Modeling Compound Flooding in Data-Scarce Regions
A Case Study of Madagascar



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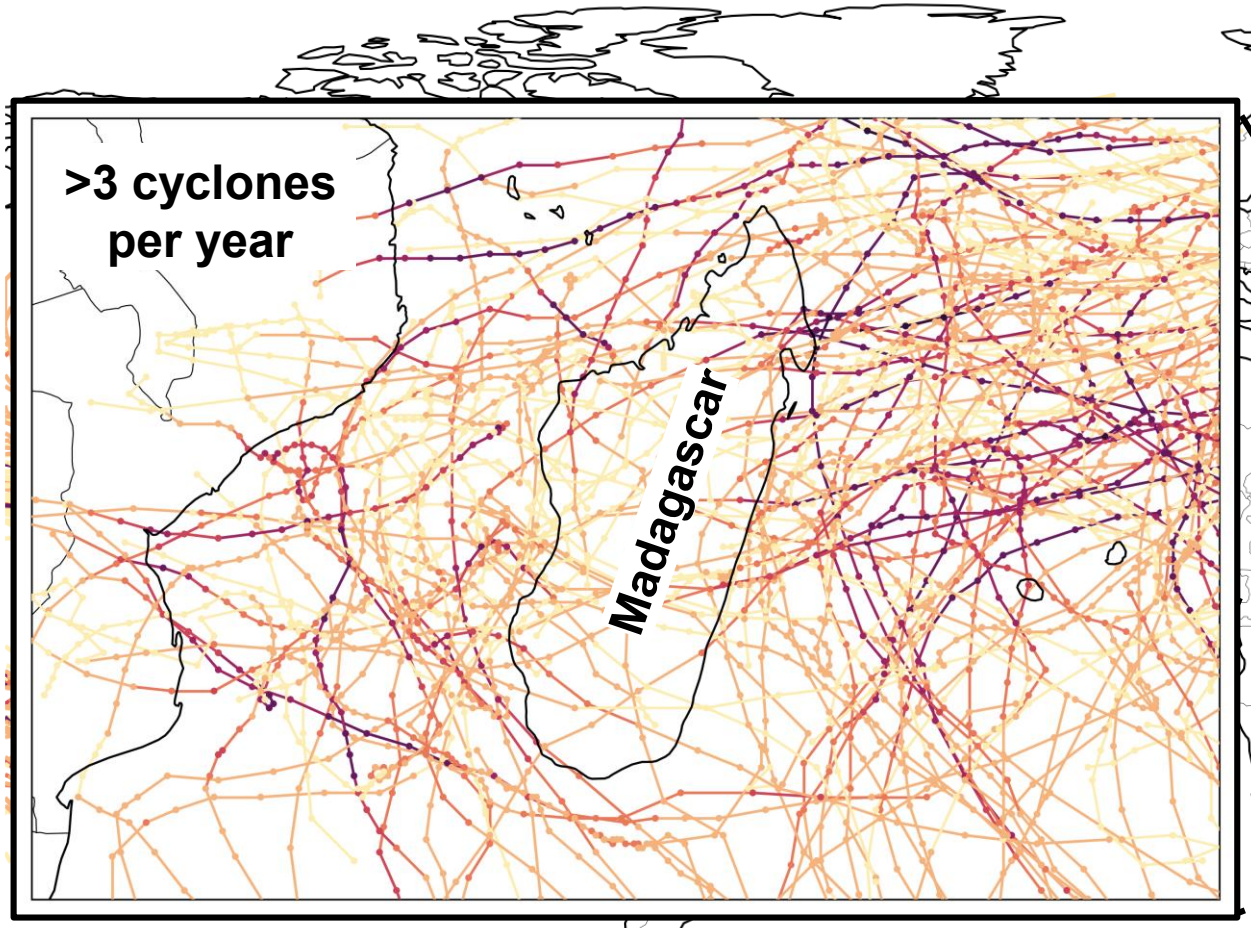
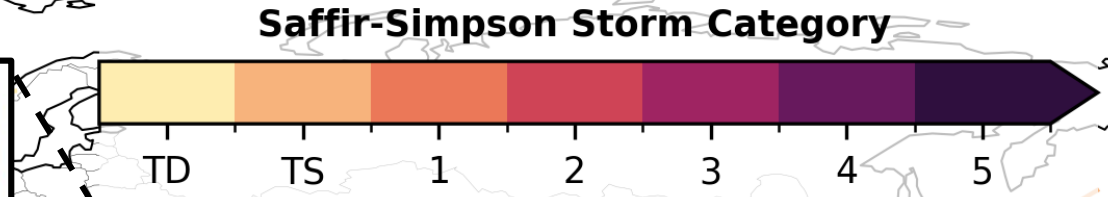
Madagascar in the compound flooding context





