Integrating hazard modeling, exposure, and vulnerability for flash flood early warning in Ecuador

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Introduction

The humanitarian community performs anticipatory action to take action before a disaster, based on early warning systems driven by Earth observations. For example, Red Cross and Red Crescent National Societies are developing Early Action Protocols (EAP) for various disaster types, but this has not been previously done for flash floods. In partnership with the Ecuadorian Red Cross, and in collaboration with the National Institute for Hydrology and Meteorology (INAMHI), we integrate flash flood hazard modeling with EO-derived population and vulnerability layers from NASA Socioeconomic Data and Applications Center (SEDAC) to create tailored flood-risk products. These will allow for the first flash flood EAP to be developed.

Flowchart of EAP

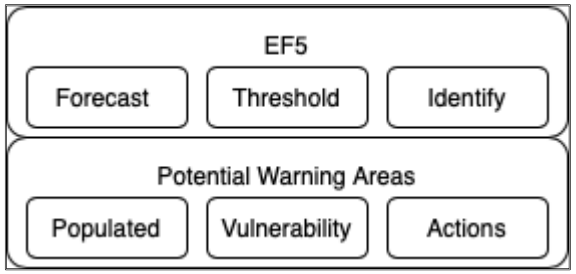

Figure 1: EF5 is used to identify flash flood early warning areas that are integrated with vulnerability data to provide context for decision making actions.

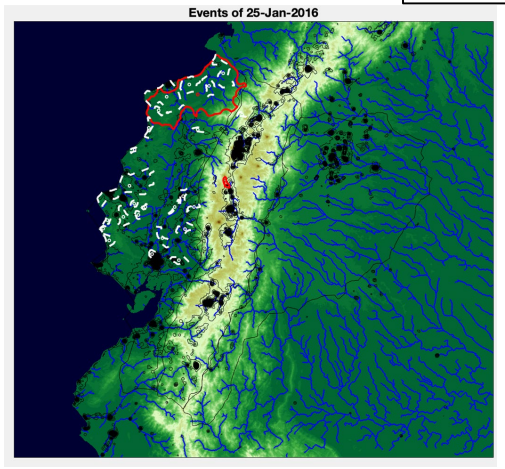

Figure 2: EF5 flash flood warning areas (red polygon) and reports (white dash-line) for one day at 1 km.

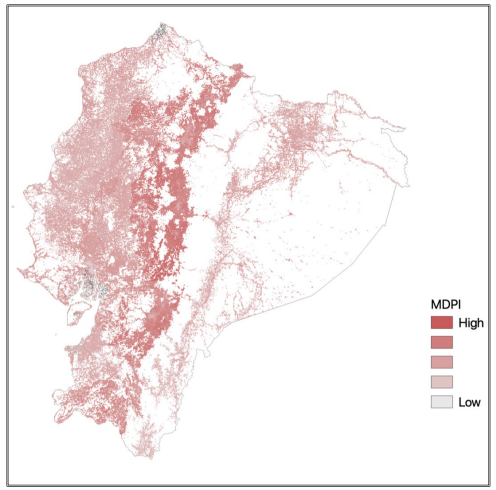

Figure 3: MDPI uses EO and survey data to capture vulnerability at 1 km.

Methods

The Ensemble Framework for Flash Flood Forecasting (EF5) is developed by University of Oklahoma at NOAA National Severe Storms Laboratory. EF5 is appropriate for anticipatory action when tuned with actionable model thresholds and approaches to specify warning areas. To support this, the Multi-Dimensional Poverty Index (MDPI) Grids are developed by NASA SEDAC to capture the relative vulnerability of populations. It is derived from building, nighttime lights, wealth, mortality, and other demographic characteristics - partly from EO. The EF5 flood hazard layer is integrated with MDPI to produce a layer highlighting areas at risk of flash floods, along with the degree of vulnerability of exposed populations.

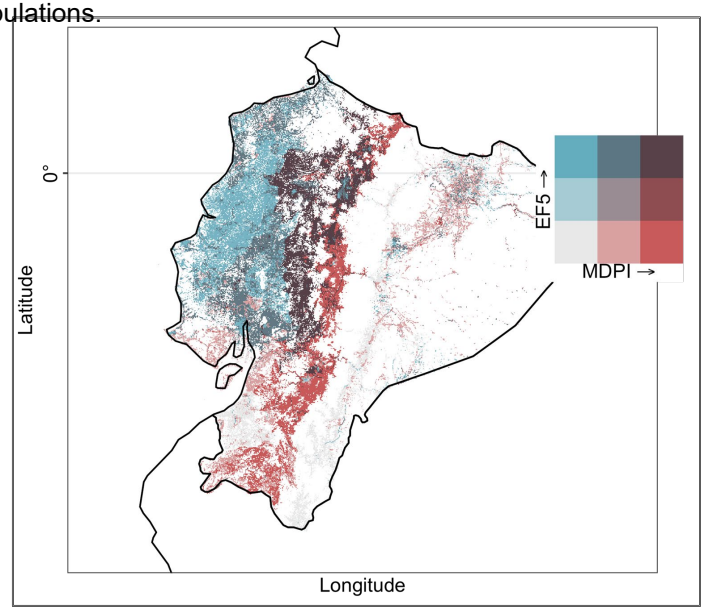

Figure 4: Deeper blues and reds correspond to higher EF5 and MDPI respectively, while brown at the intersection indicates degree of vulnerability of exposed population at 1 km spatial resolution.

Discussion

Developing an early warning system does not necessarily mean that action will take place. To ensure action will occur based on a shift in risk before a disaster, a system must be developed whereby exceeding forecast thresholds lead to disbursement of funds for specific risk reducing action. We highlight the spatial intersection of flood exposure and at-risk populations to support the understanding of risk. The structured involvement of humanitarian decision makers in the project increases the chance that outputs are directly beneficial to specific decisions, as they align with action and funding, and with official mandates.

As anticipatory action systems evolve, it is important to center people in decisions. Earth observations present a variety of opportunities, for both monitoring of floods, and especially for understanding risk. Our next steps involve the evaluation of the potential benefits of flash flood anticipatory action systems.

Acknowledgements

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