of Biometeorology* 69: 2829–2839. https://doi.org/10.1007/s00484-024-02748-9.

Reis, J., and R. C. Ballinger. 2020. "Creating a Climate for Learning-Experiences of Educating Existing and Future Decision-Makers About Climate Change." *Marine Policy* 111: S0308597X18305189. https://doi.org/10.1016/j.marpol.2018.07.007.

Riise, J., and K. Adeyemi. 2015. "Case Study: Makoko Floating School." *Current Opinion in Environmental Sustainability* 13: 58–60. https://doi.org/10.1016/j.cosust.2015.02.002.

Rousell, D., and A. Cutter-Mackenzie-Knowles. 2020. "A Systematic Review of Climate Change Education: Giving Children and Young People a 'Voice' and a 'Hand' in Redressing Climate Change." *Children's Geographies* 18, no. 2: 191–208.

Rupasinghe, C. S., and S. de Silva Weliange. 2024. "Climate Change Adaptation and Mitigation at Individual Level: Knowledge and Attitudes Among School Teachers in Kalutara District." *International Journal of Disaster Resilience in the Built Environment* 15, no. 3: 395–408. https://doi.org/10.1108/IJDRBE-02-2023-0015.

Sakurai, A., M. B. F. Bisri, T. Oda, et al. 2018. "Exploring Minimum Essentials for Sustainable School Disaster Preparedness: A Case of Elementary Schools in Banda Aceh City, Indonesia." *International Journal of Disaster Risk Reduction* 29: 73–83. https://doi.org/10.1016/j.ijdrr.2017.08.005.

Sanson, A. V., J. van Hoorn, and S. E. L. Burke. 2019. "Responding to the Impacts of the Climate Crisis on Children and Youth." *Child Development Perspectives* 13, no. 4: 201–207. https://doi.org/10.1111/cdep.12342.

Sanz-Mas, M., X. Continente, S. Brugueras, M. Marí-Dell'Olmo, L. Oliveras, and M. J. López. 2024. "Evaluating the Effect of Passive Cooling Strategies in School Buildings on Children's Well-Being in Barcelona: A Quasi-Experimental, Mixed Methods Study." *Science of the Total Environment* 949: 175104. https://doi.org/10.1016/j.scitotenv.2024.175104.

Sanz-Mas, M., X. Continente, S. Brugueras, M. Marí-Dell'Olmo, L. Oliveras, and M. J. López. 2025. "Evaluating the Effect of Green, Blue, and Gray Measures for Climate Change Adaptation on Children's Well-Being in Schoolyards in Barcelona." *Landscape and Urban Planning* 253: 105206. https://doi.org/10.1016/j.landurbplan.2024.105206.

Schlaepfer-Miller, J., C. Kueffer, and M. Dahinden. 2023. "Climate Garden 2085: An Easily Applicable Transdisciplinary Public Art-Science Experiment for Transformative Learning About Climate

Change." *Environment, Development and Sustainability* 27: 20763–20784. https://doi.org/10.1007/s10668-023-03899-2.

Schrot, O. G., L. Keller, D. Peduzzi, M. Riede, A. Kuthe, and D. Ludwig. 2019. "Teenagers Expand Their Conceptions of Climate Change Adaptation Through Research-Education Cooperation." In *Climate Change and the Role of Education*, edited by W. Leal Filho and S. L. Hemstock, 525–547. Springer International Publishing. https://doi.org/10.1007/978-3-030-32898-6_29.

Schrot, O. G., D. Peduzzi, D. Ludwig, M. Riede, and L. Keller. 2021. "Is It Possible to Build Adolescents' Cognitive Adaptive Capacity Through Climate Change Education? Insights Into a Two-Year Long Educational Programme in North Tyrol (Austria) and South Tyrol (Italy)." *Climate Risk Management* 33: 100327. https://doi.org/10.1016/j.crm.2021.100327.

Schwartz, S. E. O., L. Benoit, S. Clayton, M. F. Parnes, L. Swenson, and S. R. Lowe. 2023. "Climate Change Anxiety and Mental Health: Environmental Activism as Buffer." *Current Psychology* 42: 1–14. https://doi.org/10.1007/s12144-022-02735-6.

Selby, D., F. Kagawa, and R. Oberman. 2020. "Along the Cays and Bays: Climate Change Learning in a Small Island Developing State." *Policy & Practice: A Development Education Review* 31: 31–56.

