world

MDPI

Article

Youth Empowerment for Urban Climate Resilience: Establishing a Climate Science and Collaboration Hub in Bo City, Sierra Leone

Rebecca Morgenstern Brenner [1,*], Bashiru Koroma [2] and Sonny S. Patel [3,4]

[1] Jeb E. Brooks School of Public Policy, Cornell University, Ithaca, New York, NY 14853, USA
[2] Keep Africa Beautiful Sierra Leone, Bo City, Sierra Leone; bashiru_koroma@yahoo.com
[3] Transcultural Conflict and Violence Initiative, Department of Communication, Georgia State University, Atlanta, GA 30303, USA; sonny@berkeley.edu
[4] Harvard Humanitarian Initiative, Department of Global Health and Population, Harvard T.H. Chan School of Public Health, Harvard University, Boston, MA 02115, USA
* Correspondence: rebecca.brenner@cornell.edu

Abstract

This paper examines the critical role of youth engagement in building urban climate resilience in secondary cities of West Africa, with a specific focus on Bo City, Sierra Leone. As one of the world's most climate-vulnerable countries, Sierra Leone faces significant challenges exacerbated in urban environments where infrastructure gaps, rapid population growth, climate migration, and limited resources intersect with intensifying climate impacts (rising temperature, extreme weather events, rising sea levels, and socio-economic health impacts). We describe a pathway to invest in the adaptive capacity of this community by developing and implementing a Youth Climate Science Hub designed to inform and empower secondary school students as future climate leaders. Drawing on theories of social–ecological resilience and transformative education, we analyze how youth-centered approaches can bridge the knowledge–action gap in urban climate adaptation. The initiative represents an innovative practice-based example for building resilience in secondary cities expected to receive climate migrants while demonstrating the power of youth mobilization in creating locally appropriate climate solutions.

Keywords: resilience; disaster risk reduction; adaptive capacity; secondary cities; youth climate action; socio-ecological systems; participatory planning; mitigation

Check for updates

Academic Editors: Manfred Max Bergman and Mohammad Aslam Khan Khalil

Received: 1 December 2025
Revised: 20 January 2026
Accepted: 29 January 2026
Published: 2 February 2026

Copyright: © 2026 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

1. Introduction

Sierra Leone ranks among the most climate-vulnerable nations globally, with its urban centers experiencing compounded challenges from extreme weather events, inadequate infrastructure, and limited adaptive capacity [1,2]. Secondary cities face distinct resilience challenges as they may need to accommodate growing populations, including climate migrants from more severely impacted regions. Internal migration patterns in West Africa increasingly reflect climate drivers, with regional hub cities experiencing or expecting to experience significant population pressure [3]. As Sierra Leone's second-largest urban center, Bo City exemplifies these dynamics and faces imminent pressures as climate impacts intensify in coastal areas like Freetown. Bo is considered a secondary city [4]. What is a secondary city? The growing importance of secondary cities and their definition has evolved in fields of urban planning, economics, and development. Essentially, what

is considered a secondary city is relative as a sub metropolitan geographic area and its population, size, and economic role all with relation to the country's primary city or cities [5]. Further, primary cities tend to have stronger economic pull and access to resources, growing the need to invest in youth education and capacity to empower and to prepare for the climate and subsequent potential in-migration challenges this secondary city, Bo, faces.

In Sierra Leone there is currently no dedicated climate science and collaboration hub that is focused on youth in secondary cities. However, several research centers, university-based initiatives, and civil society clusters increasingly promote climate-related research, action, and education. These efforts include emerging initiatives such as a national center of excellence for climate change, climate impact consortia, youth and community climate networks, and adaptation innovation platforms that support awareness raising and policy engagement.

At the regional level, the West Africa Science Service Centre on Climate Change and Adapted Land Use, with its headquarters in Accra, Ghana, and a competence center in Ouagadougou, Burkina Faso, coordinates climate research, graduate education, and resilience strategies across multiple West African countries. More broadly, networks of hubs and collaborative centers in coastal and equatorial regions share data, build capacity, and promote cross-country climate research, while global programs led by international agencies and civil society organizations support youth climate education and engagement in many countries.

Urban climate vulnerability in secondary African cities remains underexamined compared to capital cities and megacities although these secondary cities will also be significantly impacted by increasing climate hazards and population shifts [6,7]. This knowledge gap extends to adaptation approaches tailored to these secondary urban contexts, particularly those emphasizing youth engagement, despite demographic profiles showing populations predominantly under 25 years old [8,9]. Critically, while youth are frequently framed as vulnerable, far less attention has been invested into their role as knowledge brokers or emergent leaders who can bridge scientific, local, and generational divides, which is a dynamic increasingly recognized as central to adaptive capacity and community resilience [10–15]. This paper addresses this gap by examining how youth empowerment through dedicated climate knowledge centers can enhance urban resilience in secondary cities which are projected to absorb significant climate-induced migration from more exposed coastal areas.

