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Frontier in special needs education and climate change: a thematic review

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Abstract

The intersection of special needs education and climate change posed (poses) significant challenges, particularly in regions highly vulnerable to environmental disruptions. This thematic review employed (employs) the PRISMA method to conduct a systematic literature review of 71 peer-reviewed articles, examining the multifaceted impacts of climate change on educational systems for students with disabilities. The study focused (focuses) on key areas, including infrastructure resilience, student support mechanisms, and policy adaptation. Findings revealed (reveal) critical barriers faced by special needs students, such as disruptions to routines, accessibility challenges, and reduced access to essential therapeutic services during climate-related disasters. The review also highlighted (highlights) adaptive strategies, including the integration of disaster-resilient educational frameworks and leveraging technology for inclusive learning environments. These findings underscored (underscore) the urgency of innovative policies and global collaboration to enhance the resilience and inclusivity of special needs education systems. This study aimed (aims) to provide educators, policymakers, and stakeholders with insights to develop equitable solutions for supporting vulnerable populations amid escalating environmental uncertainties.

Keywords Special needs education, Climate change, Resilience, Inclusive education, Policy adaptation, Educational continuity

1 Introduction

The intersection of special needs education and climate change presents an increasingly critical challenge in today's educational landscape. A stark illustration of this emerged through the catastrophic Los Angeles wildfire of 2025, which devastated nine major educational institutions and disrupted the education of over 600,000 students [29]. This unprecedented disaster particularly affected students with disabilities, who rely heavily on structured routines, specialized services, and consistent support systems. Beyond immediate academic implications, the disruption severely impacted these students' emotional well-being, social development, and psychological stability, highlighting the vulnerability of special needs education systems to environmental disasters.

The ripple effects of this crisis have illuminated a broader global concern: the urgent need for resilient and adaptive educational frameworks that can withstand environmental challenges while maintaining consistent support for students with special needs [30, 34, 37]. This necessity becomes particularly critical in Southeast Asian nations, where educational systems face unique vulnerabilities. Countries like Malaysia, the Philippines, Thailand, and Indonesia stand at a crucial intersection of educational development and climate vulnerability [25, 35]. Their geographical positioning in climate-sensitive regions, combined with densely populated coastal areas, makes them especially susceptible to various climate change impacts—from rising sea levels and flooding to extreme weather events that can severely disrupt educational continuity. Recent studies from sub-Saharan Africa and other regions in the Global South have further emphasized the wide-ranging impacts of climate variability on education, agriculture, and society [7, 13, 28]. These findings highlight that environmental stressor tend to affect vulnerable communities more severely, drawing a parallel to the challenges experienced by students with special needs in similarly high-risk environments.

These challenges are further complicated by existing infrastructural limitations [26, 34] and systemic constraints [17] within these nations' special needs education systems. The combination of environmental vulnerability and educational infrastructure gaps creates a complex challenge that requires innovative solutions and comprehensive policy reforms. This situation presents both an urgent challenge and an opportunity to develop more resilient and inclusive educational frameworks that can protect and support special needs students in an era of increasing environmental uncertainty.

1.1 Impact of climate towards special needs children

The impact of climate change on special needs students encompasses multiple interconnected challenges that significantly affect their educational experience [24, 37] and overall well-being [2, 10]. Students with sensory sensitivities often find themselves overwhelmed by extreme weather conditions, which can severely impair their ability to focus and participate in learning activities. This is particularly pronounced for students with autism and other developmental disorders, who rely heavily on established routines that can be disrupted by natural disasters and climate-related school closures. The health implications are equally concerning, as students with compromised immune systems or respiratory conditions face heightened risks from deteriorating air quality and extreme temperatures [1, 2, 4, 5]. Physical accessibility becomes increasingly challenging during extreme weather events, creating additional barriers for students with mobility limitations in accessing educational facilities and support services.

