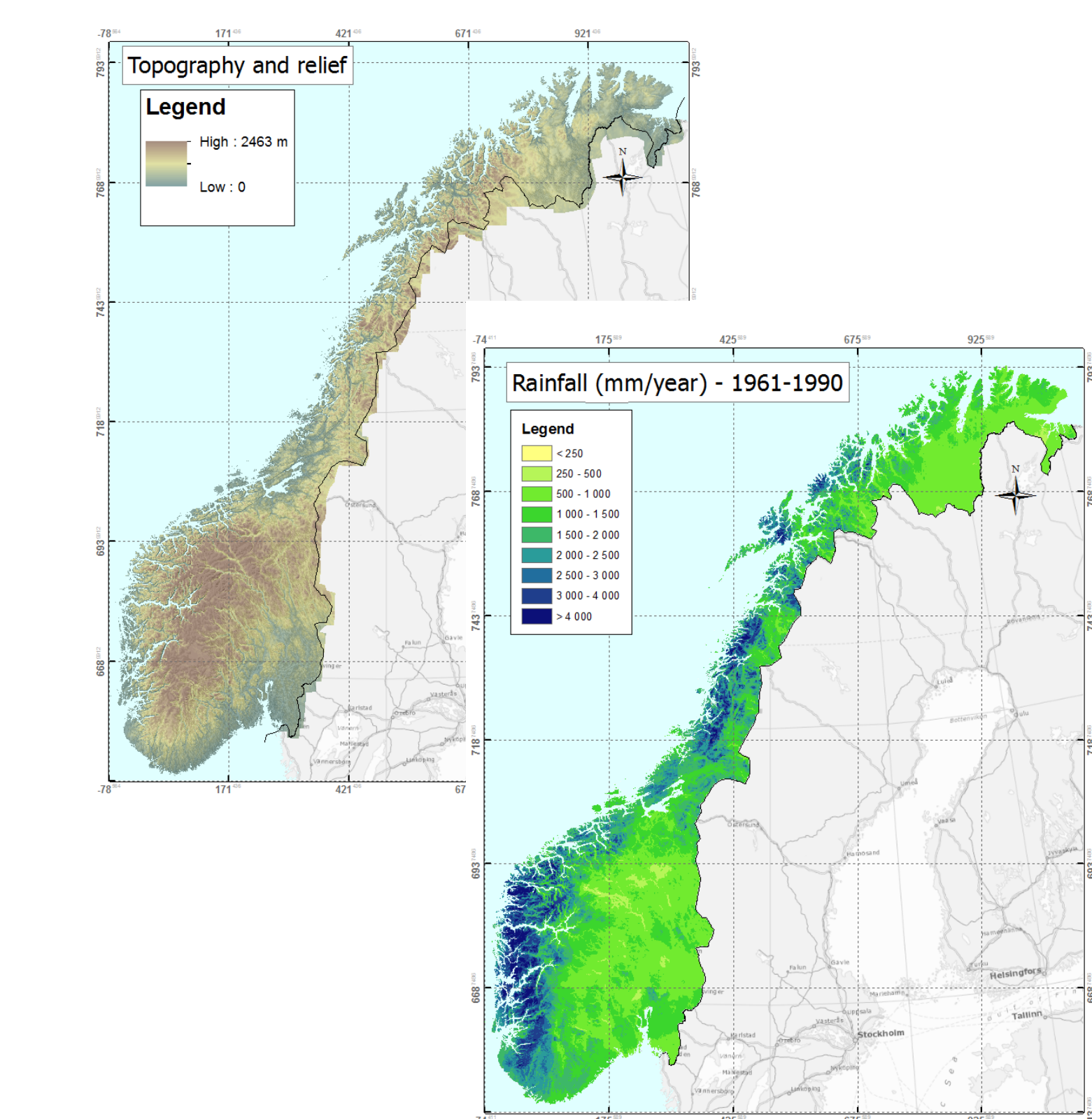


# The Norwegian early warning system for rainfall- and snowmelt-induced landslides

Nationwide regional early warning of debris slide/debris avalanches, debris flow and slushflows in synergy with the flood forecasting service.  
In cooperation with the Norwegian Meteorological Institute, the National Public Road Administration and the National Public Railroad Administration

## Landslide types



## Facts about Norway

- Land area: 324 000 km<sup>2</sup> (+ Svalbard)
- Population: 5.2 million; Density: 13 km<sup>2</sup>
- 490 000 km rivers and streams (250 000 lakes)
- Precipitation: 200 – 5 000 mm/year, ~ 1/3 as snow
- Topography: Mountains up to 2 500 m a.s.l

**Climatic contrasts:** The North Atlantic Current brings moist and relatively mild air to the west coast which gives a wet climate due to the orographic effect of the mountains. The inland experiences a more dry continental climate with cold winters and warm summers.

