

## 6.1 REPORT ON OPTIONS FOR QUALITY MANAGEMENT, VALIDATION REQUIREMENTS & SUITABILITY OF VALIDATION TOOLS

### Background and key outcomes/messages towards policy makers

The MIND STEP model toolbox consists of various models designed for specific purposes, ranging from empirical investigations to agent-based systems. Comprehensive validation is crucial for each individual model to assess its usefulness and credibility, serving as a foundation for evidence-based policy assessment. While validation approaches may vary depending on the specific tool, an integrated framework for validation is necessary for this project. Task 6.1 aims to support validation across MIND STEP's work packages and provide guidelines and indicators for assessing model validity on different scales. This report focuses on simulation models including agent-based approaches, which are increasingly used in assessing agricultural policies but there are no accepted standards for validating complex simulation models. In fact, model evaluation often lacks formal and objective procedures or is not reported adequately compromising credibility. Credibility, however, is essential for decision-making, especially when counterintuitive results arise. To establish credibility, more attention is required for validation in practice. Two strategies for enhancing credibility are comprehensive and transparent presentations of the model's structure and comparing simulation results with other models or observational data. This deliverable provides a report on these and additional options for quality management and validation in the MIND STEP project, based on a comprehensive review of the literature.

First, the deliverable presents a brief overview of selected models used and further developed in the MIND STEP project to highlight the variety of approaches and potential applications before different aspects of quality management are discussed. In this respect, quality management refers to established criteria for data quality and good practice in model/software development as well as more recent emphasize on the development of sustainable research software. Based on a comprehensive literature review, concepts and approaches for model validation are introduced and classified. The necessity of continuous model evaluation through the whole modelling process is highlighted as well as the important role of stakeholder engagement in both, the modelling and evaluation process, is emphasized because validity is conditioned on both purpose or topic *and* the addressees that will use the model or its results.

As an outcome of this task, the common framework and indicator system for model validation for the MIND STEP toolbox is proposed. The underlying idea is that quality management and validation are entangled, mutually condition themselves but also complement each other. For instance, good and transparent documentation is one crucial requirement for quality management but also necessary for successful validation while the clear allocation of responsibility is important for quality management, but might be less relevant in the realm of validation. In general, however, model evaluation is a process consisting of a set of validation (or testing) techniques – grouped into validation, verification, as well as calibration – and supported or complemented by quality management, and (mostly) dependent on data. Furthermore, a key aspect of model validation within the project is involvement of stakeholders. For instance, two stakeholder workshops were organized within work package 1 to identify relevant policy areas and scenarios and a third workshop to focus on model evaluation will be organized within Task 6.3 in autumn of 2022.

The common framework and indicator system for model validation aims to ensure, e.g., that a) tools are suitable to investigate relevant policy measures, b) cover key indicators of interest, and c) provide valid results. Based on different concepts and perspective on model validation, existing guidelines in the literature, as well as experience and results of the project partners, this task developed a checklist with quality criteria and indicators for model validation, which will serve as a mean of quality management within MIND STEP. The checklist is based on the "Checklist for the Quality of Models, Datasets and Indicators" by the Wageningen Modeling Group as well as the structure of the "Modelling Inventory and Knowledge Management System of the European Commission" (MIDAS). Both sources were synthesized and adapted to specific requirements by the MIND STEP project. In particular, the need for modularity and the aim for sustainable research software development are considered.

The checklist will be distributed among partners and the return analyzed within Task 6.2. The obtained results will be used to prepare the workshop in task 6.3 and the feedback and results will help to adapt and improve the common framework and indicator system for model validation. Eventually, the outcome of work package 6 illustrate challenges as well as potential of different validation approaches, provide guidelines for model evaluation and improve the credibility of the MIND STEP modelling toolbox.