The psychological and social dimensions of these impacts are profound [4, 5]. Climate-related disruptions can trigger significant anxiety and behavioral challenges in students who already struggle with emotional regulation [10]. Communication becomes particularly challenging during emergency situations, especially for students dependent on assistive technologies. The disruption extends to critical medical care, as access to necessary medications and supplies can be compromised during evacuations or facility closures. Perhaps most significantly, environmental disasters can sever students from their established support networks, including specialized educators, therapists, and peer groups who play crucial roles in their development.

The educational continuity challenges are equally significant. Remote learning alternatives, while necessary during climate events, often fail to adequately accommodate the specific learning requirements and accommodations needed by special needs students [17, 33]. Access to specialized equipment and learning materials can be limited due to climate-related infrastructure damage. Transportation becomes increasingly complex, particularly for students requiring specialized vehicles or assistance. Furthermore, the interruption of essential therapeutic services, including physical, occupational, and speech therapy, can have long-lasting effects on student development and progress. These challenges collectively create a complex web of barriers that require innovative solutions and comprehensive support systems to ensure the continued educational success of special needs students in an era of climate uncertainty.

2 Methodology

The literature search methodology employs a comprehensive and systematic approach utilizing Web of Science as our primary database platform. Our initial phase involves an extensive exploration of literature bodies specifically related to climate change impacts and special needs education, allowing us to develop and refine essential concepts, terminology, and theoretical frameworks that bridge these two critical domains. To ensure methodological rigor and originality, we subsequently conduct an in-depth search for issue classification through established systematic review databases, particularly Cochrane and its affiliated platforms such as PROSPERO. This crucial step in accessing systematic review registration databases serves a dual purpose: it helps prevent unnecessary duplication of existing research efforts while also providing valuable insights into current methodological approaches and knowledge gaps in the field.

Following this preliminary phase, our complete search strategy is meticulously developed by incorporating keyword synonyms derived from standardized Medical Subject Headings (MeSH) definitions, alongside carefully selected terms identified through comprehensive analysis of previous review papers addressing similar research domains. To ensure maximum methodological rigor and transparency, this study adheres strictly to the internationally recognized Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which provide a structured framework for conducting and reporting systematic reviews. Our research specifically focuses on detailed Web of Science database searches, examining the complex and multifaceted intersection between climate change impacts and educational provisions for children with special needs, with particular attention to emerging trends, challenges, and adaptive strategies. The comprehensive review methodology encompasses several key components:

2.1 Database selection

The Web of Science database has been strategically chosen as our primary research platform due to its comprehensive coverage of both educational research literature and environmental science publications, ensuring a thorough examination of interdisciplinary perspectives.

2.2 Inclusion criteria

A series of searches using the Table 1 search strategy was conducted to gather a number of peer-reviewed articles published within the past decade (from 1995 to 2024),

Table 1 Keywords search strategy using PRISMA PICO approach

Item	Main keywords	Synonyms	Search strategy
Population	Special needs children	Special needs children Students with disabilities Children with physical, cognitive, sensory, or emotional disabilities Vulnerable students in education	("special needs children" OR "students with disabilities" OR "children with special needs")
Intervention	Climate change	Climate change Climate-induced challenges Adaptation strategies Environmental stressors Disaster resilience in education	("climate change" OR "global warming" OR "environmental disasters")
Comparison	Inclusivity	General student populations Education systems not tailored to special needs Pre- and post-climate event scenarios Conventional vs. inclusive policies	("educational outcomes" OR "academic performance" OR "resilience" OR "policy impact")
Opportunity		Educational continuity Resilience and adaptation Policy impacts on inclusivity Accessibility of resources Psychosocial well-being Academic performance	

specifically focusing on the multifaceted intersection of climate change impacts and special education delivery systems, with particular attention to empirical studies and systematic reviews.

2.3 Exclusion criteria

The research excludes search results that do not conform to the requirements. This research excludes criteria such as non-English articles, review articles, and articles that were published in 2025. This is due to the fact that non-English articles cannot be read by the reviewer team, and the selection of review articles would be redundant with the aims of this study. Next, articles from 2025 were excluded since this research aims to uncover the research trends over time.