**Precipitation types:** Frontal, orographic and showery.

**Snow and snow melt:** Frequent mild weather episodes somewhere in the country. The snow pack stores precipitation, which can be released during a potentially short time span. Melt water acts as an important primer for and contributor to landslides during the spring snow melt season.

**Geology:** Vast areas with shallow till deposits on top of a relatively impermeable bed rock, representing the most significant source for landslides in steep terrain. Soil freeze during winter and thawing during spring complicates matters.

## Organization

**2009 - NVE is given the responsibility for coordination a national landslide risk management system**

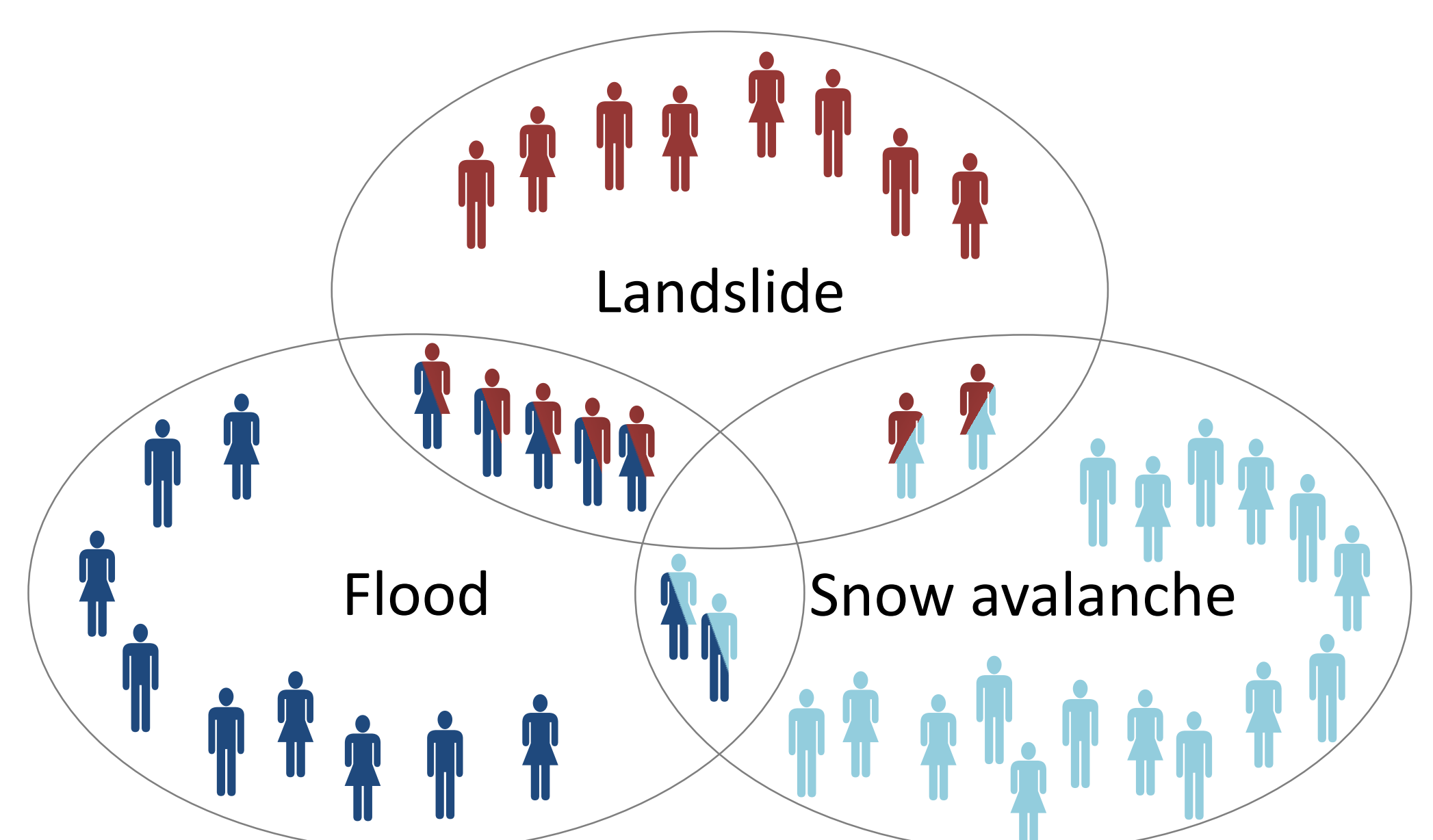
Manage the landslide database; Susceptibility and hazard evaluation and mapping; Assist municipality in land use planning and for mitigation measures; Monitoring large unstable slopes; Early warning for snow avalanches and landslides (rock avalanche and debris flows); Assist during landslides emergency; Research and communication of risk

