Multi-phase model simulation of landslide-channel connectivity during an extreme flood event in the Philippines

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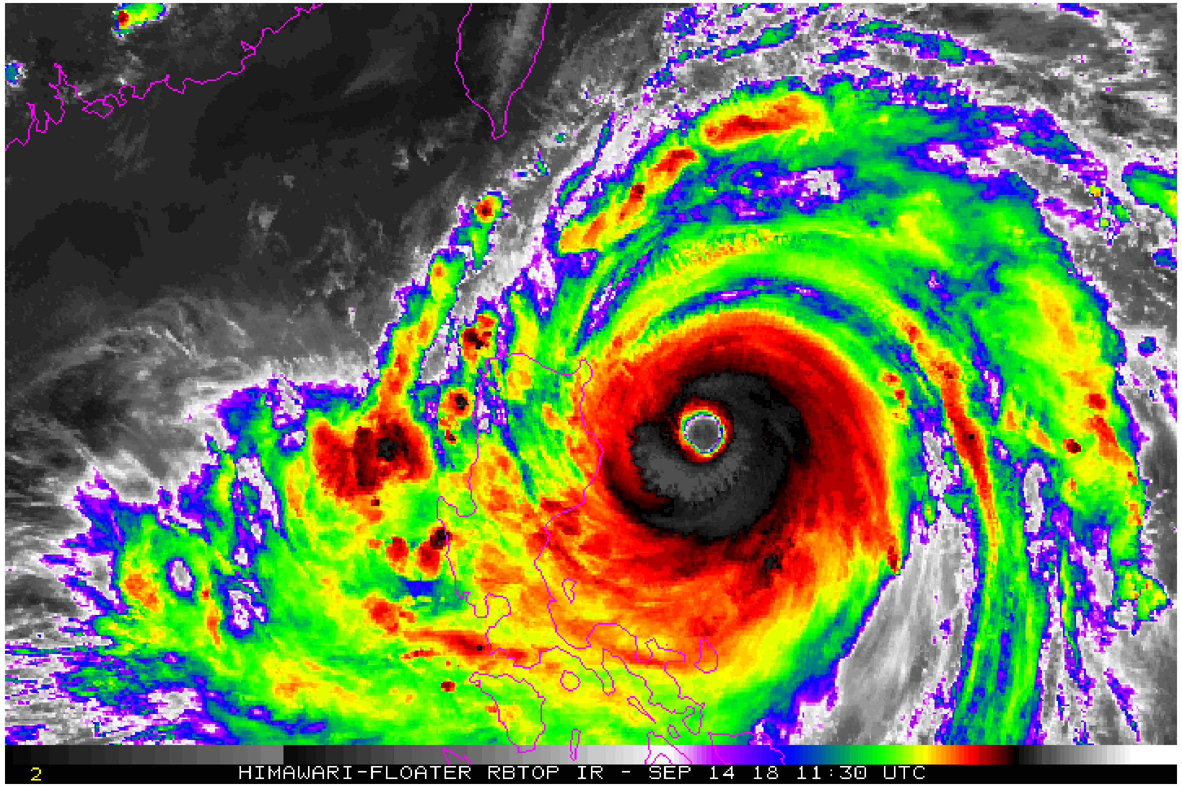
Typhoons in the Philippines

- Philippines one of the most Typhoon-prone country in the world
- Typhoon Mangkhut (aka Ompong) occurred in Sep. 2018
- Caused $627m of damage
- Thousands of landslides were triggered
- >127 fatalities
  - 80 deaths occurred from the collapse of a small mine in Itogon