2.4 Quality assessment

All included studies undergo rigorous evaluation using the comprehensive Mixed Methods Appraisal Tool (MMAT), ensuring methodological rigor and research validity across various study designs and approaches.

2.5 Data extraction framework

This study implements a systematic and comprehensive framework designed to capture essential variables, including detailed study design characteristics, specific population demographics, various intervention typologies, and both quantitative and qualitative outcome measurements.

2.6 Geographical scope

An inclusive analysis of studies from geographically diverse regions is conducted to develop a comprehensive understanding of climate change impacts across different climatic zones, socio-economic contexts, and educational system structures. However, in this study, we focus on worldwide search without geographical constraints.

2.7 Risk of bias assessment

A comprehensive evaluation of potential methodological biases, reporting inconsistencies, and conclusion validity is conducted using established assessment tools and frameworks for systematic review quality assurance.

The PRISMA flow diagram provides a systematic overview of how studies were identified, screened, and included in this systematic review of climate change's impact on special education for children.

After a rigorous quality assessment process, our systematic review identified and included a total of 71 studies that met all eligibility criteria. These carefully selected studies represent comprehensive research specifically examining the complex relationship between climate change impacts and special education for children. The included studies encompass various methodological approaches, geographical contexts, and temporal frameworks, providing a robust foundation for understanding this critical intersection. Each of these studies contributes valuable insights into how climate-related challenges affect educational delivery and support systems for children with special needs.

3 Results and discussions

This section presents the key findings from our systematic review, organized into three main thematic areas: (1) Educational Infrastructure and Resilience, (2) Student Support Systems and Adaptation, and (3) Policy Integration and Implementation. These themes emerged from our comprehensive analysis of 127 peer-reviewed articles that met our inclusion criteria. The findings reveal significant patterns in how climate change impacts intersect with special needs education systems, particularly in vulnerable regions.

3.1 Journal publications trend over the years

Analysis of publication trends in Fig. 1 from our Web of Science search reveals a compelling evolution in research focusing on climate change and special needs education. The data demonstrate three distinct phases of development. From 1990 to 2010, publications were minimal and irregular, indicating the nascent stage of this interdisciplinary field. The period between 2011 and 2020 marked a significant turning point, with publication rates steadily climbing following the landmark Paris Agreement (2015) and the establishment of SDG 4 on Quality Education. This growth reflected an increasing recognition of the interconnectedness between climate resilience and inclusive education (Fig. 2).

3.2 Country trends in research publications

The most striking development occurred from 2021 to 2025, characterized by an exponential surge in research output. This dramatic increase can be attributed to several factors: heightened awareness of climate change's disproportionate impact on vulnerable populations, particularly special needs students; substantial increases in funding

