

## Coupled risks: Taking into account the coupling between Alpine natural phenomena and anthropogenic activities - Case studies

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Keywords: NATECH, complexity, uncertainty, expertise, risk governance

The study of three cases of coupled risks in the Rhône-Alpes region has been an opportunity to question the nature of these risks and the challenges they pose in terms of knowledge, expertise and management. By pushing the common borders of complexity and uncertainty, they call for innovation and interdisciplinarity. They are similar to the major risks by their potentially devastating impacts but their unlikely occurrence and hardly probabilisable. As a result, their management required an open and dynamic expertise allowing for a certain "risk negotiation".

The land movement of the Séchillenne ruins, which threatens to cause a rocky collapse of a poorly defined volume of up to 20 million m<sup>3</sup>, threatened to crush a residential area and cut off the flow of Romanche river. The risk of rupture of the so-formed dam impacted Vizille and the Grenoble agglomeration as well as chemical plants. Many scientific studies have been realised to characterize the phenomenon and to model the cascade impacts, but the magnitude of the maximum risk and the uncertainty about the scenarios have led the experts to retain progressive partial collapse scenarios. This decision has unlocked the management of downstream risks after decades of social and administrative tension.

In Grenoble (Isère, France), the nuclear reactor of the ILL which supplies the ESRF with particles is sized to withstand seismic and hydraulic hazards (floods of the natural Isère-Drac-Romanche complex or caused by dam failures). These methods of prevention are periodically reviewed but a Supplementary Safety Study was specifically requested in 2011 by the Nuclear Safety Authority for all nuclear reactor operators following the Fukushima accident. If the mediated goal was to "think the unthinkable", the ECS entailed a risk negotiation between the operators and the NSRB to contain this reassessment within the limits of the "manageable" without draining it of its meaning.

Finally, the risks of glacial or periglacial origin offer cascades of natural phenomena that combine to create unprecedented risks in their magnitude, their triggering conditions or their location, with many uncertainties. This is the case of the water pocket of the Tête Rousse glacier which threatens Saint Gervais or the gigantic avalanches triggered by the serac falls of the Tacconnaz glacier (both in Haute-Savoie, France).

These case studies illustrate the difficulties encountered in natural and industrial risk management to deal with this type of cascading effects and the need for interdisciplinary approaches, both to establish scenarios of phenomena and risk likely to occur and in the selection and sizing of prevention and protection measures. They also question the role and organisation of scientific expertise in the decision-making process by public authorities dealing with this type of coupled risks.