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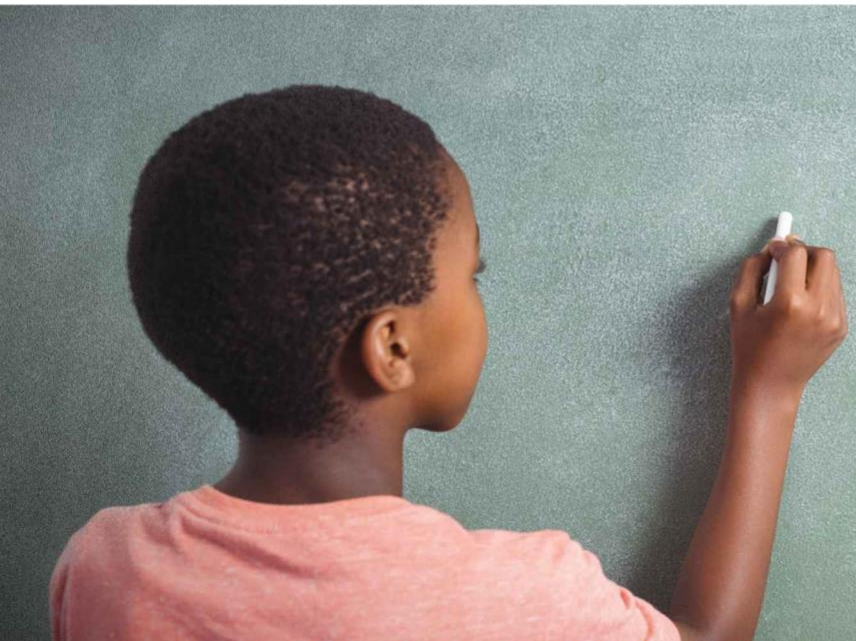
Flooding and Schooling in Sierra Leone



EXECUTIVE SUMMARY

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Flooding & schooling in Sierra Leone – Executive Summary

Overview

This document summarizes the creation of a *Schools Flood Vulnerability Index* for Sierra Leone.

This was created in two parts: first looking at how often flooding has happened in the schools locations in the last three years, using historical satellite imagery of water inundation as a proxy for the future risk (*the hazard*); and then looking at characteristics of schools using annual school census data, to see how vulnerable they might be to the impacts of future floods. We combine these measures to estimate how at-risk schools are flooding.

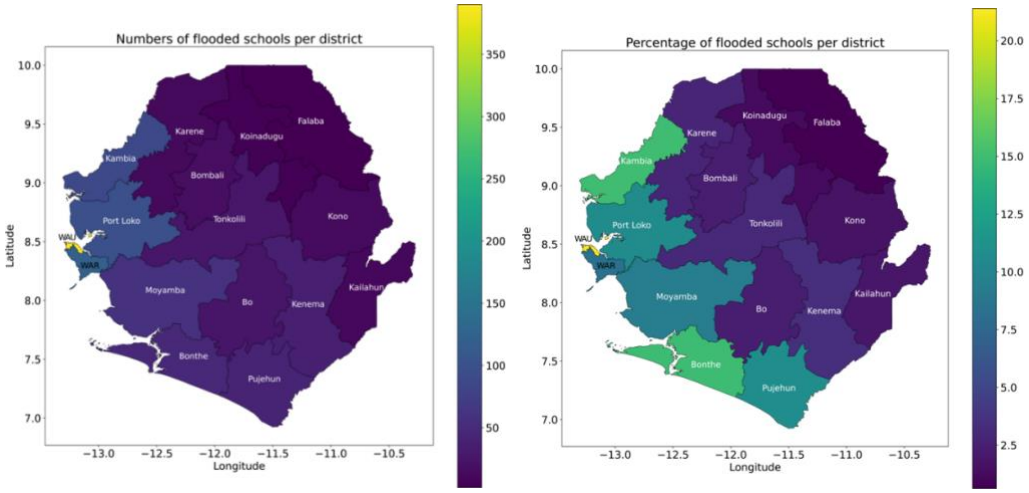
This is necessary as warming, due to climate change, has already reached around 1.1 degrees globally, and is expected to rise to above 1.5 degrees over the next 20 years. This means Sierra Leone (and everyone else) faces more frequent and severe extreme weather events including flooding. These floods are likely to have substantial education impacts, including learning time being lost as schools close or aren't accessible. As 40% of the population are in school, this can have far reaching impacts on national development if widespread or more frequent. Despite the Governments efforts to make education planning more climate smart – including through the School Catchment Planning guidance, the effects of climate change and extreme weather on the education system in Sierra Leone are not yet fully understood.

