Precipitation error characterization for extreme events and applications for hydrometerological hazards

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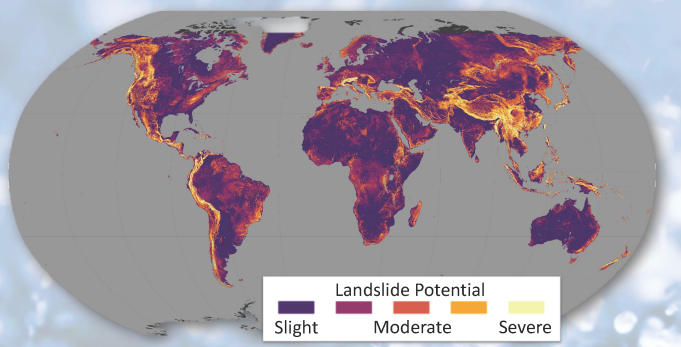
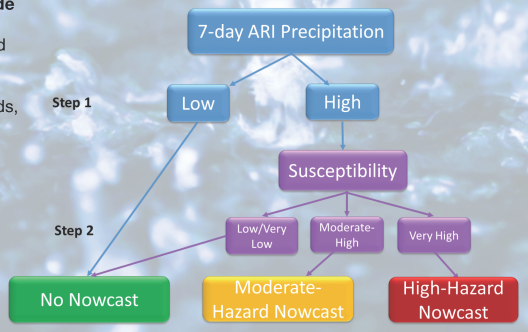
LHASA: Landslide Hazard Assessment for Situational Awareness

Approach: Merge landslide susceptibility map with satellite-based rainfall to represent potential hazard via near-realtime "nowcasts"

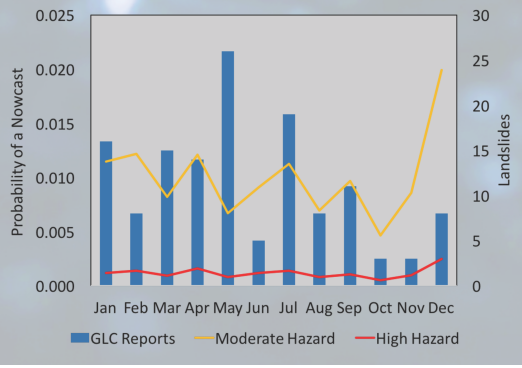


Top: "Static" landslide susceptibility map—derived from weighted combination of elevation, faults and geologic regions, roads, forest cover

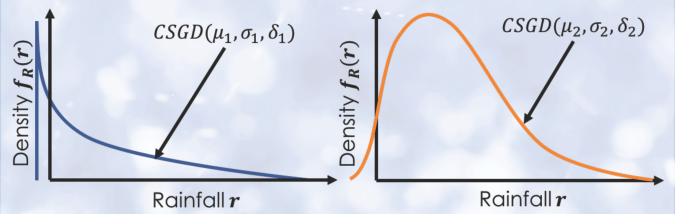
Right: Schematic of LHASA nowcast decision tree—Combination of static susceptibility map and Antecedent Rainfall Index (ARI) based on TMPA and/or IMERG



Bottom: Deterministic LHASA output—1998-2016 climatology of observed landslides vs. deterministic landslide nowcasts over IPHEX domain (NC, SC, GA, TN) using TMPA-RT



Rainfall error modeling with Censored Shifted Gamma Distributions (CSGDs)

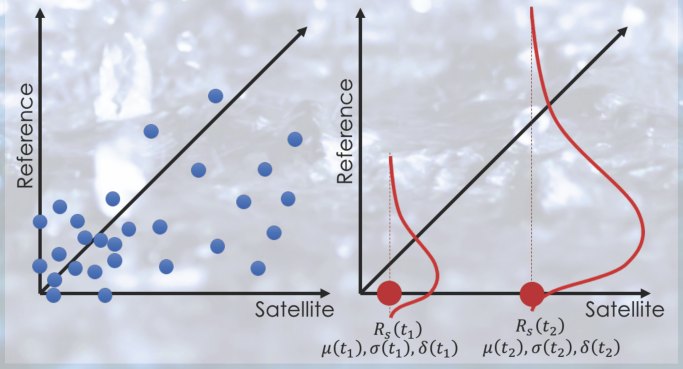


CSGD Error Model Nonlinear Regression Framework:

$$\mu(t) = \frac{\mu}{\alpha_1} log1p\left[expm1(\alpha_1)\left(\alpha_2 + \alpha_3 \frac{R_s(t)}{\overline{R_s}} + covariates\right)\right]$$