**2011 – A new section for early warning of floods and landslides is established.** Purpose to organize the early warning system for shallow landslides. Test phase of the landslide warning is initiated.

**2013 – The landslide early warning is operational in October.**

**Personel:** Background from hydrology, geology, geophysics, geography and glaciology. Some personal are integrated into more than one of NVEs warning teams (landslide, flood or snow avalanche) to ensure sufficient coverage in longstanding situations, and also gaining cross field knowledge potentially benefitting the EWSS.

**Availability:** 8 am to 9 pm every day of the year, and 24/7 during exceptional weather events.

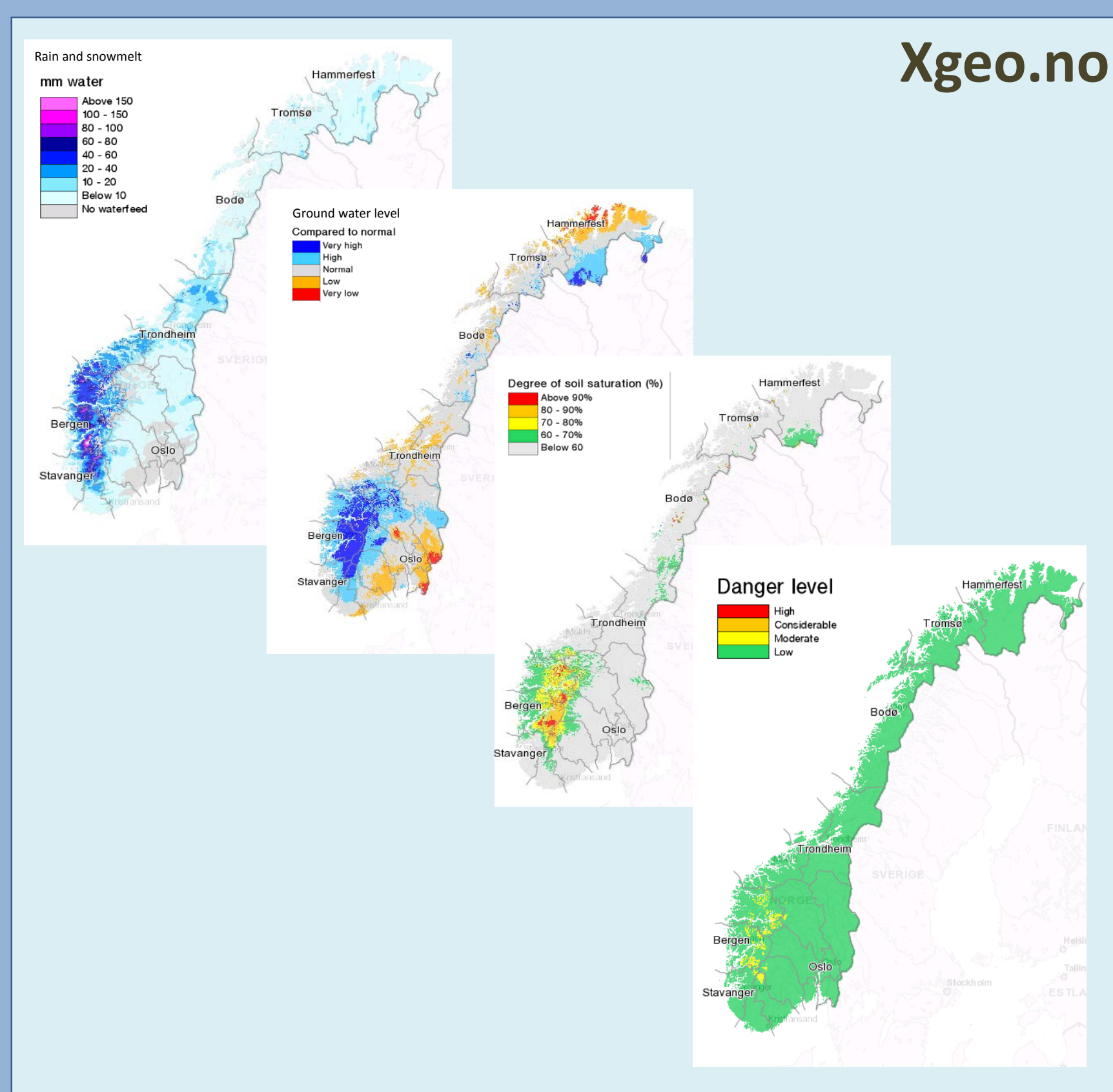
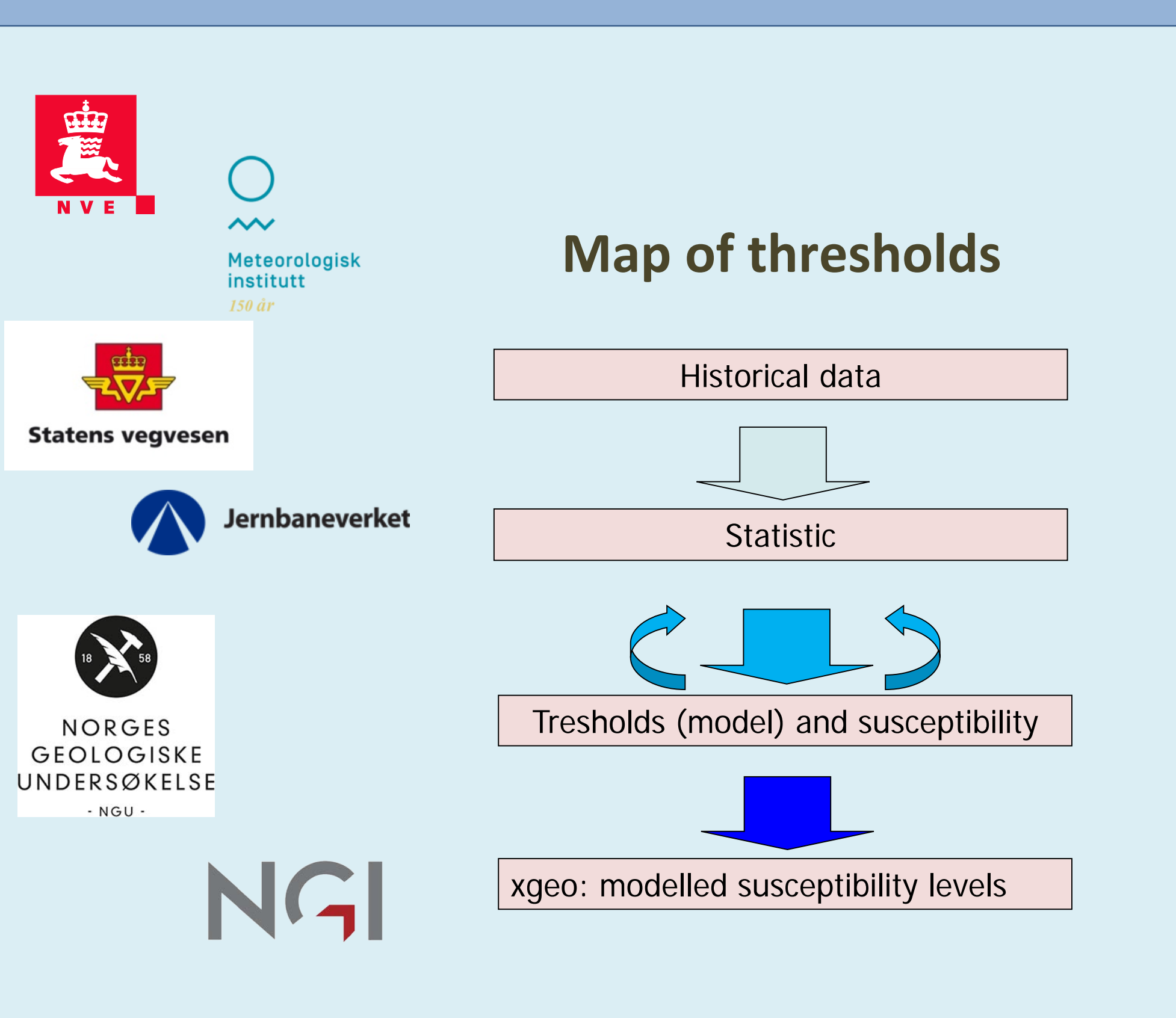
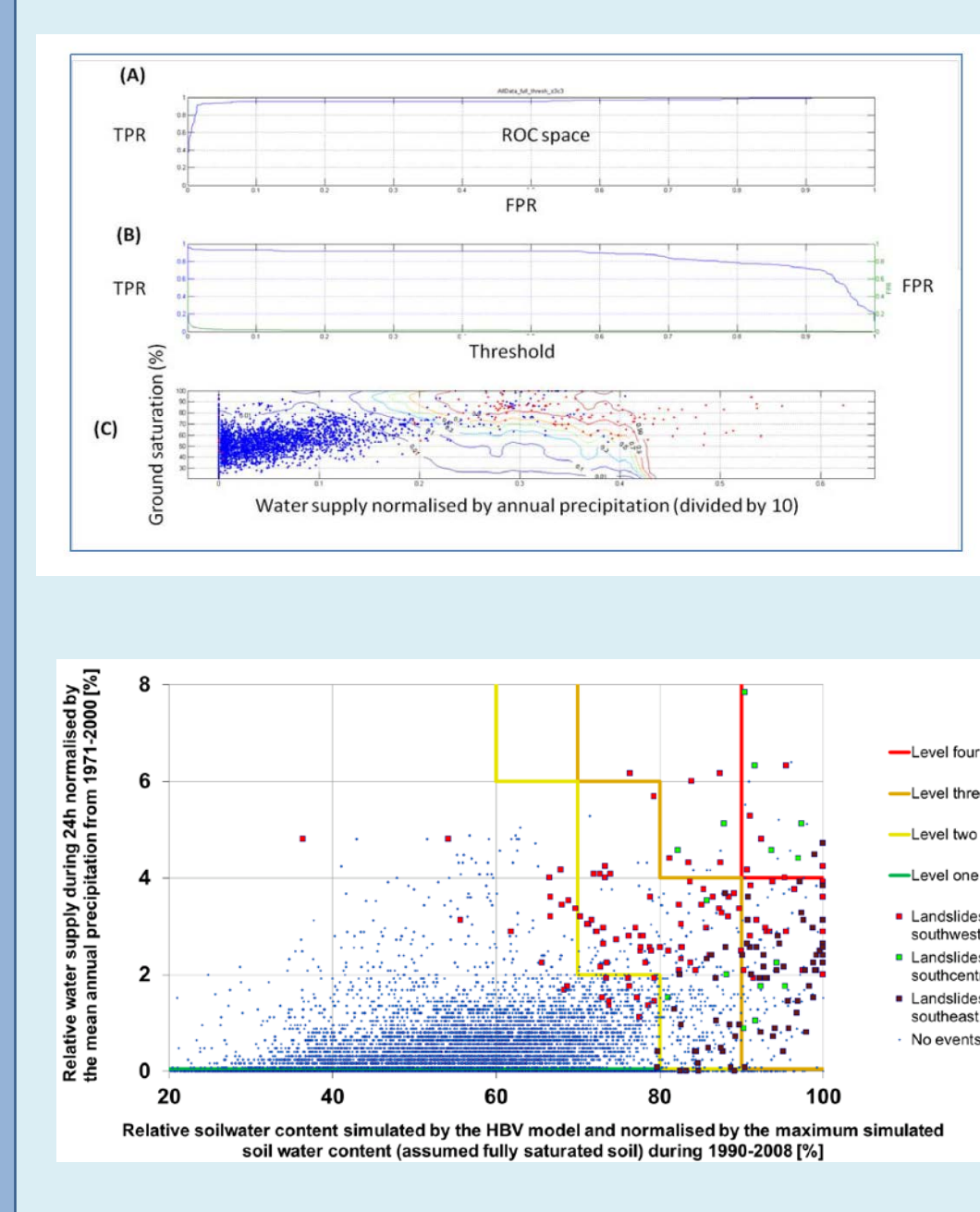