Shah, A. A., Z. Gong, M. Ali, A. Jamshed, S. A. A. Naqvi, and S. Naz. 2020. "Measuring Education Sector Resilience in the Face of Flood Disasters in Pakistan: An Index-Based Approach." *Environmental Science and Pollution Research* 27, no. 35: 44106–44122. https://doi.org/10.1007/s11356-020-10308-y.

Sheffield, P., S. Uijttewaal, J. Stewart, and M. Galvez. 2017. "Climate Change and Schools: Environmental Hazards and Resiliency." *International Journal of Environmental Research and Public Health* 14, no. 11: 1397. https://doi.org/10.3390/ijerph14111397.

Shi, L., E. Chu, I. Anguelovski, et al. 2016. "Roadmap Towards Justice in Urban Climate Adaptation Research." *Nature Climate Change* 6, no. 2: 1–25. https://doi.org/10.1038/nclimate2841.

Shi, L., and S. Moser. 2021. "Transformative Climate Adaptation in the United States: Trends and Prospects." *Science* 372, no. 6549: eabc8054. https://doi.org/10.1126/science.abc8054.

Sibanda, A., and S. Manik. 2023. "Reflecting on Climate Change Education (CCE) Initiatives for Mitigation and Adaptation in South Africa." *Environmental Education Research* 29, no. 12: 1814–1831. https://doi.org/10.1080/13504622.2022.2140781.

Spellman, K. V., A. Deutsch, C. P. H. Mulder, and L. D. Carsten-Conner. 2016. "Metacognitive Learning in the Ecology Classroom: A Tool for Preparing Problem Solvers in a Time of Rapid Change?" *Ecosphere* 7, no. 8: e01411. https://doi.org/10.1002/ecs2.1411.

Spiteri, J. 2023. "Approaches to Foster Young Children's Engagement With Climate Action: A Scoping Review." *Sustainability* 15, no. 19: 14604. https://doi.org/10.3390/su151914604.

Stahlschmidt, S., and D. Stephen. 2020. "Comparison of Web of Science." *Scopus and Dimensions Databases* 2020, no. 10: 37.

Teo, I., P. Mitchell, F. van der Kleij, and A. Dabrowski. 2022. "Schools as Community Hubs: Literature Review." *Australian Council for Educational Research*: 1–24. https://doi.org/10.37517/978-1-74286-684-0.

Trejo-Rangel, M. A., V. Marchezini, D. A. Rodriguez, et al. 2023. "Incorporating Social Innovations in the Elaboration of Disaster Risk Mitigation Policies." *International Journal of Disaster Risk Reduction* 84: 103450. https://doi.org/10.1016/j.ijdrr.2022.103450.

Trust for Civic Life. 2025. "Action Over Dialogue: The Case for Prioritizing Local Civic Engagement." In *Trust for Civic Life 2024 Community Survey Report*. Trust for Civic Life. https://trustforciviclife.org/wp-content/uploads/2025/04/Trust-Community-Survey-Report_Apr2025.pdf.

Tugjamba, N., B. Yembuu, A. Gantumur, and U. Getsel. 2016. "Policy Provisions and Teachers' Needs on Climate Change Education for Sustainable Development in Mongolia." *International Journal of Asian Business and Information Management* 7, no. 4: 36–48. https://doi.org/10.4018/IJABIM.2016100103.

Ueda, Y., E. Matsumoto, Y. Nakagawa, and R. Shaw. 2016. "International Cooperation: Grassroots Experience Sharing in Vietnam." In *Disaster Resilience of Education Systems*, edited by K. Shiwaku, A. Sakurai, and R. Shaw, 213–229. Springer Japan. https://doi.org/10.1007/978-4-431-55982-5_13.

Ueda, Y., M. Shikada, E. Matsumoto, Y. Nakagawa, and R. Shaw. 2014. "Knowledge, Education and Training for Risk Reduction: Specific Case of Myanmar, Vietnam and Japan." In *Civil Society Organization and Disaster Risk Reduction*, edited by R. Shaw and T. Izumi, 135–157. Springer Japan. https://doi.org/10.1007/978-4-431-54877-5_8.

van den Bogerd, N., D. Hovinga, J. A. Hiemstra, and J. Maas. 2023. "The Potential of Green Schoolyards for Healthy Child Development: A Conceptual Framework." *Forests* 14, no. 4: 660. https://doi.org/10.3390/f14040660.

van den Bogerd, N., and J. Maas. 2024. "Development and Testing of the Green Schoolyard Evaluation Tool (GSET)." *Landscape and Urban Planning* 241: 104921. https://doi.org/10.1016/j.landurbplan.2023.104921.