To gain insight into the nature of the flood hazard that schools face we used processed satellite imagery of water inundation over a three-year period (September 2019-2022) and combined this with school geo-referencing data. Using the Annual School Census, we collated and analyzed different elements of physical and social vulnerability. Using this information, we created a *School Flood Vulnerability Index* based on physical and social vulnerability. Using the analysis on hazards and vulnerability we created a *School Risk Index* for Sierra Leone. This was done through a simple formula: Flood risk = Flood hazard score x Flood vulnerability score.

Findings

Flood Hazards

Figure 1: Number of flooded schools and share by district



We define 'flooded' or 'flood prone' as schools that are in an area where it was estimated that 50% of the pixel is flood water – with each pixel in the data covering 375m^2. We find 984 out of 12,204 schools[1] (~8%) **were flooded at least once in the last three years.** An additional 495 schools are reported on the precipice of a water source so not could not be accurately analyzed due to their GIS precision - but as they are located so close to a potential flood hazard this means that there is a strong likelihood that they will also have been flooded. **If we include these, potentially 12% of schools in Sierra Leone are exposed to flooding.**

Being conservative, we estimate that **245,794 pupils, which is 7.45% of Sierra Leone pupils, attend schools that have been impacted by flooding in the previous three years**. This has the potential to be as much as 371,661 children, 11% of students if we included the additional schools.

Even before more extreme weather events become even more common, hundreds of thousands of children face flooding disruption to their education, with implications for outcomes, wellbeing, and safety.

The flood water lasted for five days for 271 schools – and many have multiple occurrences. Across the country, 772 (6%) schools have had two flooding events and 468 (4%) of schools have had 3 flooding events in the past three years. A significant number of schools are at risk of either prolonged or multiple flooding events.

Flooding was most prevalent across the Western Districts of Sierra Leone - **The districts with the highest percentage of flood prone schools – the 'flood prone districts' - are Kambia, Bonthe, Western Area Urban, Western Area Rural, Mayamba, Port Loko, and Pujehun.** They account for 85% of all schools affected by flooding during this period.

Unsurprisingly, flooding is also most common in certain parts of those districts, primarily along the coastal areas, river deltas and wetlands in the northern districts of Kambia and Port Loko. Western Area Urban is prone to urban and flash floods in Freetown. Flooding in Bonthe, Pujehun, and Western Area Rural includes the coastal areas, wetlands, and river-based flooding.

Flood Vulnerability

We found that many schools, including those in flood prone areas, are physically vulnerable to extreme weather. Only 69.7% of classrooms in flood prone areas are-built with solid materials in a good state, the rest needing repairs (24%) or using semi-solid materials or makeshift materials, which are more vulnerable in a flood.

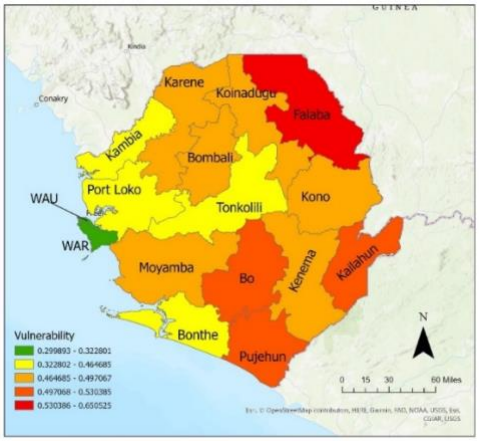
Schools lack sanitary facilities - there is an average of 3.5 latrines and 12% were classified as in a bad condition. 42% schools lack access to water and 15% of schools are connected to a well. Floods can potentially increase the transmission of water- and vector-borne diseases through open water sources. The average year of school construction is 1996 - newer buildings are more likely to comply with safety regulations, making them more resilient as flash floods or urban flooding that can exceed the capacity of outdated infrastructure. 62% of schools have no electricity, which suggests that they are vulnerable due to fewer resources.

