Conceptual Framework

Deliverable D1.1

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TRANSPATH

Transformative pathways for synergising just biodiversity and climate actions

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Contents

Executive summary

This report provides an original conceptual framework synthesising the current knowledge on how to trigger, enable and navigate transformative pathways synergising climate and biodiversity actions that are respectful to social-cultural contexts and that take into account the future's unpredictability and long-time frames. It does so by reviewing, bringing together, and advancing **four main research fields central to current transdisciplinary efforts aimed at supporting sustainability transformations: leverage points, positive tipping points, the search for a safe and just operating space for humanity, and regenerative sustainability**. A key overarching concept in this deliverable is the notion of **net-positive biodiversity-climate tipping points**, which can be used to inform and support stakeholders and researchers' dialogues across the various TRANSPATH work packages.

In the context of the TRANSPATH project, ***transformative pathways*** can be understood as consistent clusters of actions and solutions—*or systems of solutions*—coordinated under a deliberate vision or policy goal aimed at ***fundamentally altering, in a more just and ecologically safe way, the original conditions*** in which communities, organisations or large social-ecological systems operate. The proposed conceptual framework suggests that pathways aiming to synergise climate and biodiversity actions need to map out and consider *at the same time*:

- ***Multiple leverage points****:* intervening at different parts of a given system of reference and its social-ecological relationships.
- ***Multiple levels and domains of social action***: and doing so within and across personal, organisational and large-system levels; hence entailing changes in individual lifestyles, socioenvironmental practices, institutional processes as well as in political and distributional arrangements.
- ***Multiple spatial scales and time periods****:* in which individual and collective actions take place and throughout the times that their consequences materialise (in past, present and future). Transformative pathways focusing on climate and biodiversity need to consider alternative and multiple notions of time beyond only socioeconomic, linear or ecologically uncoupled notions of time; in particular, those that have to do with social-ecological cumulative processes that affect, either positively or negatively, life-support systems, such as the times left to hit certain dangerous climate thresholds (e.g., the 2°-1.5°C threshold) or/and the times left to avoid species extinction processes.
- ***Multiple notions of justice*****:** not only considering recognition, distributive and procedural notions of justice, but also taking into account more challenging approaches of *transformative justice* that combine local ideas of fairness around natural resource use and access as well as Earth System justice and the search for a just and safe operating space for humanity. This fundamentally also includes future justice.
- ***Multiple positive synergies between improvements in social conditions (capitals or stocks) and improvements in biophysical ones:*** securing the long-term viability and quality of life-support systems in a world heading possibly to 10 billion people by 2050 depends on the extent that mutual benefits between both can be created to trigger self-propelling, continuous and regenerative processes of transformative change; thus, overcoming zero sum-game

discourses of society-nature relationships while acknowledging justice considerations.

Fundamental deliberate transformations may occur at one moment when a relatively small additional force of change alters the original configuration and dynamics in which a given system—either an individual, an organisation or large systems—evolves. When these deep changes happen and follow an alternative, better-off system attractor, e.g., more aligned with sustainability principles and achieve this in a structural and enduring way—such as women's access to education or the elimination of child labour in some societies—we can talk about *positive tipping points* in social systems. Nevertheless, the present report calls for paying special attention to those deliberate transformations and actions that:

(i) **not only focus on social systems, but also include attention to biophysical ones,** that can be referred to as social-ecological tipping points.
(ii) **not only contribute to producing less harm** (<0), or lead to neutral outcomes (=0: e.g., carbon neutral) **but** to those pathways that eventually can lead to ***net-positive tipping points*** (>0) enhancing and restoring the social and biophysical conditions that make human life possible on Earth in the long term.

It is important to point out that in this report we use the notion of net-positive in a broader sense than just in a quantitative one, as the term incorporates considerations of multiple notions of justice that include both local ideas of fairness around natural resource use and access as well as Earth System justice and the search for a just and safe operating space for humanity.

In the case of climate and biodiversity pathways, it is suggested that TRANSPATH ought to pay special attention to the discovery and assessment of **net-positive nature-climate actions, leverage points and strategies**, tipping diverse systems of reference towards biodiversity-climate regenerative futures. In this regard, it is important to distinguish between an actual tipping point—the moment in which a small additional force creates a large system's change—and the tipping interventions focused on creating those enabling conditions and agents' transformative capacities for the emergence of deliberate positive tipping points. Furthermore, and using a whole-life systems perspective (Tàbara 2023a), this report also suggests that the paradigm of ***regenerative sustainability*** can play a central role in coordinating multiple transformative pathways oriented to synergise climate and biodiversity actions. Deliberate regenerative strategies refer to those coherent combinations of actions aimed at creating mutualistic, self-reinforcing positive dynamics within and between social and biophysical systems conditions. Because this approach is inherently systemic, multiple feedbacks across multiple time, social and temporal scales is required together with the consideration of a broad integrated framework of transformative system justice. Alternative combinations of leverage points yielding a safe and just operating space for humanity could unfold within a 'landscape of regenerative solutions' synergising individual, organisational and large-systems' level actions across short, mid and long temporal scales. Qualitative structural changes across many kinds of social-ecological systems, domains and scales need to be coordinated and combined to move from additive to multiplicative changes. Moreover, such synergistic actions and pathways ought to contribute to the building of

transformative and enabling conditions necessary to achieve net-positive biodiversity-climate[1] tipping points both at local and global levels, consistent with a safe and just corridor development for humanity. This conceptual framework is synthesised in Figure ES1:

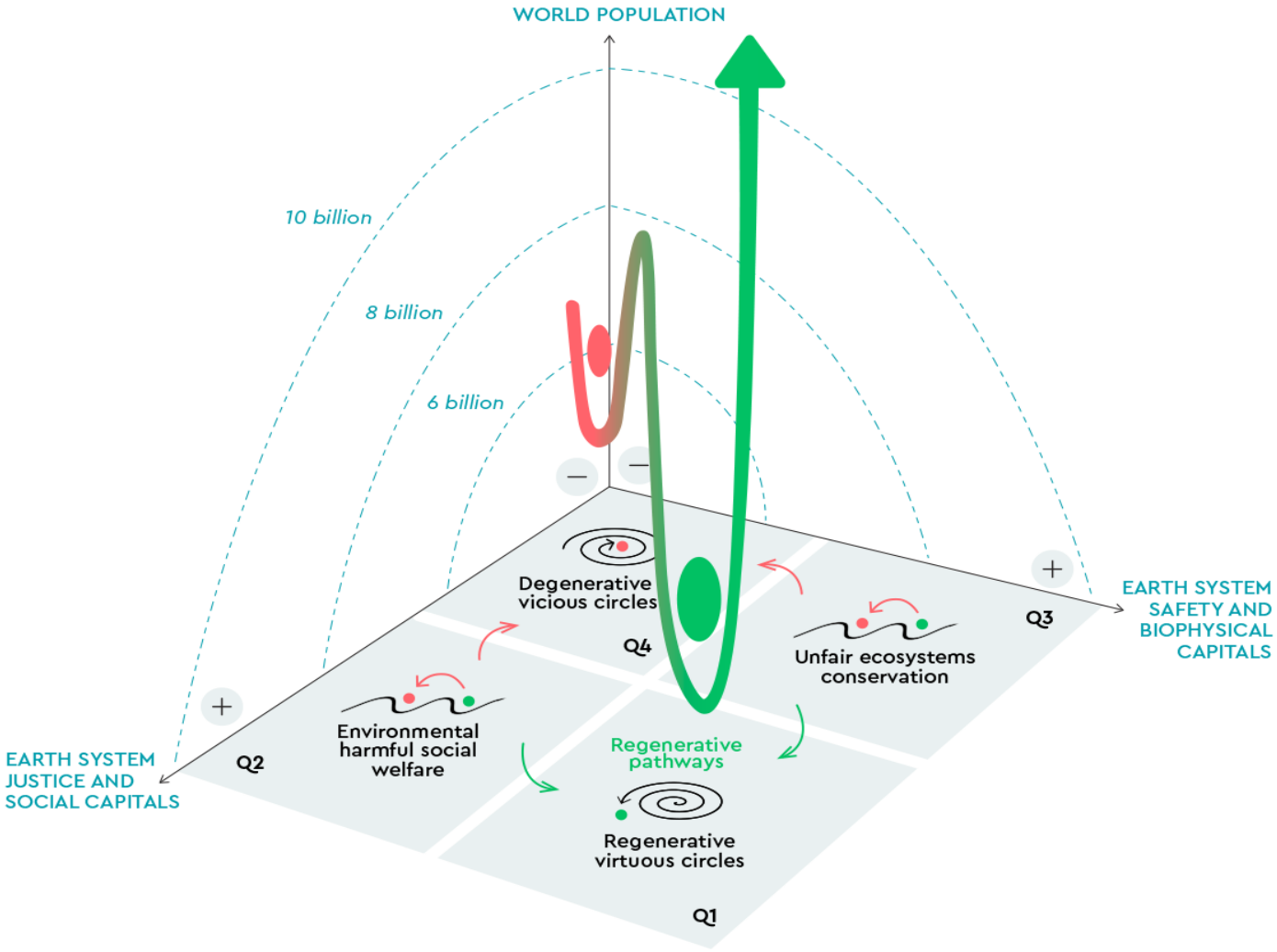


Figure ES1: Achieving net-positive biodiversity-climate tipping points that consider a safe and just operating space for humanity in a world moving towards 10 billion people requires synergising fast improvements in social conditions (stocks or capitals) and in biophysical ones across multiple spatial, temporal and social scales of action (Based on Tàbara 2023).