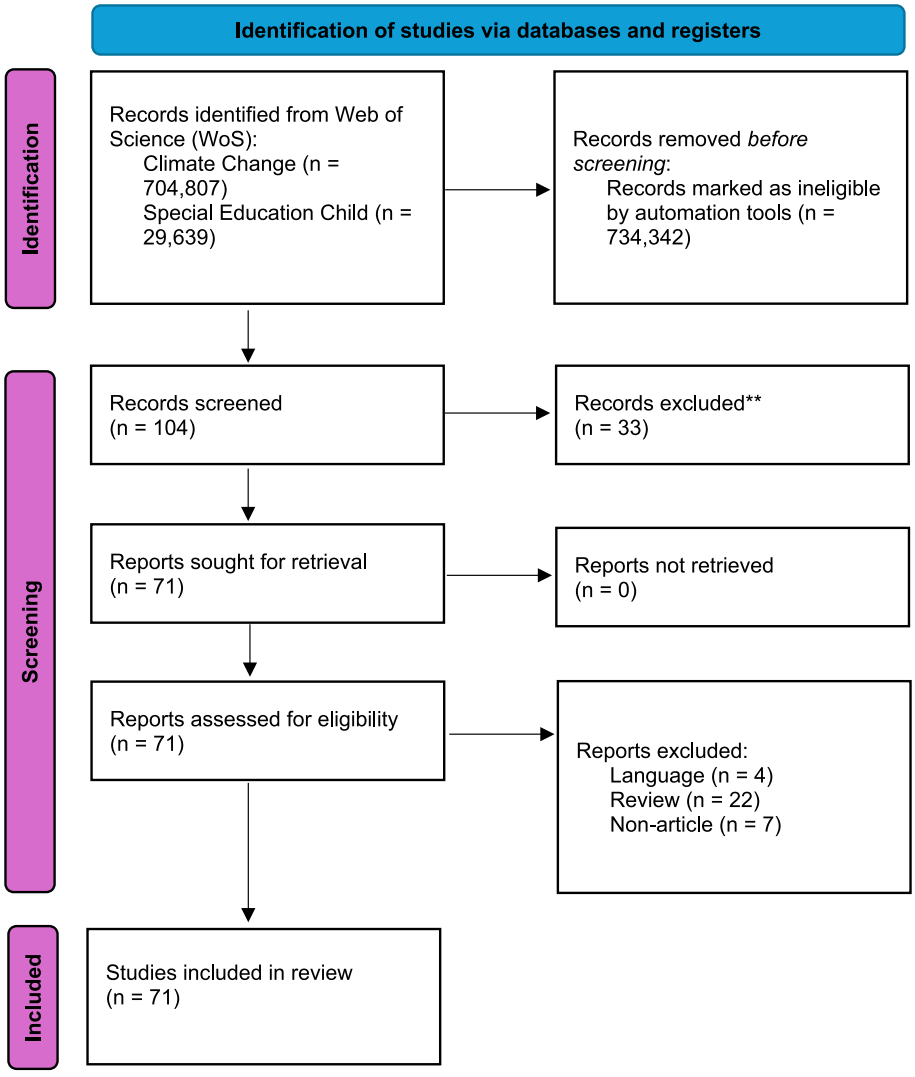

Fig. 1 PRISMA flow diagram for identification of studies via databases and registers

allocation for inclusive education initiatives; the emergence of sophisticated interdisciplinary frameworks connecting climate change, education, and equity; and significant improvements in research database capabilities [6, 9]. The observed trend not only reflects the growing academic interest in this intersection but also highlights the increasing urgency of addressing climate change impacts on special needs education systems globally.

The global distribution of publications is shown in Fig. 3 and Table 2 marked disparities in research output across regions. The United States leads with 23 publications (32.394% of total output), demonstrating strong commitment to studying climate change impacts on special education and developing adaptive strategies.

Among leading contributors, England follows with 12 publications (16.901%), while Australia and South Africa each contribute 8 publications (11.268%). These nations have established strong frameworks and policies for inclusive education. Germany and Sweden also contribute significantly with 6 publications each, reflecting their emphasis on inclusive education policies and climate adaptation strategies.