Madagascar

32 Million Inhabitants

Highly exposed, extremely poor and vulnerable
(188th per capita GDP)

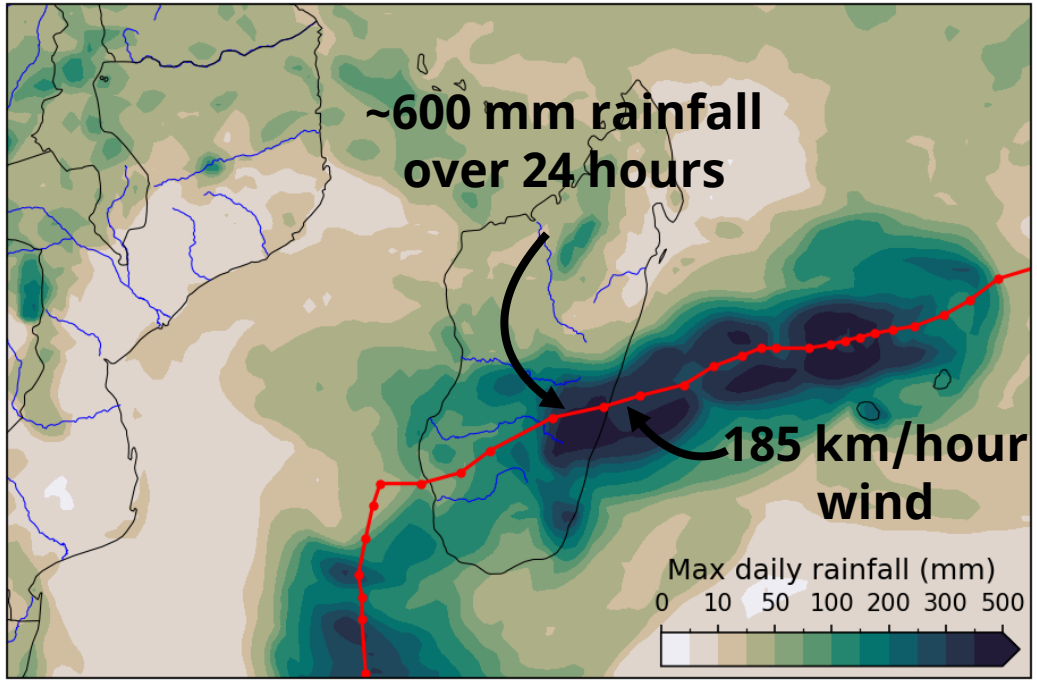
~5000 Km long coastline
Diverse geographic, hydrologic and oceanographic features

Virtually no scientific papers on cyclonic flooding!

