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Climate Hazards Data Integration and Visualization for the Climate Adaptation Solutions Accelerator (CASA) through School-Community Hubs

MEDS Capstone Project Proposal
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Objectives

To serve as community hubs for climate adaptation planning and activities, schools need information about the intersecting threats that climate change poses, including wildfire, heat, flooding, and other hazards. Results of the proposed project will contribute to a pilot project funded by the National Science Foundation (NSF) in collaboration with three public schools and three climate adaptation innovators. In the project, MEDS students will: 1) explore available data on climate risk characteristics of school districts by jurisdiction, 2) work to integrate data on multiple climate hazards, and 3) develop visualization tools at the scale of school districts.

Significance

Policymakers, scholars, and practitioners all agree: effective climate adaptation must be rapid, broad-based and center the needs of vulnerable and historically underserved communities. Yet, the obstacles to simultaneously meeting these three goals are daunting. Building trust in communities can take years (Few et al. 2007; Klenk et al. 2017). At-risk communities face socio-structural barriers to adaptation and report experiences of limited self-efficacy, resulting in communities that can be wary, uninterested, or unaware of adaptation support (Abdel-Monem et al. 2010; Whitmarsh et al. 2013; Wibeck 2014; Meerow et al. 2019; Areia et al. 2022; IPCC 2022).

The Climate Adaptation Solutions Accelerator (CASA) through School-Community Hubs project identifies school-community hubs, i.e., programs that intentionally link K-12 schools and communities through integrated support services and community engagement (Teo et al. 2022), as a novel organizational form that can be leveraged to accelerate climate adaptation in vulnerable and historically underserved communities. To serve as community hubs for climate adaptation planning and activities, schools need information about the intersecting threats that climate change poses, including wildfire, heat, flooding, and other hazards.

Background

Climate adaptation efforts range from short-term technical solutions to promoting long-term solutions that address intersecting vulnerabilities (Eisenack and Stecker 2012; Malloy and Ashcraft 2020; Gresse et al. 2023). Roadmaps for resilient, just, and transformative adaptation call for broadening participation in adaptation planning (Shi et al. 2016; Chu and Cannon 2021). The historically underserved communities who are also the most vulnerable to climate change must be at the center of planning efforts (Pelling and Garschagen 2019; Owen 2020; Shi and Moser 2021).

We propose that schools can play a pivotal role in overcoming barriers to inclusive, equitable, just climate adaptation. First, schools are already on the front lines of climate adaptation. Students are coming 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). For example, Patel et al. (2023) estimate that climate-induced increases in wildfire smoke increased children's hospitalizations due to respiratory complaints by 40-50% in just one school year and school grounds may be directly exposed to various climate hazards (Callahan et al. 2022) like wildfire (Miller and Hui 2022). Second, schools offer obvious curricular opportunities for climate change education, a direction which aligns with state educational mandates (e.g., AB.-130, Cal. (2021-2022) and AB.-285, Cal. (2023-2024), which requires climate change science and adaptation be included in K-12 science coursework). Moreover, opportunities to participate in

community-engaged environmental stewardship have been demonstrated to build students' capacity to develop solutions (Monroe et al. 2019), to alleviate eco-anxiety, and to help students develop self-efficacy around climate change adaptation and mitigation (Pinsky et al. 2020; van Nieuwenhuizen et al. 2021; Schwartz et al. 2022). Third, schools already function as community hubs, where diverse populations in a neighborhood gather for performances, sport events, graduations, and already feel like they belong (Teo et al. 2022).

To foster community climate capabilities and link communities to local adaptation planning processes, schools need access to data that reflect the compounding hazards they face with climate change and at scales relevant to their communities. This MEDS project will give schools the tools to explore this data.