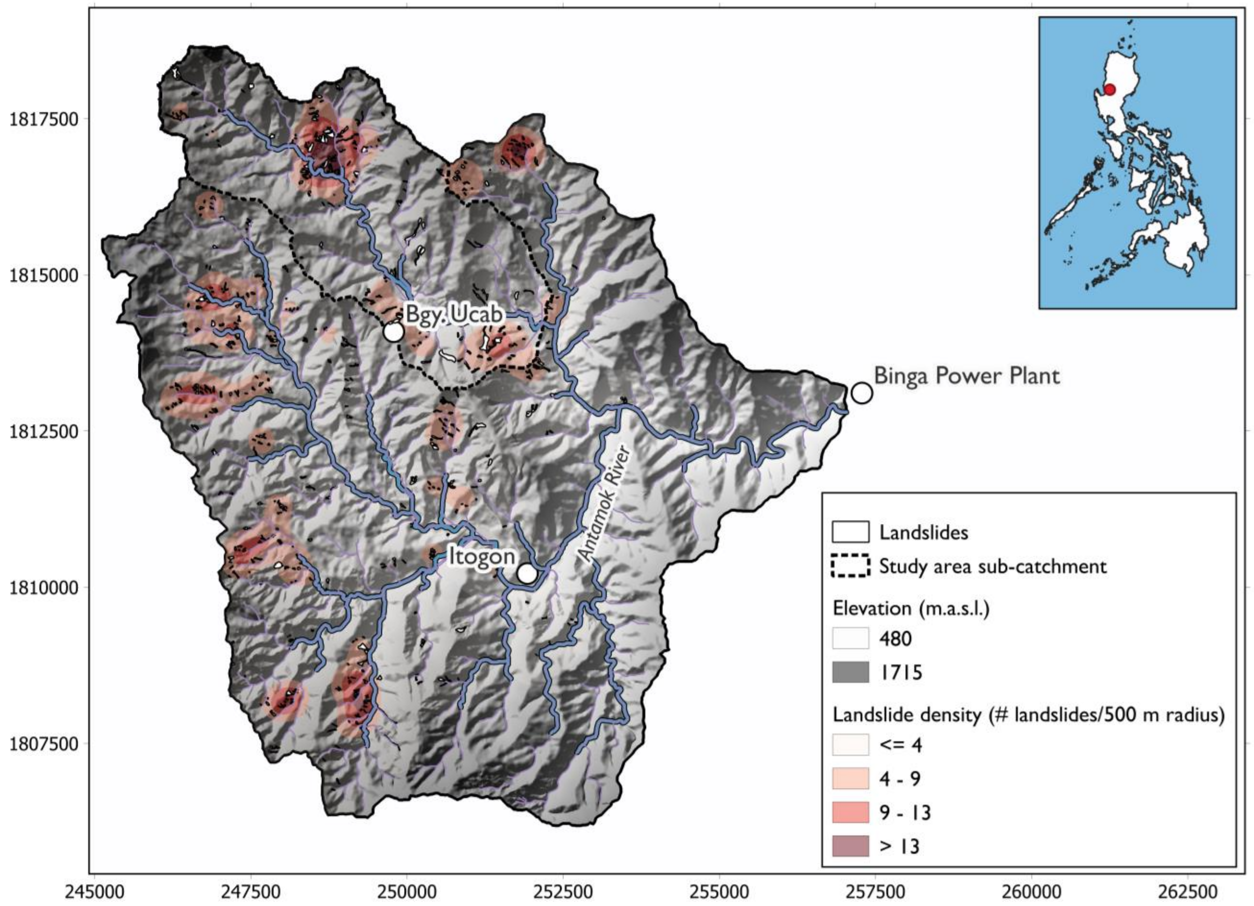
Geomorphic impacts of typhoons

- Typhoons trigger thousand of landslides
- Often landslides interact with channels during flood flows

Geomorphic impacts of typhoons

- Typhoons trigger thousand of landslides
- Often landslides interact with channels during flood flows
- Particular interest in the area of Itogon, Luzon island
  - Swept directly by the Typhoon
  - High density of landslides
  - Mining area
  - Large number of fatalities from landslides
- Focused on catchment of Antamok River