1.1. The Knowledge–Action Gap in Urban Climate Resilience

Despite growing awareness of climate change impacts, a persistent gap exists between climate knowledge and implemented adaptation measures in urban African contexts [16,17]. This gap can stem from multiple factors, such as limited access to contextualized scientific information, insufficient technical capacity within governments, and the dominance of external expertise over local knowledge systems [18]. Furthermore, conventional climate communication frequently fails to resonate at the community level, highlighting the importance of bidirectional, participatory information flows that bridge scientific and indigenous knowledge through trusted local actors, including youth [11–13,19,20]. Collaborative models that treat youth as co-creators, rather than recipients, of adaptation solutions are only beginning to be implemented and evaluated [21,22].

In Bo City, these challenges are compounded by educational systems that have not been systematically incorporated with the climate science information into curricula [23]. According to an informal needs assessment conducted by the local nongovernment organization Keep Africa Beautiful Sierra Leone, less than 15% of secondary school students reported having access to practical climate education [24]. Furthermore, opportunities for

young people to engage with climate solutions remain limited despite their demographic majority and significant stake in future climate outcomes. This disconnection between the availability of knowledge, the opportunity for intergenerational exchange, and actionable engagement represents a fundamental barrier but also a lever for strengthening urban resilience from the ground up [25–27].

1.2. Youth as Climate Change Agents: Theoretical Frameworks

Positioning youth as agents of change in climate action draws upon several theoretical frameworks. Social–ecological resilience theory emphasizes the importance of diverse knowledge types, learning networks, and adaptive governance systems in building capacity to respond to environmental change [26,28,29]. Within this framework, youth are increasingly recognized as critical actors who bridge scientific, cultural, and intergenerational knowledge systems, while introducing innovative approaches to collective problem-solving [10,12,22,30–32]. Recent research and international policy recommendations highlight youth as "knowledge brokers" and emergent leaders, able to mobilize timely information, catalyze action, and expand community resilience, particularly under conditions of uncertainty and rapid change [11,22,30,32]. These perspectives underscore the potential for youth-centered, participatory networks and knowledge commons to expand adaptive capacity and resilience within communities facing escalating climate risks [15,29,33]. Leaning into social–ecological resilience theory is how and why this research developed as an engaged, constantly adaptative, and ongoing engagement that youth will be the drivers of identifying the knowledge needed as the problems arise [34]. This research develops the pathway needed for the emerging leaders rather than a stagnant answer that is needed for them to have the adaptive capacity to constantly build and invest in their resilience.

Transformative education models similarly recognize the capacity of young people to serve as knowledge brokers and change agents when equipped with appropriate tools and platforms [31]. Climate education must move beyond information transfer and more toward empowerment and agency-building in order to catalyze systemic change [35]. These frameworks collectively suggest that youth engagement strategies can address knowledge deficits and implementation gaps in urban climate resilience efforts, particularly when designed to foster local ownership and cross-generational partnerships.

Additionally, knowledge co-creation models emphasize the importance of collaborative learning processes that validate diverse expertise, including the lived experiences of community members [11,13,33]. These models suggest that youth engagement when built on empowerment, participatory structures, and co-created solutions can meaningfully address gaps between knowledge and action and promote system-wide adaptive capacity [15,36].

2. Materials and Methods: Developing the Youth Climate Science Hub

In response to these theoretical frameworks and identified needs, a collaborative initiative was developed to establish the Youth Climate Science Lab and Collaboration Hub for Resilience Building and Empowerment (Youth Climate Science Hub) in Bo City. The project was implemented through a partnership between Keep Africa Beautiful Sierra Leone (KABSL) (BK) and a faculty member in Cornell University's Jeb E. Brooks School of Public Policy (RMB). The engagement and necessary equipment were funded by the U.S. Department of State's Mandela Washington Fellowship Reciprocal Exchange program (MRE). The initiative adopted a participatory approach to program design, engaging local stakeholders, including municipal authorities, school administrators, civil society organizations, and youth representatives, in defining priorities and implementation strategies [13].

This is innovative in the context of Bo City and addresses the challenges people in the community face; local realities of climate challenges embedded in the initiative are direct reflections of climate impacts in Bo City that affect daily lives. We found in conversations that to understand the challenges faced locally, solutions needed to bridge indigenous ideas with scientific theory; this initiative is not common in this locality, making it an innovative approach. The innovative character of this initiative lies in the way it embeds local climate realities into a youth-centered curriculum that systematically bridges indigenous knowledge and climate science. The learning modules were built around climate impacts that students and their families experience directly in Bo City, such as food insecurity, recurrent flooding, and heat stress in schools, rather than around abstract or generic climate topics. Hands-on courses, including climate-smart agriculture and school-based food security activities, use local examples and practices to connect scientific concepts (e.g., changing rainfall patterns, soil moisture, and heat islands) with familiar coping strategies, encouraging students to co-develop adaptation ideas grounded in both scientific and local knowledge.

Unlike generic programs that generalize climate related impacts, secondary cities like Bo need to have specialized targeted and engaged curriculum to understand and address the specific challenges and lean into utilizing the specific resources this community benefits from. It is explicitly youth-led and community-driven, incorporating practical tools (e.g., simple weather and soil instruments), field visits, presentations, interviews with local experts, and other experiential learning methods to move beyond theoretical instruction. To support potential re-implementation, the project team is systematically documenting participation and outputs, including the number of male and female students engaged, the number and type of schools involved, the frequency and duration of sessions, and the numbers of trees planted, school gardens established, teachers trained, and learning materials (booklets, classes, and student presentations) produced. These basic implementation data, together with the description of curriculum content and partnership arrangements provided here, are intended to make the Youth Climate Science Hub a transparent, adaptable, and replicable practice-based example for similar secondary-city contexts.

