Disability and climate change hot-spots in Senegal: considering risks and opportunities

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Abstract

People with disabilities face unique risks in response to both rapid- and slow-onset climate-related events because they may require different types of early warning information to accommodate their needs when responding to climate-related hazards. However, the needs of disabled populations are often not considered alongside climate hazards and mitigation planning. In this project, we take a significant step towards documenting and mapping the risks that people with disabilities face in the context of climate change. We use an innovative dataset—the Senegal RGPH, conducted in 2013, which measures disability using the recommended questionnaire of the Washington Group on Disability Statistics. We combine this data with satellite and gridded datasets that provide key climate measures related to temperature and rainfall, as well as land cover, population density, and infrastructure. This approach allows us to identify areas where climate hazard hotspots intersect with disabled populations, taking into account exposure and additional vulnerability factors.

1. Introduction

Climate change is an urgent issue. According to the Intergovernmental Panel on Climate Change (IPCC), the Earth's temperature is now approximately 1.1°C higher than it was in the late 1800s and is projected to reach or exceed a 1.5°C increase in average global temperatures over the next 20 years. These changes bring about a range of adverse consequences, including rising sea levels, droughts, water scarcity, severe fires, heatwaves, heavy rainfall, flooding, catastrophic storms, and more. These consequences have significant implications for human health, development, and socioeconomic well-being. However, the impact of climate and environmental changes can vary widely based on geographical location and the vulnerability of local populations(Cardona et al., 2012).

According to the latest estimates from the World Health Organization (WHO), 1.3 billion people worldwide currently experience significant disabilities, representing 16% of the global population. These numbers are expected to rise due to population aging and the increasing prevalence of non-communicable diseases (WHO, 2023). People with disabilities face unique risks in response to both rapid and slow-onset climate-related events because they may require different types of early warning information tailored to their needs when responding to climate-related hazards. However, the needs of disabled populations are rarely considered in the context of climate hazards and mitigation planning. These populations are often excluded from this discussion, and there is very limited scientific research to support policy and mitigation efforts (Gaskin et al., 2017). In this project, we take a first step towards documenting the risks people with disabilities face in a context of climate change.

We are utilizing the conceptual framework proposed by the Intergovernmental Panel On Climate Change (IPCC), which defines risk as a dynamic interaction of climate-related hazards, exposure, and vulnerability (Intergovernmental Panel On Climate Change, 2023). The IPCC defines vulnerability as the propensity or predisposition to be adversely affected, which can encompass various elements, including a lack of capacity to cope and adapt. In this study, disability is considered a significant factor of vulnerability, as individuals with disabilities often experience limited access to knowledge, resources, and services needed to effectively respond to environmental changes. They can be more susceptible to extreme events or infectious diseases and may encounter physical challenges during required evacuations or migrations. Other elements, such as age, socio-economic status, and education level, can also increase vulnerability, and due to their association with disability (Simo Fotso and Nawo, 2022), exacerbate the vulnerability of this group. A top-down evaluation of vulnerability begins with an assessment of exposure to climate hazards. Exposure, as defined by the IPCC, refers to the presence of people, livelihoods, species, ecosystems, environmental functions, services, resources, infrastructure, or economic, social, and cultural assets in locations and settings that could be adversely affected. In this work, we use the presence of people and agricultural activities to gauge exposure to potential climate hazards in order to assess the potential direct impact of climate hazards on people and the indirect impact on economic activities. The framework is summarized in Figure 1.

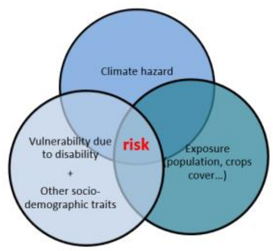

Figure 1: Climate – disability hotspots/ risks framework

Studies on disabilities are often limited due to the low number of individuals with disabilities included in surveys. The Senegal General Census of Population and Housing, Agriculture, and Livestock (RGPH) conducted in 2013 offers several advantages that allow us to overcome this limitation. The RGPH employs a culturally neutral disability screening tool known as the "WG short set of questions," developed by the Washington Group on Disability Statistics (WG) and recommended for measuring disability. This tool identifies functional limitations and restrictions in activities on an individual's level in six domains: sight, hearing, mobility, communication, concentration, and activity restrictions such as bathing or dressing (Madans et al., 2011). The data was collected for the entire population of Senegal, ensuring adequate statistical power for the analysis overall and for each type of functional limitations. This data also allows us to create disability indicators at the sub-national level, disaggregated by sex and age groups. These elements justify the choice of Senegal as the focus of our research. **The objective of this study is to identify area (hotspots) where the population with disabilities are facing risk because of climate change hazard in Senegal.**

