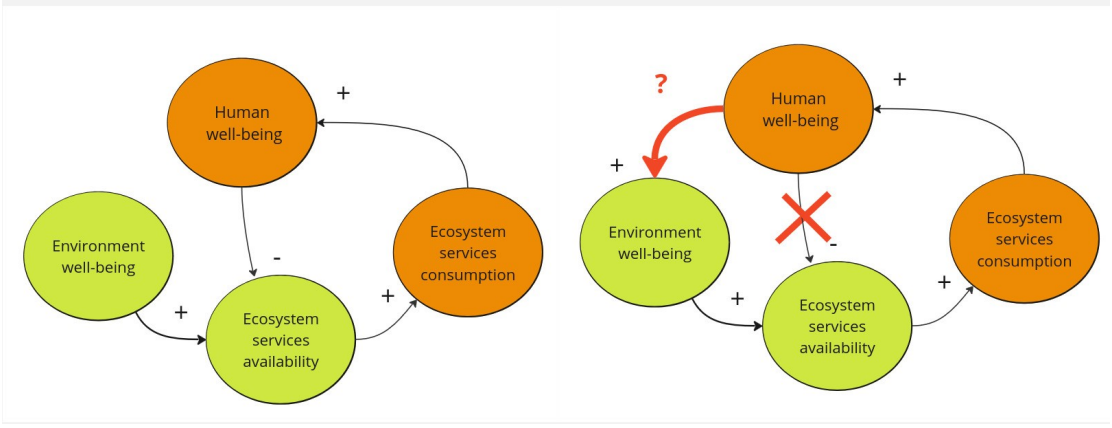
Human-environment interactions and well-being modelling

Ieva Vitolina, Una Krutova
Riga Technical University

Considering different possible approaches to measuring well-being, we have reviewed research on monitoring human and environmental well-being to outline the factors influencing well-being, data sources and methods used to characterise well-being processes (Vitolina et al., 2024). The focus of well-being studies (articles) was on the human-environment interaction aspect (perspective). We have come to the following main conclusion: The dominant approach is anthropocentric (ecosystem, nature is only a tool or service for human well-being). A holistic approach (human as part of the ecosystem) or an ecocentric approach as a research goal is hard to find in the reviewed articles.

Figure 1 illustrate current situation and desired future situation for causal relations between human and environment well-being.



a - Current situation b - Desired future situation

Fig 1. A conceptual perspective on human-environment interactions and the causal relationships of well-being. Black lines are conclusions about theoretical links from the reviewed literature, red lines are links where quantitative causation studies are needed. Human components are highlighted in orange color and environment components are highlighted in green color.

A holistic approach to well-being is given by the definition of planetary well-being, where according to Kortetmäki et al. (2024) planetary well-being is "a state in which the integrity of Earth system and ecosystem processes remains unimpaired to a degree that lineages can persist to the future as parts of ecosystems , and organisms (including humans) can realize their typical characteristics and capacities". Kortetmäki et al. (2024) conceptualize planetary well-being using a systems-oriented approach. According to Kortetmäki et al. (2024) system is “an entity that is comprised of its components, that can be impacted by the environment, has characteristic relations and interactions between its components, and has system-specific characteristics and capacities that stem from the system processes”. Attention should be paid to *critical system processes* without which the system cannot continue. System processes are interactions between system *components*. Interaction requires *inputs* to function. Another key element of the system is needs, inputs are *need-satisfiers*. Needs must be satisfied for the critical system processes to function. The concept of planetary well-being does not deny that human needs must be taken into account, but this concept draws attention to the fact that it is necessary to be able *to distinguish the basic needs of people from the desires and wills of people,* which negatively affect non-human nature or the environment (Kortetmäki et al., 2024).

Our aim is to find out how to balance human interests with non-human well-being, how to organize such systems that satisfy human needs but do not threaten the integrity of the Earth system and ecosystem processes.