The Youth Climate Science Hub in Bo City is designed to complement rather than duplicate these activities. Whereas many regional and global initiatives are anchored in universities, national research institutes, or capital city organizations, the Hub is situated in a secondary city and embedded in public secondary schools that serve under-resourced communities. It connects students directly with local climate realities, such as recurrent flooding, food insecurity, and heat stress, and links these experiences with both indigenous knowledge and climate science. In this way, the Hub functions as a local interface between larger scale climate knowledge networks and everyday decision making in schools and neighborhoods, and it offers a concrete, low-cost practice-based example that can be adapted for similar secondary city contexts in West Africa and beyond.

To do this, the project unfolded in two phases. The first step was to teach foundational climate science information at five local secondary schools in Bo: Jasfameo Secondary School, Centenary Secondary School, Muslineen Islamic Secondary School, Namya Islamic Secondary School, and Methodist Girl Secondary School. There are more than 200 public schools in Bo City. Why were these five schools chosen? These five schools are all located in the eastern portion of Bo City and near each other, they are all public schools, they all have limited access to environmental and climate information, they all have limited access to reliable wireless networking technology, and each school represents different social cohorts within the broader community. The close proximity is critical to being able to have walkable access to the physical location of the Youth Climate Science Lab and Collaboration Hub to enable longer-term, engaged participation. There is no public transit

or reliable transportation; so, to build a replicable model with a consistent cohort, the schools and students needed to be able to walk to the hub. Once the schools were selected and administrative staff at the schools agreed this was a positive opportunity for students, the learning modules were built. The Cornell faculty member (RMB) along with leadership from KABSL (KB) collaboratively built the curriculum. Then, local leaders from KABSL taught this material, engaging a wide range of secondary students, staff, and faculty at these five schools.

Secondly, as a part of this project, the Youth Climate Science Hub was physically established in Niagorehun Community, Morfindoh Layout, Bo City, as a permanent center for climate education, practical skills development, and youth collaboration. This Youth Climate Science Hub provides a physical space and place where these youth, identified as future leadership by schoolteachers, school administrators, and local government leaders, could incrementally invest in short-, medium-, and long-term planning to build adaptive capacity, resilience, and strategic planning for Bo. A cohort of approximately 100 secondary school students, identified by schoolteachers and school administrators as the most likely future leaders in Bo City, were selected from those five schools to regularly engage with each other in a long-term, continuous partnership. These future leaders consist of students who were identified based on their passion for environmental conservation, past experiences in climate action, and problem-solving potential. The students' age ranged from ten to nineteen years old with most students being twelve to seventeen; all students were enrolled at the Junior Secondary School level. It was most important to focus on building a future leadership cohort that was driven by their academic level, potential, and interest. Selection criteria emphasized gender equity, with at least 50% female participation, and identified students demonstrating leadership potential and interest in environmental issues.

At the Youth Climate Science Hub, these youth, as future leaders, meet to invest in building networks and knowledge. A longer-term educational program was developed to address identified knowledge gaps and build practical skills in climate adaptation. To bridge information gaps, experts from Cornell University, Ithaca College, the Paleontological Research Institute, and Clean International created short, engaging videos that provide foundational information, allowing youth participants to develop and envision solutions to future challenges. This was the start of a library of engaged videos on topics that were specifically requested by this initial cohort of students. The library is housed at the Youth Climate Science Hub and is accessible to participating teachers and students for repeated use with future classes. Currently, Bo does not have reliable access to internet, so the Youth Climate Science Hub is needed as a physical place to store and show video content. This library is expected to continue to grow indefinitely based on what participants request and need. These initial topics included food security and sustainable agricultural practices, waste management and recycling, water management, carbon reduction strategies, project management, and microfinance for sustainable development projects. The curriculum used at the Youth Climate Science Hub incorporated theoretical components and hands-on applications, utilizing multimedia resources, expert presentations, and field-based learning opportunities. The PowerPoint presentations were prerecorded and presented using critically needed equipment funded through this MRE program, including a projector, a projector screen, a computer, a modem for internet access, and a public address system, and was powered through a solar panel installed specifically for this use. To provide information to bridge information gaps, the program content met one or more of the ten following learning objectives:

- Food security and sustainable agricultural practices;
- Sustainability and circular economy;
- Sustainable waste management, recycling;

- Driving business towards the sustainable development goals;
- Landscape architecture, conservation, and natural resource management;
- Climate change education;
- Carbon reduction strategies;
- Tackling environmental challenges for a sustainable future;
- Gender and the sustainable development goals;
- Introduction to microfinance.

Youth, who were identified as future leaders in Bo, use the videos as a foundation to start a conversation to both develop knowledge and implement planning to invest in resiliency planning to build the adaptive capacity of themselves as future leaders. Cross-cultural exchange was facilitated through connections through these videos and platforms, providing foundational knowledge to empower local youth to develop a global perspective while emphasizing locally appropriate solutions.