[1] Here the wording 'nature-climate' and 'biodiversity-climate' are used indistinctively as synonyms, and only for communication purposes.

1 Introduction

This report provides an original conceptual framework on the current knowledge on how to trigger, enable and navigate transformative pathways that synergize biodiversity and climate actions respectful to social-cultural contexts and rights, given unpredictable futures over long timeframes.

The purpose of the proposed conceptual framework is to help TRANSPATH researchers through their empirical and grounded research to identify and reflect using a broad systems' perspective on the kinds of **combinations of biodiversity-climate solutions, actions and interventions that may trigger transformative changes at consumer, producer and organisational levels**. It also encourages researchers to place their specific research efforts within a comprehensive research discursive space on how **to secure a just and safe world** moving towards a 10 billion people in the timespan of a single generation. It does so by reviewing, bringing together, and advancing research approaches central to current transdisciplinary efforts aimed at supporting sustainability transformations: leverage points, positive tipping points, the search for safe and just operating space for humanity and regenerative sustainability. This report is also intended to help foster deliberation on transformative visions, values, actions and their systemic interactions across spatial and temporal scales. On this, it will be argued that the regenerative sustainability paradigm can contribute in original and relevant ways to the required transformative imagination (Galafassi, 2018). And this can be done by combining place-based visions and systemic coordination between the multiple actions that may emerge from the TRANSPATH transformative pathways.

This deliverable has two main parts. The first provides a synthesis of the meaning of some key concepts relevant for TRANSPATH. Starting with a brief discussion on the spectrum of sustainability understandings, it will be argued that **much of the discussions on sustainable development so far have focused on less-harm (<0) or neutral (=0) discourses and practices, but rarely have addressed the challenge to achieve net-positive outcomes (>0).** Next, concepts such as that of systems' *transformations,* as well as *transformative pathways* and *transformative knowledge* contributing to such deep systems' configurations are examined. Here, we show that the research literature has firmly established that transformations constitute a distinct kind of change. A crucial goal for transformative research is that of empowering diverse sources of agency so that original systems' conditions can be fundamentally reconfigured in better-off ways, e.g., following sustainability principles. Robust policy making addressing complex issues that are subject to multiple irreversibilities and long-term consequences, as those that aim to synergising climate and biodiversity action call for opening up democratic spaces able to explore the diverse ethical perspective on justice at stake. Therefore, it is necessary to make explicit what kinds of principles or metrics we could or need to refer to when talking about sustainability, and more specifically, to principles that have to do with justice in the context of accelerated global change. For that reason, a subsection is devoted to examining the question of 'transformations for whom' and to map out different notions of justice within the framework of Earth System Justice, and more transformative perspectives of justice.

These discussions help to prepare the ground for situating the role of leverage points or interventions in enacting transformations in different kinds of systems, from individual, organisational and large-systems levels. We suggest that multiple leverage points need

to be applied at the same time to create the enabling and transformative conditions that move present nature-climate strategies from following incremental pathways to take more exponential or multiplicative development routes. Furthermore, for this outcome to occur, a coordinating and plausible vision of **systemic transformation** is necessary. To achieve this, we propose a regenerative sustainability paradigm to help coordinate, support and trigger local and global transformations aligned with a safe and just corridor for humanity. All these arguments are then brought together in a graphical synthesis, constituting the core of the TRANSPATH conceptual framework.

The second part focuses on exploring the more practical implications of the proposed conceptual framework. Understood as an open-ended endeavour, this section addresses how such concepts can be discussed and used within the TRANSPATH project to support mutual learning and reflexivity. The literature identifies second-order learning, and even third-order learning, as intrinsic in transformations research for which a simple procedure and mapping of possible agents, and the kinds of systems and socioenvironmental practices that could be examined within the TRANSPATH project is provided.

2 Designing and supporting transformative pathways in TRANSPATH: A conceptual framework

2.1 Theories and the spectrums of sustainability change

The complex and contested concept of sustainability is fundamentally normative. It can be understood as an *objective* and/or as an *adjective.* This means that on the one hand, sustainability can be used as a personal commitment to certain moral principles, as an organisational or political goal, or more broadly, as a fundamental pillar and constitutional ideal akin to those of the French revolution of 'Liberté, Egalité et Fraternité… (and 'sustainability'[2]). Sustainability can also be used as a way to characterise and assess the quality of certain products or services, the evolution of social-ecological systems, or even the future of human prospects on Earth. Moreover, sustainability can be taken as *something to be explained*, or else, as *something that helps to explain* complex social-ecological phenomena. In this way, for instance, unsustainable practices in soil or other natural resource management can explain the collapse of certain ecosystems and the social implications can explain the unsustainability of resource practices. Circularity, multiple feedback processes, and complex interrelationships between multiple sources of agency and scales makes it necessary to take a system-level approach to conceptualise the meaning and role of sustainability in transformative change.

Regarding the theories that focus on sustainability change, Schlüter et al. (2022) identifies four ideal-type modes of theorising within sustainability science, depending on whether such theories focus on explanation or on supporting action, or on whether such theorising is carried out from an 'inside' or from 'outside' positions, as represented in Figure 1.

[2] This is so because it can be understood that societies in the long term cannot be free nor egalitarian nor ensure intra- and inter-generational fraternity if they are not sustainable; Tàbara, J. D. & S. Giner. 2004. Diversity, civic virtues and ecological austerity. *Revue Internationale de Sociologie / International Review of Sociology,* 14(2):262-283. https://doi.org/10.1080/03906700410001681329

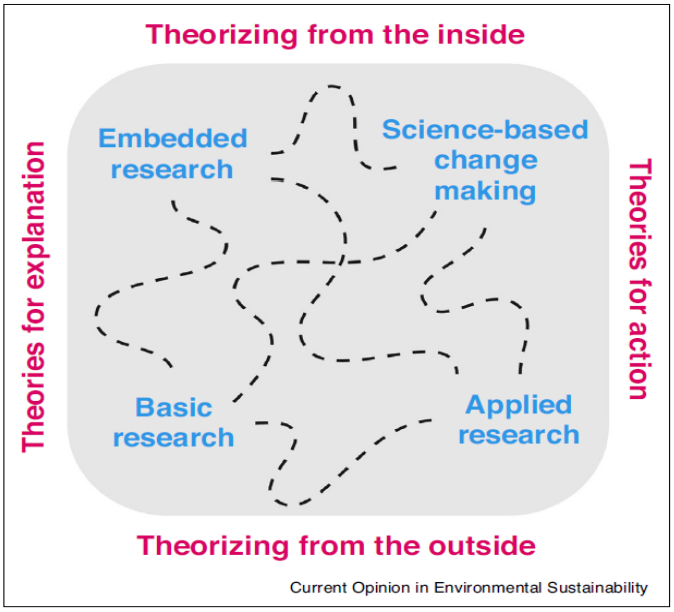


Figure 1. Four ideal-types of theorising in sustainability science according to Schülter et al. (2022).

In particular, Schlüter et al. (2022) argue that sustainability theories focusing on explanation may pursue the following purposes: framing or guiding research processes, specifying causal factors or mechanisms, predicting systems' behaviours, synthesizing knowledge, or explaining transitions or transformations; whilst theories focusing on action may aim at guiding transitions or transformations, informing interventions, providing principles for generating systemic change especially in organisations, or informing action and change processes in local context with multiple actors through learning. In this regard, they argue that acknowledging researchers' positionality in relation to the social-ecological system of reference is crucial in theorising sustainability transformations (see Section 3)

Furthermore, sustainability, whether used as an *explanandum* (to be explained) or as an *explanans* (that explains complex phenomena), inevitably requires normative criteria able to assess *to what extent and in what sense* something is sustainable. To reduce the many ambiguities, these normative criteria were to a large extent made more operational for policy with the Sustainable Development Goals (SDGs), as stated in the UN 2030 Agenda on Sustainable Development, 'Transforming our World'. Nevertheless, in practice, many of the more popular criteria used to assess the sustainability of certain practices or organisations tend to focus on limited or partial perspectives of sustainability. This is the case, for instance, in transitioning towards electric private mobility instead of fossil-fuel-based ones often being considered a 'sustainable' practice, even though this may not change any other individual practices or values in other domains. Therefore, many of the discourses on sustainability have emphasised only *processes*—sustainability as a process—but have neglected the actual outcomes or consequences, such as feedback processes and cumulative consequences on life-support systems.