Madagascar is a **priority** zone for **Compound Flood** research

Modeling the flooding from Cyclone Batsirai in Mananjary, Madagascar

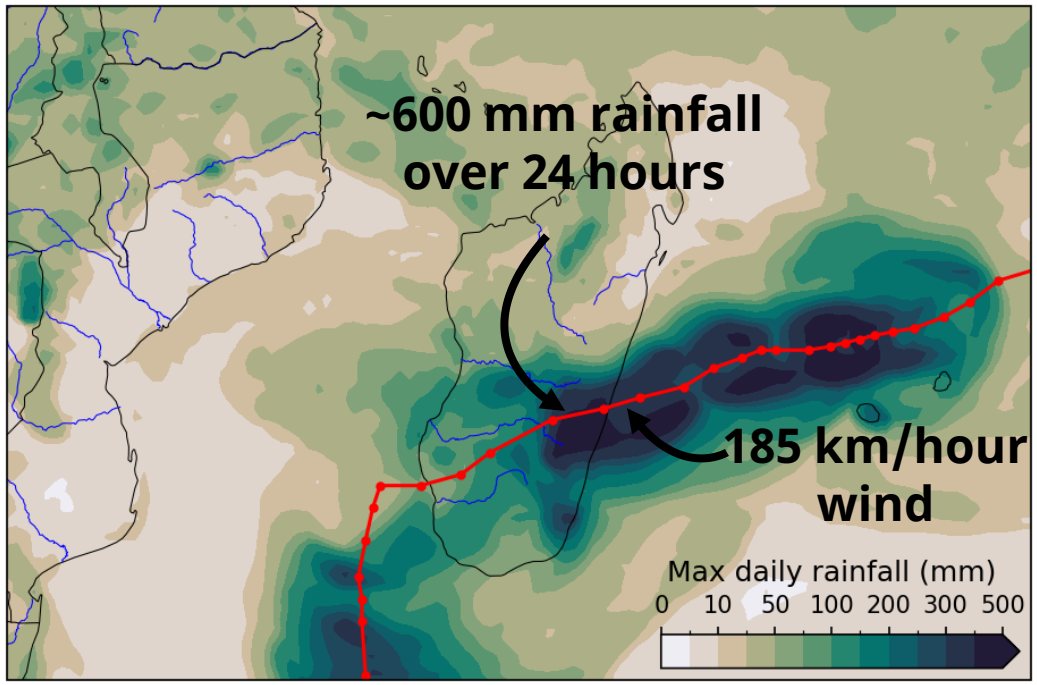
Track of Cat-4 cyclone Batsirai (2022)



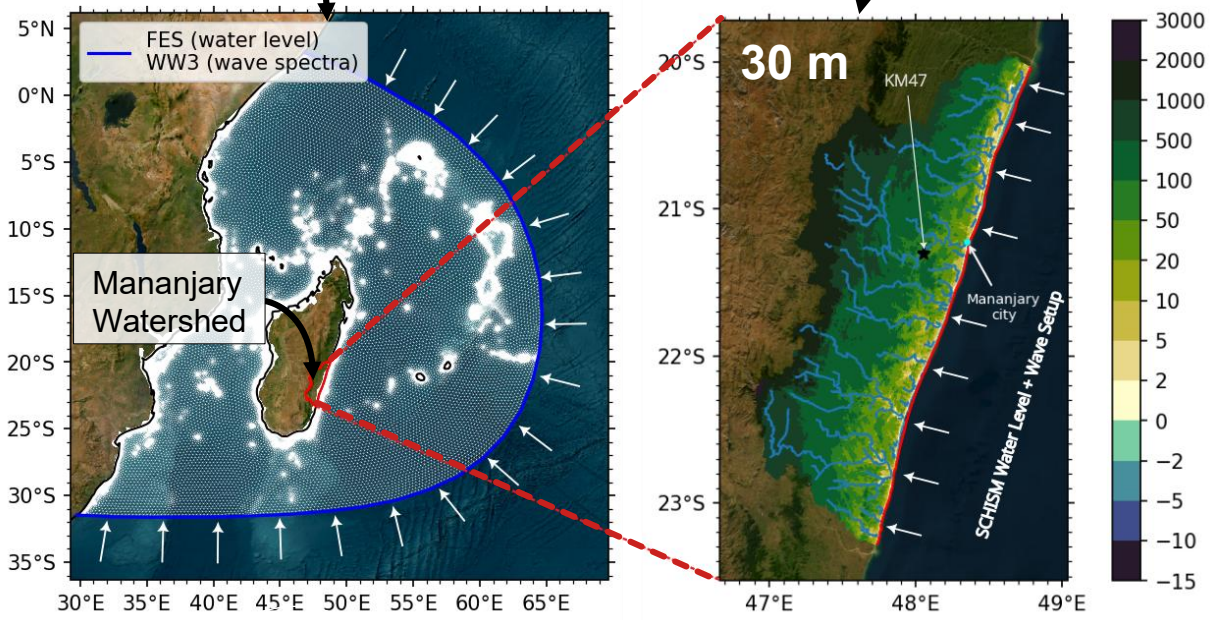
Modeling the flooding from Cyclone Batsirai in Mananjary, Madagascar

Based on the developments in Bengal delta
Khan et al. 2019, 2020, 2021

Track of Cat-4 cyclone Batsirai (2022)



Remote sensing derived topography



SCHISM-WWM

Coupled
Tide-surge-wave
Ocean model

Coupling

SFINCS

Reduced-physics
hydrology-enabled
Inland model

Successful coupled **compound flood** model in a **data-poor** region relying on **spaceborne remote sensing**

