

Title

Humanitarian costs of climate change: mapping the impact of 2022 Pakistan floods on disruption to education and health using earth observation and data fusion

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Background

In the immediate and short-term aftermath of climate-induced natural disasters, relief and rehabilitation efforts are a key priority. Rapid, reliable, and comprehensive information is required to access and help affected communities. We used earth observation and data fusion to measure the impact of the 2022 Pakistan floods on road access, health facilities and schools, and to independently validate previous estimates of impact on population displacement.

Methods Satellite-detected flooding across Pakistan (Punjab, Sindh, Baluchistan, and KPK provinces) was independently estimated by data fusion of imagery acquired from SENTINEL-1, SENTINEL-2 and LANDSAT-9 satellites at spatial resolutions of 10, 25, and 40 meters, and validated against official UNOSAT estimates. In the absence of comprehensive official records, we geo-located schools and health facilities from Google Maps using POI template matching techniques combined with available Punjab Health Initiative Management Company (PHIMC) data. Geo-located population and road network data were provided by the global WorldPop and OSM datasets. The number (%) of flood-affected road networks, schools, health facilities, and local population displaced in the two-worst affected provinces (Sindh and Punjab) was estimated by mapping the geo-located data to satellite-derived flooding data.

Results: 230 (28.5%) and 122 (27%) basic health facilities were flooded and made inaccessible due to flooding of 1427 km and 596 km of road networks in the two worst-affected provinces of Sindh and Punjab, respectively. 839 (23.5%) schools were flooded in Sindh. Our model independently validated UNOSAT estimates confirming 10% (20 million) of the total population of Pakistan, 28% (13 million) population of Sindh and 4% population of Punjab to have been directly impacted by flooding between August and September 2022.

Interpretation

Earth observation can provide timely information for critical disaster management and rescue efforts. Disruption to schools, basic health facilities and road access as shown in this work may be measured in near real time with a view to aid immediate relief and longer-term resilience efforts, particularly in resource-limited settings.

Funding

NIHR Oxford Biomedical Research Centre Programme. Additionally we would like to acknowledge funding support provided by the Higher Education Commission of Pakistan through grant GCF-521.

Contributors

The study was conceived and designed by SK, UN, and MU. Data curation and analysis was performed by UN and MTQ, and interpreted by all co-authors. The abstract was written by UN and SK and revised by all co-authors. SK is responsible for the overall study.

Declaration of Interests

SK is supported by the Innovative Medicines initiative, Bill & Melinda Gates Foundation, Health Data Research UK, British Heart Foundation, and Medical Research Council and Natural Environment Research Council outside of this work.

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