3. Results: The Youth Climate Hub in Action: Implementation and Early Outcomes

The initial phase of the initiative was built through the MRE collaboration and involved an educational program taught at five secondary schools in Bo, Sierra Leone: Jasfameo Secondary School, Centenary Secondary School, Muslineen Islamic Secondary School, Methodist Girls Secondary School, and Namya Islamic Secondary School. This educational campaign was implemented from 3 to 15 June 2024, beginning with recruiting and training three local facilitators with backgrounds in communications, community development, and youth advocacy. These facilitators served as program coordinators and trainers, helping to contextualize curriculum materials and engage effectively with student participants.

Initial stakeholder consultations brought together representatives from local government, school authorities, civil society organizations, and relevant ministries to secure institutional support and align the initiative with existing climate resilience efforts. These consultations revealed enthusiasm for youth-centered approaches and identified significant gaps in existing programs targeting secondary school students. During consultations, one district council representative noted, "We have policies for climate adaptation, but we have not effectively engaged young people who will live with these changes the longest" (personal communication, 5 June 2024).

Following the broader initial educational program, participant recruitment for the Youth Climate Science Hub launched. This focused program facilitated a series of educational modules combining theoretical foundations with practical applications. This second phase engaged with a smaller targeted cohort of approximately 100 youth identified as potential future leaders and connected them with international experts. Due to challenges with internet connections, time zones, and the need for flexible timing, it was decided to ask experts to develop pre-recorded video presentations on focused topics. Youth would meet at the Youth Climate Science Hub, watch the video presentations, then have facilitated small-group discussions to contextualize global insights for local applications. Students participated in hands-on training in climate-smart agricultural techniques, including raised bed gardening methods adapted to increasing rainfall variability. Technology components included training in basic solar energy applications and digital tools for environmental monitoring.

By the end of the initial educational program phase, several concrete results and outcomes were observed. Tree planting initiatives were established at each participating school, and student climate clubs were formed to support continued engagement. The African Civic and Environmental Education (ACEE CHANGE) Fellowship was launched to provide ongoing support for youth led climate projects. In addition, the Youth Climate Sci-

ence Hub was established as a permanent resource center where students can access climate information, use technology resources, rewatch videos and engage with new submissions from experts, and collaborate on resilience projects beyond the initial program period.

Across the five schools, students planted approximately 1500 trees at the various school compounds, at the hub compound, in public spaces, and at a demonstration site that was established by the project. Among the trees planted were 500 almond trees, 300 coconut trees, 200 royal palm trees, 200 conifer trees, and 300 cashew trees. Five climate clubs were established for each school for students to connect and engage in activities: environmental and climate change education modules as well an observation of the overall awareness raising in their schools and their surrounding communities. There were also specific activities including organizing a debate, several seminars, and a quiz competition. The students also celebrated world environment day, started investigating sustainable waste management in the various schools, organizing clean up campaigns, promoting conservation, promoting climate action advocacy, developing leadership and teamwork skills, and organizing sensitization programs in surrounding communities. In the first ACEE-CHANGE Fellowship cycle, 100 students were initiated, focusing on topics such as sustainable waste management, introduction to leadership, team building, flood preparedness, climate smart gardening, skill development, and sustainable environmental management. The Hub has since been used for regular club meetings twice per month and student-led presentations, indicating early evidence of continued engagement beyond the initial training period.

4. Discussion: Bridging Knowledge Systems for Urban Resilience

The Youth Climate Science Hub initiative demonstrates how secondary cities can develop innovative approaches to climate resilience by positioning youth as central actors in knowledge creation and dissemination. Unlike conventional climate education programs that often adopt top-down information transfer models, this approach emphasizes bi-directional knowledge exchange and localization of climate science. Effective climate adaptation requires not just scientific information but the integration of diverse knowledge systems and the development of contextually appropriate applications [37].

The program's focus on secondary school students addresses a critical demographic in rapidly growing urban areas while creating potential for intergenerational knowledge transfer. Young people often serve as knowledge brokers within communities, translating new information for family and community members while helping to overcome skepticism or resistance [10]. Early observations from the Bo City initiative support this finding, with participating students reporting discussions with parents and community members about climate impacts and potential adaptations.

The cross-cultural element of the program—connecting students in Bo City with counterparts and experts in Ithaca, New York—represents an innovative approach to building global climate citizenship while emphasizing and retaining local agency. This practice-based example addresses commonly held concerns regarding the potential for international climate initiatives to impose external frameworks without sufficient attention to local contexts and priorities [38]. By facilitating direct exchange between youth in different geographic contexts, the program enabled comparative analysis of adaptation approaches while reinforcing the importance of locally appropriate solutions.

Furthermore, establishing a physical hub as a place and space addresses infrastructure gaps that often limit access to climate knowledge in secondary cities. This addresses the concern that digital divides and limited information resources can significantly constrain climate adaptation efforts in urban African contexts [39]. The dedicated climate center pro-

vides a permanent access point for resources while symbolically elevating the importance of climate action within the community landscape.

