ETH zürich

The worldwide hydropower potential of periglacial environments

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SCCER-SoE annual conference – Horw

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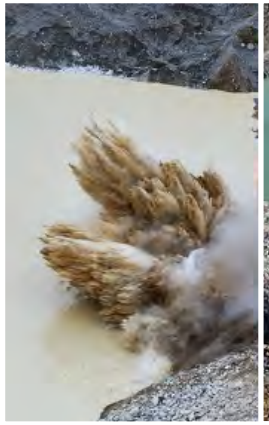
Glacier change: local effects

New landscapes

New glacier lakes

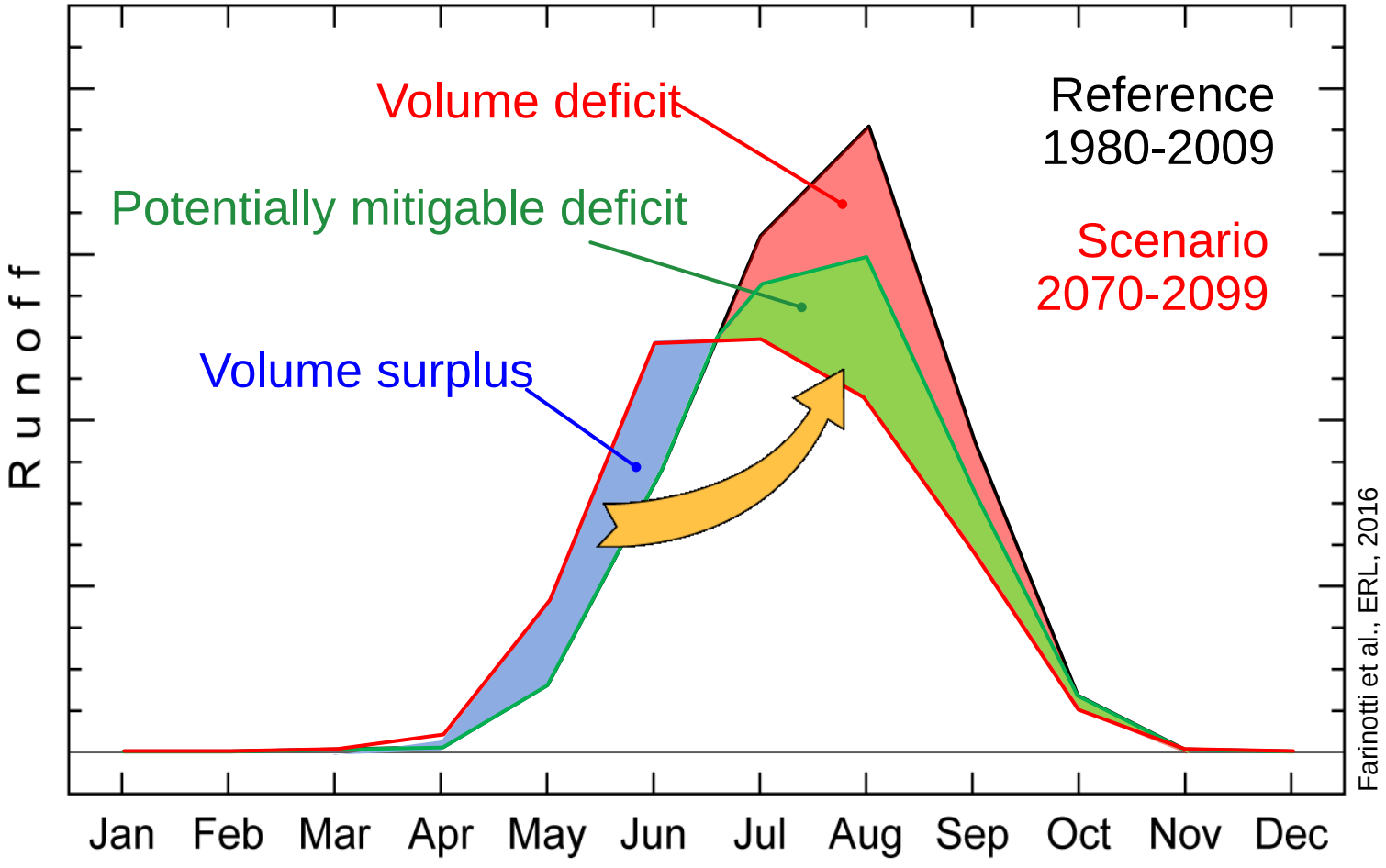
Hazards? Tourism? **Hydropower?**



Images © Glaciers online

Glacier change: downstream effects

Changes to seasonal runoff regime



Farinotti et al., ERL, 2016

Idea: Use **artificial storage reservoirs** in place of glaciers to mitigate seasonal deficit?