Instead, and focusing on more comprehensive transformations that have to take into account global climate and biodiversity challenges, it is possible to adopt an alternative cognitive and moral perspective, one that considers social-ecological interactions using a *whole-life systems* approach (Tàbara, 2023a, see for contrast also: Capra and Luisi, 2014,

Birney, A. 2021; Davelaar, 2021;). This is represented in Figure 2 where the emphasis is given on the need to move towards net-positive outcomes as well as both procedural and consequential criteria of sustainability (see also section 2.6 for further elaboration of these ideas):

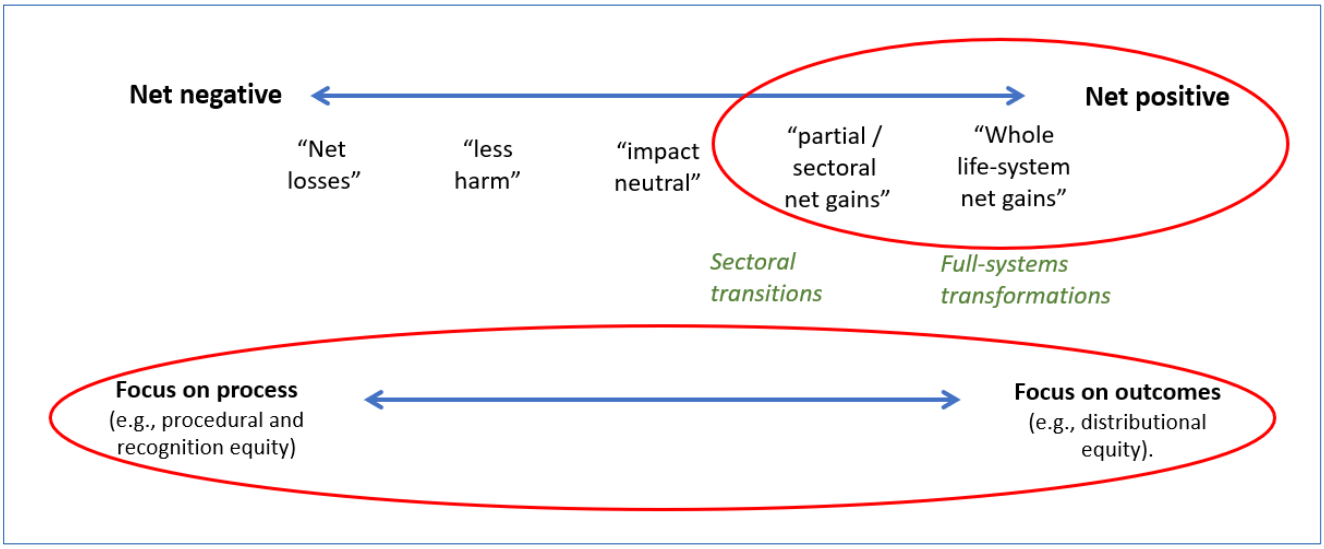


Figure 2. Spectrums of sustainability. Deliberate transformations aimed at dealing with climate and biodiversity challenges need to consider how to move from less harm (<0) or neutral targets or practices (=0) to net positive ones (>0) using a whole-life social-ecological systems perspective.

2.2 On transformations, transformative knowledge and transformative pathways

2.2.1 Defining transformations

Transformations are a distinct kind of change, because of their scope, intensity and consequences in the original reconfiguration and dynamics of a given system of reference (Fazey and Leicester 2022; Fazey et al. 2017; Feola, G. 2015; O'Brien, 2012, 2016; Vogel and O'Brien, 2022; As noted by Walker et al., (2004) and Folke et al. (2010), transformability can therefore be understood as the ability to create *a new system* when the prevalent goals of the existing one become unattainable. In this respect, Fazey and Colvin (2023) succinctly explain that transformations are also normative and subjective, and that they can be discriminated from other processes of change such as adaptation or reform: the kinds of relationships when engaging in transformations research and action address different kinds of core questions, purposes, power relationships, action logics, typical action and logics in the use of tools (Table 1):

	Adjust	Reform	Transform
Core Questions	Are we doing things right?	What are the right things to be doing?	What is right?
Purpose	Improve performance	Change the system & its parts	Create previously unimagined possibilities
Power & relationship	Confirms existing rules	Opens rules to revision	Enable new ways of thinking about power
Action logic	Project implementation	Piloting	Experimenting
Typical actions	Copying, duplicating, mimicking	Changing policy, adapting	Visioning, experimenting, inventing
Tools logic	Negotiation logic	Mediation logic	Envisioning logic

Table 1. Distinguishing between adjusting, reforming and transforming. Source Fazey and Colvin (2023).

More specifically, and according to the IPCC (2012: 436), transformations entail "a fundamental qualitative change (…) that often involves a change in paradigm and may include shifts in perception and meaning, changes in underlying norms and values, reconfiguration of social networks and patterns of interaction, changes in power structures, and the introduction of new institutional arrangements and regulatory frameworks". Moreover, transformations can be distinguished from socio-technical transitions in that they are open-ended, non-linear and entail reconfigurations in worldviews and across individual, social and organisational practices as well as in large systems' structures. Such deep reconfigurations are considered necessary to cope with major threats to humanity, such as climate change and mass biodiversity loss, as conventional strategies will not suffice. In this regard, Linner and Wibeck (2020) distinguished four general modes of transformations depending on two axes on whether they affect the whole civilisation or only segments of it, and whether they occur on a rapid or protracted pace; and also argued (Linner and Wibeck, 2021) that deliberate sustainability transformations can be encourage by three types of interventions or drivers that have to do technological innovation, transformative learning, political economy redistributions and the formulation of sustainable societies narratives.

Furthermore, transformations are also needed in many knowledge and action domains, including in science practices dealing with the production of climate-solutions (Tàbara, Jäger et al. 2018). However, the domains in which the literature argues that systems transformations are most urgent varies. For instance, in the UNEP report Making Peace with Nature (2021), the following transformation domains are mentioned: 1. Economy and finance, 2. Food and water, 3. Energy 4. Human settlements 5. Human health, equity and peace, 6. Environment. The Earth Commission (Gupta, Bai et al. 2023) has selected eight planetary boundaries (seven of which are considered to have been surpassed) and linked them to the identification of the kinds of transformations needed to achieve a just and safe corridor for humanity. In particular, four kinds of systemic transformations have been identified to ensure living within this corridor: consumption, economic, technologies and governance systems.

2.2.2 Transformative knowledge is a distinct kind of knowledge

Not all knowledge produced by science necessarily constitutes knowledge that can support sustainability transformations. Knowledge for sustainability can be understood just as a distinct *class of knowledge* deliberately oriented to transform, according to certain normative criteria and visions about what a sustainable world should be like in contrast to the present situation. Therefore, transformations-oriented knowledge is not only 'about' transformations, but is mostly 'for' transformations; in this way, it mainly emerges from the actual implementation of the knowledge itself (e.g., not following a 'deficit-knowledge' model of supply-driven knowledge production from scientist to decision-makers). **Transformative sustainability knowledge** is inevitably always ***situated knowledge, produced within and for a context*****,** that needs to be continuously validated, embodied and reframed as new experiences and as learning cycles materialise.

In particular, transformative knowledge can be understood a kind of knowledge oriented to address, on the one hand, the ultimate systemic causes of unsustainability problems and the negative consequences of human actions on global environmental change. But it also is a knowledge about how to build a better-off society according to aspirational principles such as justice, diversity and resilience. Transformative knowledge sheds light, for instance, on how to deal with persistent inequalities in resource consumption and access, in the intra- and inter-generational distribution of rights and responsibilities, as well as how to find venues to open up reflexivity processes able to question deep assumptions about many of our taken-for-granted individual and organisational practices. Thus, promoting **second-order learning** is central in transformative knowledge processes: not just doing the same faster and better, but doing things differently under a different paradigm or worldview (e.g., a sustainable, whole-life systems one; see section 3.1. and Fazey et al. 2020). Transformative knowledge moves the emphasis *from developing representative forms of knowledge about **'what is the problem' to** empowering forms of knowledge on **'who is the solution'*** in a particular context of action. Hence, it aims towards developing the necessary transformative capacities to alter those individual practices and institutional arrangements that create the persistent problems of unsustainability in the first place, and also, to find ways to synergise chains of transformative solutions across different scales of action. In this regard, there is plenty of room for individuals to contribute to transforming their most immediate contexts of action in areas like food consumption, financial and investment decisions or education, and in doing so, also connect these with other deliberate transformations in other domains and scales of action (Newell et al. 2020, Newell et al. 2021). And in doing so, trigger a cascade of multiplicative positive synergies and structural qualitative changes at larger systems levels that support the scaling out, scaling up, scaling deep of micro-solutions and transformative practices; that in combination, contribute to the enabling conditions necessary to tip global systems towards sustainable, safe and just development trajectories (Tàbara et al.2018, Oman et al 2018, Moore 2015).

In this regard, it may be important to distinguish *between information and knowledge.* For instance, the departure timetable placed in a train station panel constitutes information about when and from where a certain train is to leave, but it doesn't necessarily provide people with the necessary full-systems knowledge or capacities to interpret that information, place it in the right context to ensure that one will get to the desired destination. For information to eventually become knowledge, and in particular knowledge

to support sustainability transformations, it requires joint meaning and translation into action. In the same token, knowledge derived from transformative practices *elsewhere* is not necessarily knowledge until it is enacted in a relational way to transform a concrete system or institutional setting. This is why transformative knowledge is not only 'knowledge out there', something that we can download in a particular mobile app. It is mostly meaningful and **embodied knowledge**, in the sense that it is internalised and inseparable from contextual practices and those practices—even at organisational level—take into account and can be connected across multiple systems and scales of actions.

Several of these tenets of transformative knowledge production can also be applied to reorienting the development of climate science tools and methods, e.g., to help robust knowledge to address negative Earth tipping points. Participatory processes contributing to sustainability knowledge require the facilitation of well-structured spaces that ensure a fair and competent representation of knowledge-holders. Encouraging reflexivity and mutual learning to support transformation demands a balanced plurality of views to: adequately frame the problems at stake (including those that have to do with addressing inequalities); and to explore distributional costs and benefits of the possible interventions designed to deal with these unsustainability problems.