Source: Panici et al. (in preparation)

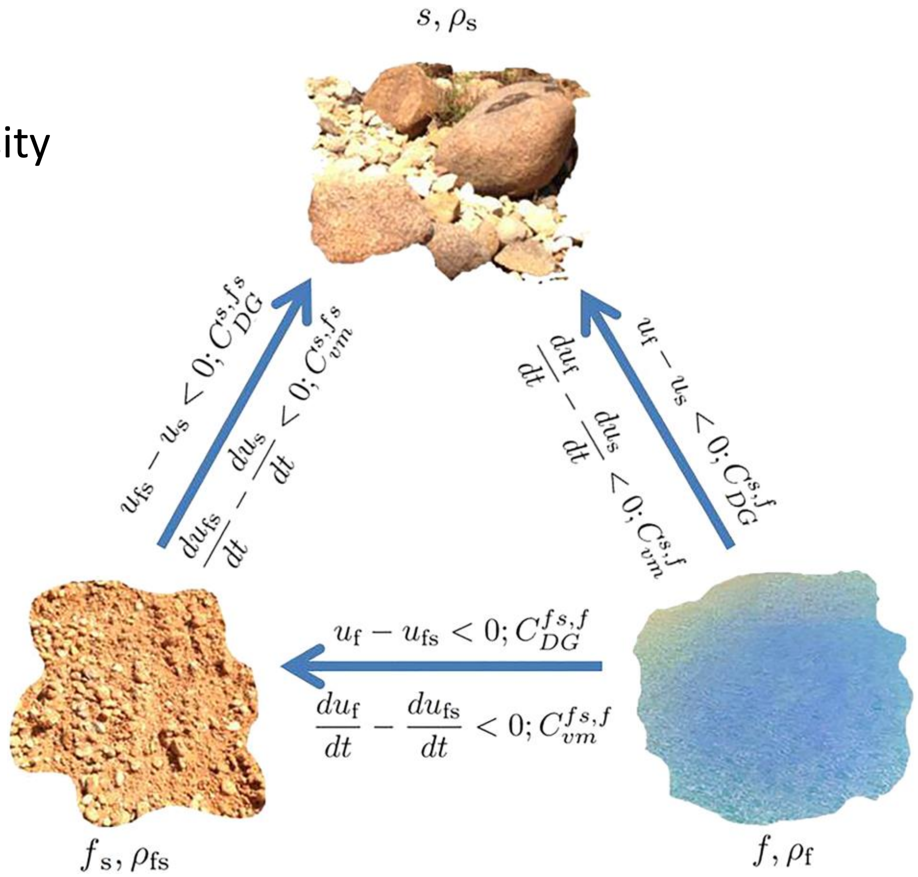


r.avaflow

- We used free software r.avaflow
- Multi-phase model:
  - Solid → Friction dominated
  - Fine-solid → Friction but includes viscosity
  - Liquid