Significant social vulnerabilities exist across flood-prone schools in Sierra Leone. Schools in flood-prone areas have a mean average of 257.1 pupils and staff, and are smaller than in non-flooded schools, which means fewer children are disrupted. Unsurprisingly, they are near a water source - distance to nearest source of floods is on average 0.11km.

[1] Schools that are geo-referenced from the Annual School Census

More rural schools are socially vulnerable due to less support services in the event of a flood. 69% of flood prone schools are in towns, the next highest category was those over 50km away from a town at 14%. Following this, population density is significantly higher in flood-prone areas, 1,074 people km^2 v 473 people km^2 in non-flooded schools. A higher population density makes a school more socially vulnerable due to being part of a larger community that can be impacted by floods. We also looked at distance to the nearest school of the same level and found that for flood-prone schools this was on average 1.55 km, this allows us to understand how feasible it is that education can continue if a school is closed for a long time.

Figure 2: Overall flood vulnerability by district



We look at factors proxying for safety and well-being. We use network coverage as a factor as without connectivity teachers, pupils and communities cannot receive real-time information about heavy rains and potential flooding or call for help - we find that 10.5% of areas around flood-prone schools lack network connectivity. We judged those with access to school feeding are more vulnerable to the impacts of flooding – we find 18% of flood-prone schools are in the School Feeding Programme.

When analyzing the overall index, we find that Primary Schools have a higher vulnerability than other levels.

Among flood-prone districts, five out of seven districts demonstrate more than half of their schools categorised as either "high" or "very high" vulnerability. That said, the Western Area Rural (67%) and Urban (74%) districts show low vulnerability compared with the rest of the districts (though are higher risk).

There is significant variation in vulnerability scores within districts. When we shift the analysis to within the district and look at differences between the most and the least vulnerable schools, the gap between them is substantial within the flood prone districts. This highlights high levels of inequality in physical and social vulnerability, which is most prevalent in Western Area Urban.

Combining these- Flood Risks

The seven districts identified as the most flood-prone exhibit the highest levels of risk compared to the other nine districts. Bonthe is the most 'at risk' district, followed by Kambia.

Western Area Urban ranks last in terms of vulnerability but third in the risk index due to its susceptibility to flooding. Freetown and the area around Freetown has a large number of at-risk schools. As these schools are at risk of urban/flash floods, as well as some from coastal flooding, it shows that a range of interventions will be needed to reduce risk.

There are clusters of risk across the seven districts that make up the focus of our report. In the North-West and along the coast, the area around the border between Kambia and Port Loko shows clusters of schools that are at risk from flooding impacts on physical infrastructure. Physical vulnerability can exacerbate social vulnerability. A similar story emerges in Bonthe and Pujehun where there are clusters of high-risk schools along the border between the two districts.

Recommendations

Improving infrastructure in schools is a key-way to reduce vulnerability. This should begin with prioritizing schools for infrastructure improvement, better building materials, repairs to existing school buildings, increasing WASH facilities, and access to reliable and resilient electricity generation.

Certain parts of districts should be targeted for intervention using a combination of hazard exposure, vulnerability, and risk. This should involve a range of physical and social support. Targeted interventions should be implemented to support primary schools in flood-prone areas.

With a high number of socially vulnerable schools in flood prone areas, support in social areas, such as maintaining school feeding programs during disruption or targeting resources to poorer areas can reduce vulnerability to flooding.

To make schools in Sierra Leone climate-smart whilst meeting the need for increased school places, it will require a range of investments of people, money, and institutional capacity. To reduce flood vulnerability this requires prioritization so that the most at risk schools can be targeted. There are policy frameworks that can be leveraged for this work. For instance, the MBSSE conducts assessments that encompass flooding and has developed *The School Catchment Policy,* incorporating building standards, including a section specifically addressing flood vulnerability.

Mitigating the flood hazard requires an understanding of the level of risk of flooding, school location, and the type of flooding that they are exposed to. Interventions should take the form of working with the most at-risk schools to understand their physical and social vulnerabilities and their current approaches to minimizing disruptions from flooding. A mechanism for decision-making should be developed that prioritizes working with and investing in the most at risk schools.

Sierra Leone has developed Disaster Risk Reduction (DRR) structures through the creation of the *National Disaster Management Agency* in 2020. Using the method, indicators, and results of this research, work with the NDMA to integrate education systems within their approach to minimize disruption to schooling because of the most extreme floods that will impact on Sierra Leone.