2.2.3 What are transformative pathways supposed to do?

TRANSPATH initially conceptualized transformative pathways as integrated sets of actions and strategies purposely and reflexively designed to achieve rapid biodiversity net gains and carbon neutrality respectful to human rights and ethics and that will evolve and be refined over time. In this regard, the IPCC (2014) defined transformations pathways as "consistent sets of possible futures of GHG emissions, atmospheric concentrations, or global mean surface temperatures implied from mitigation and adaptation actions associated with a set of broad and irreversible economic, technological, societal and behavioural changes. This can encompass changes in the way energy and infrastructure are used and produce, natural resources are managed and institutions are set up and in the pace and direction of technological change". Moreover, the GEO-6 report stated that 'transformations emerge from the co-evolution of multiple interdependent factors and the active engagement of diverse stakeholder' (UNEP, 2019).

Furthermore, transformative pathways entail ***accelerating full-systems reconfigurations*** in social-ecological systems and encompass ***deep qualitative changes*** in institutional arrangements that condition cultural, socio-economic, political and environmental interactions. In TRANSPATH, transformative pathways can then be understood as coherent combinations of actions, leverage points or sensitive intervention points placed along social, temporal and spatial scales aimed at generating deliberate transformations and/or eventually achieving a systemic tipping point ***towards net-positive biodiversity-climate outcomes***. Among the questions that need to be considered in designing such transformative pathways the following can be considered:

- What do we mean by positive qualitative structural change?
- How are time scales being defined and in relation to what kinds of biophysical processes, like increase of GHGs or the biodiversity extinctions?

- What kinds of tools and methods are most suited to co-produce usable and situated knowledge able to synergize net-positive effects within climate, biodiversity and social domains?
- What criteria need to be considered when designing participatory processes aimed at mapping out and combining potentially transformative actions at different time, spatial and social scales? (e.g., including anticipatory, complex-systems based, actionable, support of learning processes, enhancing resilience and transformative governance capacities, policy robustness, (see Hölscher and Frantzeskaki, 2020. …)
- …

And most importantly: how to map out and combine different kinds of interventions, leverage points, clusters of solutions or sensitive interventions points that entail different social scales (individual, organisational and large system levels) and also different time scales? In this respect, Figure 3 provides some possible examples of such actions within a possible 'landscape of transformative solutions' using a regenerative paradigm perspective (see section 2.5):

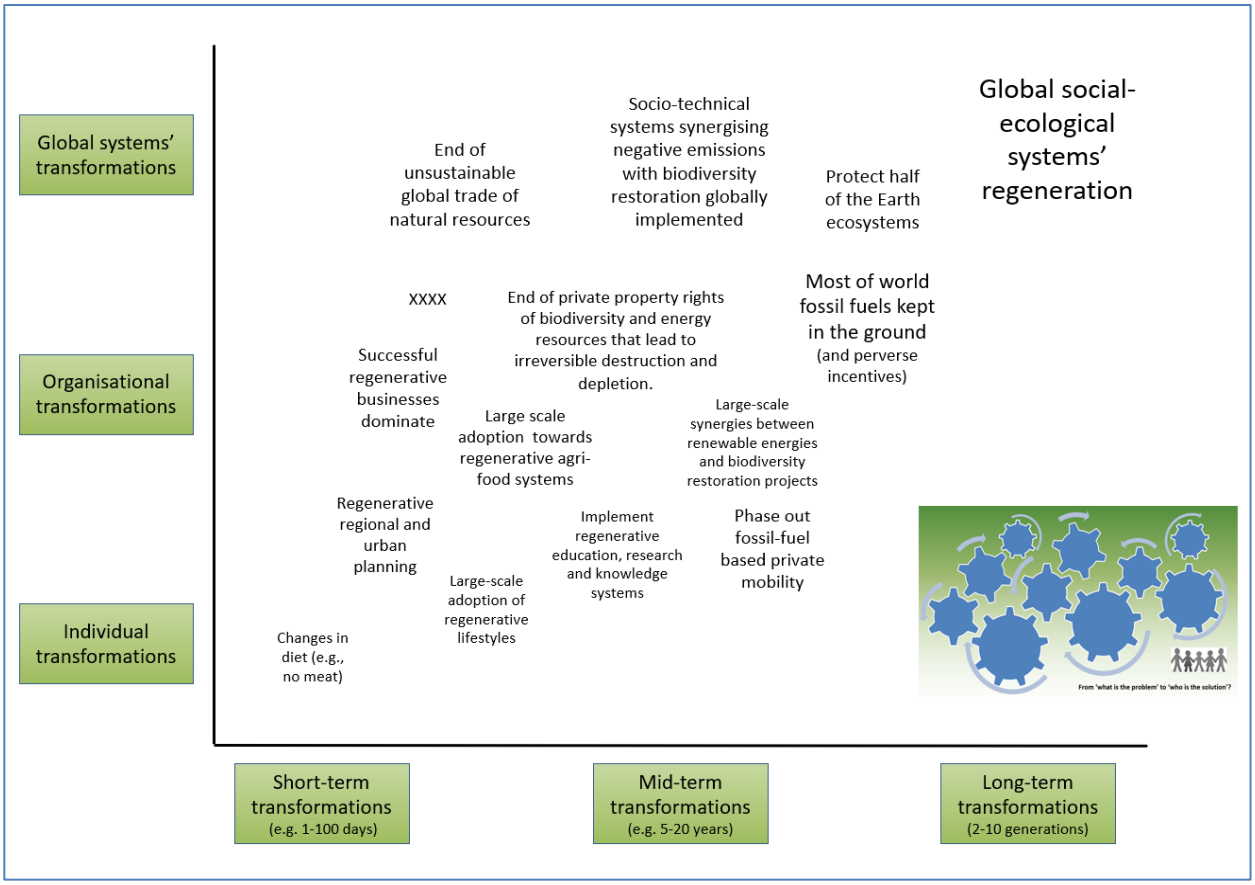


Figure 3. The Landscape of transformative solutions using a regenerative sustainability lens. Some examples of possible transformative actions aimed as accelerating fundamental systemic changes using a regenerative sustainability perspective – combining possible leverage points and interventions at different temporal, spatial and social scales (Adapted from J. D. Tàbara: http://www.highendsolutions.eu/page/transformative_solutions).

In a nutshell, the goal of the kind of knowledge that can be expected by the design and situated co-production and implementation of the TRANSPATH transformative pathways is not just about knowing 'more'; but about showing, developing and putting into practice *qualitatively different types of knowledges* that can validate different narratives and options on how agents can modify their own individual and collective behaviours toward improved relationships among themselves as well as with their life-support systems. Such learning therefore includes not only learning about what can be done, but also *learning what should not be done* (Tàbara 2013), e.g., in terms of recognising and implementing limits to destructive ecosystem practices, depletion of natural resources or the dangerous accumulation of mounting pollutants such as GHG emissions. In this regard, transformative pathways are also about providing alternative windows of opportunity on how to create social innovation procedures and distributed institutional arrangements to improve research-action imagination, collaboration and cooperation (see also Biggs et al., 2010). And because, ultimately, transformations are about modifying existing institutions and arrangements that affect the distribution of rights and responsibilities regarding the access and consumption of natural resources, they also have strong political implications; for which robust, equitable and democratic procedures need to be put in place to overcome inevitable resistances to systems' change. Or as argued by Westley et al., (2011):

> "There is no deficiency of social and technological innovations in the world. In fact, the tremendous expansion of humanity and the great acceleration into the Anthropocene are a reflection of an amazing innovation capacity, supported by easily accessible and abundant energy sources, predominantly fossil fuels. However, much of this innovation has occurred without reference to ecological integrity, or complex system interactions. It is also innovation that has been insufficiently tuned to the challenges of poverty alleviation, human rights, social justice, and human well being. A key challenge now is to use this innovative capacity to change the current unsustainable trajectories and support transformations toward global sustainability"

2.3 Transformative pathways by whom and of what?

A set of central tasks in the design of transformative pathways have to do with identifying who are the agents that can and ought to contribute to transformations; in what kinds of organisational settings and institutions they operate; what socio-environmental practices they engage with; how these resource use and consumption practices can be transformed and for what purposes; what are the principles or criteria that are used or expressed to transform them; and most importantly, what are the kinds of enabling conditions and capacities that would emerge as learning outcomes from the multiple interactions between transformative visions and deliberated situated practices in these contexts and organisations. Figure 4 provides a first approximation to these questions that necessarily will need to be refined and specified based on the research carried out within TRANSPATH:

