

Quality of models for policy support

The Statutory Research Tasks Unit for Nature & the Environment (WOT N&M) at Wageningen UR uses models, geodatabases and indicators in its policy-oriented research for PBL Netherlands Environmental Assessment Agency (see Bouwma et al., 2014) and the Dutch Ministry of Economic Affairs. This research is undertaken for a variety of purposes, for example for the Nature Outlook reports, the review of the National Ecological Network and the evaluation of the policy on fertilisers and crop protection products. WOT N&M operates a quality system to improve and maintain the quality of these models and databases.^{1,2} This WOt Paper describes this quality system.

Importance of quality assurance

Models play an important role in the preparation of advice on complex policy issues, especially ex ante evaluations of sectoral policies and forecasting and outlook studies, but there are risks involved if the quality of the models is not adequately assured. Any discussion about the quality of the models used will make the political decision-making process much more difficult. Moreover, the efficiency of the whole policy advice process can be impaired if models of inadequate quality are used and shortcomings in the resulting output have to be corrected.

Quality assurance aims to minimise such risks. Given the importance of effective and efficient policy advice, quality assurance of the models used in the preparation of policy advice is relevant to all stakeholders. However, quality assurance is not free. Whether it is worth investing in quality assurance is ultimately a question of weighing the risks associated with a certain level of quality against the costs of guaranteeing this level of quality. The right

balance between costs and quality may turn out to be different for each model or group of models, but in most cases prevention is better (cheaper) than cure.

Quality Impulse

The quality assurance of models used for the statutory research tasks is provided through the long-term Quality Impulse project (*Kwaliteitsslag*). This project started in 2004 following a recommendation by the Task Force on the Quality Assurance of Databases and Models for Policy Assessment Functions. The current WOT quality system for models and data is based on the methodology described in the task force's final report (Jansen et al., 2004). The Quality Impulse project structure is shown in Box 1.

Box 1: Quality Impulse project structure

The project structure for quality assurance is as follows:

1. Steering group: consists of representatives from PBL Netherlands Environmental Assessment Agency and Wageningen UR (Alterra, LEI and WOT N&M) and acts as the delegated commissioning body for the project.
2. Project team: carries out the project, including the further development of the quality system.
3. Internal audit team: assesses the models, databases and indicators against the standards.
4. Sub-projects for improving and maintaining the models, databases and indicators.

Each year a contract is drawn up between WOT N&M and Alterra and LEI, that states which models will be used for the WOT N&M tasks and therefore have to meet the quality standards.

¹ Where in this paper we refer to models or models and databases, we mean models, geodatabases and their associated indicators.

² These are mainly models, geodatabases and indicators used by WOT N&M and maintained by Wageningen UR

Jansen *et al.* (2004) specify two generic quality levels: A and AA. Level A seeks to guarantee a basic quality and focuses primarily on ensuring the completeness of the documentation. Level AA sets higher quality standards and focuses more on content.

In addition to the generic quality levels A and AA, Jansen *et al.* (2004) also specify a 'dedicated' quality level that sets additional requirements above the basic quality level A, to be decided on in consultation with the client. For example, PBL Netherlands Environmental Assessment Agency makes additional quality requirements, commensurate with the needs and risks of policy assessment applications. The level of quality required by PBL is therefore higher than the basic quality level A and is referred to as quality level A+. The Quality Impulse project therefore recognises three quality levels, which have been worked up into three standards: Status A, A+ and AA. These standards are briefly described below.

Status A

WOT N&M employs Status A as the standard for the basic quality level required of models and databases. Status A focuses mainly on the completeness of the documentation and the routine maintenance of the model or database. Adequate documentation forms the basis for effective communication between the developers and other stakeholders about the suitability (and limitations) of a model or database for a particular application. The documentation required for Status A is listed in Box 2. The various elements of the documentation relate to the diagram of the model development cycle shown in Figure 1. To comply with the Status A requirements, for each of the elements in Box 2 a reference must be given to a publication that contains the relevant documentation. In other words, this is an absolute requirement that defines the basic quality level for models.