➡ **What about the**

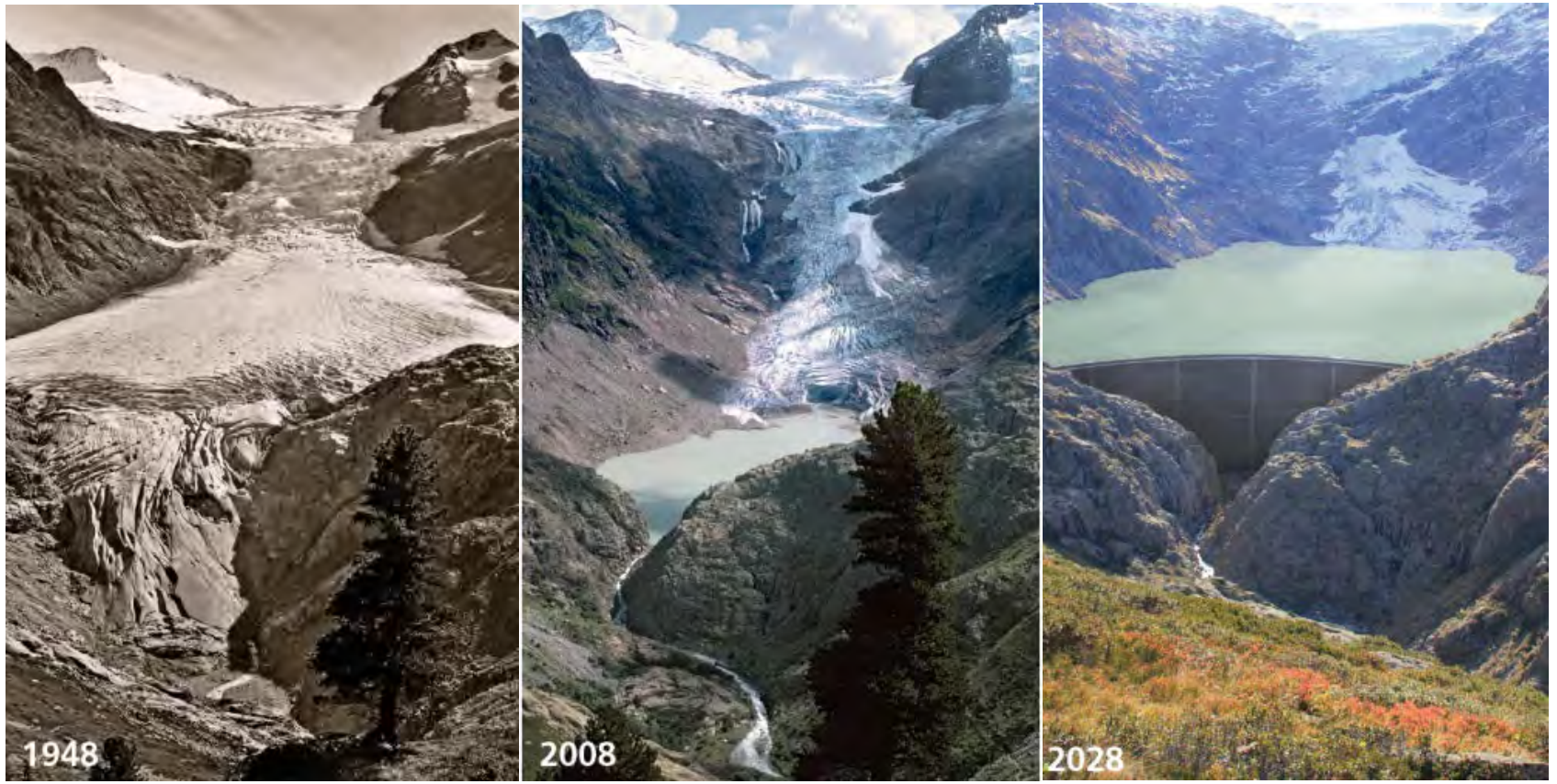
hydropower potential

of such artificial storages?

Dams instead of glaciers?

The idea is not completely new…
and has been implemented in the past.

Triftgletscher, Switzerland



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Goal:

Quantify the theoretical hydropower potential of deglacierizing areas at the global scale.