In addition to advancing the literature and understanding of the impact of climate hazards on populations, especially the most vulnerable, this work will provide policymakers with a valuable tool to develop people-centered climate change mitigation efforts. The IPCC recognizes that vulnerabilities and climate risks can often be reduced through carefully designed interventions that address context-specific inequities, such as those based on disability (Intergovernmental Panel On Climate Change, 2023).

2. Data and Method

Different datasets were used for this study. Initially, we utilized the Senegal General Census of Population and Housing, Agriculture, and Livestock (RGPH) conducted in 2013 by the Senegalese national statistical agency (ANSD). ANSD provided us with data aggregated at the lowest administrative units (communes or districts) and 10% of the individual datasets, with the intention of protecting confidentiality. Senegal comprises a total of 502 communes. Prevalence of disability by type of functional limitation and the proportion of women who have not received formal education, which was used as a measure of literacy, were extracted form RGPH. All these metrics were calculated using the complete census data. Additionally, we calculated the proportion of the elderly (individuals aged 60 and older) using the 10% data set. ANSD also supplied us with an indicator of household poverty rates at the district level, based on their poverty map.

Next, we employed various satellite and gridded datasets to assess climate-related hazards, exposure, and infrastructure vulnerability. The satellite data used were gridded and had different resolutions. Given the variations in resolution and the fact that disability data were provided at the commune level, all satellite data were aggregated at the district level. The discrepancies in scale between disability and climate data will be further discussed in the full paper.

The Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) was utilized to measure precipitation. CHIRPS is a 35+ year quasi-global rainfall and high resolution (0.05° , approx. 5km) estimates from rain gauge and satellite observations (Funk et al., 2015). Extreme precipitation was quantified by the number of days with rainfall exceeding 50mm per year, averaged over a 5-year period (2010-2015).

For temperature data, we employed the Climate Hazards Center InfraRed Temperature with Stations Tmax (CHITS) high-resolution dataset (0.05° x 0.05°, approximately 5km) of daily maximum temperatures (Verdin et al., 2020). Extreme temperature was assessed through the count of hot days with temperatures exceeding 40°C per year, averaged over a 5-year period (2010-2015). To account for other types of climate hazards, we used the Geocoded Disasters (GDIS) Dataset, version 1 (2010-2018). To capture accessibility or infrastructure, we utilized the Global Roads Open Access Data Set (gROADS), version 1 for 2010. For indirect exposure, Land Cover data with a resolution of 30 meters was employed. This dataset enabled us to identify areas with crop cultivation (where food is grown) and categorize these areas as exposed. In addition, the Global Human Settlement Layer for 2015 (Schiavina et al., 2023) was used to assess direct exposure. This dataset allowed us to identify densely populated areas, which were considered highly exposed due to the presence of people.

Following the conceptual framework presented above, the climate-disability risk estimates can be represented as in Equation 1.

$$\text{Risk}_j = \text{Hasard}_j \times \text{Exposure}_j \times \text{Vunerability}_j \; [1]$$

Based on this equation, the first step of our analysis will employ a descriptive approach. We will map the extreme event indicators described above (climate hazards). Then, to account for specific exposure, the indicator for each extreme event in each commune will be recalculated, including only areas where people live (an indicator of extreme events corrected for exposure). Finally, we will identify zones with extreme events that are highly exposed and have a high prevalence of disability. This process will be repeated for each extreme event, taking into account each source of exposure (population and crops), as well as overall and for each functional limitation.

In the second step of our analysis, we will account for multiple sources of exposure and vulnerability simultaneously. We will calculate the proportion of the commune's surface covered by crops and densely populated areas, which will be used to construct an exposure indicator using both weighted and unweighted arithmetic mean – geometric means, and Data Envelopment Analysis (DEA) methods will also be used to create indicators for sensitivity analysis.

