Participatory decision making for operational earthquake forecasting and earthquake early warning

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PARTICIPATORY DECISION MAKING FOR OPERATIONAL EARTHQUAKE FORECASTING AND EARTHQUAKE EARLY WARNING

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Practical implementations of operational earthquake forecasting (OEF) and earthquake early warning (EEW) require a decision (or many decisions) to be made in order to mitigate risk. For example, for OEF a decision may be made to remove hazardous material from an industrial site during a period of heightened seismic hazard to reduce the chance of a chemical spill in case of an earthquake. In the context of EEW, a gas network may be automatically shut down to decrease the risk of fire following an earthquake. To make such decisions requires a clear framework to be defined well before the occurrence of an earthquake or an increase in seismic activity. In addition, because these decisions can have an impact on many groups it is important that the decision making takes account of their views and that it is conducted in a participatory manner. As part of REAKT, we have proposed a framework for use when developing participatory decision making plans for OEF and EEW (Figure 1).

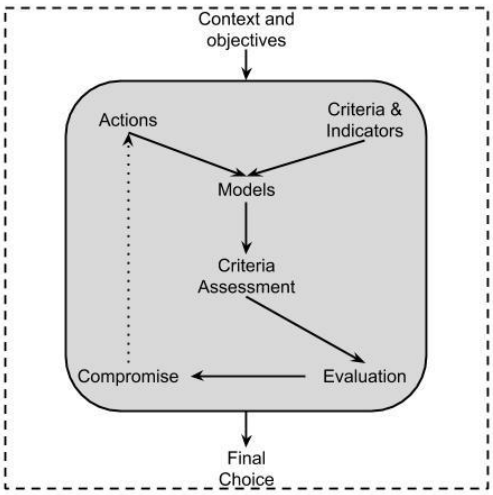

Figure 1: Proposed framework of participatory decision making

The development framework begins with clearly defining the context and the objectives of the plan (e.g. to reduce seismic risk related to a given installation). Defining the context will imply

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identifying all actors that should be considered when developing a decision-making plan (e.g. the local population, installation workers, regulatory authorities and local and national governments). Next, a brainstorming exercise is conducted to produce a list of all possible actions that may lead to achieving the overall objectives. The idea at this stage is not to auto-censor but to list everything that is potentially relevant; later on the actions will be whittled down. In the next step, criteria need to be defined that allow the objectives to be judged. These criteria need to be measurable through quantifiable indicators. The next stage is to decide on the method and the models that will be used to measure the effectiveness of the different actions (e.g. cost-benefit analysis or multi-criteria decision analysis). The various alternatives (including business-as-usual) to be compared then need to be clearly defined and quantified using the method agreed upon in the previous step. The subsequent part of the analysis is the actual criteria assessment considering all the identified stakeholders and for all the considered alternatives. This will potentially lead to a clear 'best' possible decision but it may indicate that there is no optimal action. If this is the case then the various 'best' alternatives should be compared and negotiation conducted between the affected parties in order to produce a compromise proposal. This compromise may require compensation being offered to affected stakeholders or other mitigation measures suggested. The criteria assessment, comparison, negotiation and compensation steps may need to be followed a number of times before coming to the final compromise proposal. Once this proposal is reached it is up to the decision-maker to make the final choice about what actions are to be taken. Once the decision is acted it is necessary to check on the effectiveness of this choice by collecting data and checking that it is having the desired impact. It may be necessary to repeat the exercise if the situation changes.

In this study we present the different steps of this procedure in more detail. We then apply them to various case studies, some of which are based on actual situations and some are more hypothetical, using different approaches to measure the impact of potential actions.

This work highlights how to deal with several challenges. The first one concerns performing a loss balance, i.e. comparing the gains and the losses when evaluating a given action. Often, this comparison is made through a cost-benefit analysis, requiring monetizing all the items at stake. An alternative is to use a multi-criteria approach that does not require this monetization but makes the comparison less intuitive. A second challenge is the management of uncertainties, and how to make decisions, taking into account the preferences of the stakeholders, who might react in different manners to risk. A third challenge is performing the analysis for multiple events over the lifetime of the element at risk, as opposed to a single event. The evaluation then poses computational issues, enhanced by typical conditional probabilities.