Theoretical storage volumes

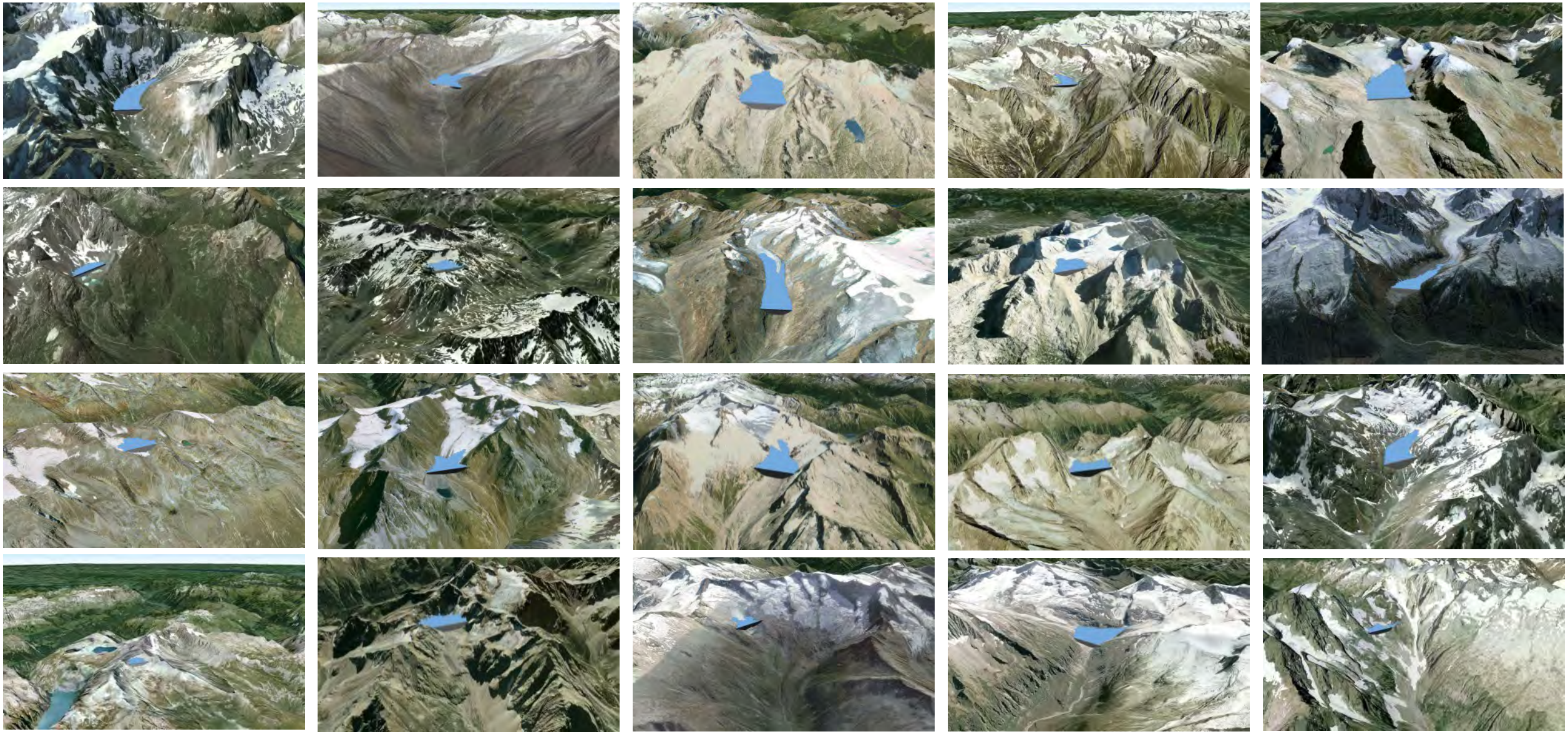
Subglacial topography
(from *Huss & Farinotti, JGR, 2012*)

Place a dam at the current glacier terminus

Reservoir optimization:

- wall angle providing minimum "wall area / lake volume" ratio
- max. 280m high, 800m wide