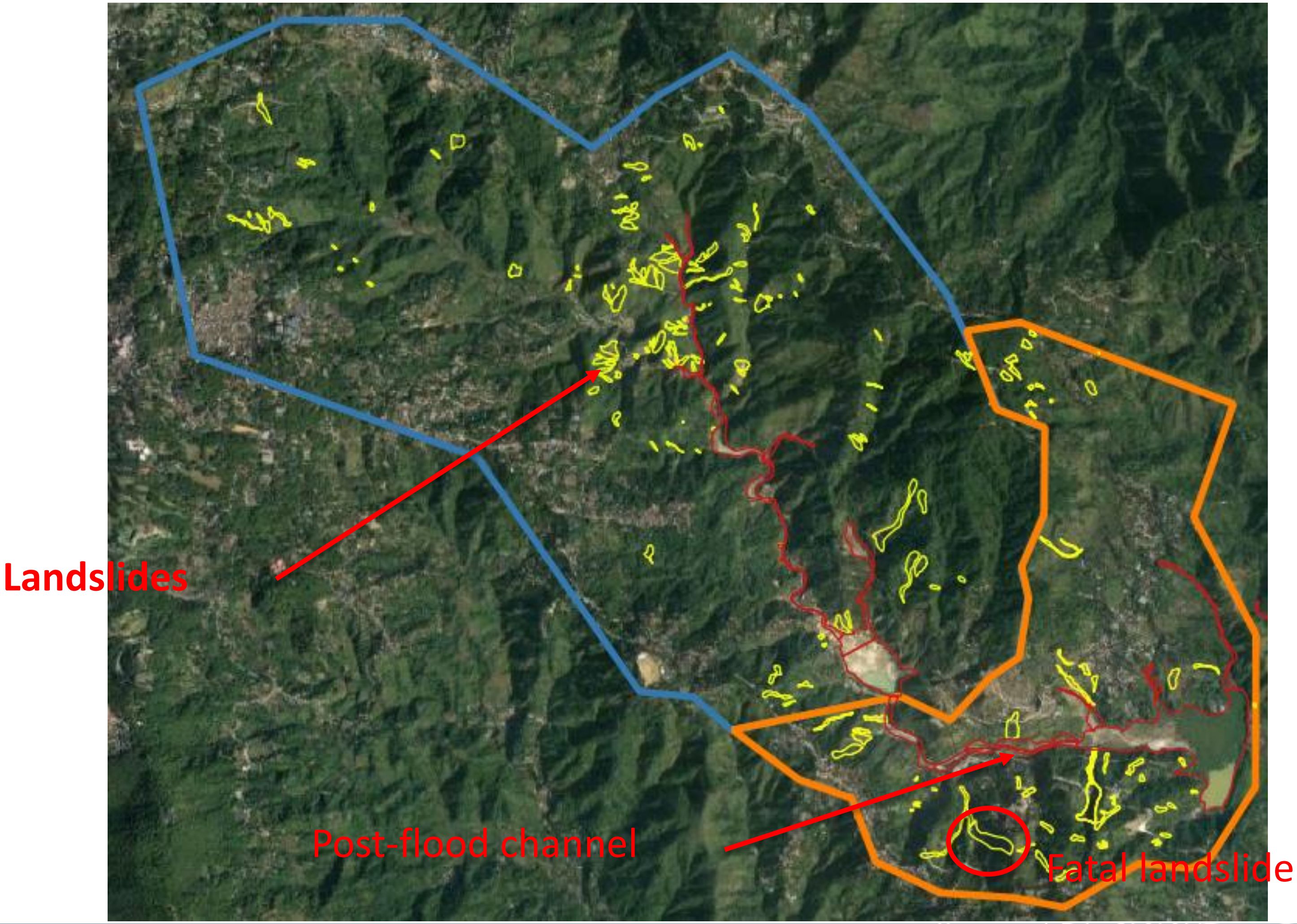
- Based on conservation of energy and momentum internally and between phases
- This occurs mostly by **drag force** exerted on each phase and **virtual mass forces**

Source: Pudasaini and Mergili (2019)