These findings align with and extend previous research on community resilience, which has emphasized the necessity of grounding adaptation efforts in local knowledge, participatory structures, and sustained engagement to build genuine adaptive capacity [12,14,15,26,36]. By integrating youth perspectives and leadership, the Hub operationalizes a key hypothesis in the resilience literature: that empowerment and locally rooted education can drive more effective and lasting adaptation outcomes than externally imposed interventions. The program's results suggest that engaging youth is not solely beneficial for social learning but is also instrumental in establishing new channels for climate communication, intergenerational dialogue, and broader community mobilization, an approach consistent with calls for transformative, bottom-up methods in resilience scholarship [10,12,36,40].

In the broadest context, this study illustrates the significant potential of youth-centered, place-based examples to serve as catalysts for urban climate adaptation within rapidly changing and resource-constrained environments. The results reinforce the theory that adaptive urban engagement must be rooted in both social and spatial context [26,27]. By positioning youth as emergent leaders and knowledge brokers, the initiative not only bridges generational divides but also enhances social networks and collective capacity, echoing insights from the knowledge commons literature that timely information sharing among community members fosters collective action in times of deep uncertainty [10,11,27].

In this study, the Youth Climate Science Hub is operationalized as a knowledge commons, a shared, collectively governed space in which climate-related knowledge is generated, curated, and used by youth, educators, and community partners. Concretely, students contribute local climate observations, mapping products, and project results. These are compiled into shared repositories, for example classroom archives, digital platforms, and public displays, that remain accessible to participating schools and organizations. Teachers and local partners co-design learning activities and adaptation projects that draw directly on this common pool of information, and they use it to inform discussions about preparedness at school, neighborhood flooding, heat risks, and other urban climate challenges. The Hub functions as an interactive arena where norms for access, contribution, and use of knowledge are negotiated. Participants decide who can add information, how it is validated, and how it is mobilized in practice. It therefore operates as more than a one-way channel of expert communication.

Immediately, it was clear that social networks were being formed by students participating in the Youth Climate Science Hub, and those bridges and bonds are continuing to grow. The participation of students elevated them to be active stakeholders giving them ownership of this space and place with visible changes in attitudes to look to adopt new climate actions. One of the intended purposes of this initiative is to let the students implement what they are learning in schools at home so that parents and grandparents can also benefit from the training as well.

There is a need to invest in building the infrastructure for a knowledge commons as an interactive space for decision-makers to have more effective access to resources during disasters in order to invest in sustainable, adaptive communities [11]. In this light, the Youth Climate Science Hub can also be understood as a physical manifestation of the knowledge commons, strategically centered to address both current and future needs arising from climate disasters and to inform the design of future interventions.

Challenges and Limitations

Despite promising early outcomes, several challenges that warrant consideration for similar initiatives emerged during program implementation. First, technological constraints, including inconsistent electricity access and limited internet connectivity, complicated a live version of the virtual exchange components, requiring flexible scheduling and backup systems. This reflects broader infrastructure challenges facing secondary cities that must be considered in resilience planning [41].

Second, aligning program content with participants' diverse educational backgrounds requires additional scaffolding and differentiated instruction approaches. Some concepts required significant contextualization to overcome terminology barriers and connect to students' lived experiences. For climate education to be effective and useful, it must bridge scientific terminology with local understanding of environmental change [40].

Third, institutional coordination presented challenges, particularly in securing consistent engagement from municipal authorities facing competing priorities and limited resources. Secondary cities, like Bo City, compared with primary urban centers, face challenges to climate adaptation such as limits to technical capacity and the availability of dedicated personnel [42]. To bring in expert or outside knowledge, one pathway that was successful in Bo City was through short, recorded inputs that are stored on a hard drive physically housed at the Hub, which allows local facilitators to reuse these materials in future sessions without requiring live online connections or repeated expert involvement. Further, to address similar constraints, other secondary cities in West Africa can begin by designating a simple focal point for climate education within municipal structures and build from a focused target. Also, it is important to partner with both local schools and civil society organizations to co-design youth focused activities, and in this way use existing public or school facilities as low-cost hubs for climate learning and engagement. Then, by using the schools as a starting point, we can build with the community partners.

Finally, the limited time frame of the initial pilot phase constrained the ability to monitor longer-term impacts on student learning, behavior change, and broader community adaptation efforts. A recurring theme in resilience research is the importance of longitudinal assessment to gauge program sustainability and transformative potential [12,26,29,33,36]. However, establishing permanent structures (both physical and programmatic) provides a foundation for ongoing engagement and evaluation.

While the Youth Climate Science Hub shows strong potential for replication, questions remain regarding its scalability and adaptability to other secondary cities with different socio-political and resource contexts, as well as its dependence on continued funding and partnership support. Future research should examine how youth climate hubs evolve over time and their sustained impact on urban resilience measures.

Moving forward, addressing these challenges will benefit from an integrated strategy that invests in local infrastructure, strengthens institutional partnerships, and incorporates both quantitative and qualitative evaluation of program outcomes across time. Expanding regional networks of youth-focused climate hubs and continuously refining curricula in response to participant feedback will be necessary to sustain momentum. As secondary cities in West Africa and beyond confront increasing climate variability and urbanization, youth-centered and locally grounded initiatives like the Bo City Hub contribute valuable empirical insights into how adaptive capacity can be built from the ground up.