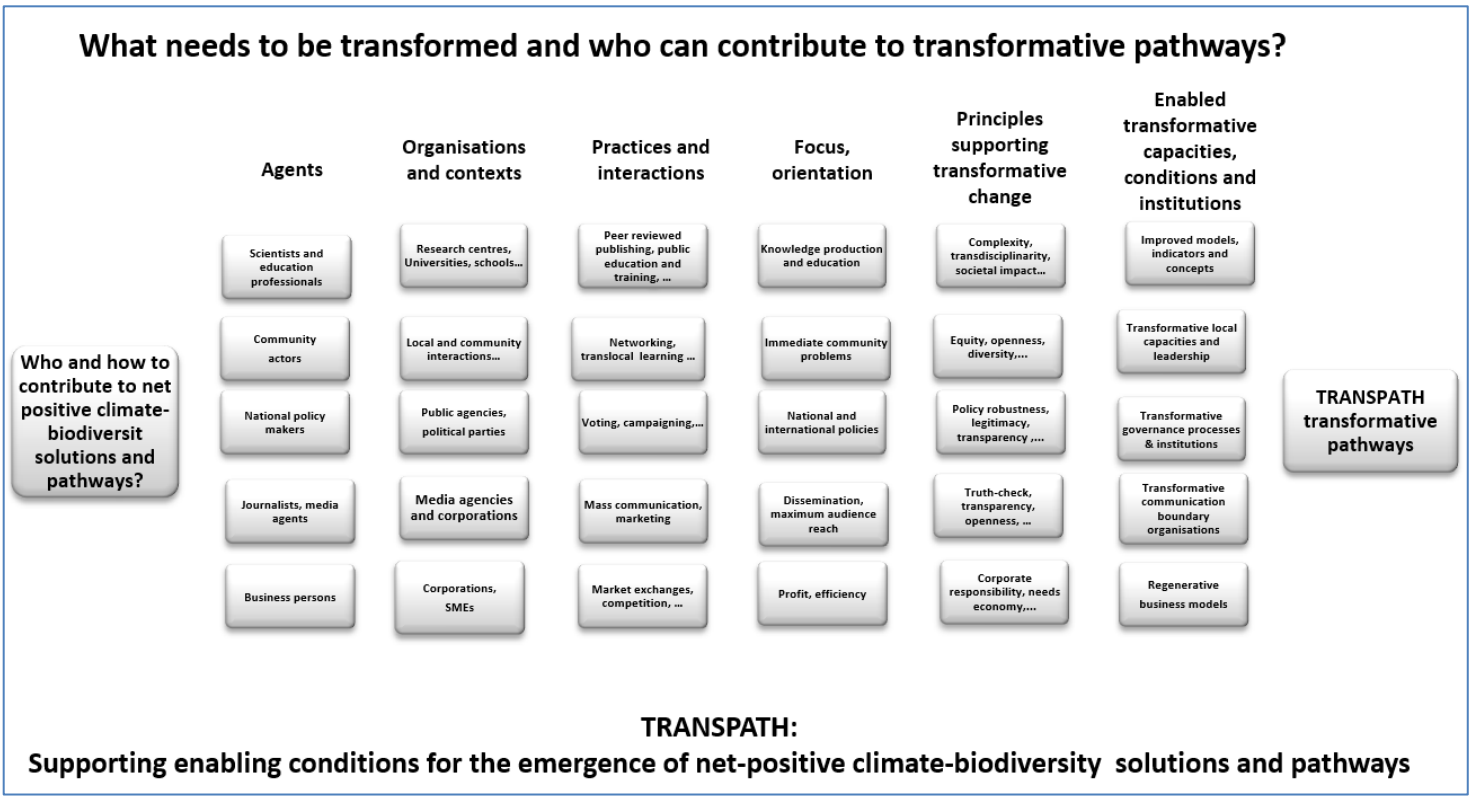


Figure 4. Mapping out the kinds of agents, organisations, orientation, principles and potential enabling capacities and conditions for transformations. A first approximation.

Among this mapping of agents and systems interactions, it is worth noting that, in sociology and other transdisciplinary approaches, the notion of **social practices** is becoming increasingly central in explaining social-environmental change and in particular the challenges facing deliberate societal transformations (Haberl, 2021, Rau, 2018). Placed in-between individual agency and systems' structures, **socioenvironmental practices** can be understood to emerge from routine and normalised habits, such as the consumption of high-energy intensive goods and services, the decision of which does not necessarily derive from or fully deliberate decisions by individuals. They are reproduced and intelligible acts, mostly taken for granted, that create new conditions in the form of institutions or generally accepted procedures, that in turn affect the reproduction of these same acts. Socioenvironmental practices have their own situated logics in particular organisations and contexts, and because of that, they are difficult to change, unless the reason for the existence of those contexts disappears. Hence, the examination of practices needs to be carried out together with the specification of the situational contexts, and opportunity spaces, in which they are carried out and reproduced. Practices provoke cumulative and depletive effects (e.g., on fish stocks or quality soils for agriculture), that in turn affect the original practices and hence create new conditions that make necessary also to adapt or remove such practices. In the realm of climate and biodiversity change, it is therefore important to recognise that a large part of global emission growth or processes that lead to the extinction of species are not necessarily derived from intentional or conscious actions by individuals, but from many unintended, indirect and often difficult-to-track consequences of apparently bounded socioenvironmental practices upon other contexts or systems. The notion of socioenvironmental practices in this context also suggests a different way to understand knowledge production processes and their use to

support transformations. In a similar guise that no one learns to ride a bicycle by listening to an expert how to ride a bicycle, concerted actions towards sustainability transformations, rather than waiting for the perfect policy or instrument, they require a lot of 'practicing' 'experimenting' and assessing together the cumulative and impacts (both positive and negative) of the very acting such situated practices.

In short, the generation of coherent narratives that will eventually constitute the different alternative transformative pathways in TRANSPATH ought to be able to help respond the following basic questions, expressed in Figure 5:

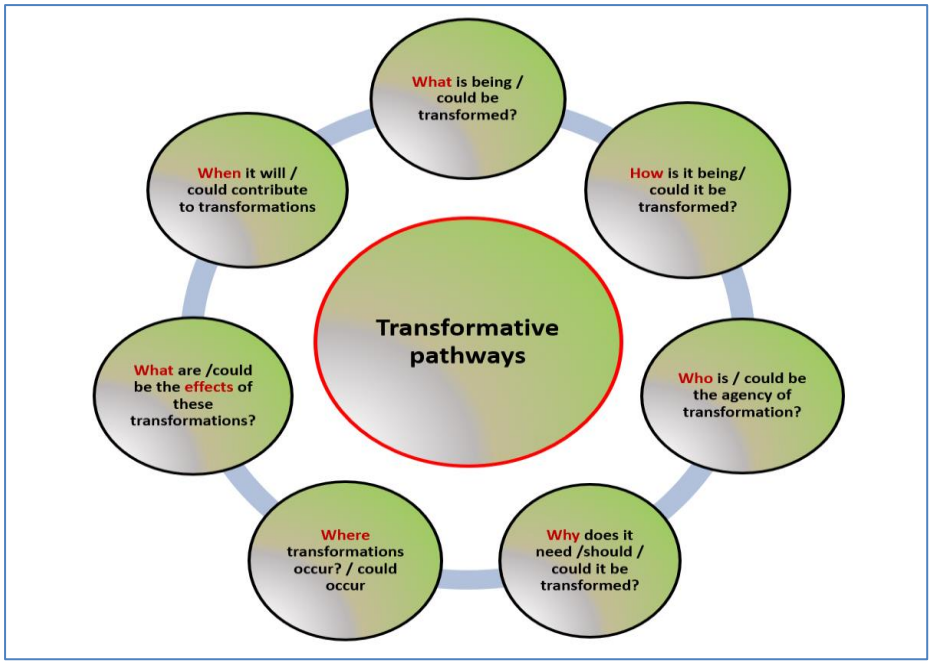


Figure 5. Basic interlinked questions in the development of transformative pathways.

2.4 Transformations for whom? Justice in transformative pathways

In social systems, justice is both a main driver and outcome of positive tipping points. The drive for a more equitable society by those groups often excluded or underrepresented in a system can create the conditions for systemic change -such as the case of the right to universal access to education (see Whyte, 2019). And at the same time, if the new fairer conditions are achieved, these can also create new forms of action and institutional reform conducive to new forms of deliberate transformations that have synergistic and positive effects on biophysical systems too. For structural positive transformations to endure, the agents in a given context must develop and implement new institutional arrangements able to ensure the redistribution of existing rights, responsibilities and power arrangements, e.g., according to new emerging interests or moral principles. Early gains in justice at local level, can thus create the necessary transformative conditions for achieving positive tipping points at larger scales and also help to trigger chains of positive changes in other domains. Addressing inequalities from the start and providing possible mutual gains derived from tackling climate and biodiversity crises, are can help local agents and decision-makers, even previously marginalized ones, to support the attendant policies, and function as demonstrators for other places, showing that cross-scale positive transformations are possible (see Amundsen et al., 2018).

In particular, multiple dimensions of justice need to be considered in processes that have to do with the interlinkages of global and local climate and biodiversity strategies. These include aspects of distributive justice, entailing an equitable distribution of resources and benefits, as well as of compensation of the burdens caused by the energy transition among the different groups. However, on the one hand, a more integrative approach to justice would entail moving beyond compensation approaches in dealing with (in)justices to local populations. That is, to **consider those perspectives that, besides the traditional notions of distributive, representative and procedural justice, also into account a more ideal, radical or transformative notions of justice that aim to achieve a much broader cross-scale systems' transformations, in terms of redistributions of rights, harms, benefits and responsibilities**. The need to reconcile and take into account these tensions between (i) universal, standardized and global ideas of justice versus contextual, diverse and local ones and (ii) those notions of justice that take a reformist stance versus those that adopt a more transformative one is depicted in Figure 6.