Van Der Geest, K., and R. Van Den Berg. 2021. "Slow-Onset Events: A Review of the Evidence From the IPCC Special Reports on Land, Oceans and Cryosphere." *Current Opinion in Environmental Sustainability* 50: 109–120. https://doi.org/10.1016/j.cosust.2021.03.008.

van der Plank, S., K. Appeaning Addo, R. Anderson, et al. 2024. "The 'More Than Maps' Framework for Building Research Capacity Among Young People in Coastal Climate Change Adaptation." *Area* 56, no. 2: e12919. https://doi.org/10.1111/area.12919.

van Nieuwenhuizen, A., K. Hudson, X. Chen, and A. R. Hwong. 2021. "The Effects of Climate Change on Child and Adolescent Mental Health: Clinical Considerations." *Current Psychiatry Reports* 23, no. 88: 1–9. https://doi.org/10.1007/s11920-021-01296-y.

Venegas Marin, S., L. Schwarz, and S. Sabarwal. 2024. "Impacts of Extreme Weather Events on Education Outcomes: A Review of Evidence." *World Bank Research Observer* 39, no. 2: 177–226. https://doi.org/10.1093/wbro/lkae001.

Verlie, B., and S. M. Blom. 2022. "Education in a Changing Climate: Reconceptualising School and Classroom Climate Through the Fiery Atmos-Fears of Australia's Black Summer." *Children's Geographies* 20, no. 5: 618–632. https://doi.org/10.1080/14733285.2021.1948504.

Walker, C., E. van Holstein, and N. Klocker. 2025. "Young People at a Crossroads: Climate Solidarity Through Intergenerational Storytelling." *Geographical Research* 63, no. 1: 153–168. https://doi.org/10.1111/1745-5871.12668.

Walshe, R. A., D. Chang Seng, A. Bumpus, and J. Auffray. 2018. "Perceptions of Adaptation, Resilience and Climate Knowledge in the Pacific: The Cases of Samoa, Fiji and Vanuatu." *International Journal of Climate Change Strategies and Management* 10, no. 2: 303–322. https://doi.org/10.1108/IJCCSM-03-2017-0060.

Wang, J.-J., and N.-Y. Tsai. 2022. "Factors Affecting Elementary and Junior High School Teachers' Behavioral Intentions to School Disaster Preparedness Based on the Theory of Planned Behavior." *International Journal of Disaster Risk Reduction* 69: 102757. https://doi.org/10.1016/j.ijdrr.2021.102757.

Wang, Y., X. Zhang, Y. Li, et al. 2022. "Knowledge, Attitude, Risk Perception, and Health-Related Adaptive Behavior of Primary School Children Towards Climate Change: A Cross-Sectional Study in China." *International Journal of Environmental Research and Public Health* 19, no. 23: 15648. https://doi.org/10.3390/ijerph192315648.

Wensing, A. J., E. J. Wensing, and M. Virgo. 2018. "Towards a Core Curriculum for Civic Engagement on Appropriate Technology: Characterizing, Optimizing and Mobilizing Youth Community Service Learning." *African Journal of Science, Technology, Innovation and Development* 10, no. 7: 867–877. https://doi.org/10.1080/20421338.2018.1439279.

World Health Organization (WHO). 1996. "Regional Guidelines Development of Health-Promoting Schools – A Framework for Action." In *World Health Organization – Regional Office for the Western Pacific Health-Promoting Schools. Series*, vol. 5, 1–25. https://iris.who.int/server/api/core/bitstreams/2fe154be-327e-4589-8833-ab4cd9126098/content.