Equity

Historically underserved communities are often the most vulnerable to the impacts of climate change, yet face barriers to adaptation. More traditional forms of public engagement, such as public noticing and hearings (Freij 2022) and community or technical advisory boards and workshops (Nabatchi and Amsler 2014), often do not generate productive collaboration (Gonzales 2020; Migchelbrink and Van de Walle 2022) and can even result in "antagonistic and hostile" encounters (Haverkamp 2021:2). The participation of marginalized and underserved communities in planning processes may be limited by socio-structural factors, information deficits, and lack of agency (Whitmarsh et al. 2013; Wibeck 2014; Meerow et al. 2019). Schools are uniquely positioned to address barriers to community engagement in climate adaptation planning. The adoption of school-community hubs to connect underserved communities with the resources to participate in climate planning projects allows these communities to have agency in their decision-making processes.

Data

Project members will have access to all datasets necessary to complete the proposed research. These data are described below, and can be accessed in this Google Drive directory. The data is divided into three sections, titled "Boundary Layers," "Climate Hazards," and "Social Vulnerability." Each section is described as follows:

1. Boundary Layers: Lists spatial boundaries for California, including school district boundaries, school district offices, county boundaries, and census data;
2. Climate Hazards: Lists primary climate hazards in California, including flood, heat, and fire risk; and
3. Social Vulnerability: Lists primary social vulnerability hazards, including health, and energy resiliency.

Additional information can be found in the "Supporting Materials" section at the end of this document.

Computational tools and needs

Project members will need to conduct geospatial analysis to produce a comprehensive (and possibly interactive) map using R or Python. Interactive software may be utilized to provide an examination of the three identified study areas to synthesize historical context using spatial

mapping elements. Interactive web applications may potentially require hosting services to enable public access.

Possible approaches

We believe that the proposed objectives can be achieved through a combination of geospatial analyses and data visualizations. We envision:

1. Exploring data and compatibility across the various data sources and platforms through creation of geospatial overlays;
2. Data analysis to produce a statistically defensible aggregation of climate hazards by school district;
3. Data visualization to allow users to identify specific climate hazards within their communities; and
4. Creating an interactive web application that provides a comprehensive picture of intersecting climate risks for the three identified schools.

Deliverables

Deliverables will include:

1. A geospatial visualization of co-located climate hazards in California mapped at school district levels;
2. Development of an index of compounding climate hazards;
3. A visualization of the intersection between social vulnerability and climate hazards for researchers to use in selection of priority school districts; and
4. An interactive web application for the three identified schools to be used in curriculum development and school interactions.

Audience

There are three audiences for the data and data visualizations produced in this analysis. First, the early audience for this analysis will be the school administrators, teachers, and students at the three identified schools in Ventura County and Santa Barbara County, as well as climate partner organizations.

Second, the audience will be the CASA School-Community Advisory Council, which consists of:

- groups working with schools to support community resilience,
- school administrators and teachers with expertise and interest in community-engaged learning and/or climate change education, and
- representatives from organizations that have developed curricula and workshop materials relevant to climate risk and adaptation.

Third, there is a research audience for the products of this project as groups, planners, and academics seek to select school districts on the basis of social and climate vulnerability.

Supporting materials

Citations

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Additional data description

Boundary Layers:

- These data are the foundations that our geospatial visualizations will be mapped on. All data in this section were found on the California State Geoportal and are downloadable as a CSV, KML, Shapefile, and GeoJSON. Boundary layers from the US Census Bureau will also be used. The data will be used to map the co-related climate hazards; focusing on school district boundaries and using the counties, zip codes, district offices, and census boundaries to aid in overall spatial aggregation.

Climate Hazards:

- These data will act as the supporting materials to build our index and aggregation of climate hazards. The data was collected from several sources, including: Toxic Tides, Cal EPA, the California State Geoportal, the USGS, Cal-Adapt, and the Office of the State Fire Marshal. The data is available in a variety of formats including CSV, Shapefiles, GeoTIFF, and XML.

Social Vulnerability:

- These data will act as the supporting materials to aid in our mapping of social vulnerability as it intersects with climate hazards. The data was collected from several sources, including: PSE Healthy Energy, the California Department of Public Health, EJScreen, CalEnviroScreen, the California State Geoportal, and the CDC. The data is available in formats such as Shapefiles, CSV, Geodatabase, and KML.

