VALIDATION OF MODELS USED FOR SCENARIO GENERATION

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Scenario-based studies are increasingly used to capture the complexity and deep uncertainty in global challenges, such as mitigation of and adaptation to climate change. In these studies, quantitative systems models are the main means of scenario generation, alongside qualitative and participatory approaches. The confidence in these models has been established with validation techniques, which traditionally tend to rely on the past data and system structures, and to eliminate behavioral sensitivity. However, to capture a variety of uncertainties and to accommodate the consequences of unknown unknowns, shocks or structural changes, the models now need to generate a rich diversity of scenarios. Therefore, traditional validation techniques potentially reduce the model’s ability to generate such scenarios and new validation approaches are required.

In this study, we investigate the existing validation viewpoints and approaches, especially when models are used in scenario-based studies. For this purpose, we employ (i) a text-mining analysis on a vast body of academic publications mainly from environmental and decision sciences, and (ii) a survey among modelling practitioners.

According to the text-mining results, empirical data plays an important role in the validation practice in all main areas of sustainability science. Qualitative and participatory approaches that can enhance public reliability are much less visible. Data-oriented validation is prevalent even when models are used for scenario exploration. Uncertainty does not result as a frequently mentioned concept in these scenario-based studies, which can be related to uncertainty framing attitudes in scientific communication. Furthermore, a bibliometric analysis shows that the validation practice in different fields of environmental modeling is distinct from each other both in terms of content and citation references.

According to the survey results, there is no consensus among the practitioners about whether the validation of models used for scenario generation should indeed be different. Still, the majority of respondents think that model structure is more important than the output for validation if the models are used for scenario generation. The respondents think that data-driven validation is demanded by decision-makers, and they acknowledge the call for clarifying uncertainties and assumptions. As the experience level of modellers and users increases, they tend to acknowledge the decision-makers’ demand for clear communication of assumptions and uncertainties more. Moreover, logical consistency and likelihood plausibility are the most important scenario characteristics, according to the respondents, that should be taken into account if model validation is to focus on scenarios generated. Diversity and imaginability, which relate to capturing shocks and unknown unknowns, receive less consideration by the respondents.

These findings on the existing perspectives provide a reflection on current validation practices and are expected to facilitate communication at the modelling and decision-making interface. They can also guide future research on the development of validation frameworks for scenario-oriented models. Such frameworks can focus on scenario attributes such as plausibility, consistency and diversity, and the modelling choices that drive these scenario attributes, such as the strategy of sampling and the logic of connecting experimental results to policy recommendations.