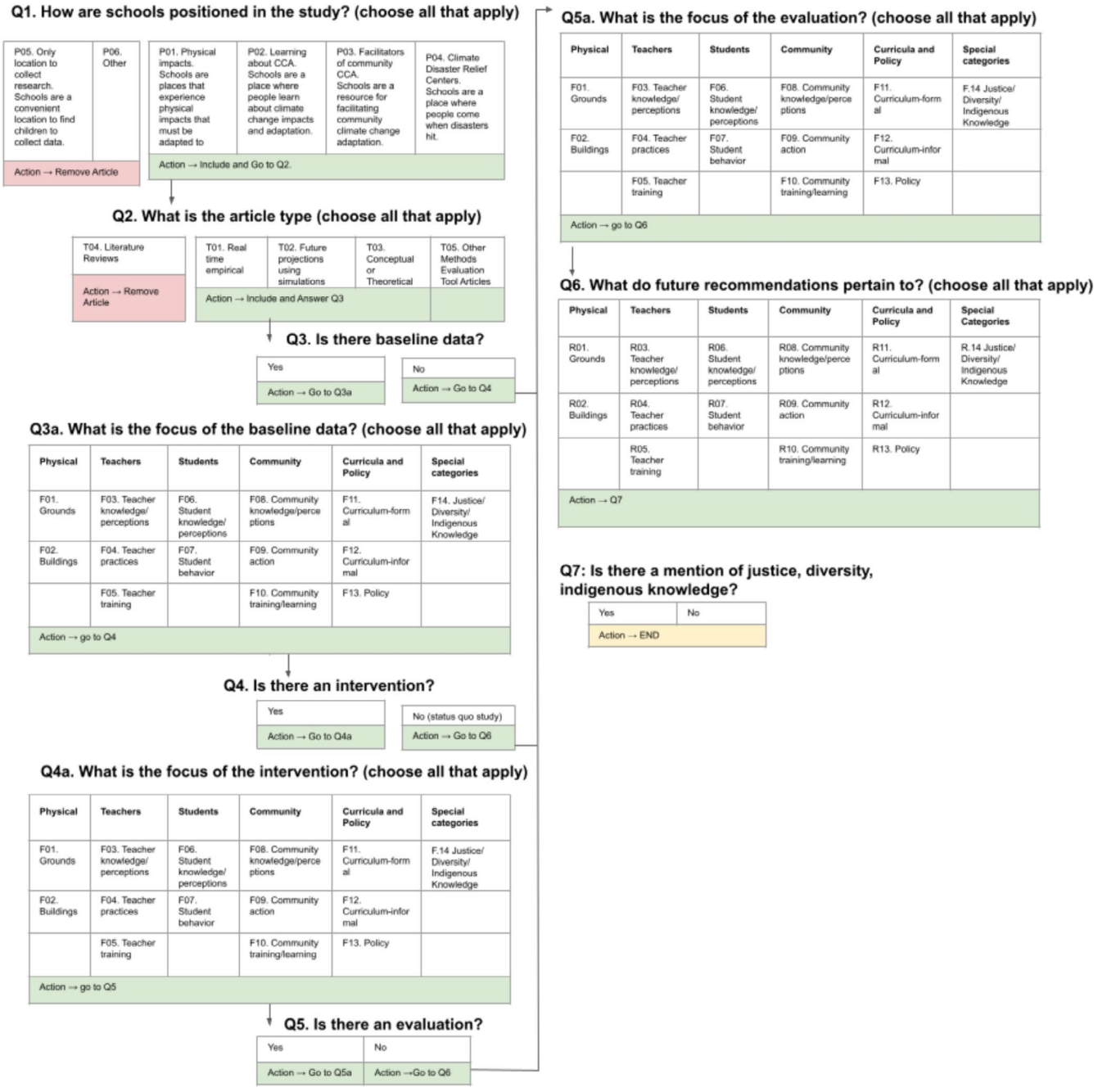
Wu, J., C. Huang, M. Pang, et al. 2019. "Planned Sheltering as an Adaptation Strategy to Climate Change: Lessons Learned From the Severe Flooding in Anhui Province of China in 2016." *Science of the Total Environment* 694: 133586. https://doi.org/10.1016/j.scitotenv.2019.133586.

Yan, S., A. I. Race, H. L. Ballard, et al. 2023. "How Can Participating in a Forest Community and Citizen Science Program Support Elementary School Students' Understanding of Socio-Ecological Systems?" *Sustainability* 15, no. 24: 16832. https://doi.org/10.3390/su152416832.