Satellite observation based validation

Tide	: Satellite Altimetry (Xtrack, pyaltide)
River water level	: Satellite Altimetry (Hydroweb)
Water bodies	: Satellite imagery (Pekel et al. 2015)
Flood extent	**: Satellite imagery (EMS 2022)**

Pre-event image : **2021-08-07 06:56 UTC** (WorldView-1)

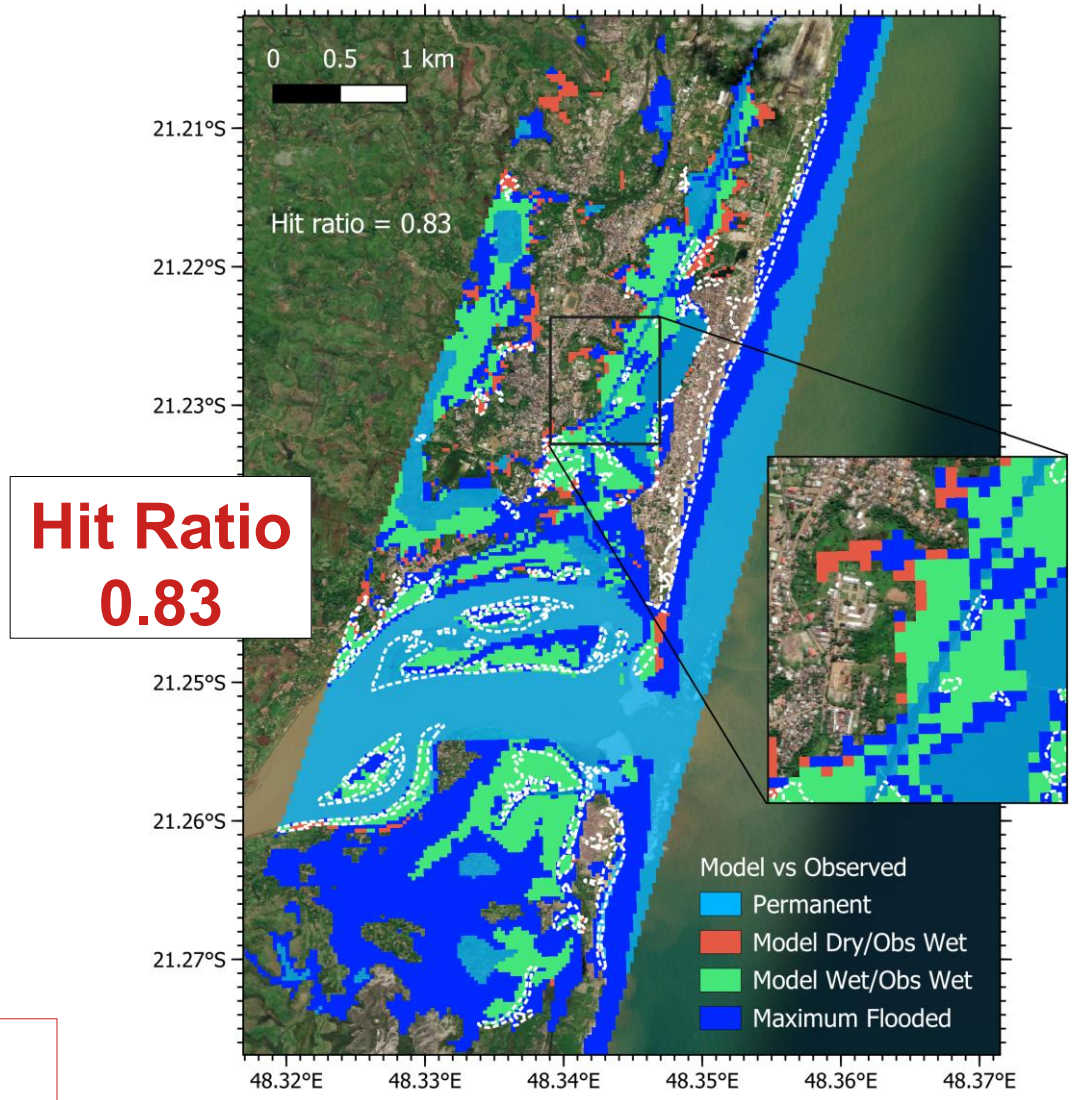
Post-event image : **2022-02-07 07:20 UTC** (WorldView-2)

1.5 days after the landfall

Maximum flooded extent: (**28/01/2022 to 11/02/2022**)

Remote sensing can be a great source of validation!

