

Cost effective risk management of glacier hazards:

A new procedure and its application to the Canton of Valais (Switzerland)

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The financial means for safeguarding against natural hazards are limited. Therefore, it can occur that in future, when planning safety measures to counteract against natural hazards, priority is not given to how we may protect ourselves against these hazards, but decision making will be influenced more by the relative costs of the safety measures and their contribution to risk reduction. Behind this idea is the vision for long-term risk management systems, which are transparently clear and in accordance with well defined rules that allow for a balanced safety system.

Within the project of the European Research Project GLACIORISK (Survey and Prevention of Extreme Glaciological Hazards in European Mountainous Regions) a new procedure for hazard-risk management, an example being glacier hazards, was developed and put into operation to cover the entire area of Canton Valais. Glaciers can be the cause of various categories/classes of danger.

Critical situations arise as a result of glacier variations, which may lead to dangerous ice avalanches or to the formation and outbreak of glacier lakes. The distinctive glacier hazards can intensify each other, i.e. increase with mutual intensity, and in combination with additional types of hazards e.g. debris-flows, lead to damage on a catastrophic scale. In view of the present climate changes and the rapid retreat of the glaciers, the risk level may rapidly alter. For this reason, a flexible but stable procedure with regard to the risk management is necessary.

The risk originating from the dangerous glaciers has been assessed in a participatory process. For this purpose, workshops with experts stationed at the concerned place were organized, and their evaluations taken into account. For every potential hazard-area, nine representative risk-scenarios were set up regarding their probability of commencement and the expected damage to persons and property. Since the concerned parties, the decision-makers and the experts at the location, during the evaluation process could all be called upon, for each case analyzed the combined risk of consensus not being reached was dismissed. An overview of the glacier risks for the Canton of Valais provided the diagram given above.

On the basis of this risk overview of the 10 glaciers posing the greatest risks, a preliminary planning for preventative measures was carried out. For these ten glaciers, various safety measures were considered and their cost-effectiveness determined. Thereby, the annual costs (operation, maintenance, depreciation of investment) in relation to the risk reduction were fixed. The smaller the cost effectiveness ratio, the more suitable is the corresponding measure. This means that with a cost effective ratio of 0.5, for each invested Swiss-Franc the risk would be reduced by two Francs.

At the beginning, the total risk attached to the ten glaciers under consideration amounts to 4.4 Mio. Fr./year. In the following diagram, the reduction of the initial risk under discussion is presented as a function of the cumulative preventative measure costs. From this presentation, one recognizes that the more measures which are realized, the less cost-

effective the operation becomes. If of all eleven represented measures being realised, the preventative-measure package would show a cost-effectiveness of 0.3. Indeed, it should also be noted that the last two preventive-measures point to the fact that to reflect a cost effectiveness of 1.3, respectively 9.2 was produced and therefore could not be recommended for realisation.

These safety measure assessments showed that glacier risks could be efficiently reduced without large capital expenditure. The combination of measures relating to monitoring, raising the alarm and emergency-planning proved to be cost-favourable and very efficacious. The costs of structural preventative measures, such as the construction of protective dams, are generally presented in a poor light in relation to risk reduction measures.

The procedure described above pertaining to the risk management of glacier hazards may be applied by analogous means to other natural hazards to the benefit of other regions and countries concerned.