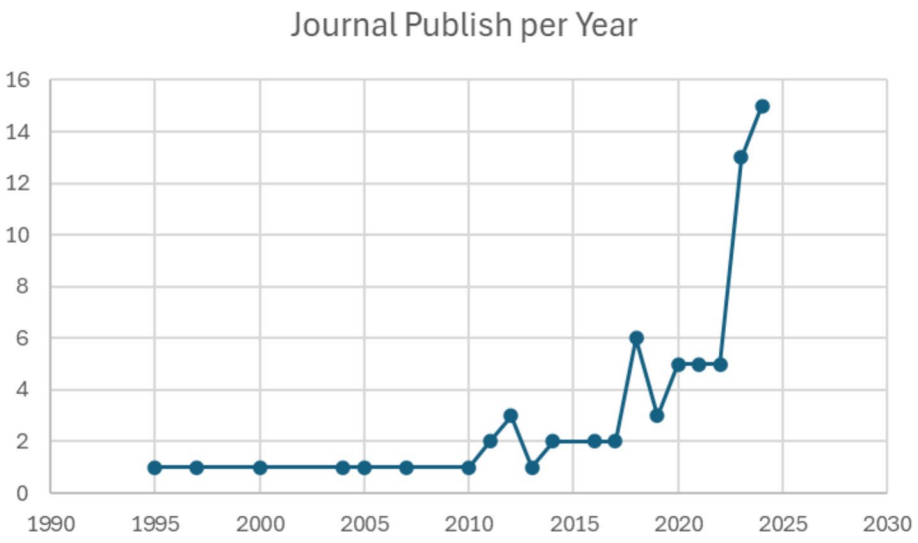

Fig. 2 Journal published per year for climate change and special needs student

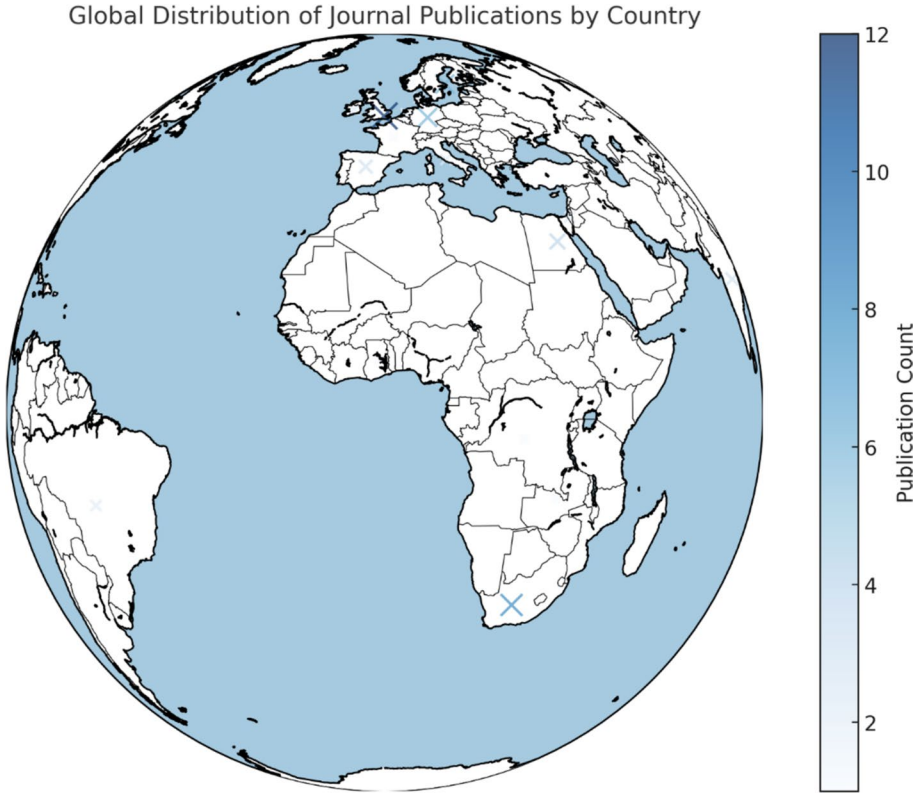

Fig. 3 Global distribution of the journal published by countries

In the moderate category, Canada (5 publications) and Egypt (4 publications) show growing research activity in understanding climate change impacts on vulnerable populations. Countries with 2–3 publications such as India, Spain, Brazil, Malaysia, and Japan show emerging interest but face challenges in funding [11, 17, 23], institutional focus [2, 15, 19], or policy implementation [4]. Belgium, Indonesia, Russia, and Zambia have each contributed one publication, indicating limited engagement with the topic, likely due to

