Validation of uncertainty-oriented environmental models
A review of the existing approaches

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Model “Validation”

- **In environmental modeling,**
  whether model outcomes are consistent with observational data, or the model is an accurate representation of physical reality.

- **In decision sciences,**
  establishing confidence in the model by judging its usefulness with respect to some purpose.

- **In Merriam-Webster,**
  valid: “well-grounded and justifiable.”
Three complementary paradigms for modelling the future

Source:
Validation of uncertainty-oriented models

What are the existing validation viewpoints, in a general modeling context?

What are the existing validation viewpoints, when models are used for scenario exploration?

- Text-mining of the academic literature
- Online survey
## Overview of the model validation literature

### Text-mining analysis

<table>
<thead>
<tr>
<th>Any of the title, abstract or keywords include</th>
<th>DATASET I</th>
<th>DATASET II</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;model validation&quot; OR &quot;model validity&quot; OR &quot;model evaluation&quot; OR &quot;model assessment&quot;</td>
<td></td>
<td>(&quot;model validation&quot; OR &quot;model validity&quot; OR &quot;model evaluation&quot; OR &quot;model assessment&quot;) AND scenario</td>
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<table>
<thead>
<tr>
<th>Years</th>
<th>1980-present</th>
</tr>
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<tbody>
<tr>
<td>Language</td>
<td>only English</td>
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</tbody>
</table>

### Predefined Scopus fields

- Environmental science
- Agricultural and biological sciences
- Energy
- Social sciences
- Economics, econometrics and finance
- Decision sciences
- Multidisciplinary

| Number of documents returned | 15821 | 1124 |
Overview of the model validation literature

Dataset 1

Ecosystem & agriculture

Energy systems

Water management

Method
Overview of the model validation literature

Dataset II ("scenario")

- **Ecosystem & agriculture**
  - soil, crop, water, forest
- **Hydrology**
  - climat, chang, hydrolog
- **Emissions & pollutants**
  - concent, water, qualiti, nume
- **Method**
  - data, develop, system, structur
Survey on Model Validation
Survey on Model Validation

Representativeness vs Usefulness

2. The most important criterion for a model's validity is how useful it is for a given purpose.

1. The most important criterion for a model's validity is how well it represents reality.
Survey on Model Validation

Data

5. Models cannot provide accurate projections; therefore, we cannot use them for prediction purposes.

4. Multiple models can create the same output that matches with the historical data. Therefore, a model’s validity cannot be linked to its replication of the past.

3. A match between the model output and historical data is a strong indicator that the model can provide accurate projections of the future.
Survey on Model Validation

Decision maker’s view

6. A model user, for instance a decision maker, finds a model credible if it can replicate the historical data.

7. A decision maker finds a model credible if it is comprehensive and detailed.

8. A decision maker finds a model credible if the uncertainties and critical assumptions are communicated well.
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Modelling role

The most important criterion for a model's validity is how useful it is for a given purpose.

- None
- Both
- User
- Developer

Strongly disagree
Disagree
Neutral
Agree
Strongly agree
Survey on Model Validation

Experience

A decision maker finds a model credible if the uncertainties and critical assumptions are communicated well.

- Less than 2 years
  - Strongly disagree
  - Disagree
  - Neutral
  - Agree
  - Strongly agree

- 2-5 years
  - Strongly disagree
  - Disagree
  - Neutral
  - Agree
  - Strongly agree

- 5-10 years
  - Strongly disagree
  - Disagree
  - Neutral
  - Agree
  - Strongly agree

- More than 10 years
  - Strongly disagree
  - Disagree
  - Neutral
  - Agree
  - Strongly agree
Conclusions

• Data-oriented validation for predictive power
• ... even when models are used for scenario exploration
• No dichotomy of representativeness vs usefulness
• Strong support for comparison to historical data
• Structure and scenario ensemble are more important in the validation of uncertainty-oriented models
Validation of uncertainty-oriented environmental models

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