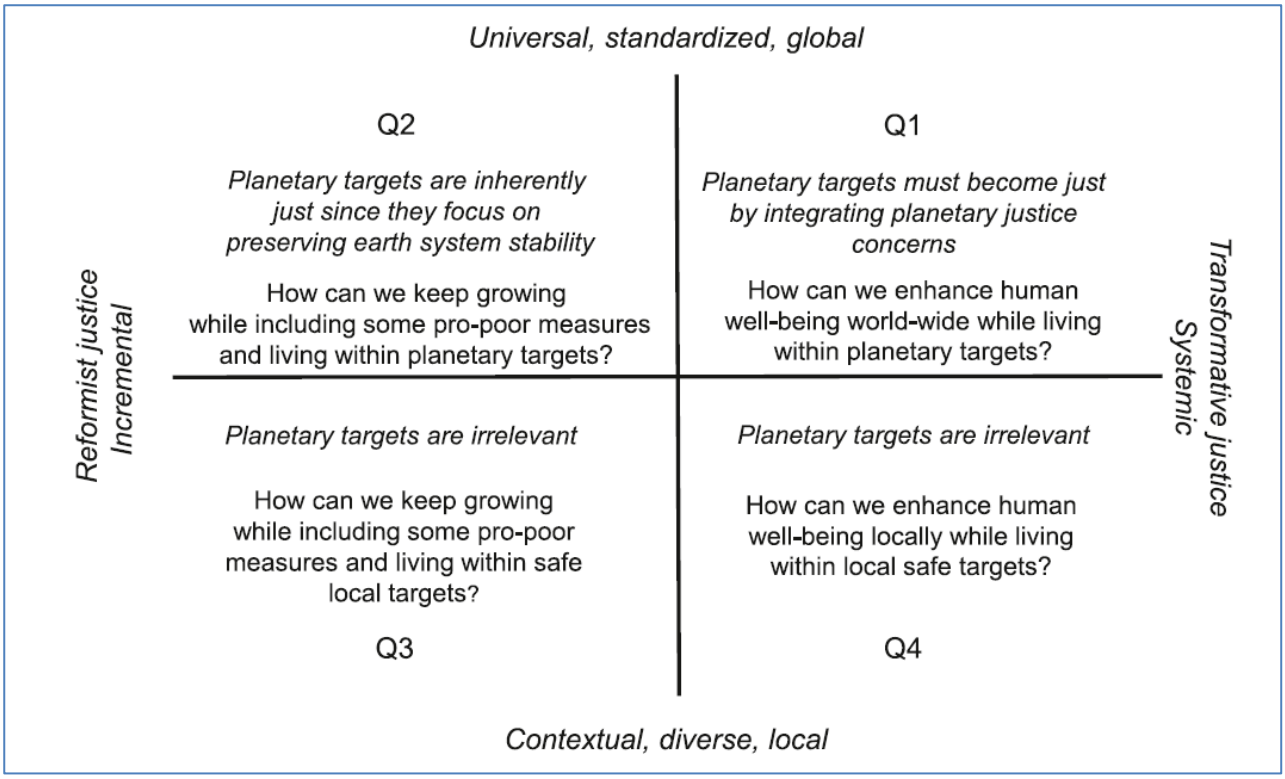
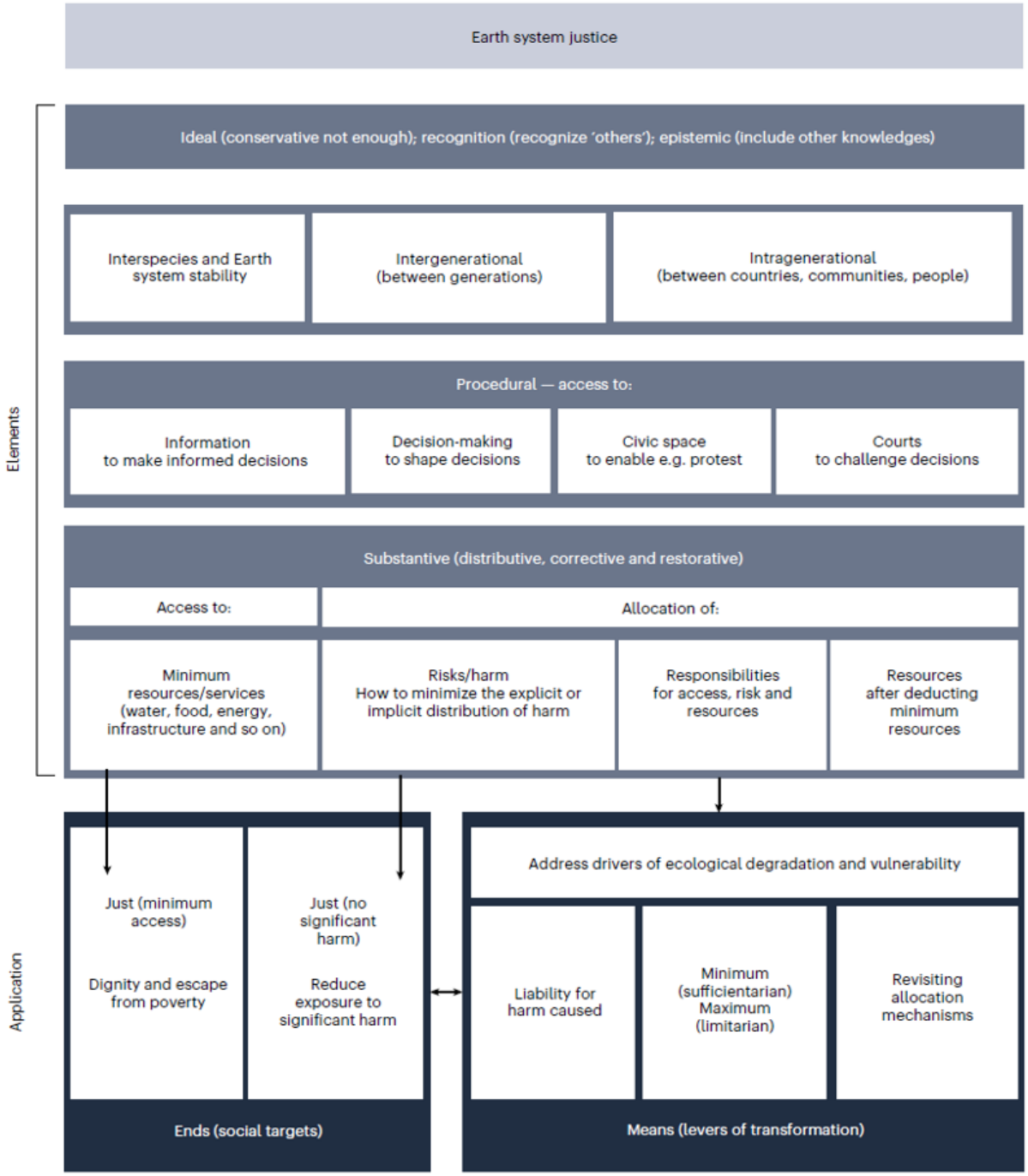


Figure 6. Alternative framing of justice according to universal-context and reformist-transformative conceptions (Source Gupta et al., 2021)

Moreover, there is an asymmetrical relationship between the different dimensions of justice and injustice. For instance, intersectional injustice happens when multiple social characteristics or conditions overlap and confluence negatively upon certain groups, revealing the need to apply equity policy interventions beyond those applied to the general population. Also, epistemic injustice happens when the knowledge or expertise claims of certain groups are disregarded, ignored or misrepresented, as with indigenous knowledge or non-expert people. Thus capability approaches stand out as they emphasize the need to foster and transform the necessary means, such as political or community power of agents, necessary influence inclusive decarbonization decisions, relevant to climate change mitigation, adaptation or more broadly tipping processes towards systems'

transformations. From an Earth System justice perspective, it is considered an imperative to avoid trespassing planetary boundaries (Rockström et al.,2009) and to ensure a safe and just corridor for humanity. This entails the adoption of more nuanced conceptions of justice, which also consider intergenerational, intra-generational as well as interspecies dimensions of justice. But it also requires, as argued by Pickering and Persson (2020), opening up democratic spaces at multiple levels of governance, from local to transnational, for deliberate contestation about the actual meaning and implications of planetary boundaries and global risks and how to respond to them.

Earth system justice is concerned with how to achieve in a fair way the long-term stability of the earth system and ensuring that a world population moving toward a possibly ten billion people by 2050 can have access to sufficient resources to ensure dignified levels of well-being. It recognizes that human activities, such as the burning of fossil fuels, deforestation, and pollution, are causing widespread harm to the Earth's systems and this impinges especially upon marginalized communities and future generations, who are likely to bear the greatest burden of these impacts. Hence as noted by the Earth Commission Gupta, Liverman et al. 2023 ‘Living within planetary limits requires attention to justice as biophysical boundaries are not inherently just’, and therefore it is important to consider the various dimensions that may constitute an Earth System justice. To this aim it also defines the ‘three Is’ relevant for Earth System justice as: (I1) interspecies justice and Earth system stability, thus rejecting human exceptionalism, focus on the more-than-human world and humans as guardians of the natural world, (I2) intergenerational justice between past and present (I2a) and between present and future (I2b) and (I3) intragenerational justice: between countries, communities including indigenous peoples, and individuals. The different components of justice then are then framed according to two basic dimensions of *ends* or targets of justice and *means* or the levers of transformations more concerned about *how* to realise Earth System justice, as expressed in Figure 6:



Conceptualization of ESJ through just ends and just means. The elements of ESJ include concepts (ideal, recognition and epistemic), the subjects of justice (interspecies and Earth system stability, intergenerational and intragenerational justice), procedural justice (access to information, decision-making, civic space and courts) and substantive justice operationalized as ends that include targets that reduce exposure to significant harm and provide access to resources/services and equitable allocation of resources, risks/harm and responsibilities. Equitable access and allocation within safe and just ESBs are difficult without just means (levers of transformation), which includes addressing the drivers of ecological degradation and vulnerability, liability for harm caused, setting minimum needs and maximum consumption levels, and revisiting allocation mechanisms.

