"There is all too little awareness that man is part of nature, and that the price of conquest may well be the destruction of man himself."

- Rachel Carson, June 1962

Sustaining human life on planet Earth in ways that enable living in dignity can only be achieved with an advanced understanding of how humanity is intertwined with the biosphere. New findings and insights are awaiting from investigating the human life as intertwined and embedded within the biosphere. We invite you to support the further development of a conceptual framework by answering the following questions:

Development of Framework

- What are necessary features of an ontology to foreground humanity's embeddedness within the biosphere?
- How can these entanglements of human life with elements of the biosphere be empirically studied?

Application of framework

- What are potential pilot studies to explore and understand entanglements of human life (with living conditions throughout space and time)?
- What does a foregrounded understanding of the intertwined biosphere mean for science, policy, and practice?

The Intertwined Biosphere

The biosphere is the collection of all living beings on planet Earth, their relationships, and their interactions with the elements of lithosphere, cryosphere, hydrosphere and atmosphere (Figure 1). The Earth's biosphere is 'intertwined' and living beings are inextricably interconnected. Human beings are also 'embedded' within this unique biosphere and entangled with the elements and relationships within it. Anthropogenic activity has expanded to such an extent that it has become a major global force shaping the operation of the whole biosphere and its relations to the broader Earth system, with significant interactions and feedbacks to be unravelled and understood. By foregrounding the different ways that humans are embedded within the biosphere, we aim to contribute to narratives that bridge divided human-nature imaginaries and foster a deeper understanding of the critical interplay of humans as part of the living biosphere.

The 'Intertwined Biosphere' project is based on the premise that a sustainable presence of humanity on planet Earth can only be fostered through an advanced understanding of how human life is intertwined with the biosphere. Human practices shape resource flows, vegetation patterns and biodiversity, which in turn feedback on human well-being. Research shows that 60% of all mammals alive on the planet are kept by humans for food production, and the widespread simplification of the biosphere's ecosystems has caused significant vulnerability for both people and ecosystems[1–3]. Social conditions; such as health, culture, democracy, power, justice, equity, matters of security, and even survival, are interwoven with elements of the biosphere, resulting in a complex interplay of interdependent local, regional, and global interactions.

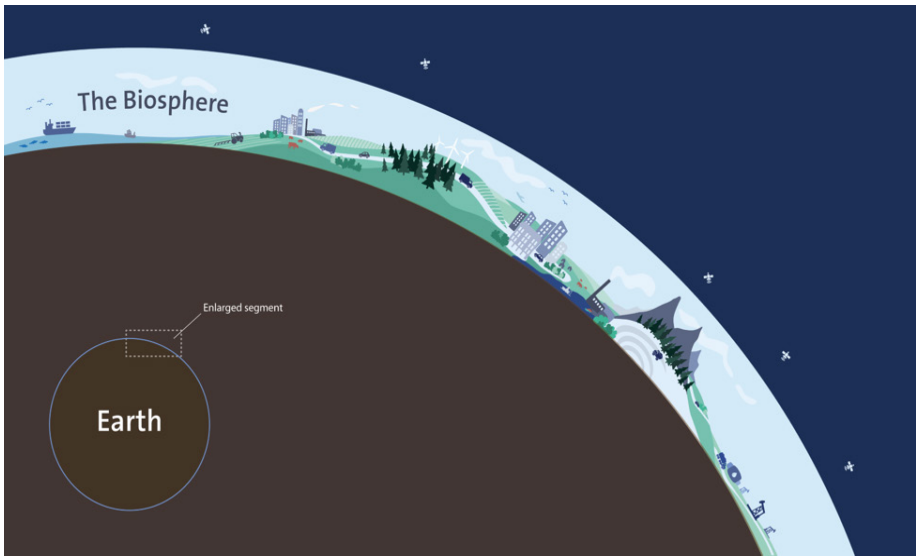

FIGURE 1: There is a dynamic interplay between the living biosphere and the broader Earth system, with the atmosphere, the hydrosphere, the lithosphere, the cryosphere, and the climate system. Humans have become a major force in shaping this interplay. Artwork by J. Lokrantz, Azote[2].

Within this project, we call for investigations and analyses, through a diversity of approaches and methods, which capture and demonstrate what being intertwined and embedded means. We envision that such studies cover multiple topics varying over spatiotemporal scales. We aim to acknowledge and engage with multiple cultural backgrounds, ways of being, cosmologies and knowledge systems that do not make clear distinctions between notions of culture and nature, and which base their interactions among humans and nonhumans on respect, kinship, agency and reciprocity, but receive less recognition in dominant scientific debates[4,5]. We invite you to engage across disciplines in developing a conceptual framework for recognising and better understanding the embeddedness of humanity within the intertwined biosphere.