5. Conclusions and Future Directions

The Youth Climate Science Hub represents an innovative approach to urban climate resilience that addresses multiple dimensions of adaptation challenges in secondary cities. The overarching goal is to equip youth in Bo and similar secondary cities with the knowl-

edge and tools they need to participate in shaping local and national resilience strategies, and that rather than offering a fixed, modular solution, the Youth Climate Science Hub supports students and partners to identify the information and capacities they consider most urgent and to use these to design context specific adaptation pathways from within their communities. By positioning youth as central actors in knowledge co-creation and dissemination, the initiative demonstrates the potential for bridging the persistent gap between climate information and implementing adaptation measures. The multi-stakeholder approach, combining international partnership with local ownership, provides a replicable practice-based example for similar contexts where limited resources necessitate strategic investment in capacity building.

Future development of this Hub should include a longitudinal assessment of impacts on youth participants' knowledge, attitudes, and behaviors related to climate action. Additionally, research should examine how youth climate hubs influence broader community adaptation efforts and municipal planning processes. Expansion possibilities include developing a network of youth climate hubs across secondary cities in West Africa to facilitate regional knowledge sharing and collaborative problem-solving.

To do this, we propose that national, municipal, and local policymakers and community partners do the following:

(1) Recognize secondary cities as priority sites for youth climate engagement in national adaptation and education strategies;
(2) Designate simple municipal focal points to coordinate with schools and civil society on youth climate activities;
(3) Support low-cost, school-based climate hubs that link student projects with city-level resilience planning.

As climate impacts intensify and migration patterns respond to environmental pressures, secondary cities like Bo will play an increasingly important role in national resilience strategies. Preparing the youth of these cities to understand climate science, develop adaptation skills, and participate in resilience planning represents a critical investment in sustainable urban futures. The Youth Climate Science Lab and Collaboration Hub demonstrate one pathway for making this investment while recognizing and amplifying the agency of young people in creating climate-resilient communities.

Author Contributions: Conceptualization, investigation, resources, data curation, project administration, funding acquisition, R.M.B. and B.K.; validation, S.S.P.; writing—original draft preparation, supervision, validation, R.M.B.; writing—review and editing, formal analysis, R.M.B., B.K. and S.S.P.; visualization, B.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded through Mandela Washington Fellowship, grant number SECAGD21CA3082. The Mandela Washington Fellowship is a program of the U.S. Department of State with funding provided by the U.S. Government and administered by IREX. The views and information presented herein are those of the U.S. Participants and Fellowship Alumni Collaborators in the Reciprocal Exchange and do not represent the Mandela Washington Fellowship, the U.S. Department of State, or IREX.

Data Availability Statement: The data presented in this study are not publicly available due to privacy restrictions, as the data contains information that could compromise the privacy of research center.

Acknowledgments: The authors and community members would like to thank the contribution of the following individuals: without their dedication, guidance, and effort this work would not have been possible. First, the core team of event facilitators Bashiru Korma, James H.B. Yambassu, Alberta Samuels, and Peter Samuels for organizing and running the in-person learning modules in schools in Sierra Leone. Bashiru Korma for facilitating educational experience in schools to

meet learning objectives. The schools, including teachers, principals, administrators, and students, for participating in the learning modules Jasfameo Secondary School, Centenary Secondary School, Muslineen Islamic Secondary School, Namya Islamic Secondary School, and Methodist Girl Secondary School. Specifically, the following teachers prepared for and coordinated the educational experience: Mohammed John Sannoh, Namya Islamic School; David Morray, Methodist Girls High School; Emmanuel M. Manah, Jasfameo Secondary School, Musa Ibrahim, Muslineen Islamic Secondary School; Adonis A. Aellu, Centenary Secondary School. The developers of the critical engaged videos to provide expert-based knowledge for a resilient and adaptive future: Heather Baker, Clean International; Jacob Brenner, Ithaca College; Rebecca Morgenstern Brenner, Cornell University; Candace Hulbert, Cornell Cooperative Extension; Thomas O'Toole, Cornell University; Ingrid Zabel, Paleontological Research Institute. Rebecca M Brenner for facilitating expert-built videos to meet learning objectives. This article is dedicated to late James H.B. Yambassu.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of this study; in the collection, analyses, or interpretation of data; in the writing of this manuscript; or in the decision to publish the results.

Abbreviations

The following abbreviations are used in this manuscript:

ACEE	African Civic and Environmental Education (ACEE CHANGE)
KABSL	Keep Africa Beautiful Sierra Leone
MRE	U.S. Department of State's Mandela Washington Fellowship Reciprocal Exchange