Theoretical storage volumes

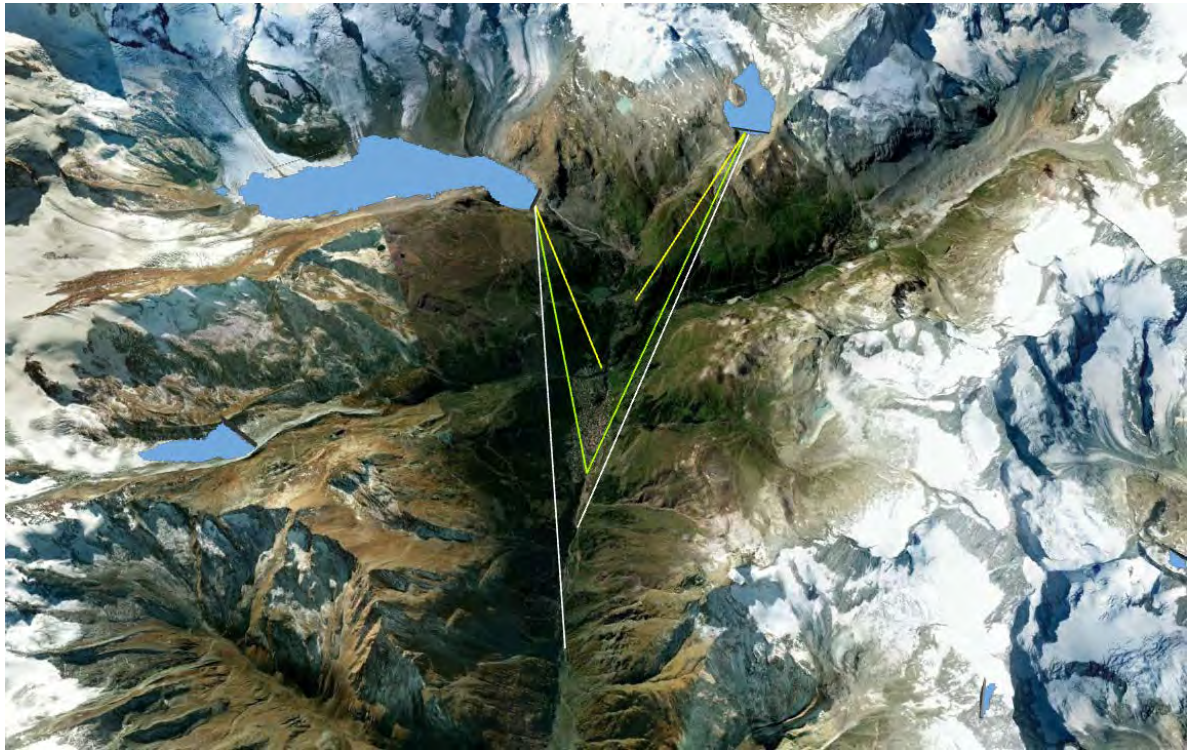


Theoretical hydropower potential

Power = hydraulic head • runoff rate • gravity • density • efficiency

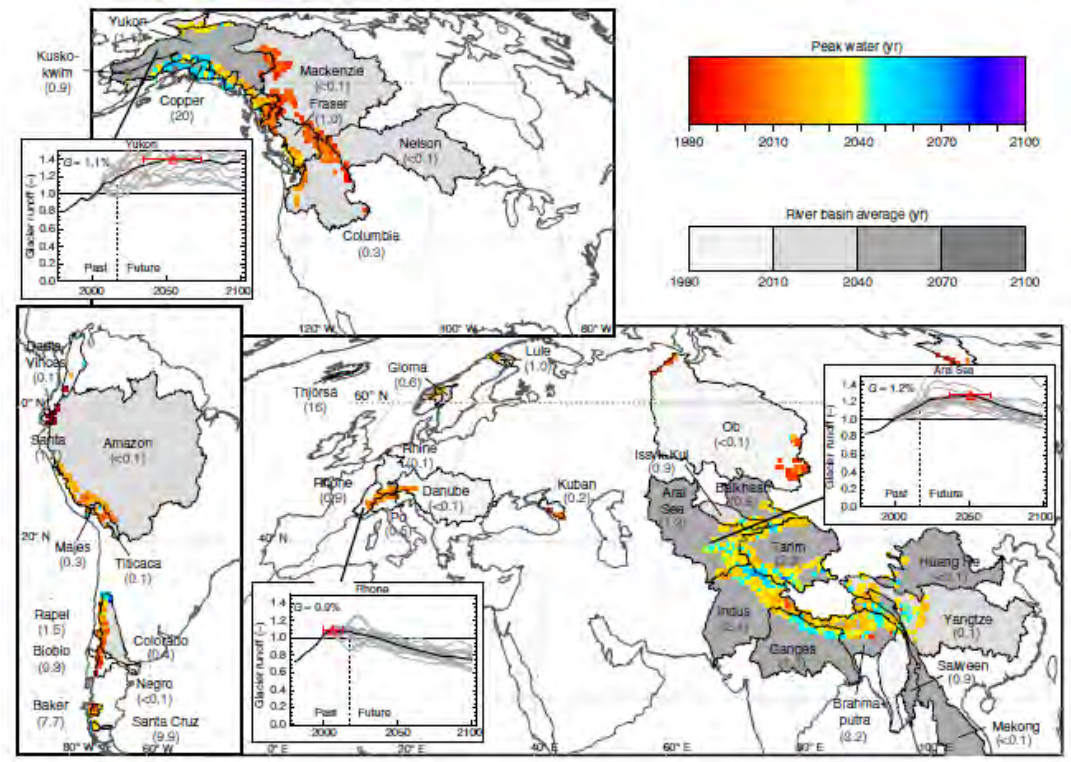
Hydraulic head

Maximum elevation drop from glacier terminus
(use *ASTER global DEM and* impose min slope)