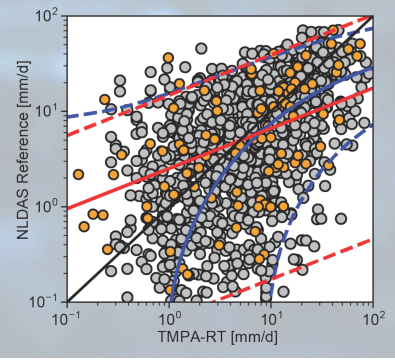
$$\sigma(t) = \alpha_4 \sigma \sqrt{\frac{\mu(t)}{\mu}}$$

$$\delta(t) = \delta$$

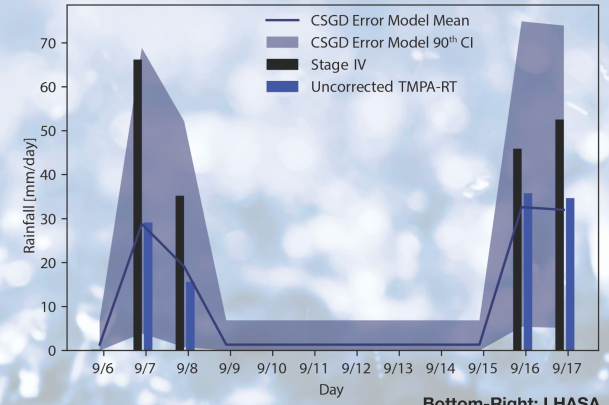


Above: CSGD Error Model—nonlinear regression framework generates CSGD parameters $\mu(t), \sigma(t), \delta(t)$ conditioned on satellite observation $R_s(t)$

Right: CSGD and PUSH error models—TMPA-RT vs. NLDAS-2 precipitation in NC



Rainfall error model → ensemble-based landslide "nowcasting"

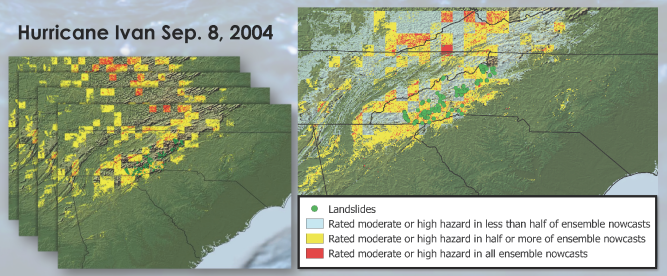


Top: TMPA-RT, CSGD Error estimates, and Stage IV radar—for Hurricane Ivan in September 2004

Bottom-Left: LHASA susceptibility ensembles—Landslide occurrences and ensemble nowcasts

Bottom-Right: LHASA ensemble composite susceptibility—with probabilistic nowcast results based on ensemble statistics

Hurricane Ivan Sep. 8, 2004



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Related Publications

- Wright, D. B., D. B. Kirschbaum, and Soni Yatheendradas (2017). "Satellite Precipitation Characterization, Error Modeling, and Error Correction Using Censored Shifted Gamma Distributions." *Journal of Hydrometeorology*
- Kirschbaum, D., and T. Stanley (*in revision*). Global Landslide Nowcasting System using Remote Sensing Data, *Earth's Future*
- Stanley, T., and D. B. Kirschbaum (2017), A heuristic approach to global landslide susceptibility mapping, *Natural Hazards*
- Stanley, T., D. B. Kirschbaum, G. J. Huffman, and R. F. Adler (2017), Approximating long-term statistics early in the Global Precipitation Measurement era, *Earth Interactions*