Building railway transport resilience to Alpine hazards in Austria [1]

Image from Climate Adapt about this case study [2]

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The railway transportation system of the Alpine country Austria plays an important role in the European transit of passengers and freights. Moreover, the Austrian railway network is essential for the accessibility of lateral alpine valleys and is thus of crucial importance for their economic and societal welfare. If traffic networks are (temporarily) disrupted, alternative options for transportation are rarely available. Due to the Alpine topography and the limited space available, railway lines often follow floodplains and are located along steep and unsteady slopes. This considerably exposes them to flooding and in particular to alpine hazards, such as debris flows, rock falls, avalanches or landslides. These events can cause substantial damage to railway infrastructure, pose a risk to the safety of passengers and are thus a great issue of concern for the Austrian Federal Railways (ÖBB Infra AG). In the future, the risk from Alpine hazards could increase considerably due to climate change. To address current and future risks from climate related hazards, the ÖBB Infra AG employs a combination of structural protection measures and a railway-specific weather monitoring and early warning system.

Case Study Description

Challenges:

The harsh mountainous nature of the Eastern Alps, in which around 65% of the national territory of Austria is situated, poses a particular challenge to railway transport planning and management. Relief and steep slopes limit the space usable for permanent settlements and infrastructure. Hence, railway lines often follow floodplains or are located along steep unsteady slopes, which considerably exposes them to flooding and in particular to alpine hazards, e.g. debris flows, rock falls, avalanches or landslides. As a result, railway infrastructure and operation has been repeatedly impacted by alpine hazards. For instance, several coaches of an intercity train derailed at the Masonbach torrent (Vorarlberg) on 11th August 1995, following a debris flow event that had destroyed a bridge. Three people were killed, 17 people were heavily injured and the track had to be closed for almost one week. Also in June 2013, floods and debris flow events caused substantial damage to the railway infrastructure. The national railway operator ÖBB Infra AG reported losses of about €75 million to its railway network.

The majority of alpine hazards are triggered by extreme/severe (hydro-) meteorological conditions such as heavy precipitation, rapid snow melt or extreme temperatures. In the future, the risk from Alpine hazards could significantly increase due to the impact of climate change. For instance, the number of very intense rainfall events could increase by 36% in the Alpine areas and 70% in the lowlands of the country (between the reference period 1961–1990 and the projection period 2011–2040; Kellermann *et al*. 2016 [3]).

The Austrian Federal Railways (ÖBB Infra AG), along with partners from civil society, the private sector and the government, are left with the challenging mandate to assess risks, take preventive measures, and ensure the safe and continuous operation of the network. One risk reduction strategy followed is the implementation of structural protection measures, such as dikes and embankments. In this respect, prioritization of measures and issues of cost-sharing with other governmental stakeholders is a challenge. At the same time, the implementation of structural measures against alpine hazards in Austria – with its approximately 5,000 torrents and 3,800 avalanche paths – is often not feasible for both economic reasons and aspects of nature and landscape protection. Since technical measures are thus limited in ensuring a commensurate level of safety for

railway operations in the alpine topography, there is a strong need for additional (non-structural) risk reduction measures, such as weather monitoring and early warning.

Objectives:
Meteorological extreme events pose a great risk for railway infrastructure and the safety of passengers. In the future, climate change will presumably have serious implications on meteorological hazards in the Alpine region. To minimize direct damage to railway infrastructure, structural protections measures are implemented by the ÖBB Infra AG along with its partners where this is economically, technically and environmentally feasible. However, especially in the alpine environment full protection is not possible and the risk profile continuously changes due to climate change. To ensure the safe and continuous operation of the network and the safety of passengers, a complementary weather monitoring and early warning systems was installed.

Solutions:
The ÖBB Infra AG follows mainly two complementary risk management strategies. On the one hand, risk from Alpine hazards is reduced by implementing structural protection measures. ÖBB Infra AG is mainly responsible itself for constructing and maintaining protective measures, such as dikes or debris sheds. In most cases, it also needs to finance these measures. Nevertheless, if the planned measures protect also settlements or other infrastructure elements such as roads or energy supply, cooperation with other state and regional authorities or communities takes place and the protection system can be subsidized within the Hydraulic Engineering Assistance Act (WBFG [1985] 2014).

On the other hand, risk from Alpine hazards is reduced by improving preparedness for response and emergency management. A key element of ÖBB's risk reduction strategy is the weather monitoring and early warning system called infra:wetter, which is jointly operated by ÖBB and the private weather service UBIMET GmbH. This interactive web-portal available to the ÖBB staff combines data from own and external weather stations of the ZAMG (Zentralanstalt für Meteorologie und Geodynamik - Central Institute of Meteorology and Geodynamics), radars, satellites as well as local and global weather projections with detailed information on the complete railway network in Austria. It provides a calculation of important meteorological parameters like temperature, wind speed, precipitation, snowfall, and the snow line at a local level.

Besides providing individualized and route-specific warnings to approximately 1,500 users, infra:wetter is also used to identify so-called critical meteorological conditions (CMCs) in advance: weather conditions that potentially lead to larger disruptions of train traffic and thus require coordinated action by the Natural Hazards Management Department of the ÖBB Infra AG. In case a critical meteorological condition is detected with sufficient pre-warning time, a weather warning is issued and a plan of procedures is implemented. This can include the installation of an incidence command that decides about operational safety precautions, such as speed limits, track closures or temporary mitigation measures. For instance, in the case that heavy snowfall is predicted, measures such as a revised planning of human resources and provision of winter services, or preheating of switch points can be undertaken to ensure the operability of the network. The existence of a functioning weather monitoring and early warning system is also an effective and flexible risk management solution to address the projected changes in the frequency and intensity of climatic hazards due to climate change.

Importance and relevance of the adaptation:
OTHER_POL_OBJ;

Additional Details
Stakeholder engagement:
To address the risk posed by natural hazards, ÖBB Infra AG provides relevant resources for natural hazard management and is approved to take its own decisions as a company. However, due to the complex situation of alpine hazards, their management within the railway transportation in Austria cannot be handled by ÖBB Infra AG alone, and structural risk mitigation measures in the transport sector have to be aligned with public risk management strategies in many places. Thus, partnerships and vital cooperation between various stakeholders

at different administrative levels, i.e. from the local level to the national level, are needed.

At a superordinate level, ÖBB Infra AG cooperates with federal ministries on strategic issues such as decisions in legislation and technical standards. At the level of structural risk reduction measures, ÖBB Infra AG cooperates with regional authorities, communities and the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW). Regarding non-structural measures, ÖBB Infra AG cooperates with the private sector, academic institutions and regional authorities for operating the weather monitoring and early warning system and to improve risk assessments.

Success and limiting factors:
Budget, funding and additional benefits:
Legal aspects:
Implementation time:
The construction of structural protection measures can take up to several years for implementation. For instance, following the debris flow event at the Taxenbach in 2013, the ÖBB constructed a structural debris flow barrier that was completed in 2016. The weather monitoring and early warning system infra:wetter was implemented in 2005 jointly by ÖBB Infra AG and UBIMET GmbH.

Reference Information
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Websites:
http://www.enhanceproject.eu/case_study/10 [5]

Sources:
FP7-funded ENHANCE “Enhancing risk management partnerships for catastrophic natural hazards in Europe” project

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