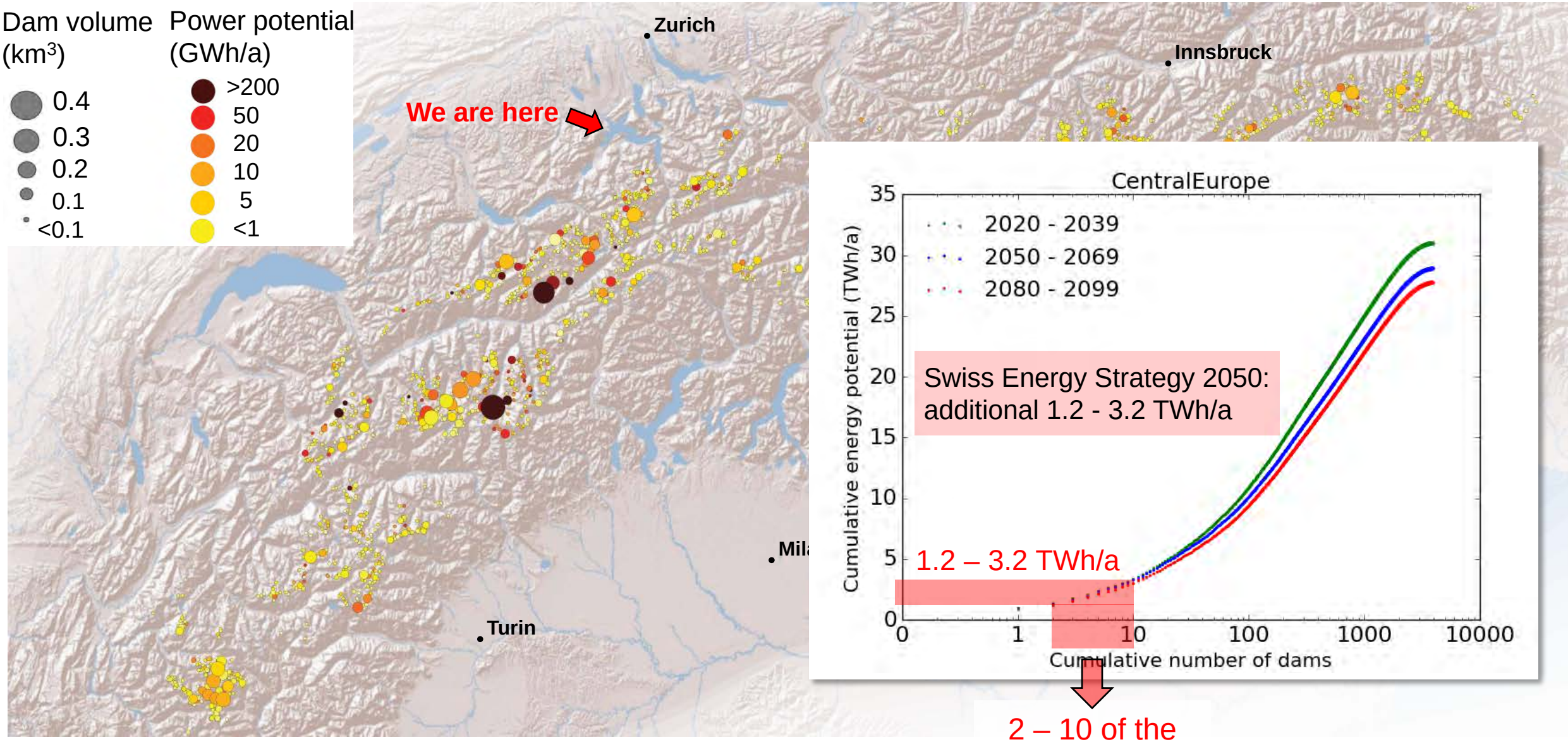
Runoff rate

Glacier runoff projections from the Global Glacier Evolution Model (GloGEM) *(Huss & Hock, FRO, 2015)*



