Systems modelling for sustainability transitions: Virtues and vices

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Abstract: The world's progress towards the United Nations Sustainable Development Goals (SDGs) so far has been limited (van Vuuren et al., 2022). Global disruptions of social, health, and economic systems from the COVID-19 pandemic also further exacerbate the already slow pace, distracting nations from the focus required to meet the SDGs. This challenges the achievement of even the least ambitious sustainability aspirations by 2030 (Obersteiner et al., 2016), making a new round of assessment and ambitious sustainability target-setting (Díaz et al., 2020) imperative. Within this context, models are increasingly used to inform the transition towards a sustainable future, aligned with the Sustainable Development Goals (SDGs).

In the interface of modelling and transitions research, various methods and approaches have been used for understanding systemic change in human-natural systems and providing case-specific policy insights (Köhler et al., 2018). Recent studies (Guivarch et al., 2022) have suggested that using a greater diversity of models with different methodologies, sectoral scopes, and levels of structural complexity can provide more robust insights about future uncertain transitions that involve side-effects, non-linear behaviours, and complex interactions.

We will draw on recent modelling works (Liu et al., 2023; Moallemi et al., 2022) at the global scale and framed by the SDGs to demonstrate how system dynamics as a modelling approach can support sustainability transitions. We use a system dynamics model of coupled human-natural systems to analyse the dynamics of and interactions between demography, economy, energy, land, food, biodiversity, and climate systems through the SDG lens. The adoption of a system dynamics model, with different sectoral boundaries and levels of structural complexity (compared to the original marker integrated assessment models) helps expand the exploration of the scenario space to capture a wider set of futures in global scenarios, driven by different perspectives and model uncertainties. We explore the progress in 50,000 different scenarios, ranging from continuation of current trends to the implementation of the strong measures for sustainable development to the end of this century, to comprehensively deal with uncertainties that prevail in the specification of future pathways. We will finally highlight some of the strengths and limitations of this study and the use of system dynamics for transitions research in general.

REFERENCES

Díaz, S., Zafra-Calvo, N., Purvis, A. et al. 2020. Set ambitious goals for biodiversity and sustainability. Science 370, 411.

Guivarch, C., Le Gallic, T., Bauer, N., et al. 2022. Using large ensembles of climate change mitigation scenarios for robust insights. Nature Climate Change 12, 428–435.

Köhler, J., de Haan, F., Holtz, G., Kubeczko, K., Moallemi, E.A., Papachristos, G., Chappin, E. 2018. Modelling sustainability transitions: An assessment of approaches and challenges. Journal of Artificial Societies and Social Simulation 21, 8.

Liu, Q., Yang, J., Gao, L., Dong, Y., Guo, Z., Moallemi, E.A., Eker, S., Obersteiner, M. 2023. Robust sensitivity analysis to uncertainties in environmental and socio-economic scenarios: A perspective from a global socio-ecological system model. Journal of Cleaner Production 410, 137244.

Moallemi, E.A., Eker, S., Gao, L. et al. 2022. Early systems change necessary for catalyzing long-term sustainability in a post-2030 agenda. One Earth 5, 1–20.

Obersteiner, M., Walsh, B., Frank, S. et al. 2016. Assessing the land resource–food price nexus of the Sustainable Development Goals. Science Advances 2, e1501499.

van Vuuren, D.P., Zimm, C., Busch, S., et al. 2022. Defining a sustainable development target space for 2030 and 2050. One Earth.

Keywords: *Sustainable Development Goals, sustainability, integrated assessment modelling*