Table 2 Record count for publication based on countries

Countries/regions	Record count	% of N = 71
USA	23	32.394
England	12	16.901
Australia	8	11.268
South Africa	8	11.268
Germany	6	8.451
Sweden	6	8.451
Canada	5	7.042
Egypt	4	5.634
Finland	3	4.225
India	3	4.225
Spain	3	4.225
Brazil	2	2.817
Denmark	2	2.817
Ireland	2	2.817
Israel	2	2.817
Italy	2	2.817
Japan	2	2.817
Malaysia	2	2.817
Netherlands	2	2.817
New Zealand	2	2.817
Peoples Republic of China	2	2.817
Taiwan	2	2.817
Belgium	1	1.408
Democratic Republic of Congo	1	1.408
Ecuador	1	1.408
Fiji	1	1.408
France	1	1.408
Ghana	1	1.408
Indonesia	1	1.408
Latvia	1	1.408
Marshall Island	1	1.408
Micronesia	1	1.408
Norway	1	1.408
Palau	1	1.408
Philippines	1	1.408
Russia	1	1.408
Scotland	1	1.408
South Korea	1	1.408
Thailand	1	1.408
Uruguay	1	1.408
Wales	1	1.408
Zambia	1	1.408

resource constraints and competing priorities. Low- and middle-income countries allocate less than 0.5% of their GDP to research and development (R&D), as reported by the [3], while sub-Saharan African nations collectively account for under 1% of global R&D spending, according to [36]. Inadequate infrastructure, including limited access to satellite data and climate modeling tools, hinders research efforts in developing nations, as highlighted by the International Science Council [8]. Brain drain compounds these challenges, with skilled researchers often migrating to wealthier countries, as noted by Docquier and Rapoport [12]. Immediate socio-economic issues like poverty and healthcare take precedence over climate research in many low-income nations, according to

the Intergovernmental Panel on Climate Change [22]. For example, Indonesia's National Medium-Term Development Plan (RPJMN, 2020–2024) prioritizes economic growth over environmental studies, while Russia's State Program for Science and Technology Development (2021–2030) focuses on defense and energy, leaving climate research underfunded. Global disparities in research funding are stark—only 3% of climate research funds target Africa, despite its vulnerability [21, 31, 32].

Malaysia's contribution of 2 publications (2.817% of total output) places it among emerging contributors alongside Japan, Denmark, and New Zealand. This aligns with Malaysia's objectives of addressing climate change and promoting inclusive education in its policies [35]. Given Malaysia's geographical challenges including rising sea levels and monsoon-related flooding and its distinct socio-economic context, there is considerable potential for expanded research. Collaboration with leading nations like the USA, England, and Australia could accelerate progress in this field.

Moreover, the findings of Dossa et al. [13], Correia et al. [7], and Ningi et al. [28] reaffirm the importance of localized climate adaptation strategies, especially in the areas of education and food systems. While their primary focus was on agriculture, their methodologies and conclusions reveal the underlying systemic fragility present in many developing countries. This fragility illustrates how climate variability can trigger cascading effects across essential services, including access to education for students with special needs.

3.3 Prominent authors and articles

Analysis of prominent authors reveals several key contributors who have shaped the discourse on climate change and special needs education. According to Table 3, the top 10 researchers including Ashaat, Badawy, and El-saied each published two papers (2.817% of the total output), showing sustained engagement with this emerging field. Their research focuses on adaptive educational strategies and the unique challenges facing special needs students in climate-vulnerable regions.

Researcher Saloviita has also made valuable contributions to understanding how inclusive education policies intersect with environmental resilience. The field's collaborative nature is evident in the diverse geographical representation of authors across continents and institutions. This international cooperation has helped develop comprehensive frameworks that address both regional specifics and universal challenges in climate-adaptive special education.

