Global Flood Alerting with an Ensemble of Models and Remotely Sensed Observations

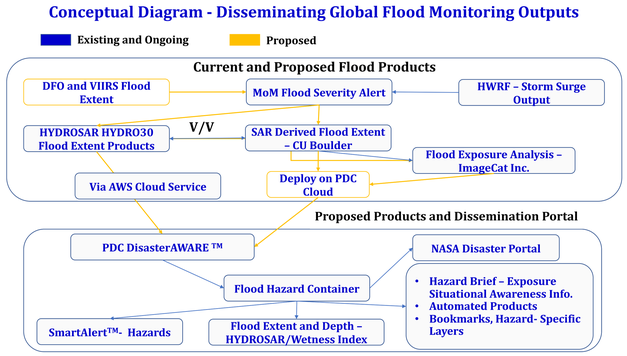
Margaret Glasscoe[1], Bandana Kar[2], Guy Schumann[3], Marina Mendoza[3], Doug Bausch[4], Jun Wang[5], and Greg Hampe[4]

[1]University of Alabama, Huntsville, [2]AAAS Science, Technology and Policy Fellow at Department of Energy, [3]ImageCat, Inc., [4]Pacific Disaster Center, and [5]Indiana University

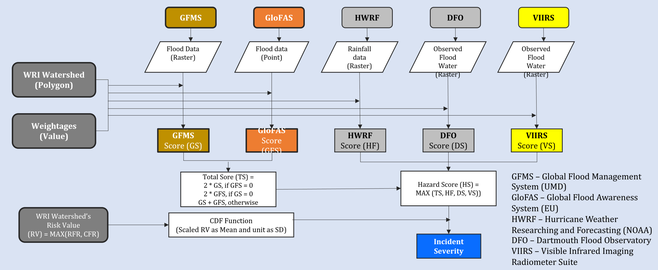
Global Initiative for Flood Forecasting and Alerting – GIFFT

The **Global Initiative for Flood Forecasting and Alerting (GIFFT)** deploys an ensemble model - **Model of Models (MoM)** - to integrate flood products (forecasted flood extent, precipitation level) from optical sensors and hydrologic models to forecast flood risk daily across the globe at sub-watershed basins.

The flood risk is used to disseminate alerts including flood extent and potential impacts to global stakeholders via the Pacific Disaster Center's **DisasterAWARE®** platform.



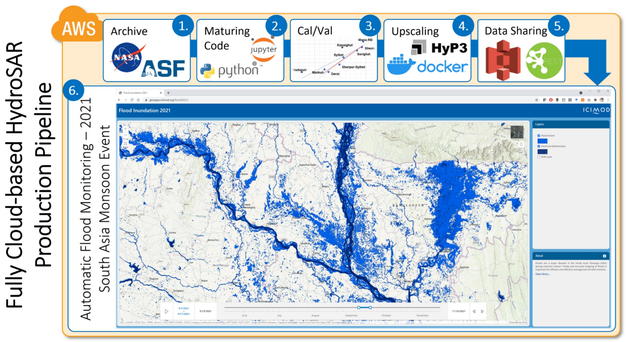
Model of Models (MoM)



- MoM integrates the outputs of GloFAS, GFMS, and HWRF models to forecast flood risk (probability scores);
- MODIS and VIIRS flood products are used to validate and calibrate flood risk scores daily;.
- The flood risk scores are used to disseminate alerts (watch, warning, advisory and information) using PDC's DisasterAWARE platform.
- The risk scores are used to trigger processing of ***SAR imagery*** to compute flood depth and extent at a finer resolution and estimate impacts.

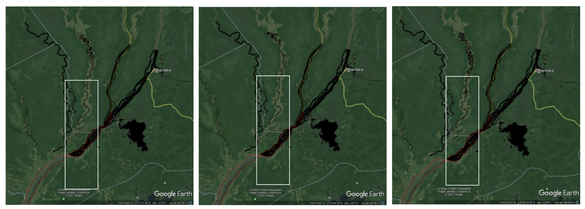
SAR Flood Extents

- **HydroSAR** provides post-event flood maps, flood depth estimation, flood risk using Sentinel 1 SAR imagery (below).
- Water depth and extent are also calculated using **machine learning and thresholding** (right).
- The white box in each frame in the bottom figure shows where flooding is occurring north of Lukolela, DRC.



1 Integration with NASA ASF DAAC in AWS | **2&3** Code development & cal/val in AWS
4 Automation using Docker | **5&6** Data sharing via REST & ArcGIS image services

SAR Derived Flood Extent and Depth - Change Detection Using Thresholding Methods for Democratic Republic of Congo



03/03/2020 | 03/15/2020 | 03/27/2020

MoM Accuracy Assessment

ID	Region	Flood type	Country	Year	MoM detected	MoM severity*	EM-DAT	GFM	Social	Copernicus GFMS	Int. Charter
1	South Asia	Monsoon flood	Pakistan	2022	Yes	Warning	Y	Y	Y	Y	
2	Africa	Flash floods	Sierra Leone	2022	Yes	Warning	Y	Y	Y	N	
3	Africa		Chad	2022	Yes	Warning	Y	Y	Y	Y	
4	Europe	Flash flood	Italy	2022	Yes	Watch	N	Y	N	N	
5	S. America	Flash flood	Brazil	2022	Yes	Watch	Y	N	Y	N	
6	Australia		Australia	2022	Yes	Warning	Y	Y	Y	N	
7	N. America	Atm. River	United States	2022-2023	Yes	Warning	Y	Y	Y	N	
8	South Asia	Monsoon flash floods	Bangladesh	2022	Yes	Warning	Y	Y	Y	Y	
9	Southeast Asia	Tropical storm	Philippines	2022	Yes	Warning	Y	Y	Y	Y	