We would like to propose the following theoretical well-being model that provides feedback loop dynamics: (1) Positive feedback from environmental well-being to human well-being; (2) Positive feedback from human well-being to environmental well-being; (3) regulation of desires.

Feedback loop dynamics are based on our following assumptions: (1) Higher environmental well-being enhances the availability of ecosystem services. (2) More available ecosystem services lead to greater human well-being as basic needs are met effectively. (3) As human well-being improves, there can be greater investment in sustainable practices or restoration efforts, enhancing environmental well-being. This can occur through policy changes, conservation initiatives, or a cultural shift towards environmental stewardship. (4) The model differentiates between basic needs, which have a positive impact on well-being, and desires, which can lead to overconsumption and thus pose risks to or reduce environmental well-being. By controlling desires, people can reduce negative impacts on environmental well-being and support a sustainable loop.

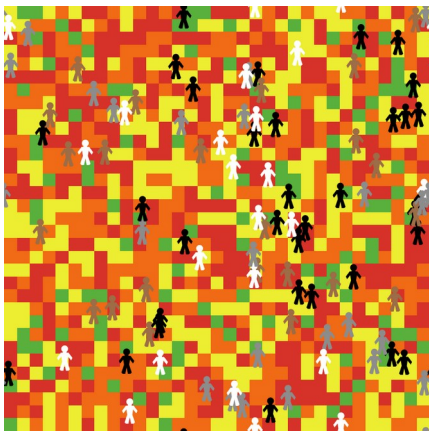
The operational scenario of our model from a time perspective is based on the following assumptions: (1) Early stage: Human well-being increases as basic needs are met, leveraging the available ecosystem services. (2) Mid-stage: As desires increase, they lead to higher consumption of ecosystem services, reducing availability of ecosystem services, and potentially slowing the growth of human well-being. However, the positive feedback from environmental well-being to human well-being is still there. (3) Long-term: If human well-being promotes better environmental practices, environmental well-being stabilizes or grows, creating a sustainable reinforcing loop. If desires are not controlled, environmental well-being may decline, breaking the positive feedback loop.

We have begun to study these dynamics of well-being using an agent modeling approach. We used multi-agent programmable modeling environment Netlogo (**https://ccl.northwestern.edu/netlogo/**). We have created the 1st draft version for the planetary well-being concept, which we plan to develop further. The model can simulate interactions between humans (agents) and the environment (patches). In this model, agents consume ecosystem services to meet their needs, and the environment regenerates these services based on certain parameters. The goal is to observe how human well-being and environmental well-being evolve over time based on agents' consumption patterns (basic needs and desires) and environmental regeneration.
Figure 2 presents the 1st draft model of human and environment well-being. The model shows that initially environmental and human well-being increases, then environmental well-being decreases, but human well-being forms a slightly increasing trend with relatively large fluctuations, until it rapidly decreases.
Next, we plan to examine how environmental and human well-being curves are affected by changes in people's basic need and desire ratio. Our goal is to test the configuration of the model to achieve a balance between environmental and human well-being.

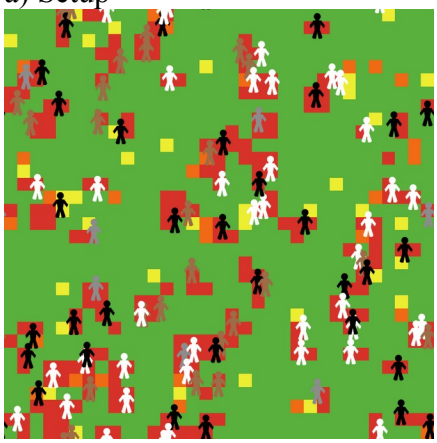
The background color represents environmental well-being: green – very high; yellow - high, orange – low; red - very low.

