



## Integration of expert knowledge and uncertainty in natural risk assessment

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Natural hazards occurring in alpine regions during the last decades have clearly shown that interruptions of the Swiss railway power supply and closures of the Gotthard highway due to those events have increased the awareness of infrastructure vulnerability also in Switzerland and illustrate the potential impacts of failures on the performance of infrastructure systems.

This asks for a high level of surveillance and preservation along the transalpine lines.

Traditional simulation models are only partially capable to predict complex systems behaviours and the subsequently designed and implemented protection strategies are not able to mitigate the full spectrum of risk consequences. They are costly, and maximal protection is most probably not economically feasible. In addition, the quantitative risk assessment approaches such as fault tree analysis, event tree analysis and equivalent annual fatality analysis rely heavily on statistical information. Collecting sufficient data to base a statistical probability of risk is costly and, in many situations, such data does not exist; thus, expert knowledge and experience or engineering judgment can be exploited to estimate risk qualitatively.

In order to overcome the statistics lack we used models based on expert's knowledge in order to qualitatively predict based on linguistic appreciation that are more expressive and natural in risk assessment.

Fuzzy reasoning (FR) can be used providing a mechanism of computing with words (Zadeh, 1965) for modelling qualitative human thought processes in analyzing complex systems and decisions. Uncertainty in predicting the risk levels arises from such situations because no fully-formalized knowledge are available. Another possibility is to use probability based on triangular probability density function (T-PDF) that can be used to follow the same flow-chart as FR.

We implemented the Swiss natural hazard recommendations FR and probability using T-PDF in order to obtain hazard zoning and uncertainties. We followed the same approach for each term of risks i.e. hazard, vulnerability, element at risk, exposition. This risk approach can be achieved by a comprehensive use of several artificial intelligence (AI) technologies, which are done through, for example: (1) GIS techniques; (2) FR or T-PDF for qualitatively predicting risks for possible review results; and (3) A Multi-Criteria Evaluation for analyzing weak points.

The main advantages of FR or T-PDF involve the ability to express not-fully-formalized knowledge, easy knowledge representation and acquisition, and self updatability. The results show that such an approach points out quite wide zone of uncertainty.

### REFERENCES

Zadeh L.A. 1965 : Fuzzy Sets. Information and Control, 8:338-353.