## Tools

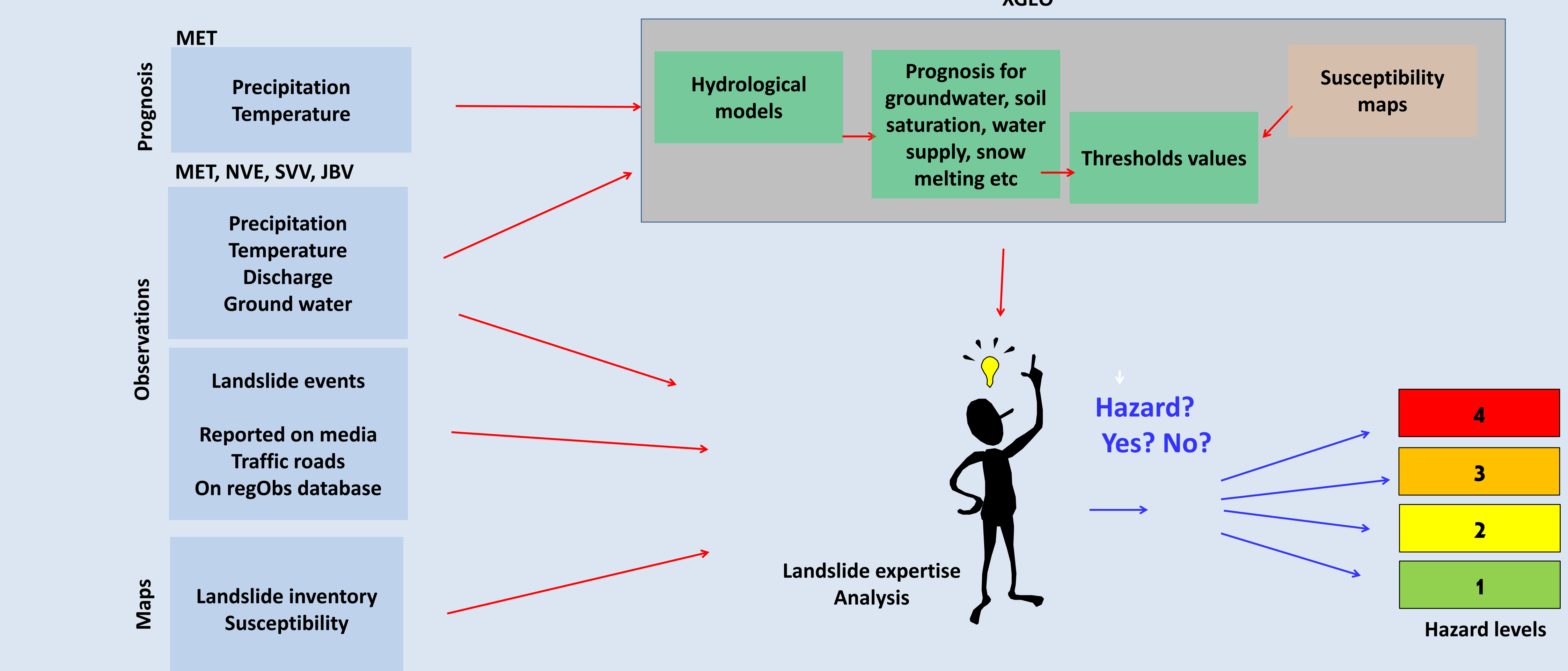
### Historical observations



### Statistics



## Assessment



Quantitative processes  
Qualitative processes



Forecast communication

## Communication and performance

### Distribution of warning messages