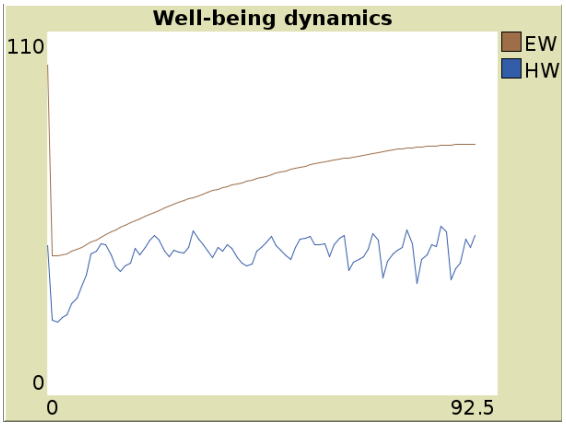
The color of the person's icon shows the human well-being: white – very high; grey - high, brown – low; black - very low.

In plots: blue line represents average human well-being, brown line represents average environmental well-being.

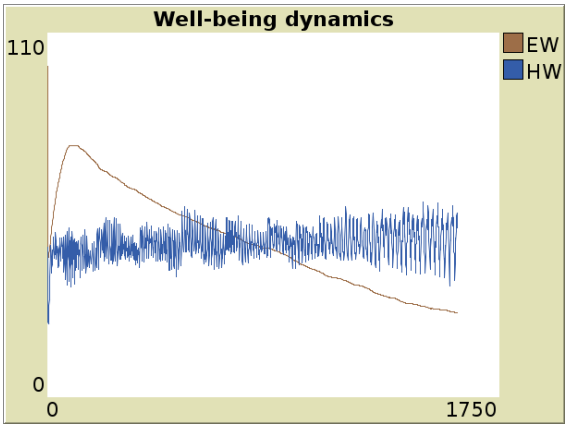


a) Setup

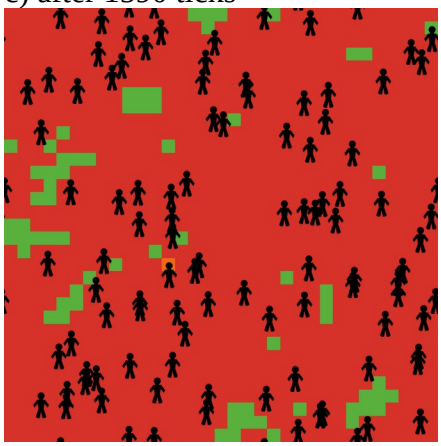


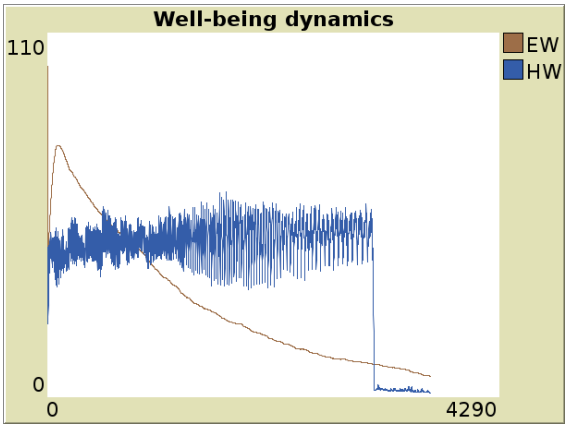


b) after 88 ticks



c) after 1590 ticks





d) after 3636 ticks

Fig. 2. Agen based model of human and environment well-being.

Acknowledgments

This research has been funded by the European Union. Project ”Twinning in Environmental Data and Dynamical Systems Modelling for Latvia”. TED4LAT, No. 101079206. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Research Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

References

Kortetmäki, T., Puurtinen, M., Salo, M., Aro, R., Baumeister, S., Duflot, R., ... & Kotiaho, J. S. (2024). Planetary well-being 1. In *Interdisciplinary Perspectives on Planetary Well-Being* (pp. 9-25). Routledge.

Vitolina I., Mathias J-D., Krutova U., Gorbunovs A., Kapenieks A., Kapenieks (Sen.) J., Kapenieks (Jun.) J., Jakobsone-Snepste G. (2024). Human - Environment interactions and well-being monitoring: a Systematic Review. *Submited for publication*