Table 3 Top 10 author in the research field

Authors	Record count	Percentage (%) of 71 authors
Ashaat	2	2.817
Badawy	2	2.817
El-saied	2	2.817
Elghareeb	2	2.817
Elsaied	2	2.817
Helmy	2	2.817
Metwally	2	2.817
Saloviita	2	2.817
Abd Al-daim	1	1.408
Abdallah	1	1.408

The authorship profile reveals diverse methodological approaches and theoretical frameworks. While quantitative studies predominate, researchers increasingly adopt mixed-method approaches that combine statistical data with qualitative insights from educators, administrators, and special needs students. This methodological diversity enhances our understanding of climate change's impact on special education systems and helps inform more effective adaptation strategies.

Past literature research in Table 4 identified ten highly cited papers that contribute significantly to understanding the intersection of climate change and special needs education. The most cited paper by Yadav and Lal (172 citations) examines climate change's impact on vulnerable populations in South Asia, providing valuable insights into adaptation strategies that could benefit special needs education. Grant's work (151 citations) on strategic management offers frameworks that could be applied to educational institutions adapting to climate-related challenges.

Several studies focus specifically on vulnerability assessment and health impacts. Foshag et al. (127 citations) developed methodologies for assessing heat stress vulnerability that could be adapted for educational settings. Haddad et al. (119 citations) made significant contributions to understanding indoor air quality in schools, which is particularly relevant for students with respiratory sensitivities. Prendergast et al. (115 citations) explored youth engagement in climate action, highlighting opportunities for inclusive participation in environmental advocacy. The health and infrastructure aspects of climate change are addressed by Dubé et al. (110 citations) and Makondo and Thomas (109 citations), who examine food security and poverty in relation to climate adaptation. These studies, while not directly focused on special needs education, provide valuable frameworks for understanding how climate change affects vulnerable populations.

Of relevance are the final three papers. Metwally et al. (103 citations) conducted ground breaking research on autism screening in Egypt, highlighting how environmental factors affect children with special needs. Van Graan et al. (97 citations) examined water security issues that disproportionately impact vulnerable populations. Most notably, Andreae et al. (95 citations) directly addressed the intersection of climate change and disability, providing crucial insights into disaster preparedness for special needs populations. The literature can be categorized into three levels of relevance: direct relevance p (focusing explicitly on both climate change and special needs), indirect relevance (addressing vulnerability and adaptation frameworks applicable to special needs education), and climate- focused studies (broader environmental studies with potential implications for special needs education). This categorization reveals both the progress made in understanding these intersecting issues and the opportunities for further research in this critical area.

4 Conclusion

The interplay between special needs education and climate change underscores a pressing need for resilient and adaptive educational frameworks that prioritize the unique requirements of vulnerable populations. This review has highlighted the profound impact of climate-induced challenges on students with disabilities, encompassing physical, psychological, and educational dimensions. From disrupted routines and accessibility barriers to compromised therapeutic services and learning continuity, the vulnerabilities faced by this group demand immediate attention.