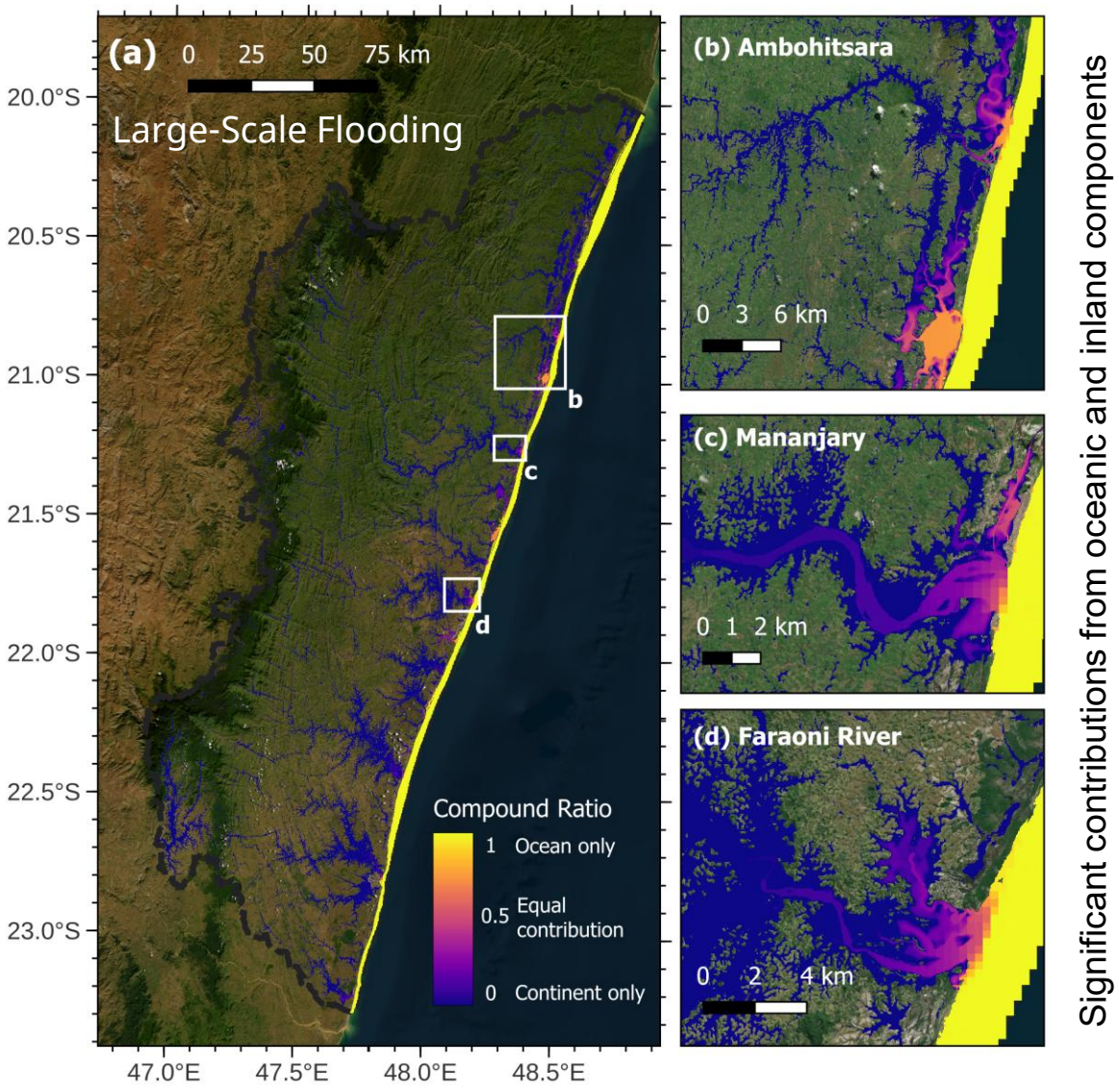
Worldview 1 – 2 (50 cm) vs Model (30 m)



