



**HAL**  
open science

# Analysing the validity and robustness of the iconic World 3 global model: what can sensitivity and feedback loop analysis say?

Mathilde Jochaud Du Plessix, Serge Fenet, Pierre-Yves Longaretti

## ► To cite this version:

Mathilde Jochaud Du Plessix, Serge Fenet, Pierre-Yves Longaretti. Analysing the validity and robustness of the iconic World 3 global model: what can sensitivity and feedback loop analysis say?. CCS 2021 - Conference on Complex Systems, Oct 2021, Lyon, France. pp.1-1. hal-03558243

**HAL Id: hal-03558243**

**<https://inria.hal.science/hal-03558243v1>**

Submitted on 4 Feb 2022

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## **Analysing the validity and robustness of the iconic *World 3* global model: what can sensitivity and feedback loop analysis say?**

M. Jochaud du Plessix<sup>1</sup>, S. Fenet<sup>2,1</sup>, P.Y. Longaretti<sup>1</sup>. (1) Université Grenoble Alpes, CNRS, Inria, Grenoble INP, LJK, Grenoble, France, [mathilde.jochaud-du-plessix@inria.fr](mailto:mathilde.jochaud-du-plessix@inria.fr). (2) Université Lyon 1, LIRIS, Lyon, France. (3)

*World3* is a flagship complex model. It was the first to widely explore potential future global socio-environmental trends, and to point out in a focused and sophisticated manner the possible dire consequences of forced growth in a finite and constrained environment. Since the inception of its first version in 1971 [1], it has attracted a lot of attention, comments, praises and criticisms. Many were however based on shallow arguments, and of the few in-depth analysis of the model that have been performed, most were carried out in an early period and lead to some incorrect conclusions due to their highly generic level of assessment of the model input parameters (see in particular [2]). The interest in the model has been revived in the last decade or so, in light of the growing concerns about planetary limits and the impact of human activity on natural systems, and following an *ex post* analysis of Turner [3]. Along with the availability of recent data, this revival of interest fueled the need to re-evaluate both the robustness of the model and the validity of its conclusions. This task presents however a delicate epistemological dimension: how can we evaluate the validity of a model with only one historical instantiation, and whose focal point of projection lies in the future? We will present the first two steps in the answer to this question.

First, we have performed an extensive analysis of the parameterization choices made by the authors of the model, based on a comprehensive sensitivity analysis of the whole model, made possible by modern computing power. This relies both a one-step-at-a-time screening method and a variance decomposition method. This first analysis allowed us to identify the most influential parameters in an objective way. Second, we performed an analysis of the inner dynamics of the model based on the relative importance of its feedback loops, based on a complete loop structural dominance analysis [4]. In order to deal with the large number of feedback loops of the model, we have used an enumeration of the smallest independent loop sets.

In conclusion, we will briefly outline the next step in this study, bearing on the role of modelling choices, and discuss in light of our results the relevance of the model to the real world and emerging Anthropocene era, some fifty years after its initial development.

### **References**

- [1] D.L. Meadows, W. W. Behrens, D. H. Meadows, R. F. Naill, J. Randers, E. Zahn. Dynamics of growth in a finite world. Cambridge, MA: Wright-Allen Press, 1974.
- [2] P. Vermeulen, D. C. de Jongh. Parameter sensitivity of the ‘Limits to Growth’ world model. *Applied Mathematical Modelling*, 1(1), 29-32, 1976.
- [3] G. M. Turner. A comparison of The Limits to Growth with 30 years of reality. *Global environmental change*, 18(3), 397-411, 2008.
- [4] C. E. Kampmann, R. Oliva. Structural dominance analysis and theory building in system dynamics. *Systems Research and Behavioral Science: The Official Journal of the International Federation for Systems Research*, 25(4), 505-519, 2008.