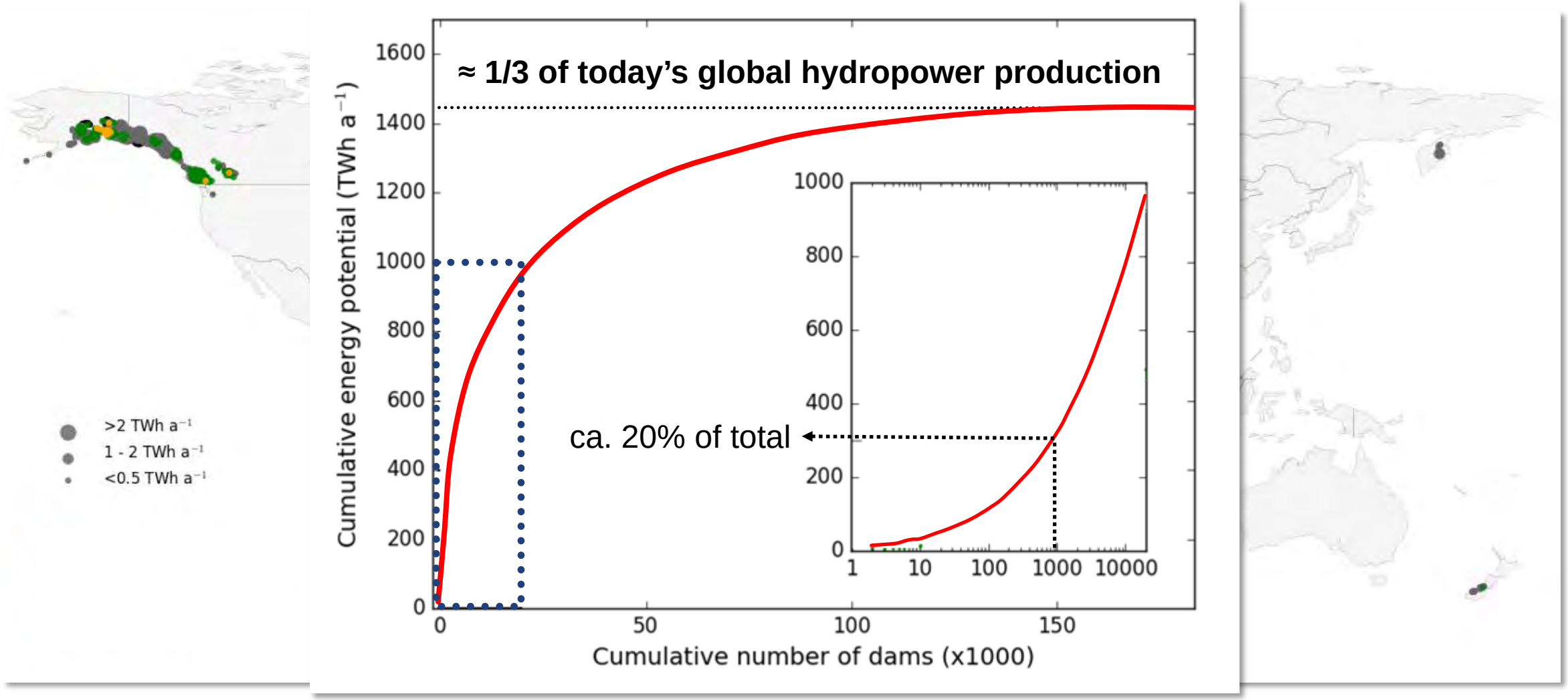
Huss & Hock, NCC, 2018

Results: Theoretical potential



The global-scale picture

Global total potential ≈ 1.4 PWh/a



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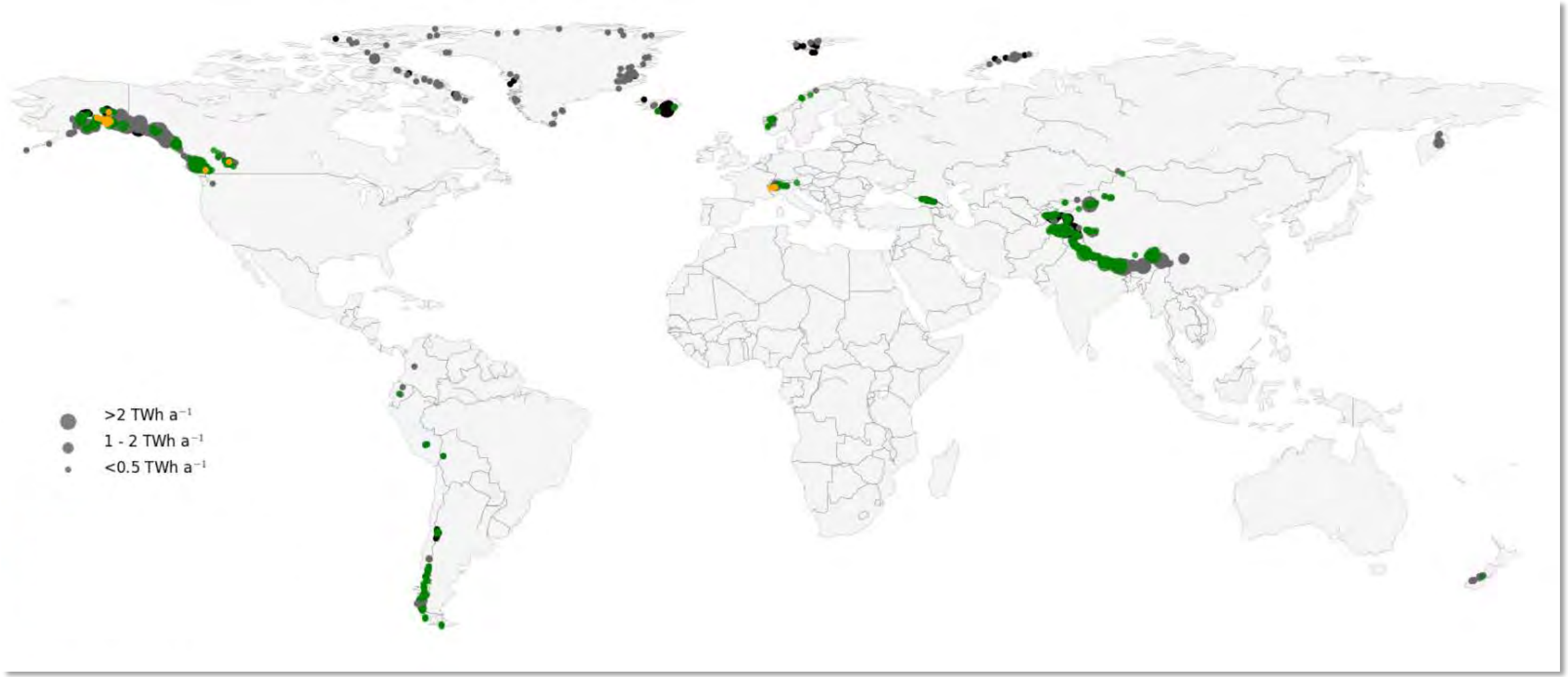


What's about suitability?