Developing a conceptual framework

We want to work with you on a conceptual framework to foster the emergence of an ontology for an improved understanding of Anthropocene dynamics and to offer a new point of departure for investigating relevant feedback loops for supporting a thriving biosphere. By looking for an 'ontology', we will explore different ways to discern multiple 'entities' within the biosphere, how they can be grouped into categories, and the relations between such elements. By developing an ontology on the intertwined biosphere, we aspire to nudge ways of thinking, feeling, and doing (see Figure 2). The purpose of developing a conceptual framework for the intertwined biosphere is, therefore, to:

1. Help identify, discover, and understand critical intertwined interactions and feedback loops between people and nature embedded in the biosphere;
2. Stimulate investigations and analyses through a diversity of approaches and methods that capture and demonstrate what being intertwined and embedded means, and the implications for the sciences and humanities, as well as for practice and policy of such findings; and
3. Inspire others to use the intertwined and embedded framework in investigations and actions.

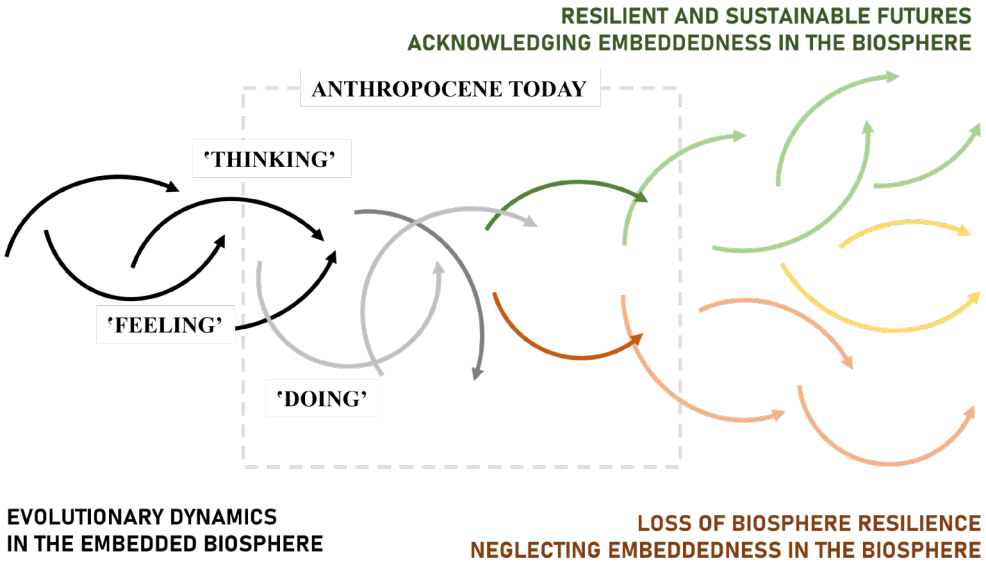

FIGURE 2: The role of a new ontology paradigm for ushering humanity towards a sustainable future embedded in the biosphere. Changes in perspectives on 'good' dietary habits, for example, can influence the organisation of agricultural practices, and, therefore, vegetation patterns, which influence the storage and evaporation of water, which cycle back again to people's lived experiences.

We take inspiration from the notion of social-ecological systems (SES) that are often conceptualised as complex adaptive systems[6]. SES "are human and natural coupled systems where people interact with biophysical components; they often exhibit nonlinear dynamics, feedbacks, time lags, heterogeneity and resilience"[7]. As a building block of our framework, we want to consider the notion of '*complex evolving systems*' to explore ways to consider the intertwined biosphere.

By using the notion of complex evolving systems, we want to study continuously changing systems as a congregation of processes, i.e. a continuous becoming of new situations. Complex evolving systems are historically contingent, their shapes depend upon many prior conditions, which also depend on historical conditions. These developments are heterogeneous, and can be of diverse composition and character. The nature of these systems is also nested, meaning that each complex evolving system is embedded in larger complex evolving systems.

A conceptual framework building on an understanding of complex evolving systems can help describe how entities and their developments are mutually shaping each other. Studying complex evolving systems as emerging, means studying how a system becomes through the interaction and feedback loops of multiple developments. Developments in the financial markets, for instance, can, in turn, be described as something that comes into being through the interaction of multiple developments.

We tentatively propose three dimensions to be included in a new framework as concrete starting points for analysing embeddedness quantitatively and qualitatively: compositional, relational, and evolutionary (Fig. 3).