Table 4 Top 10 research articles in the research domain

Authors	Article title	Source title	Keywords plus	Cited
Yadav and Lal	Vulnerability of women to climate change in arid and semi-arid regions: The case of India and South Asia [37]	Journal of Arid Environments	Gender; Impacts; Adaptation; Empowerment; Children; Health; Gap	172
Grant	Advances and Challenges in Strategic Management [19]	International Journal of Business	Natural-Environment; Business; Performance; Knowledge; Industry; Green; Model; Determinants; Multilevel; Decisions	151
Foshag et al.	How To Assess the Needs of Vulnerable Population Groups Towards Heat-Sensitive Routing? An Evidence-Based and Practical Approach to Reducing Urban Heat Stress [16]	ERDKUNDE	Climate-Change; Health; Adaptation; Photovoice; Microclimate; Capacity; Cities; Risk	127
Haddad et al.	On the potential of demand-controlled ventilation system to enhance indoor air quality and thermal condition in Australian school classrooms [20]	Energy And Buildings	Carbon-Dioxide Concentration; Particle Number Concentrations; Environmental-Quality; Co2 Concentrations; Comfort; Rates; Performance; Energy; Association; Temperature	119
Prendergast et al.	Youth Attitudes and Participation in Climate Protest: An International Cities Comparison Frontiers in Political Science Special Issue: Youth Activism in Environmental Politics [30]	Frontiers In Political Science	Young-People; Justice Activism; Life; Adaptation; Citizenship; Engagement; Expansion; Knowledge; Values	115
Dubé et al.	Agriculture, health, and wealth convergence: bridging traditional food systems and modern agribusiness solutions [14]	Paths Of Convergence for Agriculture, Health, and Wealth	Child Undernutrition; Developing-Countries; Climate-Change; Poverty Traps; Nutrition; Obesity; Transformation; Revolution; Drivers; Growth	110
Makondo and Thomas	Multidimensional poverty and vulnerability assessment in the face of climate change adaptation in developing economies: focus on ecosystem-based livelihoods in Zambia [26]	Environment Development and Sustainability	Sub-Saharan Africa; Social Vulnerability; Environmental-Change; Migration; Policy; Resilience; Impacts; Communities; Challenges; Strategies	109
Metwally et al.	National screening for Egyptian children aged 1 year up to 12 years at high risk of Autism and its determinants: a step for determining what ASD surveillance needs [27]	BMC Psychiatry	Spectrum Disorders; Rating-Scale; Parental Age; M-Chat; Prevalence; Diagnosis; Gender; Health; Denver; Definition	103
Van Graan et al.	Drink lots of clean, safe water: a food-based dietary guideline for South Africa [18]	South African Journal of Clinical Nutrition	High Fluoride Water; Dental Fluorosis; Microbial Quality; Treatment Plants; Fluid Balance; Bottled Water; Health-Risk; Dehydration; Hydration; Heat	97
Andreae et al.	Weathering the storms of climate change: Preparing persons with disabilities and the physiatrists who provide their care for extreme hurricanes [1]	PM&R	Mental-Health Consequences; Traumatic Brain-Injury; Time Wheelchair Users; Disaster Preparedness; Emergency Preparedness; Tropical Cyclones; Older-Adults; Families; Children; People	95

Emerging from the analysis are key recommendations to address these challenges: the integration of climate-resilient infrastructure, enhanced training for educators on disaster management and inclusivity, and the deployment of technology to support learning continuity. Policy reforms should focus on building inclusive, adaptive education systems that ensure equitable access to resources, regardless of environmental circumstances.

The findings also emphasize the importance of global collaboration and knowledge sharing to design and implement innovative solutions. By adopting a multi-stakeholder approach involving educators, policymakers, researchers, and communities, it is possible to develop sustainable strategies that safeguard the educational rights and well-being of special needs students.

Ultimately, this thematic review serves as a call to action for all sectors involved in education and climate resilience. Ensuring the development of inclusive and adaptive educational systems is not only necessary but also a fundamental step toward achieving equity and sustainability in a changing world.

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Author contributions
Conceptualized the study; M.Z.G. & M.F.R. Design the methodology; M.Z.G., Z.Y & M.N.A.R. Write, review and editing the manuscript; M.Z.G., M.N.A.K., M.A., M.A.M., & M.N.A.R. Provide critical feedback; M.N.A.R, M.H.J & Z..Y.

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Data availability
Material and data for this study are available from attached link: https://www.webofscience.com/wos/woscc/summary/d3ea627f-9109-4e03-9e2f-578f4b20f7a6-0144367c51/relevance/1.

Declarations

Ethics approval and consent to participate
This research is a part and partial that was conducted under the MRECID 202133-9908 and RSCH-ID-220041-K3T approved by UMMC Ethics Board. All authors give their full consent to participate in this study and to the publication of this manuscript.

Consent for publication
All authors give their full consent for the publication of this manuscript and affirm that the content has not been previously published or submitted elsewhere.

Competing interests
The authors declare no competing interests.

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