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# Validity of Cost-Benefit Analysis for Flood Prevention Projects: Insights from Sensitivity Analysis

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**Abstract** Cost-Benefit Analysis (CBA) is widely promoted as a tool for discussing efficiency of flood management policies. It gives rise to a global indicator, the Net Present Value (NPV), which allows the discussion of allocating regional, national, or supra-national fundings to local projects. Concerning flood management policies, CBA relies on damages avoided approach which consists in measuring the benefits of a project by differentiating without and with project situations in term of expected damages.

One of the under-explored area is uncertainty and sensitivity analyses linked to CBA based on damages avoided approaches. The main reason relies on the complexity of analysing precision of the NPV indicator, which is a combination of hydrological, hydraulic, geographic and economic knowledge, and which depends on the precision of the underlying information. In hydrology, uncertainties result from interpolation or extrapolation in space and in time of some gauging stations. In hydraulics, uncertainties come from outputs of the hydraulic model (water level errors) combined to topographical data when mapping submersion duration and water levels (interpolation errors, DTM errors). In economics, uncertainties depend on multi-scale network effects considered in damages modelling. On a first modelling level, elementary space units segment the studied area. These units, denoted stakes, can be points, lines or polygons. In this case, damages supported by stakes are only depending on their exposition to the hazard realization, independently from others stakes. On a second level, stakes may be seen as a system of elementary units (e.g. a farm is a system containing the farm buildings and cultivated areas). In that case, damages on a particular stake can affect others since they are related to them (an agricultural co-operative outside the flooded areas is affected by damages encountered in the farms located in the flooded areas).

Nevertheless, uncertainty analysis should be systematically performed as a necessary complement of any CBA: how could projects efficiency be discussed on a synthetic indicator which we cannot precise the validity? Sensitivity analysis, as it serves to define hierarchically the required precision (i.e. quality) for each input data, is also a necessary step. A particular issue in the CBA for flood prevention is linked to the various uses of the geographical space for each one of the chained models. The sensitivity analysis should take into account another particular point: the output scale of the economic models can be local or global, include only one event or several events. Thus, a link between data resolutions (e.g. spatial resolution) and economic model output precisions has to be developed.

In this paper, we present two complementary analysis based on a case study in the Orb delta, South of France. Firstly, a sensitivity analysis is performed on a CBA of a flood reduction project. This analysis was based on Sobol indices calculated with a Monte-Carlo approach, giving a hierarchical view of the inputs, data or parameters, impacting the CBA results. In the same time, this analysis allows the computation of a confidence band for the global NPV of the project, considering uncertainties on inputs. In a second step, an analysis on the use of mapped intermediary and local outputs of CBA such as mapped damages for a particular event, and mapped annual expected damages are presented. Spanning spatial resolutions on these outputs and considering imprecisions resulting from the chained model, this analysis exhibits appropriate and avoided spatial resolutions for local outputs. This latter result arises new questions on CBA mapped output communication.

**Keywords** flood risk, cost-benefit analyis, uncertainty modelling, sensitivity analysis, spatial simulation, multi-scale estimation, map.