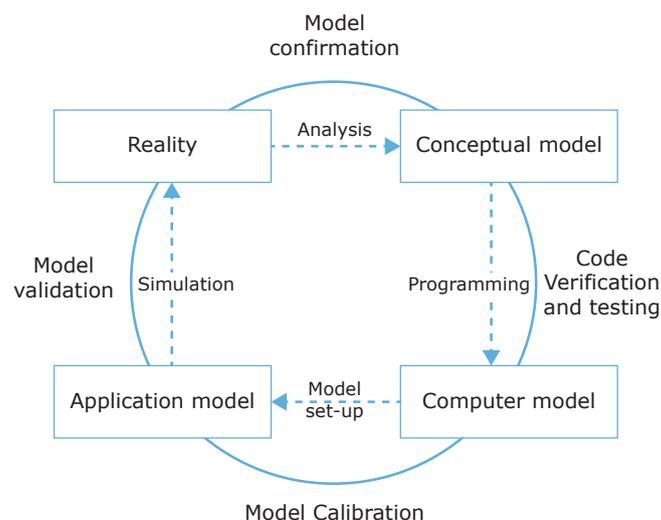


Figure 1. The model development cycle in four aggregated steps, based on Refsgaard & Henriksen (2004). The documentation required for the quality assurance matches the steps in this model development cycle.

The models, databases and indicators used by WOT N&M are assessed against the Status A standard in an audit. The procedure to be followed in this audit is described in Box 3. A comprehensive list of models used by WOT N&M and their current quality assurance status is given on the WOT N&M website.

Status A+

Right from the start, Wageningen UR/WOT N&M and PBL Netherlands Environmental Assessment Agency have worked closely together on the development of the quality system for models, databases and indicators. The demands made by PBL on the core instruments to be used for policy advice are stated in its standards framework document for models (PBL, 2010a) and the PBL standards framework for databases (PBL, 2010b). These requirements differ from the minimum quality level defined in the Status A standard on a number of points. This led to the development of the Status A+ standard, which contains the criteria and standards for Status A as well as the PBL standards framework. A model that meets the requirements of Status A+ therefore meets the PBL's quality requirements in addition to those of WOT N&M.

The main additional requirements in the Status A+ standard compared with Status A are:

- a qualitative uncertainty analysis according to the methodology described by Jansen *et al.* (2003) and Walker *et al.* (2003);
- continual quality improvements, involving the identification and planned realisation of improvement targets based on a systematic evaluation of the application of the model;
- publication of the model in a peer-reviewed journal;
- an assessment of the scientific quality of the model in a scientific review.

Status AA

The quality assurance of models by WOT N&M has so far been limited to quality levels A and A+. However, Jansen *et al.* (2004) recommend raising the quality of models to level AA.

Quality levels A and AA cover more or less the same aspects. The difference is that level AA sets a higher quality standard and focuses more on the scientific content of the model. In addition, whereas the standards for quality level A are static and absolute, those for level AA are more dynamic. The AA standard implies a procedure for systematically raising quality, for example by working to gradually increase the validation status of a model.

This increase in quality is partially incorporated into the A+ standard. The two main additional requirements in Status AA above those of Status A+ are:

Box 2: Status A checklist for models

1. Scientific fundamentals
 - a. purpose of the model
 - b. the conceptual model
 - c. the mathematical model
2. Technical documentation
 - a. global description of how the computer program works
 - b. model parameters and variables
 - c. input specifications
 - d. output specifications
3. User documentation
 - a. meta information about the model
 - b. field of application of the model
 - c. the limitations of the computer program
 - d. the user interface
 - e. description of the input for the user
 - f. description of the output for the user
4. Verification and testing
 - a. verification of the computer program
 - b. description of completed tests
5. Calibration
 - a. calibration of the application model
6. Sensitivity analysis
 - a. sensitivity analysis of the application model
7. Validation
 - a. description of the application-oriented validation of the model
 - b. critical analysis of the test results, sensitivity analysis, calibration and validation of the model
8. Maintenance plan

Box 3: Audit procedure

Audits to establish whether the documentation on a model or database satisfies the requirements of the Status A standard are carried out by a WOT N&M internal audit team that was not involved in the development of the model or database under investigation. The audit team is chaired by a professor at Wageningen UR.