Hit Ratio 0.83

Compound flooding in Mananjary, Madagascar

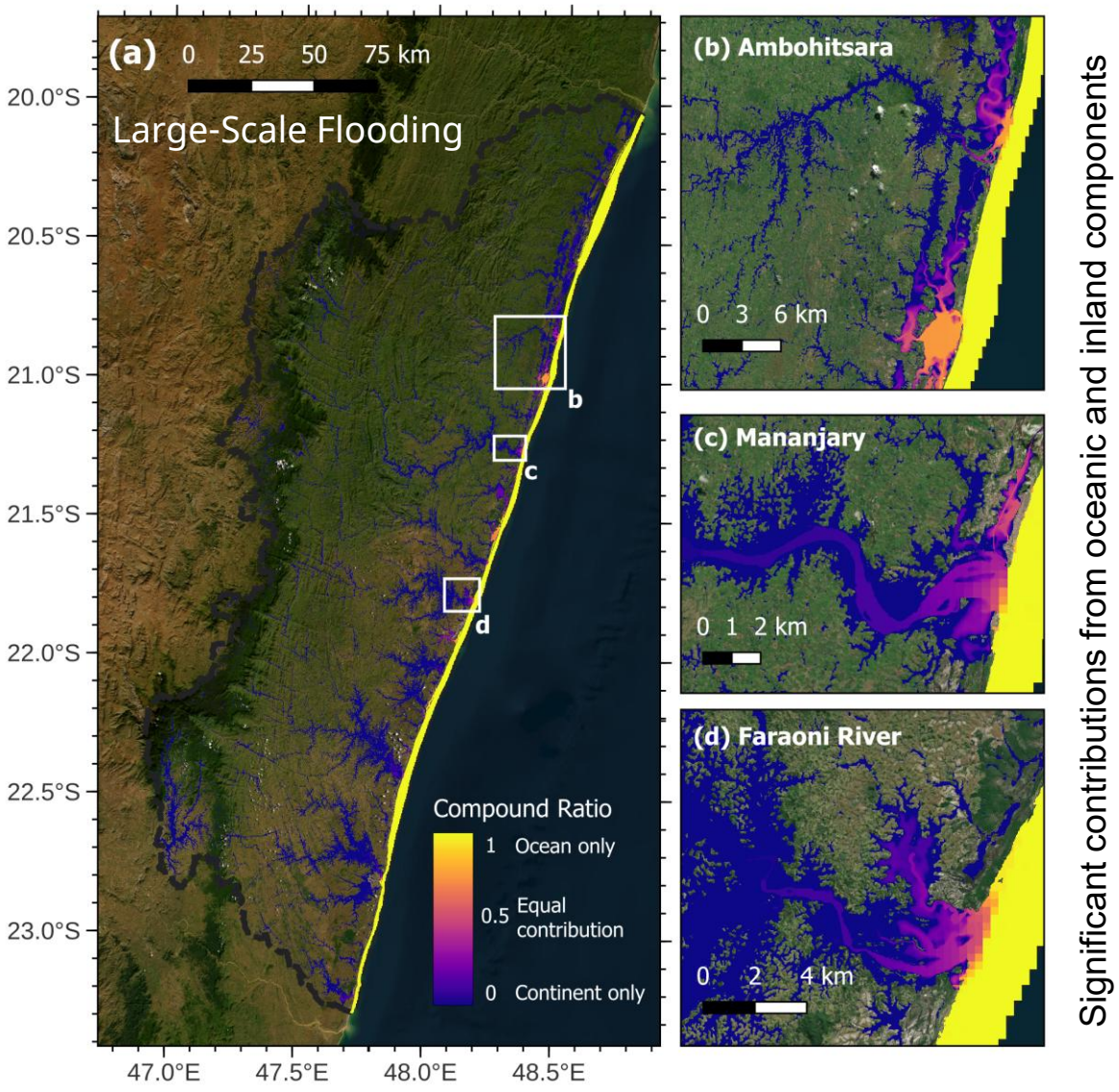
Oceanic and Inland contribution to flooding (Khan et al. 2025)



Significant contributions from oceanic and inland components

Compound flooding in Mananjary, Madagascar

Oceanic and Inland contribution to flooding (Khan et al. 2025)



- **"Are there non-linear interaction?"**
- **"How much did the rainfall-runoff contributed to the surge at the coast?"**
- **"What difficulties you faced with remote sensing bathymetry/topography data?"**
- **"Is ERA5 rainfall good to use or do you need bias correction?"**
- **"What are your next plans?"**

... let's discuss in front of the poster!