Pakistan

MoM detected	Number instances	Percentage
FALSE	38	39%
TRUE	60	61%
Total	**98**	**100%**

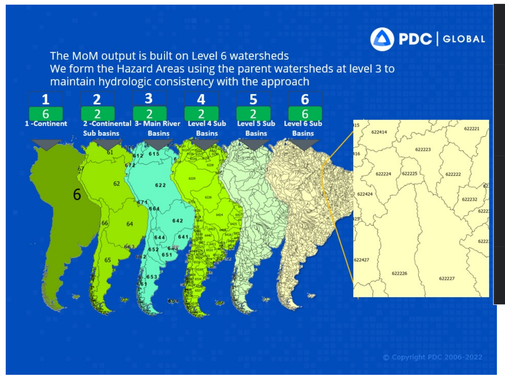
Chad

MoM detected	Number instances	Percentage
FALSE	9	11%
TRUE	71	89%
Total	**80**	**100%**

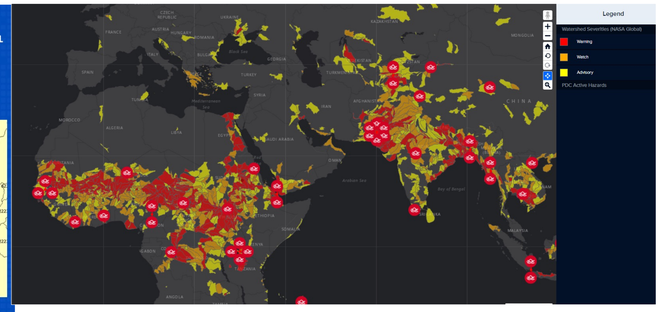
- MoM output accuracy was evaluated for selected flood events based on (i) global coverage, (ii) diverse flood types, and (iii) high severity.
- Compared with EM-DAT database, International Charter, Copernicus EMS activations and against single model (GFMS).

DisasterAWARE®

DisasterAWARE - a multi-hazard decision support platform used globally by over 7K users. Disaster Alert app has more than 2M users. The platform incorporates flood outputs as flood "incidents," visually depicting potential floods that will impact population and critical infrastructures. Flood risk based trigger is used to categorize MoM outputs as "hazards" and to disseminate flood risk and response products as part of alerts to stakeholders.



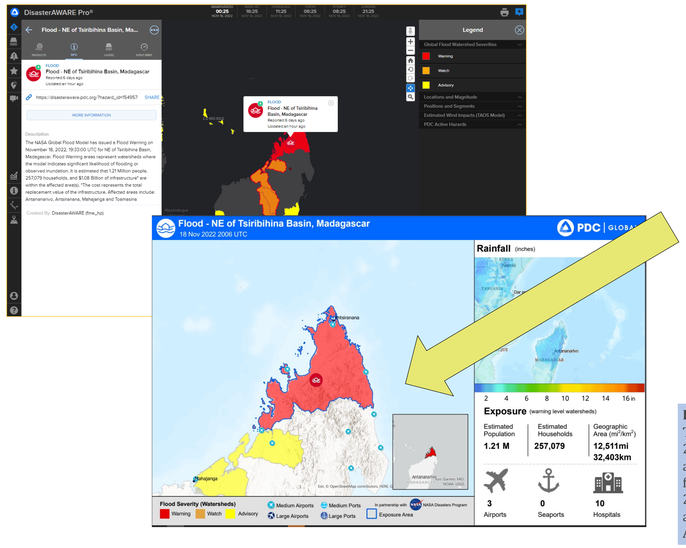
All watershed are assigned flood risk by the model (Warning, Watch, Advisory, Information) from a combination of probability risk scores and any observed flood information from MODIS and VIIRS Flood extent is the combined watersheds that form the incident while exposure is the highest severity watersheds only.



Global Flood Layers

- **Watershed Severity:** Visualized output from the Model of Models with color representation of the assigned severity.
- **Flood Incident:** Shape of the hazard extent, formed by aggregating watershed. Used for Smart Alert™ notification.
- **Exposure:** Formed from the "warning" level watersheds associated with the Hazard

Global Flood Situational Awareness



Key Elements

Derived whole or in part from remote sensing data:

Severity: A Flood hazard's severity is the flood risk score derived using MoM algorithm.

Exposure: Formed from the aggregated watershed cluster identified by the MoM.

Description: Formed from the data of the incident and its intersection with other reference datasets such as populated areas and infrastructures.

This example shows potentially a million people affected based on population density of the affected areas.

DESCRIPTION
The NASA Global Flood Model has issued a Flood Warning on November 18, 2022, 19:33:00 UTC for NE of Tsiribihina Basin, Madagascar. Flood Warning areas represent watersheds where the model indicates significant likelihood of flooding or observed inundation. It is estimated that 1.21 Million people, 257,079 households, and $1.08 Billion of infrastructure* are within the affected area(s). *The cost represents the total replacement value of the infrastructure. Affected areas include: Antananarivo, Antsiranana, Mahajanga and Toamasina

Future Research Directions

- Estimate infrastructure impacts based on flood risk for emergency response.
- Develop data driven AI models to forecast flood risk and identify high risk basins for resilience and justice efforts.

SCAN ME

For more information, contact Margaret Glasscoe: mtg0014@uah.edu. This work was funded by the NASA Applied Sciences Disasters Program. For more information on DisasterAWARE®, visit: https://www.pdc.org/disasteraware Please visit the GIFFT project website: https://gifft.org