Remember: It's about 200,000 sites.

Hydropower Sustainability Assessment Protocol

Technical

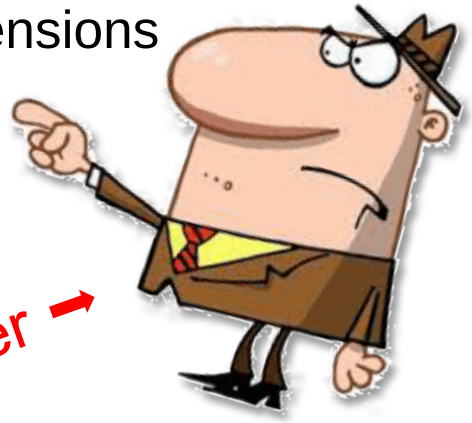
- Reservoir fill time (=volume/runoff)
- Timing of glacier retreat, and surging
- Catchment slope (proxy for gravitational hazards)

Environmental and social indicators

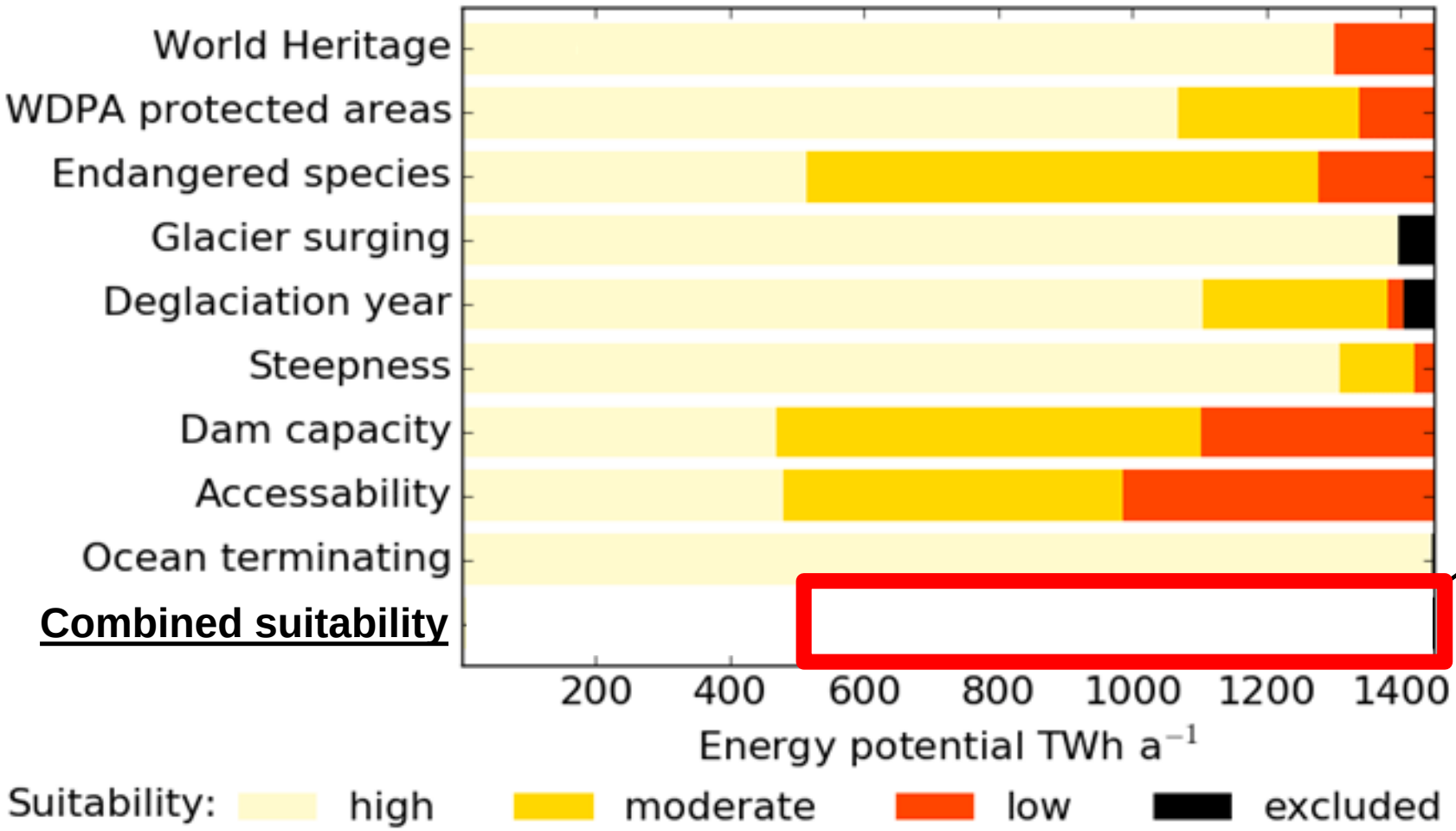
- World Heritage and protected areas
- Density of endangered species
- Global population density (proxy for demand)
- World Bank Development indicators:
  - political effectiveness and capacity
  - power production, usage, accessibility