References

1. World Bank. *Sierra Leone—Country Climate and Development Report*; Country Climate and Development Report; World Bank Group: Washington, DC, USA, 2025.
2. Thomas, K.; Hardy, R.D.; Lazrus, H.; Mendez, M.; Orlove, B.; Rivera-Collazo, I.; Roberts, J.T.; Rockman, M.; Warner, B.P.; Winthrop, R. Explaining Differential Vulnerability to Climate Change: A Social Science Review. *WIREs Clim. Change* **2018**, *10*, e565. [CrossRef]
3. Barrios, S.; Bertinelli, L.; Strobl, E. Climatic Change and Rural-Urban Migration: The Case of Sub-Saharan Africa. *J. Urban Econ.* **2006**, *60*, 357–371. [CrossRef]
4. Hillson, R.; Alejandre, J.D.; Jacobsen, K.H.; Ansumana, R.; Bockarie, A.S.; Bangura, U.; Lamin, J.M.; Malanoski, A.P.; Stenger, D.A. Methods for Determining the Uncertainty of Population Estimates Derived from Satellite Imagery and Limited Survey Data: A Case Study of Bo City, Sierra Leone. *PLoS ONE* **2014**, *9*, e112241. [CrossRef]
5. Roberts, B.H.; Hohmann, R.P. The Systems of Secondary Cities: The Neglected Drivers of Urbanising Economies. *Civ. Shar. Knowl. Learn. Cities* **2014**, *1*, 1–12.
6. OECD; African Development Bank; Cities Alliance; United Cities And Local Governments of Africa. *Africa's Urbanisation Dynamics 2025: Planning for Urban Expansion, West African Studies*; West African Studies; OECD Publishing: Paris, France, 2025; p. 168.
7. Williams, P.A.; Crespo, O.; Abu, M. Adapting to Changing Climate through Improving Adaptive Capacity at the Local Level—The Case of Smallholder Horticultural Producers in Ghana. *Clim. Risk Manag.* **2019**, *23*, 124–135. [CrossRef]
8. Leck, H.; Atkins, L.; Dreyer, L.; Dubuzana, Y.; Marais, C.; Pasquini, L.; Piprek, T.; Spires, M.; Strachan, K. *Climate Change: Crosscutting Report*; African Cities Research Consortium; The University of Manchester: Manchester, UK, 2025.
9. United Nations Population Fund (UNFPA). *State of World Population 2025: The Real Fertility Crisis-The Pursuit of Reproductive Agency in a Changing World*; Stylus Publishing: Sterling, VA, USA, 2025.
10. Taylor, M.; Bhasme, S. Model Farmers, Extension Networks and the Politics of Agricultural Knowledge Transfer. *J. Rural Stud.* **2018**, *64*, 1–10. [CrossRef]
11. Comfort, L.K.; Okada, A. Emergent Leadership in Extreme Events: A Knowledge Commons for Sustainable Communities. *Int. Rev. Public Adm.* **2013**, *18*, 61–77. [CrossRef]
12. Patel, S.S. *Community Resilience When Disaster Strikes: Security and Community Health in UK Flood Zones*; Advanced Sciences and Technologies for Security Applications; Springer: Cham, Switzerland, 2022.
13. Brenner, R.M.; Mayberry, D.; Kennedy, K.R.; Anthonisen, M. Nations Among Nations: Strengthening Tribal Resilience and Disaster Response. In *Current and Emerging Issues in International Disaster Management*; Kendall Hunt Publishing Copany: Des Moines, IA, USA, 2025.

