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An integrated approach to assess both risk and impacts related with geo-resources exploration and exploitation

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To the welfare of both economy and communities, our society widely exploits geo-resources. Nevertheless, with benefits come risks and even impacts. Understanding how a given project intrinsically bares such risks and impacts is of critical importance for both industry and society. In particular, it is fundamental to distinguish between the specific impacts related to exploiting a given energy resource and those shared with the exploitation of other energy resources. In order to do so, it is useful to differentiate impacts in two categories: routine impacts – caused by ordinary routine operations, investigated by Life-cycle assessment with a deterministic approach – and risk impacts – caused by incidents due to system failure or external events, investigated by risk assessments with a probabilistic approach. The latter category is extremely interesting because it includes low probability/high consequences events, which may not be completely independent or unrelated, causing the most disastrous and unexpected damages. For this reason, it is becoming more and more crucial to develop a strategy to assess not only the single risks but also their possible interaction and to harmonize the result obtained for different risk sources. Of particular interest for this purpose is the Multi-Hazard/Multi-Risk Assessment.

The aim of our work is to present an approach for a comprehensive analysis of impacts of geo-resource development projects. Routine operations as well as risks related to extreme events (as e.g.,seismic or meteorological) are linked using a Multi-Hazard Risk (MHR) approach built upon a Life-Cycle analysis (LCA). Given the complexity of the analysis, it is useful to adopt a multi-level approach: (a) an analysis of routine operations, (b) a qualitative identification of risk scenarios and (c) a quantitative multi-risk analysis performed adopting a bow-tie approach. In particular, after studying the two tools, i.e. LCA and MRA, we have implemented a protocol to interface them and to evaluate certain and potential impacts.

The performance of the proposed approach is illustrated on a virtual site (based on a real one) for geothermal energy production. As a result, we analyse the outcome of the LCA, identify risk-bearing elements and events, to finally obtain harmonised risk matrices for the case study. Such approach, on the one hand, can be used to assess both deterministic and stochastic impacts, on the other hand, can also open new perspective in harmonizing them. Using the LCA outputs as inputs of the MRA can allow the analyst to focus on particular risk pathways that could otherwise seem less relevant but can open new perspective in the risk/impact evaluation of single elements,

as we show in this case study.

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