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Management of uncertainties on parameters elicited by experts – Applications to sea-level rise and to CO₂ storage operations risk assessment

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In a context of high degree of uncertainty, when very few data are available, experts are commonly requested to provide their opinions on input parameters of risk assessment models. Not only might each expert express a certain degree of uncertainty on his/her own statements, but the set of information collected from the pool of experts introduces an additional level of uncertainty. It is indeed very unlikely that all experts agree on exactly the same data, especially regarding parameters needed for natural risk assessments. In some cases, their opinions may differ only slightly (e.g. the most plausible value for a parameter is similar for different experts, and they only disagree on the level of uncertainties that taint the said value) while on other cases they may express incompatible opinions for a same parameter. Dealing with these different kinds of uncertainties remains a challenge for assessing geological hazards or/and risks.

Extra-probabilistic approaches (such as the Dempster-Shafer theory or the possibility theory) have shown to offer promising solutions for representing parameters on which the knowledge is limited. It is the case for instance when the available information prevents an expert from identifying a unique probability law to picture the total uncertainty. Moreover, such approaches are known to be particularly flexible when it comes to aggregating several and potentially conflicting opinions. We therefore propose to discuss the opportunity of applying these new theories for managing the uncertainties on parameters elicited by experts, by a comparison with the application of more classical probability approaches. The discussion is based on two different examples.

The first example deals with the estimation of the injected CO₂ plume extent in a reservoir in the context of CO₂ geological storage. This estimation requires information on the effective porosity of the reservoir, which has been estimated by 14 different experts. The Dempster-Shafer theory has been used to represent and aggregate these pieces of information. The results of different aggregation rules as well as those of a classical probabilistic approach are compared with the purpose of highlighting the elements each of them could provide to the decision-maker (Manceau et al., 2016).

The second example focuses on projections of future sea-level rise. Based on IPCC's constraints on the projection quantiles, and on the scientific community consensus level on the physical limits to future sea-level rise, a possibility distribution of the projections by 2100 under the RCP 8.5 scenario has been established. This possibility distribution has been confronted with a set of previously published probabilistic sea-level projections, with a focus on their ability to explore high ranges of sea-level rise (Le Cozannet et al., 2016).

These two examples are complementary in the sense that they allow to address various aspects of the problem (e.g. representation of different types of information, conflict among experts, sources dependence). Moreover, we believe that the issues faced during these two experiences can be generalized to many risks/hazards assessment situations.

References

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