The audit procedure consists of the following steps:

- Carry out a quick scan to determine whether the documentation required for Status A is available.
- If the quick scan reveals any missing information, this is first obtained to ensure the documentation is complete.
- The manager of the model or database completes the Status A checklist, which is used as a guideline when assessing the documentation.
- The internal audit team investigates and assesses the documentation.
- An audit interview is held in which the internal audit team and the manager discuss the outcome of the audit of the documentation.
- The audit team and manager of the model agree on a list of corrections, amendments or additions to redress the shortcomings (critical deviations from the standard) identified in the audit and the time span within which these should be completed.
- Once all the requirements have been met, Status A is awarded for a period of three years. Recommendations are usually made on any non-critical deviations from the standard that must be rectified before the next audit is due.

- evaluation of the complexity of the modelling, which involves assessing the model complexity in relation to the application and the available data; Van Voorn *et al.* (2011) describe a method that can be used for this assessment;
- a greater emphasis on software quality, model analysis (especially sensitivity and uncertainty analysis) and application-oriented validation.

Maintenance of models, databases and indicators

In 2015 about 50 of the WOT N&M modelling tools, including geodatabases, models and indicators, were covered by the quality system described here. Adequate maintenance of these tools is required by the first quality level in the quality system: Status A. This maintenance is coordinated in three clusters that reflect the three fields of expertise at WOT N&M for which modelling is an important tool: Agricultural Systems, Semi-Natural Systems and Landscape (Figure 2). By maintaining the models per cluster rather than individually we are better able to monitor and harmonise the development, quality improvement and quality assurance of the models in the cluster. This harmonisation is important because applications often involve model chains linking one or more databases and models and an indicator.

Latest developments

WOT N&M's quality system for models, geodatabases and indicators is now operational. The quality assurance of most of these tools has been set at Status A, the quality level for adequate documentation. For some modelling tools – the so-called core instruments – the quality assurance must be extended to cover the more substantive and application-oriented aspects (Status A+ and AA). In recent years, however, budget cutbacks have put a strain on the quality assurance of models and

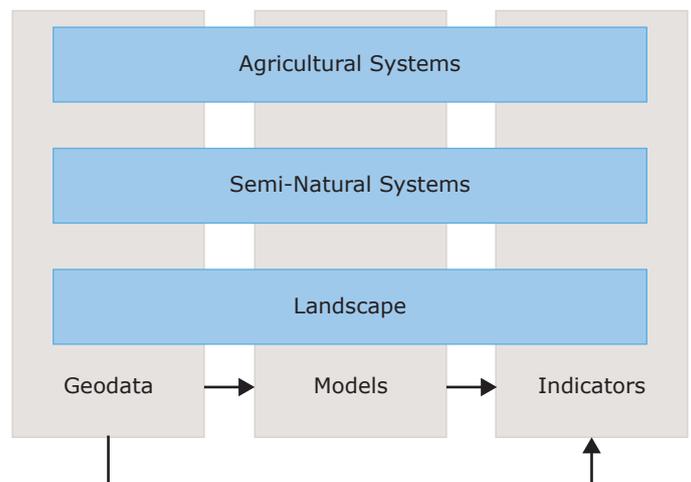


Figure 2.

Clusters (in blue) of data on soils, land use and hydrology, models for making ex ante analyses, and indicators that link the results with the policy objectives.

databases, especially those in the agri-environment cluster. The risks this entails have been described above.

Alterra Wageningen UR is the main supplier of models and databases used by WOT N&M. Alterra will deploy the quality assurance methodology described in this paper on all its strategic models and databases, irrespective of whether they are used by WOT N&M or not. This will further optimise the quality assurance throughout the whole process from model development (by LEI Wageningen UR as well as Alterra) to applications in policy assessment and advice.

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