14. Gunderson, L. Ecological and Human Community Resilience in Response to Natural Disasters. *Ecol. Soc.* **2010**, *15*, 18. [CrossRef]
15. Brenner, R.M. Building Community Resilience through Academic and Practitioner Partnerships. In *Service-Learning for Disaster Resilience Partnerships for the Social Good*; Velotti, L., Brenner, R.M., Dunn, E., Eds.; Routledge: New York, NY, USA, 2023; pp. 37–50.
16. Akanbang, B.A.; Hamid, A.A.; Baanbil, J.N.; Anoyege, R. Trends and Drivers of Urbanisation in Africa: Exploring the Implications for Urban Planning and Development. In *Urban Planning Challenges and Innovations in Sub-Saharan Africa*; Routledge: New York, NY, USA, 2025; pp. 10–29.
17. Conway, D.; Schipper, E.L.F. Adaptation to Climate Change in Africa: Challenges and Opportunities Identified from Ethiopia. *Glob. Environ. Change* **2011**, *21*, 227–237. [CrossRef]
18. Ziervogel, G.; Enqvist, J.; Metelerkamp, L.; Breda, J. Supporting Transformative Climate Adaptation: Community-Level Capacity Building and Knowledge Co-Creation in South Africa. *Clim. Policy* **2022**, *22*, 607–622. [CrossRef]
19. Moser, S.C.; Ekstrom, J.A. A Framework to Diagnose Barriers to Climate Change Adaptation. *Proc. Natl. Acad. Sci. USA* **2010**, *107*, 22026–22031. [CrossRef]
20. Brenner, R.M.; Arias, C.; Schmitt, A. Gender Inclusive Planning for Disasters: Strategic Planning to Build Adaptive Capacity and Resilience. *J. Emerg. Manag.* **2025**, *23*, 201–210. [CrossRef] [PubMed]
21. Hayward, B. *Children, Citizenship and Environment: #SchoolStrike Edition*, 2nd ed.; Routledge: New York, NY, USA, 2020.
22. Chan, S.; Singh, S.; Chang, K.; Tailor, P.; Joshi, M.; Mohan, M.; Amponsem, J. *Young People and Drivers and Barriers to Climate Adaptation Action*; A technical paper on past experiences, current drivers of engagement, and pathways to resilience; Global Center on Adaptation (GCA): Rotterdam, The Netherlands; Centre for Environment Education (CEE): Ahmedabad, India; Kai Analytics: Vancouver, BC, Canada; Foundation for Environmental Education (FEE): Copenhagen, Denmark, 2021.
23. Government of Sierra Leone. *Sierra Leone Education Sector Plan 2022–2026*; UNICEF: Freetown, Sierra Leone, 2022; pp. 1–132.
24. Koroma, B. Keep Africa Beautiful Sierra Leone (KABSL). Available online: https://keepafricabeautifulsl.weebly.com/ (accessed on 1 December 2025).
25. Ojwang, L.; Rosendo, S.; Celliers, L.; Obura, D.; Muiti, A.; Kamula, J.; Mwangi, M. Assessment of Coastal Governance for Climate Change Adaptation in Kenya. *Earths Future* **2017**, *5*, 1119–1132. [CrossRef]
26. Norris, F.H.; Stevens, S.P.; Pfefferbaum, B.; Wyche, K.F.; Pfefferbaum, R.L. Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness. *Am. J. Community Psychol.* **2008**, *41*, 127–150. [CrossRef]
27. Cutter, S.L.; Ash, K.D.; Emrich, C.T. The Geographies of Community Disaster Resilience. *Glob. Environ. Change* **2014**, *29*, 65–77. [CrossRef]
28. Folke, C.; Biggs, R.; Norström, A.V.; Reyers, B.; Rockström, J. Social-Ecological Resilience and Biosphere-Based Sustaina-Bility Science. *Ecol. Soc.* **2016**, *21*, 41. [CrossRef]
29. Brenner, R.M. Knowledge to Practice in the Vulnerability, Adaptation, and Resilience Literature: A Propositional Inventory. In *Integrating Science and Policy: Vulnerability and Resilience in Global Environmental Change*; Science in Society Series; Earthscan: London, UK, 2011.
30. Mrema, E.M. Empowering Youth for Climate Action: A Call to Leadership and Sustainable Change. In Proceedings of the Innovating for a Cooler Future, Bankok, Thailand, 27 October 2024.
31. O'Brien, K.; Selboe, E.; Hayward, B.M. Exploring Youth Activism on Climate Change: Dutiful, Disruptive, and Dangerous Dissent. *Ecol. Soc.* **2018**, *23*, 42. [CrossRef]
32. Van Uffelen, A.; Tanganelli, E.; Gerke, A.; Bottigliero, F.; Drieux, E.; Fernández-de-Larrinoa, Y.; Milbank, C.; Sheibani, S.; Strømsø, I.; Way, M.; et al. *Indigenous Youth as Agents of Change: Actions of Indigenous Youth in Local Food Systems During Times of Adversity*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2021.
33. Allen, C.A.; Angeler, D.G.; Garmestani, A.S.; Gunderson, L.; Holling, C.S. Panarchy: Theory and Application. *Ecosystems* **2014**, *17*, 578–589. [CrossRef]
34. Turner, B.L.; Kasperson, R.E.; Matson, P.A.; McCarthy, J.J.; Corell, R.W.; Christensen, L.; Eckley, N.; Kasperson, J.X.; Luers, A.; Martello, M.L.; et al. A framework for vulnerability analysis in sustainability science. *Proc. Natl. Acad. Sci. USA* **2003**, *100*, 8074–8079. [CrossRef]
35. Joseph, N. Sustainability of Community Managed Disaster Risk Reduction Projects. In *Disaster Risk Reduction*; Zutshi, B., Ahmad, A., Srungarapati, A.B., Eds.; Palgrave Macmillan: Singapore, 2019.
36. Pfefferbaum, B.; Pfefferbaum, R.L.; Van Horn, R.L. Community Resilience Interventions: Participatory, Assess-Ment-Based, Action-Oriented Processes. *Am. Behav. Sci.* **2015**, *59*, 238–253. [CrossRef]
37. Adger, W.N.; Butler, C.; Walker-Springett, K. Moral Reasoning in Adaptation to Climate Change. *Environ. Polit.* **2017**, *26*, 217–239. [CrossRef]
38. Schlosberg, D.; Collins, L.B.; Niemeyer, S. Adaptation Policy and Community Discourse: Risk, Vulnerability, and Just Transformation. *Environ. Polit.* **2017**, *26*, 413–437. [CrossRef]
39. Robinson, S.; Shine, T. Achieving a Climate Justice Pathway to 1.5 °C. *Nat. Clim. Change* **2018**, *8*, 564–569. [CrossRef]

40. Monroe, M.C.; Plate, R.R.; Oxarart, A.; Bowers, A.; Chaves, W.A. Identifying Effective Climate Change Education Strategies: A Systematic Review of the Research. *Environ. Educ. Res.* **2019**, *25*, 791–812. [CrossRef]
41. Parnell, S.; Elmqvist, T.; McPhearson, T.; Nagendra, H.; Sörlin, S. Situating Knowledge and Action for an Urban Planet. In *Urban Planet: Knowledge towards Sustainable Cities*; Elmqvist, T., Ed.; Cambridge University Press: Cambridge, UK, 2018; pp. 1–16.
42. Simon, D.; Leck, H. Understanding Urban Adaptation Challenges in Diverse Contexts. *Urban Clim.* **2014**, *7*, 1–5. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.