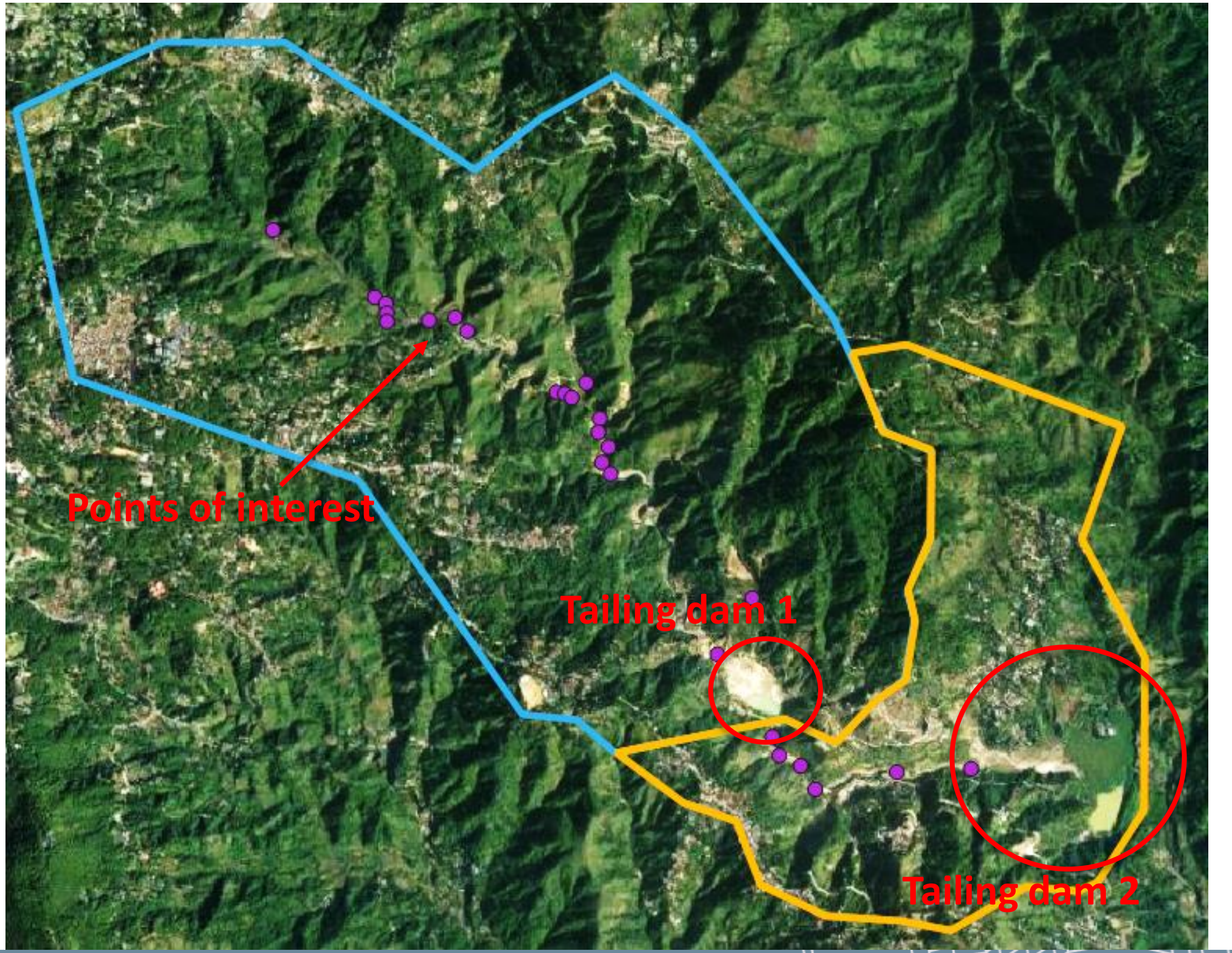
Landslide-channel simulations

- Manually mapped landslides used as sediment input
- Landslide run-outs and channel extents used for entrainment