Similar calculations will be used to determine an indicator of vulnerability, taking into account other socio-demographic elements that are likely to exacerbate the vulnerability of people with disabilities, including poverty levels, age composition, literacy rates, and the infrastructure of the commune. We will assign higher weights to the disability sub-indicator since it is the primary focus of the analysis. Additionally, the various methods used for constructing the exposure indicator will also be employed for sensitivity analysis.

3. Preliminary and expected results

The last map in Figure 2 displays the Disability-Heat Wave Hotspots Map, showing areas where the maximum population of people with disabilities is impacted due to higher degrees of climate hazards, particularly heatwaves. These hotspots are primarily located in the North-East of the country along the Senegal River.

We anticipate that this paper will highlight the risks that disabled people face in the context of climate change. It will provide commune-level disability-climate risk indicators for each type of functional limitation. The findings of this study can be used to inform disaster preparedness and promote appropriate climate adaptation strategies to safeguard people. This type of work could also be applied to other vulnerable groups and contexts.

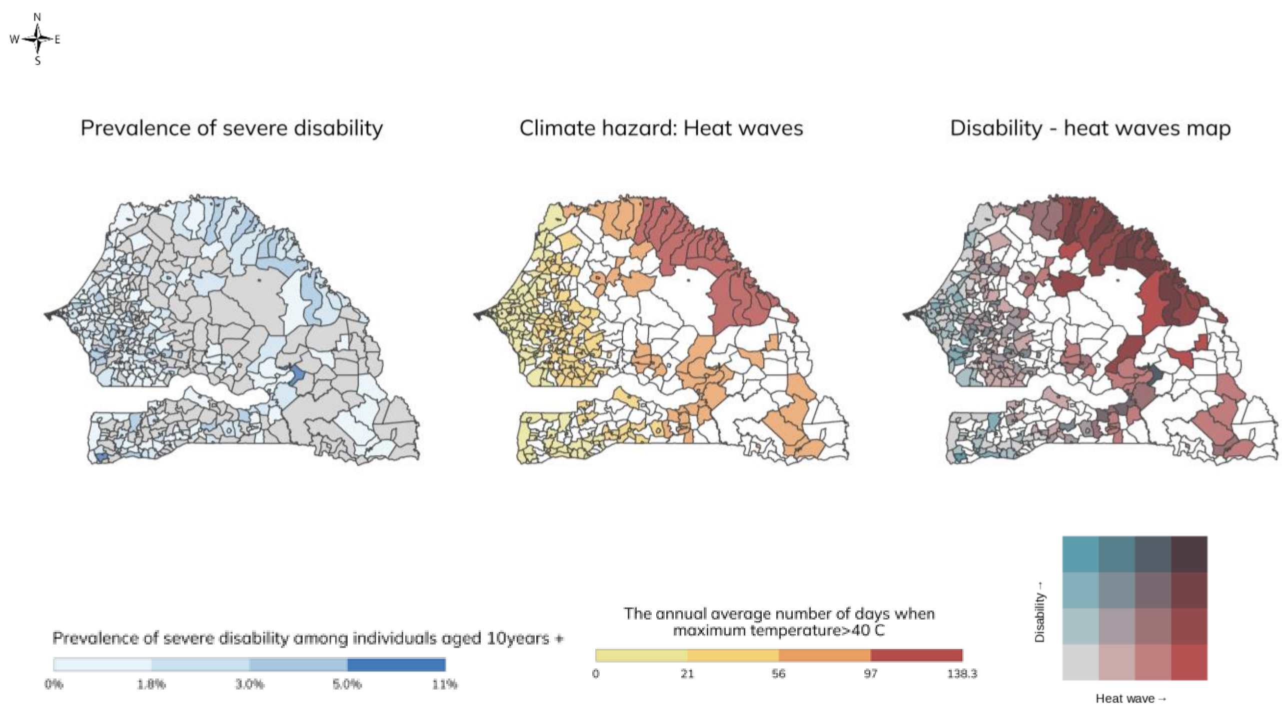

Figure 2: Severe disability-heatwave map

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