Figure 6. Earth System Justice components according to the Earth Commission (Source Gupta et al. 2023)

2.5 Regenerative sustainability: Mapping out synergies between social and biophysical actions and pathways

As mentioned in Section 2.1., a central challenge in the making of transformative narratives (Hinkel et al., 2020) for the design of pathways synergising climate and biodiversity has to do with identifying actions and strategies able to yield net-positive gains whilst also being sensitive to the aforementioned considerations of justice. Regenerative sustainability provides an interpretative framework to assess to which extent certain activities or policy proposals only contribute to just 'reducing harm' or to 'neutral' outcomes—and therefore only generate relative and short-term gains that in the long run may even create negative rebound effects—or else, do generate actual net-positive impacts on the long-term quality and quantity of the Earth's biophysical stocks. In this regard, strategies focusing on climate change or biodiversity could focus on only the improvement of biophysical indicators, such as the reduction of GHG or the restoration of a wetland, but at the cost of increasing inequalities or reducing participation and engagement of local communities. Likewise, populist policies aimed at apparently providing livelihood means to poor populations can be done at the cost of irreversible environmental destruction. However, and as argued in Tàbara (2023), ensuring the long-term viability of global ecosystems in which humans depend on requires creating positive synergies between the improvements of social conditions (or stocks or capitals) and improvements of biophysical ones. In a simplified fashion, this can be represented in Figure 9 (see section 2.6.2 on tipping points, 'TP'; and Buckton et al., 2023; Reed, 2007):

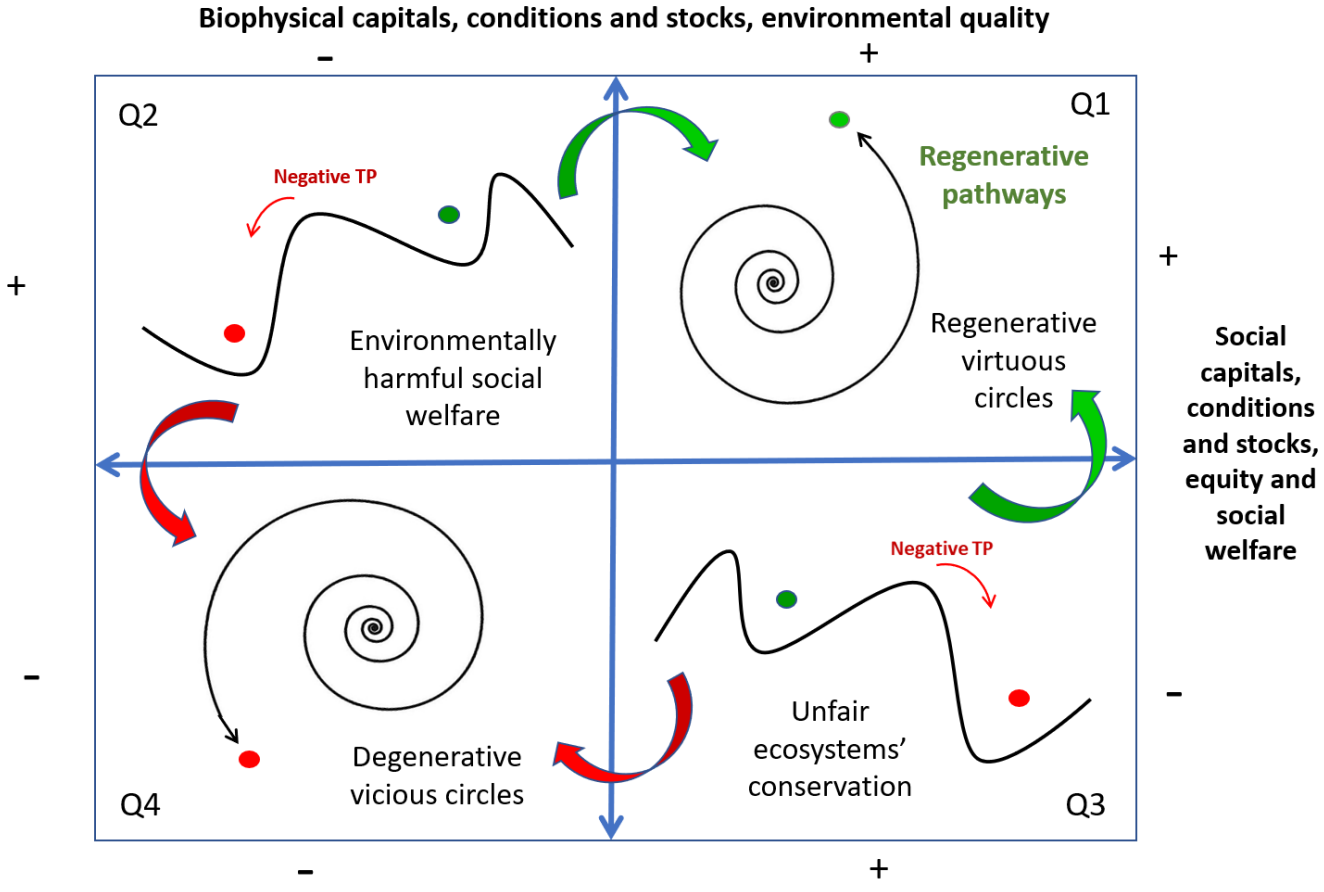


Figure 8. Moving towards regenerative development pathways depends on the extent to which self-propelling cycles able to restore and synergise improvements both social and biophysical conditions (stocks or capitals) *at the same time* can be created, as represented in quadrant Q1.

Therefore, in quadrants Q2 and Q3, the dynamics of social-ecological systems tend to move toward negative development pathways or negative basins of attraction, eventually leading to degenerative vicious circles of development (Q4). In Q4, not only future opportunities for human welfare, dignity and equity are reduced, but also the basic conditions that make life possible on Earth are undermined. Achieving a net-positive tipping point leading towards Q1 requires deep transformations in social-environmental practices at different levels of agency and also in the ways humans conceive and perform all SEIC subsystems' interactions.

Another important aspect of the paradigm on regenerative sustainability relevant for TRANSPATH has to do with the notions of *agency, systems and the interactions between both*. As already noted by Donella Meadows (next section), a complex system, or in our case, a social-ecological system, can be constituted by individuals, organisations, communities or even countries. Hence, in the identification of transformative pathways, a key task is to unveil the *kinds of social-ecological relationships* that the agents in our systems of reference or case study engage with the natural world. Such relationships can be easily mapped out by using the SEIC model (Tàbara 2023a; Figure 9) that represents, in a simplified way, the four kinds of necessary and inevitable relationships that all humans perform with their biophysical systems. Note that according to this non-dualistic, non-exemptionalist perspective, the non-human world has also 'agency' insofar that at one point human-induced changes on biophysical systems trigger autonomous forces that eventually also condition the configuration of human societies; thus, transformative strategies need to be able to harness both kinds of forces of structural change. This notion is also taken up in the literature as reciprocity between human-nature relations (Buckton et al. 2023; Giusti and Samuelson, 2020).

These relationships are characterised in terms of four basic subsystems of: institutional norms, rules and social structures (S), information and knowledge systems (I), energy and resources (E), and cumulative / depletive global environmental change, and cumulative environmental change (C), whereby:

- *The S-subsystem* (S): composed of social norms, rules, and institutions.
- *The E-subsystem* (E): constituted by the energy, biodiversity and natural resources that are used, available and interact with a given social-ecological system of reference, e.g., an organisation or society.
- *The I-Subsystem* (I): formed by the information and knowledge pools, including the symbolic representations and communication artifacts for their transmission, available to, or being used or communicated by that society.
- *The C-Subsystem* (C): constituted by the anthropogenic, human-driven cumulated environmental change that at one point becomes an autonomous force of change that affects the structure and dynamics of the whole social-ecological system in which humans live.

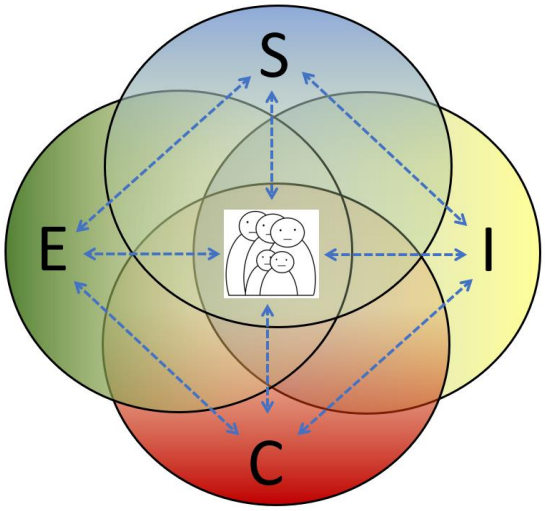


Figure 9. The SEIC model representing four main kinds of socio-environmental interactions of humans with their biophysical systems (Tàbara 2023a)

A main argument that follows from this relational conceptualisation of agency and systems (and in contrast to many positions describing the future prospects of global environmental change), is that the impacts of human actions on cumulative environmental change (the C-subsystem) do not necessarily need to be negative (e.g., growing GHGs) or depletive (of energy and natural resources); but conscious, deliberate and transformative action can be carried out precisely to prevent such negative development and help restore and regenerate the conditions that make human societies possible on Earth. Applied ecosystems restoration research shows that such social-ecological regeneration is possible, although as mentioned, requires finding ways to synergise not only actions within biophysical domains—e.g., between climate and biodiversity—but most importantly between social and biophysical conditions and interactions in a mutual, continuous approach of sustainability learning (see Gosnell, 2022; Surya, 2020).

The ideas of regenerative sustainability are now receiving growing attention internationally to frame in a fresh light many kinds of system transformations across individual, organisational and large system levels, many relevant for TRANSPATH. This includes, for instance, businesses and ‘sustainability-oriented hybrid organisations’ (SOHOs) working in the creating alternative forms and rationales for economic development, the main purpose being not to maximize short-term benefits but to create the transformative capacities for systems’ transformations (Hestad, 2020, 2021), new forms of business practices and relationships with ecosystems.

