

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

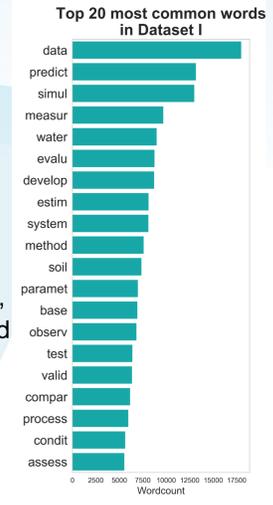
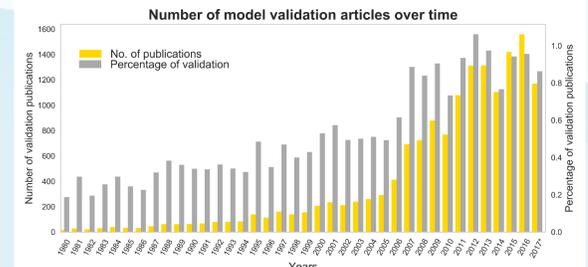
Sibel Eker\*, Elena Rovenskaya, Michael Obersteiner, Simon Langan  
*International Institute for Applied Systems Analysis, Laxenburg, Austria*  
 \*eker@iiasa.ac.at

## Motivation: Changing model purpose

- Models have traditionally been used to find the **best-estimate** futures, therefore the validation (evaluation, assessment) approaches focused on building a “robust” model that narrows all the complexity and uncertainty down to a single estimate.
- Models are increasingly used to explore a variety of **scenarios**, instead of generating a best-estimate future. Therefore, the validation approaches should be aligned with this changing model purpose.
- Before investigating potential validation techniques for uncertainty-oriented models, this study reviews the existing validation approaches.

## Conclusions

- The number of model validation publications has significantly increased over time, yet it is still a small fraction of the total number of modelling publications.



## Validation viewpoints

Philosophy of Science	Validation viewpoint
<i>Foundationalist / Objectivist:</i> Rationalism Positivism Logical empiricism	• True or False • <b>Representativeness</b> • <b>Accuracy</b> • Historical <b>data</b> reproduction
<i>Anti-foundationalist</i> <i>Relativist</i>	• Validity on a continuum • <b>Usefulness</b> • Semiformal, conversational process • Equifinality
<i>Post-normal science</i>	• “facts uncertain, values in dispute, stakes high and decisions urgent” • <b>Usefulness</b> • Credibility in participatory settings

- The most common words are **data**, **predict** and **simulate**, implying a prediction orientation in the model purpose, and a data-driven validation. This finding points out a predominant *foundationalist* viewpoint.
- Even when the studies on both model validation and scenarios are considered, the results are similar. **Data** receives very high emphasis, while **uncertainty** is mentioned rarely.
- Evaluation and assessment are more commonly used terms than validation.
- Hydrology and crop yield models are mostly associated with **calibration**, whereas the ecosystem studies prevalently mention **prediction**. Overall, the common model validation approach is **data-oriented**.

## Text-mining on the model validation literature

- What are the prevalent concepts and major clusters of work in the model validation literature?
- Are the validation approaches different when models are used in “scenario” studies?
- Two datasets of academic publications with the following search criteria on Scopus:

	DATASET I	DATASET II
<i>Any of the title, abstract or keywords include</i>	"model validation" OR "model validity" OR "model evaluation" OR "model assessment"	("model validation" OR "model validity" OR "model evaluation" OR "model assessment") AND <b>scenario</b>
<i>Number of documents</i>	15355	1109
<i>Years</i>	1980-present	
<i>Predefined Scopus fields</i>	<ul style="list-style-type: none"> <li>Environmental science</li> <li>Agricultural and biological sciences</li> <li>Energy</li> <li>Social sciences</li> </ul>	<ul style="list-style-type: none"> <li>Economics, econometrics and finance</li> <li>Decision sciences</li> <li>Multidisciplinary</li> </ul>

## Main topics in the model validation publications (Dataset I)

- Latent Dirichlet Allocation to identify the main topics and their contents
- Prediction** and **data** orientation in the ecosystem and energy studies; **calibration**-focus in the hydrology models
- Evaluation** and **assessment** are more common than validation
- Little emphasis on **uncertainty**

## Main topics in the model validation & scenario publications (Dataset II)

- Not data but **calibration** in the crop yield models
- Strong emphasis on **scenarios** in the hydrology/climate change studies, while data, prediction and uncertainty receive relatively low attention
- Emphasis on **quality**, and low association with data and prediction in the emission & pollution studies
- Little emphasis on **uncertainty**