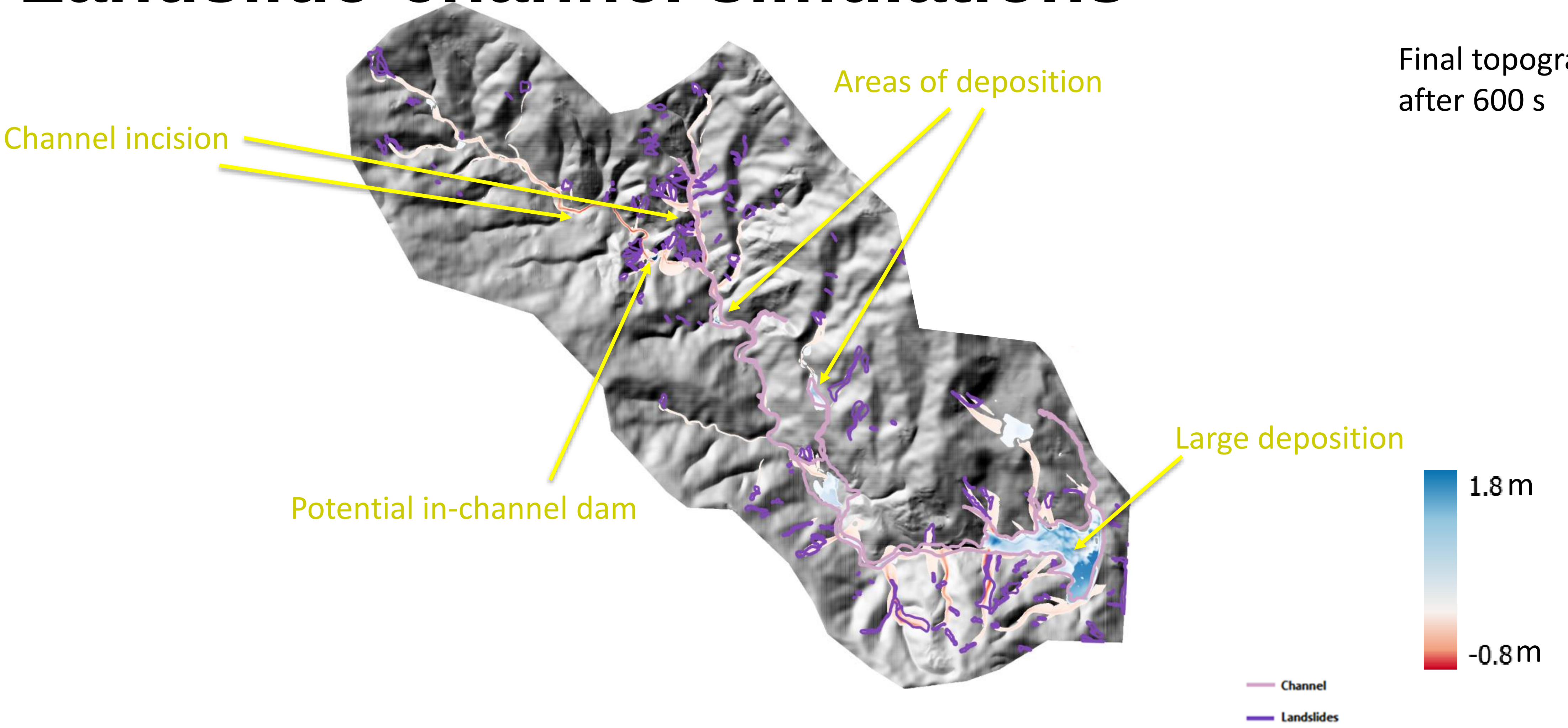
Landslide-channel simulations

- Simulation time was 600 s, assuming all landslides released at the same initial time
- Two separate catchments for simulations, tailing dams splitting the catchment

