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An approach for the anticipatory and participatory management of current and future flood risks

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Despite the fact that many measures to attenuate flood hazards and reduce vulnerabilities are being implemented, adverse effects of floods are ever-increasing in most parts of the world. On the one hand this holds true for economically and/or demographically growing regions. On the other hand this applies also to areas that face population shrinkage and economic problems. Such flood risks occur in human-environment systems and are subject to dynamics caused by a number of drivers such as climate change, land-use changes, and others. Many drivers evolve slowly over time or show time-lag effects and long return periods. Moreover, certain decisions may determine the control actions of the following decades. At present, current flood risks are mostly determined based on historic developments and the ex post analysis of flood events. Approaches that look at the future dynamics of both hazards and vulnerable elements ex ante in an integrated manner are rare. Instead, future hazard scenarios are often just overlaid with current socio-economic data, which poses a strong inconsistency. Usually the focus lies on rather short-term, specific or local problems. But many developments and measures show their effects only after long time periods and when considering the whole catchment area. This calls for a holistic and long-term view into the future and implies the challenge of dealing with many uncertainties due to the system's complexity.

In order to anticipate and react to these developments, this contribution suggests developing a flexible, yet holistic approach to design, analyse and evaluate alternative futures of such human-environment systems. These futures follow a scenario understanding that considers both specific (current) factor constellations as well as consistent assumptions on autonomous developments (so-called development frameworks) and potentials for control (strategic alternatives) of the interacting entities that influence flood risk. Different scenario concepts and the application of respective techniques are thus reviewed and incorporated with regard to their suitability for an integrated management of current and future flood risks. In particular, "hybrid scenarios" with qualitative and quantitative components represented by nested models as well as assumptions across different spatiotemporal scales, respectively, are suggested for dealing with the uncertainties when assessing flood risks throughout a system's possible evolution.

The (initially top-down developed) approach and its components will be briefly presented. These "scenario products" could later serve as a stimulus for discussions that bring together different actors and enhance – and eventually legitimise – the scenarios further in a "scenario process":
(1) A first step is the conceptualisation of a flood risk system following the SPRC-model. Its physical geographical and anthropogenic factors may either be subject to autonomous trends, target-oriented control, or facultative system behaviour (e.g. dike breaches). With this concept, the integration of different processes and scales is aspired.
(2) Secondly, it is conceptually shown how the risk cascade for present and future states of the flood risk system can be calculated based on coupled models ranging from climate change projections to a damage simulation models.
(3) Thirdly, ways to develop socioeconomic storylines for the development frameworks and guiding principles for the strategic alternatives are presented and the futures are combined. This involves making plausible and consistent assumptions for many system factors and their drivers and finding ways to harmonise existing data for the same areas and time steps.
(4) Fourthly, selected futures can be analysed and evaluated ex ante applying the coupled models of the second step to derive the emerging flood risks. The evaluation addresses, amongst other aspects, the identification of (i) the sensitivity of all scenarios against the current strategic alternative; (ii) the resulting risks when applying different strategic alternatives against one selected scenario; (iii) the efficiency (as cost-effectiveness) and robustness of one selected strategic alternative against the different scenarios; and (iv) the model uncertainty, for example caused by different climate downscaling methods.

It is of growing importance to place any scenario/simulation results in a societal or even individual context and confront them with the perspectives of the people potentially affected. Only this yields a holistic picture and may lead to sustainable, comprehensible decisions.

The approach is partly exemplified with research conducted in Saxony (Germany) and the Elbe River catchment in Central Europe and concentrates on river or plain floods, neglecting water quality issues.