FIRST RESULTS FROM THE SWISS WIDE NATURAL HAZARD AND RISK ASSESSMENT ON NATIONAL ROADS

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INTRODUCTION

With the ultimate aim to use a risk- based approach for the management of and protection against natural hazards on Swiss national roads, the federal roads office (FEDRO) decided to initiate a Swiss-wide year project, called "Naturgefahren auf Nationalstrassen" (national hazards on national roads - NHNR). This project aims at quantifying and mapping all natural hazards and resulting risks due to gravitational processes, which threaten the Swiss national road network (total length = 1892 km), analogue to the work of Roberds (2005). In the end, the project will provide intensity and probability maps for all studied natural hazard, the historical hazard events, the existing protective measures (technical and biological, i.e., protection forest) and their efficacy, as well as risk maps showing the potential damage in CHF/year/100 m highway section for the entire national road network.

PROJECT ORGANISATION

The FEDRO is in charge of the project coordination and technical support and expertise on hazard and risk analysis is provided by the division of hazard prevention of the Federal Office for the Environment (FOEN). The field and modeling studies needed for the hazard and risk analysis are being done by ARGEn (ARGE = *Arbeitsgemeinschaft* = group of jointly working geotechnical bureaus). An ARGE works within a section of the Swiss national road network with a length that roughly varies between 30 and 70 km. In general, each ARGE consists of an interdisciplinary project leader with experience in natural hazards (but not necessarily), an avalanche expert, one or two geological experts, a hydraulic engineering/flooding expert and a risk analysis expert. The ARGE has about one year to complete the natural hazard assessment in their highway section and subsequently, the risk analysis is finalised within the following 3 to 4 months. At the time of writing, 12 highway sections are being analysed (Gotthard highway from Canton Uri until the Italian border, the Mesolcina valley, the whole of Canton Grisons, The complete Rhône valley, as well as the Simplon Pass. In 2012, we will be able to present the results of all the national roads crossing mountainous terrain (Alps and Jura).

PROJECT METHODOLOGY

The data models and the project methodology, a document of over 100 pages, downloadable at: http://www.astra.admin.ch/dienstleistungen/00129/00183/01156/index.html?lang=en, form a key basis of the project. The methodology describes in detail the following 4 main parts: 1) hazard assessment, 2) risk analysis, 3) risk evaluation and 4) planning of protective measures. As such the methodology defines the natural hazards to be studied, the study perimeter, the standards of the hazard assessment, the risk equations, and values of the prefixed parameters to be used, as well as the products to be delivered. The methodology has been developed by a working group consisting of natural hazard and road management experts from federal and cantonal organizations, universities, and private bureaus. It is mainly based on the methods presented in BUWAL (1999) and Wilhelm (1999). The methodology does not prescribe the models to be used for simulating the different natural hazards to be assessed; it only prescribes the required products in detail, as well as a maximum degree of transparency and traceability of the methods, models and assumptions used.

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The natural hazards that need to be assessed are snow and rock avalanches, rock- and ice-fall, flooding, collapse dolines and different types of landslides. To aim for a Swiss-wide homogeneous and comparable dataset, 4 event-size scenarios (return period 0 – 10 yrs, 10 – 30 yrs, 30 – 100 yrs, 100 – 300 yrs and intensity classes low, medium and high) should be defined for each potential hazard source zone (FEDRO, 2009).
The working perimeter that is to be taken into account is an area of 10 m at both sides of the highway, which is defined as the damage potential perimeter. All natural hazard processes that reach this perimeter should be studied in detail in the complete area that is covered by that natural hazard, which means from the source to the deposit area. The risk analysis is carried only on a line representing the road axis or on surrounding facilities within the damage potential perimeter.
To standardise the risk analysis done by the different bureaus, we developed an internet based risk calculation tool called RoadRisk (http://www.roadrisk.admin.ch/). This tool requires the intensity maps of all studies natural hazards for the defined return periods intersected with the damage potential (national roads axes and surrounding facilities, such as parking areas, tunnel ventilation installations, …). The resulting intersected lines or areas need to be imported as text files. The "damage" types considered in the risk analysis are highway closure, damage to infrastructure or casualties. Highway closure can occur after a hazard event took place or before its occurrence as a preventive measure. Both damage types are included in the risk calculation. The damage type casualties will also be expressed in costs and is based on a value of 5 million CHF per human life. Casualties can occur due to direct hits of cars or due to collisions with deposits on roads or cars that are directly hit by natural hazards. Therefore, variables that required are the maximum speed defined at the highway section, the average number of cars passing daily, the probability of having a traffic jam, the lethality of the people in a car being hit or colliding with deposits, etc.

FIRST RESULTS

The methodology that has been developed is exhaustive, allowing a very detailed risk analysis. The key challenge is to ensure a similar level of detail in the hazard assessments done by the different expert bureaus. Our solution is to discuss the hazard scenarios for the different hazard sources with the bureaus in the terrain. The first results of the hazard assessment proved that this is essential and effective. Also, a thorough proof of the hazard assessment results and the underlying, transparently presented, calculations and assumptions is of key importance.
The first risk analysis results show that potential damages per 100 m highway section can add up to several millions CHF/year. In most cases this is due to road closure in areas that are strongly affected by snow avalanches. Damage to infrastructure is in general only 5-20% of the total potential damages. Victims are mostly caused by rockfall, which can add up to several 10'000 CHF/year. If all risk analyses are available, the FEDRO evaluates if protective measures planned with high priority. Three criteria will be used for this: 1) an individual probability of death of 1*10-5 per year or higher or, 2) Risk on road segment > 100 CHF/year/m, or 3) risk of one single hazard source > 10'000 CHF/year. The experience gained in this project will show if these values are suitable for practical implementation.

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