Budget and justification

Funding sources to include the following:

1. Awarded NSF Planning Grant for work conducted under this project to support the Centers for Research and Innovation in Science, the Environment and Society (CRISES) program
2. Standard project support made available to all MEDS capstone projects
3. No additional funding beyond already approved funds required

Items to be included in budget:

- Up to $700 for data acquisition and $300 hosting services provided through NSF Planning Grant (PI and co-PI research funding)
- [redacted]
- Trip to Oakland to work with PSE Engineering partner (up to 1 student, $1,100 per trip provided through NSF Planning Grant)
- Trip to Sacramento to connect with leaders in State Capital on Climate Resiliency (up to 1 student, $1,100 per trip provided through NSF Planning Grant)
- $250 standard project support from the Bren School to manage basic operations and printing that will only be accessible by students
- Map domain/ hosting services for public access

Client letter of support

As the lead author of this proposal, Sarah Anderson commits to providing the data and computational resources that are detailed throughout this document. She is willing to serve as the project's faculty advisor to ensure the group's success towards the project's stated objectives. Please see attached letter of support.

Contact Information

For questions or concerns connected to this RFP, we can be reached at:

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October 19, 2023

Dear Members of the Selection Committee:

We write to affirm our enthusiastic logistical, advising, data, and financial support for the proposed Master's of Environmental Data Science Capstone Project, Climate Hazards Data Integration and Visualization for the Climate Adaptation Solutions Accelerator (CASA) through School-Community Hubs.

Historically underserved communities are both disproportionately vulnerable to climate risk and less able to participate in adaptation planning. This project explores the use of schools as community hubs to build knowledge regarding climate hazards, to build capacity to participate in adaptation planning, and to accelerate the uptake of climate adaptation solutions.

The project aims to both integrate data across climate hazards in California and to create platforms for data visualization available to schools, communities, and planners. Although the underlying climate hazard and social vulnerability data are readily available (e.g., CDC Social Vulnerability Index, UCLA's California Healthy Places Index (HPI): Extreme Heat), they have not been combined with school district boundaries in ways that allow them to be usable to a school. Nor have the various compounding climate hazard data been aggregated in a statistically defensible way to represent aggregate risk.

Professors Sarah Anderson, Simone Pulver, and Danielle Harlow have received an NSF Planning Grant to support pilot projects, including this data integration and visualization project, under the Centers for Research and Innovation in Science, the Environment and Society (CRISES) program. The three professors, with lead responsibility falling to Professor Anderson, will provide advising support on the project and serve as the project clients. In addition, they will provide any funding needed for software or data, though all data are publicly available, and we anticipate that the Bren School already has the necessary licenses for software. The clients will also provide funding for research related travel to San Francisco and/or Sacramento. [redacted]

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Please feel free to contact any of us if you have any questions.

Sincerely,

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Data files for the proposed project are to be downloaded here and are listed in Table 1 below. Further description is available under **Supporting materials** in the proposal.

Table 1, Data sources for the proposed project

Boundary Layers	Climate Hazards	Social Vulnerability
California School District Boundaries 2022-2023	Toxic Tides Flood Risk and Demographic Data	PSE Healthy Energy Resilience Hub Mapping Tool
California Zip Codes 2021	CalEPA Urban Heat Island Downloadable Data	Climate Change & Health Vulnerability Indicators for California (CCHVIs)Viz
California School District Offices 2022-2023	California Toxic Release Inventory (TRI) Facilities 2023	EJScreen: Environmental Justice Screening and Mapping Tool
California Counties 2021	Cal-Adapt Climate Data	California Communities Environmental Health Screening Tool: CalEnviroScreen 4.0
California State Boundary	Fire Hazard Severity Zone (FHSZ) maps	Statewide Power Outage
	USGS Drought and Snowfall Data	CDC/ATSDR Social Vulnerability Index
		California Census Bureau Tables