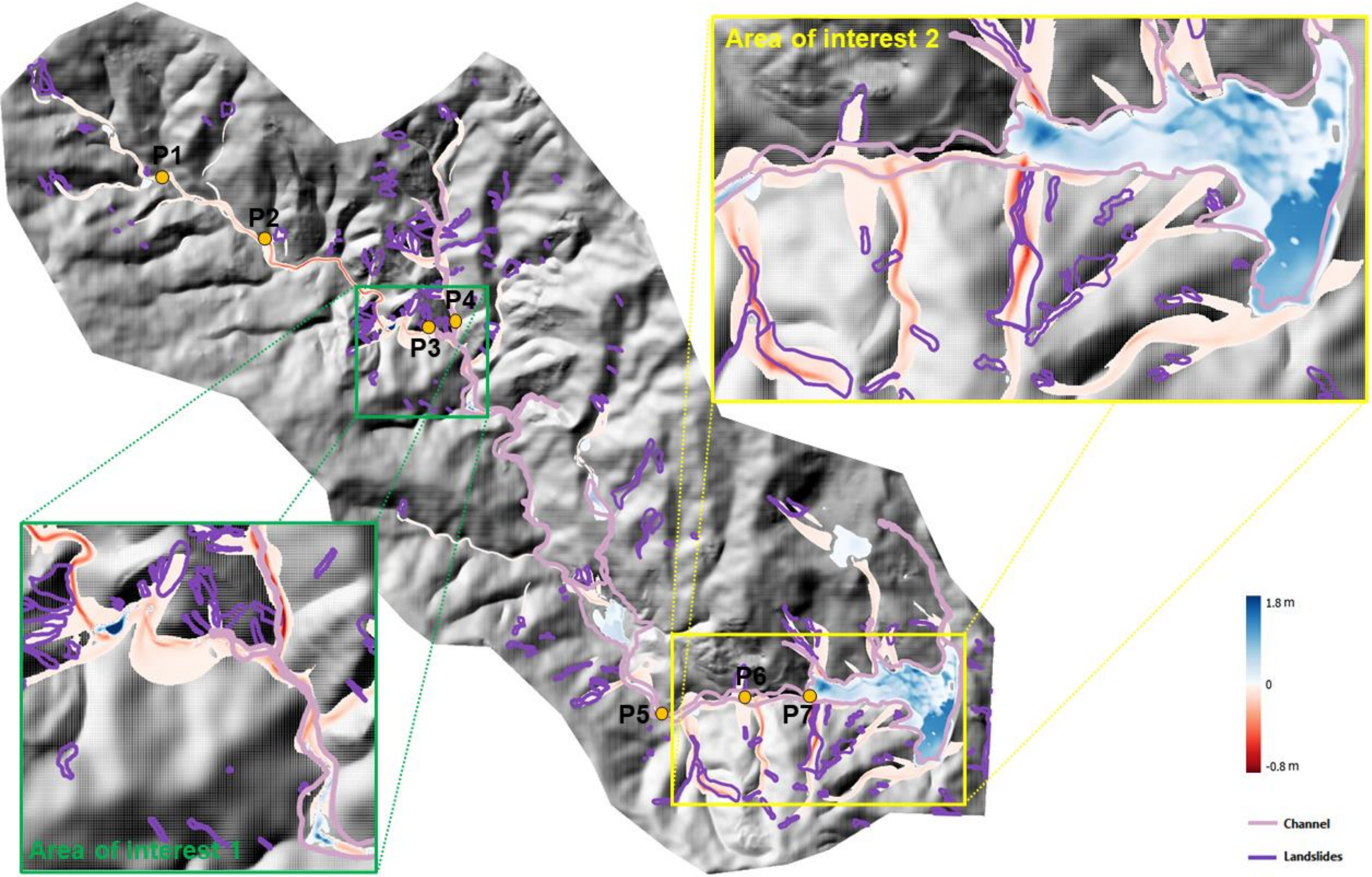


Landslide-channel simulations

Final topography after 600 s



Landslide-channel simulations



Final topography
after 600 s

Source: Panici et al. (in preparation)

Conclusions

- Landslide-channel interactions are complex, sometimes hard to predict with simplified approaches
- Multi-phase models showed to be good at predicting these interactions, as simulated channel widening is broadly comparable to satellite observations
- Some features (e.g. in-stream ephemeral sediment dam) were modelled and potentially never observed
- Tailing dams had crucial influence on sediment transport and river geomorphology, especially trapping large quantity of sediment

Thank you!

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