Economic factors

- Accessibility cost: Global travel time grid
- Construction cost: Dam dimensions
- Costs to benefit ratios



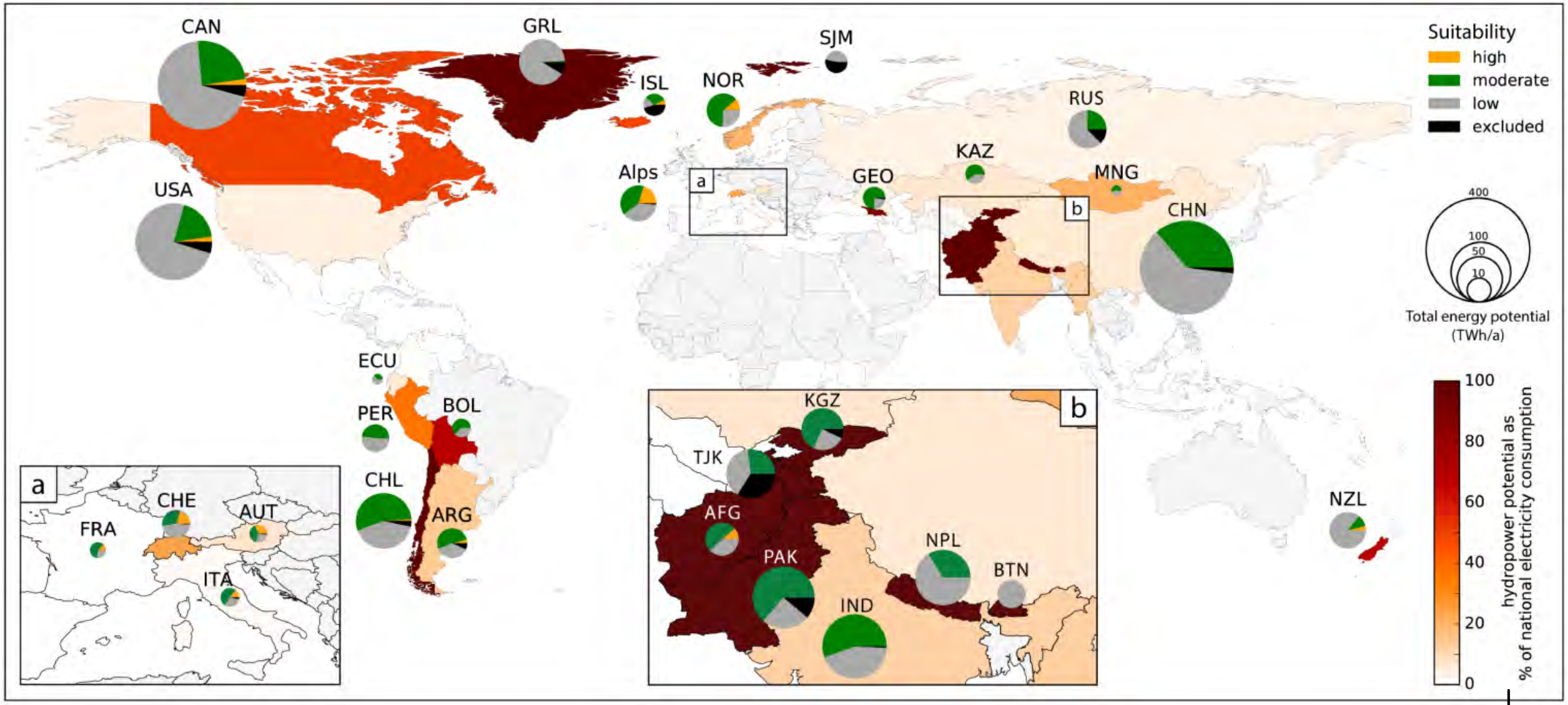
Suitability indicators



~550 TWh/a "left"

Significant realization barriers for ca. 60% of the sites.

Everything combined, and put into context



only high and moderate sites

Conclusions

- We provide the first quantification of the hydropower potential from deglacierizing areas at the global scale (ca. 200,000 potential sites).
- We estimate the potential to be ca. 1.4±0.5 TWh/a, of which about 40% passes a first-order suitability assessment.
- For some Countries, a small number of large dams could have a significant contribution to the national electricity demand.
- We acknowledge that our analysis is not exhaustive, and stress that site-specific analysis is necessary.

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Thank you
for your attention!

Top 10 sites* per country

* by energy potential