• An early warning system is intended to work as a mitigation measure in lowering the consequence and thus the risk of a natural threat. One of the several factors determining the quality of such system is the way warnings are communicated to the public.

• What is the ethical responsibility in forecasting and communicating natural hazards?



Geoethical considerations in early warning of flooding and landslides: Case study from Norway

1. Introduction

The Norwegian Water Resources and Energy Directorate (NVE) runs the national/regional early warning systems for flooding (since 1989) and landslides (since 2013) based on weather forecasts, various hydro-meteorological prognosis, real-time data, discharge and groundwater observations and expert evaluation.



Daily warning messages and related information are prepared and presented to the public through custom build internet platforms. Warnings are also sent by email to relevant emergency authorities



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- 2. Challenges and ethical questions
- Daily evaluation: uncertainty in rainfall/temperature prognosis, thresholds estimations
 - > What are the repercussions for forecasters when erroneous warning messages are issued?
 - > What is the most responsible way to describe uncertainties in warnings issued?
 - > What is the optimal compromise between avoiding false alarms and not issue a warning?
 - > Is experience and "gut feeling" an acceptable tool for determination of hazard level?
- Communication of warning messages: warning areas, multi-hazards and duration
 - > Is it acceptable to issue general warnings for large geographical areas without being able to pinpoint the threat on local scale?
 - > What are the challenges in defining spatial extent of the warning area?
 - > Separate warnings for flood, debris flows, shallow slides and slushflows?
 - > How to communicate the presence of several hazards and the duration? Different hazards with different warning's duration time and geographical extent.





2. Moderate

. Considerable



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- flows are expected
- I. High Many large and smaller debris flows, shallow slides and/or slush flows are expected in a large area

- Dissemination of warning messages:
 - issued and updated?

 - "moderate hazard level"?
- Emergency plans and actions/expectations:



3. Summary

By presenting how floods and landslide early warnings are communicated in Norway and the faced challenges, we add to the discussion some ethical questions that should be addressed by scientists working with the forecast and the communication of natural hazards

> When and how often should warning messages be

> Different users have different needs.

> Is it responsible to notify authorities only in cases of "high hazard level" and no longer in cases of

 \succ What responsibility lies within the early warning system in recommending evacuation or other practical measures to local authorities?