Yildiz, A., J. Dickinson, J. Priego-Hernández, R. Teeuw, and R. Shaw. 2024. "Effects of Disaster Education on Children's Risk Perception and Preparedness: A Quasi-Experimental Longitudinal Study." *Geographical Journal* 190, no. 2: e12556. https://doi.org/10.1111/geoj.12556.

Zhong, S., Q. Cheng, S. Zhang, C. Huang, and Z. Wang. 2021. "An Impact Assessment of Disaster Education on Children's Flood Risk Perceptions in China: Policy Implications for Adaptation to Climate Extremes." *Science of the Total Environment* 757: 143761. https://doi.org/10.1016/j.scitotenv.2020.143761.

Appendix A: Codebook Flowchart



Appendix B: Complete List of Publications in Review

Citation	Teaching and learning	Experiencing and adapting	Supporting communities
Akkose et al. (2021)		X	
Allen and Crowley (2017)	X		
Ashraf and Faruk (2018)		X	
Baba et al. (2026)		X	
Baba et al. (2023)		X	
Bardsley (2017)	X		
Bidassey-Manilal et al. (2020)		X	
Bofferding and Kloser (2015)	X		
Boon (2015)	X		
Brown et al. (2023)	X	X	
Caluwaerts et al. (2021)	X		
Caprari et al. (2024)	X		
Chineka and Yasukawa (2020)			X
Chinowsky et al. (2014)		X	
Cost (2015)			X
Dania et al. (2022)	X		X
Davies and Hügel (2021)	X		X
Dawkins et al. (2024)		X	
de Lara (2017)	X		
Dong et al. (2023)		X	
Dong et al. (2024)		X	
Dueñas I Cid and Ochoa I Cañigueral (2016)	X		X
Eichinger et al. (2022)	X		
Feinstein and Mach (2020)	X		
Giezen and Pellerey (2021)		X	
Goritz and Kolleck (2024)	X		
Guler et al. (2022)	X		X
Haida et al. (2019)	X		
Haraha and Ernawati (2014)		X	
Heberger et al. (2011)		X	
Heracleous et al. (2021)		X	
Hviid et al. (2020)		X	
Kabir et al. (2015)	X		
Kerr et al. (2019)		X	
Krasny and DuBois (2019)	X		X
Langenheim et al. (2020)		X	
Lanza et al. (2023)		X	
Lanza et al. (2021)	X	X	
Lassa et al. (2023)			X
Leckey et al. (2021)	X		X

Citation	Teaching and learning	Experiencing and adapting	Supporting communities
Li et al. (2022)	X		X
Lock (2019)	X		X
Manalo et al. (2016)	X		X
Mavrogianni and Mumovic (2010)		X	
McNamara and Westoby (2016)	X		X
Meyer et al. (2018)	X		X
Nahayo et al. (2018)	X		
Neset et al. (2020)	X		
Nguyen et al. (2021)		X	
Nurdin et al. (2017)	X		
Opach et al. (2020)		X	
Parham (2022)	X		
Park, Choe, and Kim (2020)	X		X
Park, Behrer, and Goodman (2020)		X	
Pickering et al. (2021)	X		X
Raines and Fitchett (2024)		X	
Reis and Ballinger (2020)	X		
Riise and Adeyemi (2015)		X	
Rupasinghe and de Silva Weliange (2024)	X		
Sakurai et al. (2018)	X	X	
Sanz-Mas et al. (2024)	X		
Sanz-Mas et al. (2025)		X	
Schlaepfer-Miller et al. (2023)	X		
Schrot et al. (2019)	X		
Schrot et al. (2021)	X		
Selby et al. (2020)	X		X
Shah et al. (2020)	X	X	X
Spellman et al. (2016)	X		
Trejo-Rangel et al. (2023)			X
Tugjamba et al. (2016)	X		
Ueda et al. (2016)	X		
Ueda et al. (2014)	X		
van den Bogerd et al. (2023)		X	
van den Bogerd and Maas (2024)		X	
van der Plank et al. (2024)	X		
Verlie and Blom (2022)	X	X	X
Walker et al. (2025)	X		X
Walshe et al. (2018)	X		
Wang and Tsai (2022)	X		
Wang et al. (2022)	X		
Wensing et al. (2018)	X		
Wu et al. (2019)			X

Citation	Teaching and learning	Experiencing and adapting	Supporting communities
Yan et al. (2023)		X	
Yildiz et al. (2024)		X	
Zhong et al. (2021)		X	