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Evaluating Environmental Impacts of Flood-Induced Tank Failures: A Risk Chain Model for Soil and Groundwater Contamination in NaTech context

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The European "Floods Directive" requires European River district authorities to create flood damage and risk maps, but the process of assessing flood damage is complex and lacks established methods. Flood risk assessment also requires an understanding of how industrial equipment is vulnerable to flood events and the potential for toxic releases in such scenarios. In this study a practical case is presented regarding multicomponent flood risks in the Secchia River catchment, a tributary of the Po River, and proposes a new risk chain model for evaluating the environmental impact of soil and groundwater contamination in the event of a flood caused by the failure of storage tanks containing hazardous materials. The model is demonstrated using an illustrative case and shown to be a useful tool for managing the risk of such events. Our methodology presents a multi-component model for assessing environmental risk resulting from technological accidents triggered by natural disasters. In particular, we focus on the failure of storage tanks containing hazardous materials due to flooding. The proposed method first evaluates the probability of tank failure under defined flood conditions, including flood height, velocity, and probability of occurrence. To simplify the analysis, we consider all tanks to be unanchored atmospheric storage tanks. The final output of the method for each tank is a monetary estimation of the hypothetical costs for environmental remediation after tank failure, including the contamination of soil and groundwater by the spilled liquid. Our methodology proposed a conservative approach by assuming that all stored liquids are contaminants and by using a fixed value for the density of the stored liquid.

To evaluate the probability of tank failure, it has been considered four types of failure dynamics: buckling, displacement, floating and overturning. The tank failure assessment is based on our recent study that developed vulnerability different dynamic models for unanchored steel atmospheric tanks. Our methodology not only evaluates the probability of tank failure during flood events, but also analyses the potential consequences of failure, including direct damages to the tank and costs associated with recovering the spilled product and mitigating contamination in the affected area. The results of this study can be used to develop strategies for minimizing the risks of tank collapse during flood events and to increase awareness of potential NaTech risks. The ultimate goal of this study is to create a comprehensive procedure for evaluating and comparing the dynamics of tank collapse during flood events, including the potential environmental

consequences, and providing risk managers with a full understanding of the risks associated with tank failure during flooding, including potential NaTech risks.