1. Systems and entities, as well as behaviours and dynamics, could be studied in terms of their constituents (compositional). For example, the compositional embeddedness of a human body (entity/system) can be studied by identifying and assessing to what extent different human body components, such as water, minerals, and microbes, originate from other ecosystem activities or biosphere functions. The compositional embeddedness of non-material systems (behaviour/dynamics) could also be studied with a compositional lens, for example, by dissecting the contributions of various ecosystem functions for a certain type of behaviour or way of organisation (e.g., the role of geography for geopolitical organisations).
2. Relational embeddedness can similarly be studied with a material (metabolic) and/or non-material (cultural) focus. With a relational lens, the focus turns to the flows and connections, such as trade networks (metabolic) or information exchanges (cultural).
3. Evolutionary embeddedness can be studied as historical explanations (roots of embeddedness), potential future co-existence (existential interdependence), and co-evolving feedbacks and emergence between the compositional and relational entities, systems, and assemblages in the biosphere.

The evolutionary perspective allows for explaining and complementing the contemporary compositional and relational characteristics (e.g., the current microbe content of human bodies explained by evolutionary theory), as well as for identifying asymmetrical interdependencies (e.g., humans depend existentially on the water cycle, whereas the existence of the water cycle is relatively unaffected by human existence).

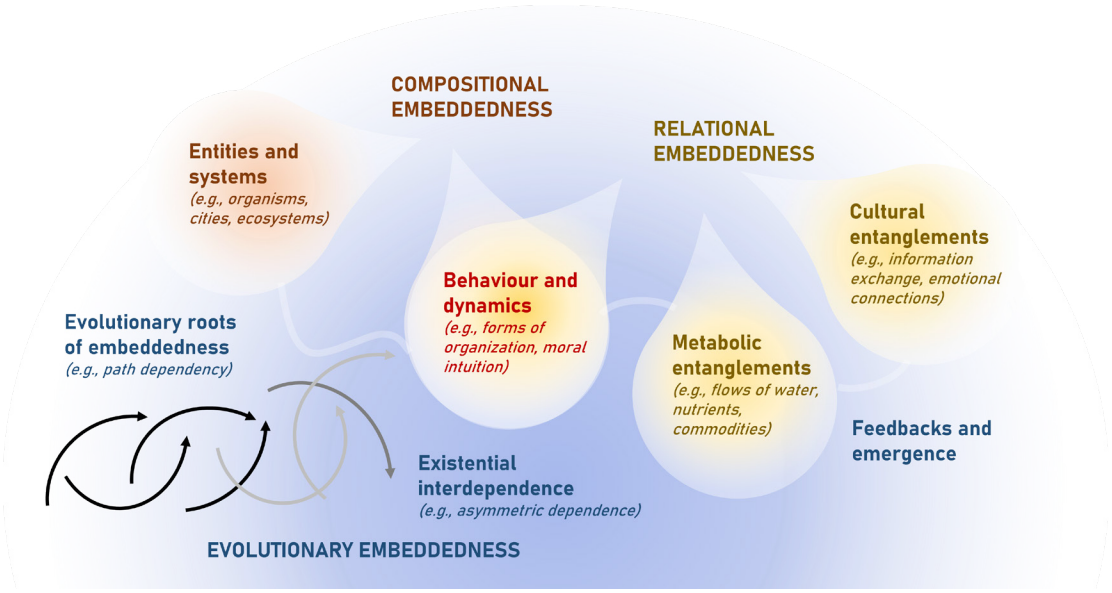

FIGURE 3: Features in embeddedness analyses. Three dimensions of embeddedness: compositional, relational and evolutionary.

Vision forward

In the following months, we invite you to engage with us in our project to foreground humanity's embeddedness in the intertwined biosphere. During the 'Intertwined Biosphere' workshop (12th to the 14th of February 2024), we aim to establish a conceptual framework to help identify, discover and understand humanity's embeddedness in the intertwined biosphere

Our ultimate goal is to contribute to an elaborate understanding of Anthropocene dynamics, and the guidance of actions for sustaining human life within thriving ecosystems. We envision this framework to be applied to a series of pilot studies to highlight humanity's embeddedness within the biosphere.

We envision this conceptual framework to be applied in transformation research addressing solutions for thriving ecosystems with embedded human beings living in dignity. Inspired by the design criteria of transformation research from Hölscher et al.[8], we ideate that these pilot studies use both descriptive-analytical approaches and transformative research approaches to address real-world problems at multiple spatiotemporal scales. Finally, we envision that the pilot studies include a historical account of how situations emerge, and acknowledge plurality in lived experiences, socio-material realities and positions within power structures.

To conclude, we aim to foster change in science and society by addressing humanity's intertwinedness and embeddedness in the biosphere, and contribute to ontologies and practices that acknowledge their intertwinedness in every facet. The understanding gained by the analyses, empirical work, and examples of intertwinedness is envisioned to increase the understanding of Anthropocene dynamics and help guide actions for transformations towards sustainable futures.

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