Table 2. Practical applications of regenerative business strategies.

Principles		Systems based level of aspiration			Adaptive management approach		
Criteria / Strategies		Impact on ecosystem	Relation with ecosystem	Underlying business rationale	Sense of place	Temporal orientation	Business strategy and strategizing practices
Degree of regeneration	Restore	Firms deploy damaging activities, such as open pit mining, but acknowledge the need to repair the damage.	Firms see ecosystems, such as mineral deposits, as commercially valuable objects to be owned and exploited.	Firms optimize the rent from exploiting ecosystems under the constraint of restoring ecosystem functioning.	Firms engage with place to the degree necessary to restore ecosystem functioning, for instance, through renaturation plans.	Firms interact with the ecosystem for the limited time of the transaction, often codified through temporary exploitation rights.	Firms adhere to profit maximizing strategies but adjust practices so that SES can resume functioning.
	Preserve	Firms choose practices that safeguard the functioning of the SES, such as restricting access to ecotourism sites.	Firms understand that they depend on functioning ecosystems, such as ecotourism sites.	Firms are willing to limit business growth to remain within the carrying capacity of the ecosystem they depend on.	Firms seek to understand the conditions and dynamics of local SES they rely on.	Firms are interested in the long-term functioning of ecosystems that they depend on.	Firms react to changing conditions of SES to preserve the status quo, such as fauna and flora of an ecotourism destination.
	Enhance	Firms develop business practices that enhance the health of SES, for instance, through farming practices that increase soil quality.	Firms see themselves as one part among others in a SES.	Firms couple their business activities to the development and health of SES.	Firms see themselves as integral part of a specific place and its SES dynamics.	Firms live with the cyclical and seasonal rhythm of the SES they are part of.	Firms iteratively adapt to the evolving conditions through robust action in collaboration with stakeholders.

SES: social-ecological system.

Figure 10. Regenerative business criteria and strategies as per Hahn and Tampe (2021).

2.6 The TRANSPATH conceptual framework: linking cross-scale leverage points for the emergence of net-positive biodiversity-climate tipping points

2.6.1 On leverage points

Donella Meadows (1999:1) originally defined leverage points as 'places within a complex system (a corporation, and economy, a living body, a city, and ecosystem) where small shift in one thing can produce big changes in everything". She defined leverage points as 'places to intervene in a system', being in increasing order of effectiveness, the following: 12. Constants, parameters, numbers (subsidies, taxes, standards) 11. The sizes of buffers and other stabilising stocks, relative to their flows, 10. The structure of material stocks and flows (such as transport networks, population age structures, 9. The lengths of delays, relative to the rate of the system change, 8. The strength of negative feedback loops, relative to the impacts they are trying to correct against 7. The gain around driving positive feedback loops 6. The structure of information flows (who does and does not have access to what kinds of information) 5. The rules of the system (such as incentive, punishments, constraints) 4. The power to add, change, evolve, or self-organise system structure 3. The goals of the system 2. The mindset or paradigm out of which the system -its goals, structure, rules, delays, parameters- arise and 1. The power to transcend paradigms. Notice that there is a hierarchical understanding on these leverage points in so far that the more influential ones can condition and determine the potential for change of the less influential ones.

It is important to underline that Donella Meadows used a general notion of *complex systems*, that in her mind included for instance, 'a corporation, an economy, a living body, a city, an ecosystem', in which common system properties could be identified. This conceptualisation would not only encompass any kind of social or biophysical systems, but was also based on the assumption that dynamics identified and occurring on certain biophysical or technological systems could also help to understand dynamics in social or symbolic ones, although such a distinction between both had not been made explicit. A system would have both stocks and flows ('inflows and outflows') and their dynamics would be determined by the relationships of these with its overall structure, system parameters and feedback processes among them. Notice that in the system language that she used, 'positive' meant reinforcing feedbacks and 'negative' meant dampening ones, and therefore such words did not have any normative or aspirational connotation.

The approach of leverage points has been further operationalised and applied to various domains and cases exploring sustainability change. For instance, Moser et al. (2019) elaborated the Meadows framework to argue that transformations require changes in policies, practices and resource flows as well as on the underlying relationships and power dynamics among actors as well as in the mindsets in which these conditions are based. Moreover, and based on the Meadows idea that whilst certain leverage points or interventions may be easier to be implemented but they may have limited impact on systems' transformation and vice versa, Abson et al. (2017) grouped the original Meadows' twelve leverage points into four categories depending on their potential to influence transformation: parameters, feedbacks, design and intent (Figure 11). They also contended that solution-oriented research focused on sustainability transformations should particularly engage in interventions that address systems' intent and design rather than adjustment of feedbacks and parameters as the latter deal with the deep and ultimate causes of unsustainability (see also Fischer, J., and M. Riechers. 2019). And Systemiq (2023) recently introduced the notion of 'positive super leverage points' to explore transition dynamics in a variety of sectors, including food and agriculture (alternative proteins) and land-use change (by valuing nature-based solutions) underlying the role of affordability, attractiveness and the enabling environment, although issues of equity and justice have not been elaborated there.

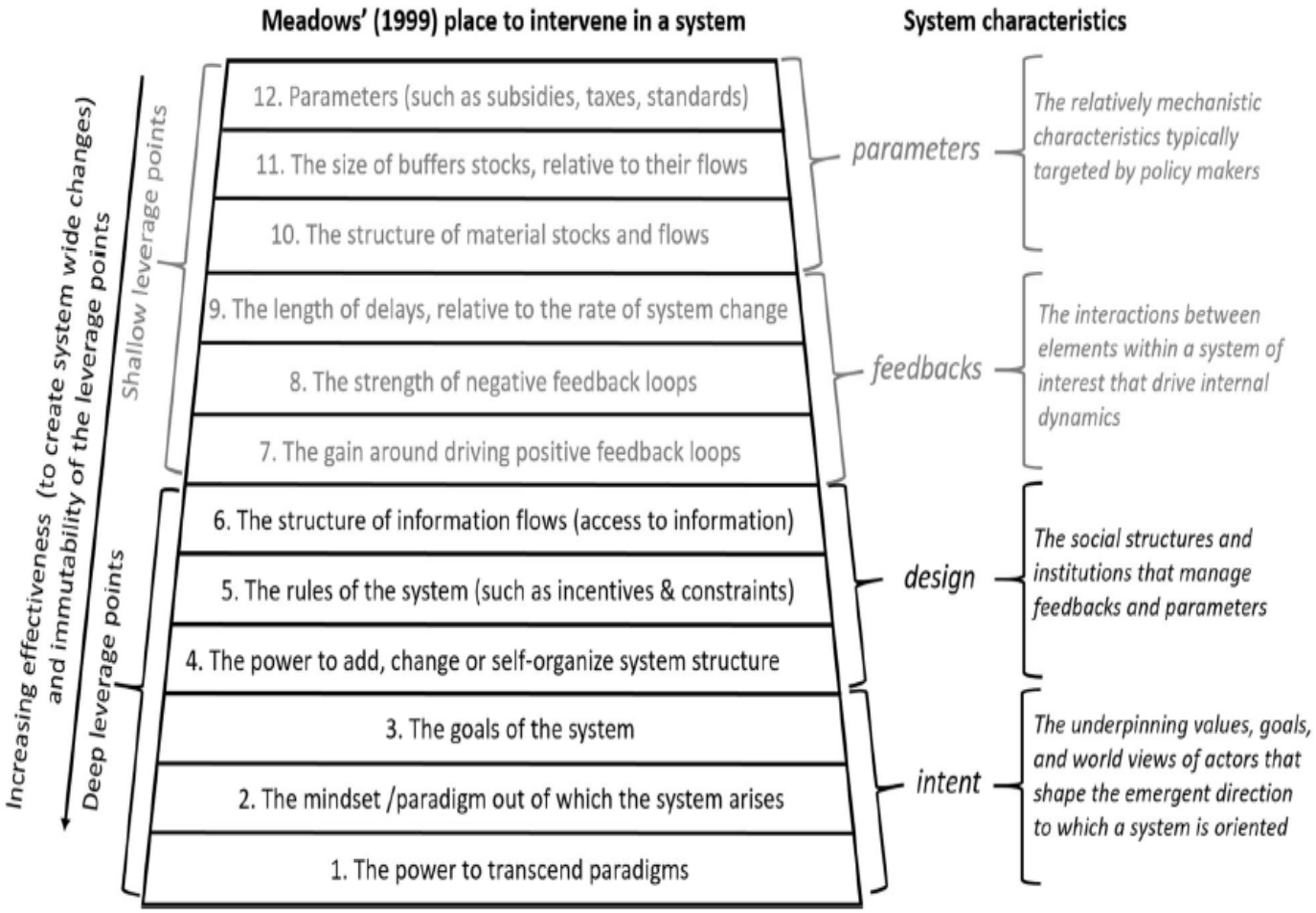


Figure 11. Clustering of the original 12 Meadows tipping points into four main categories of parameters, feedbacks, design and intent: from 'shallow' places where interventions are relatively easy to implement but with limited effects on systems transformation to 'deeper' ones that generate the opposite.

Likewise, O'Brien (2018) clustered these leverage points into three kinds related them to the kinds of transformations involved. In her view, transformations occur across personal, political and practical spheres as *practical* -those situated in the lower part of the ladder, *political,* situated in the middle, and personal, situated at the top (Figure 12):

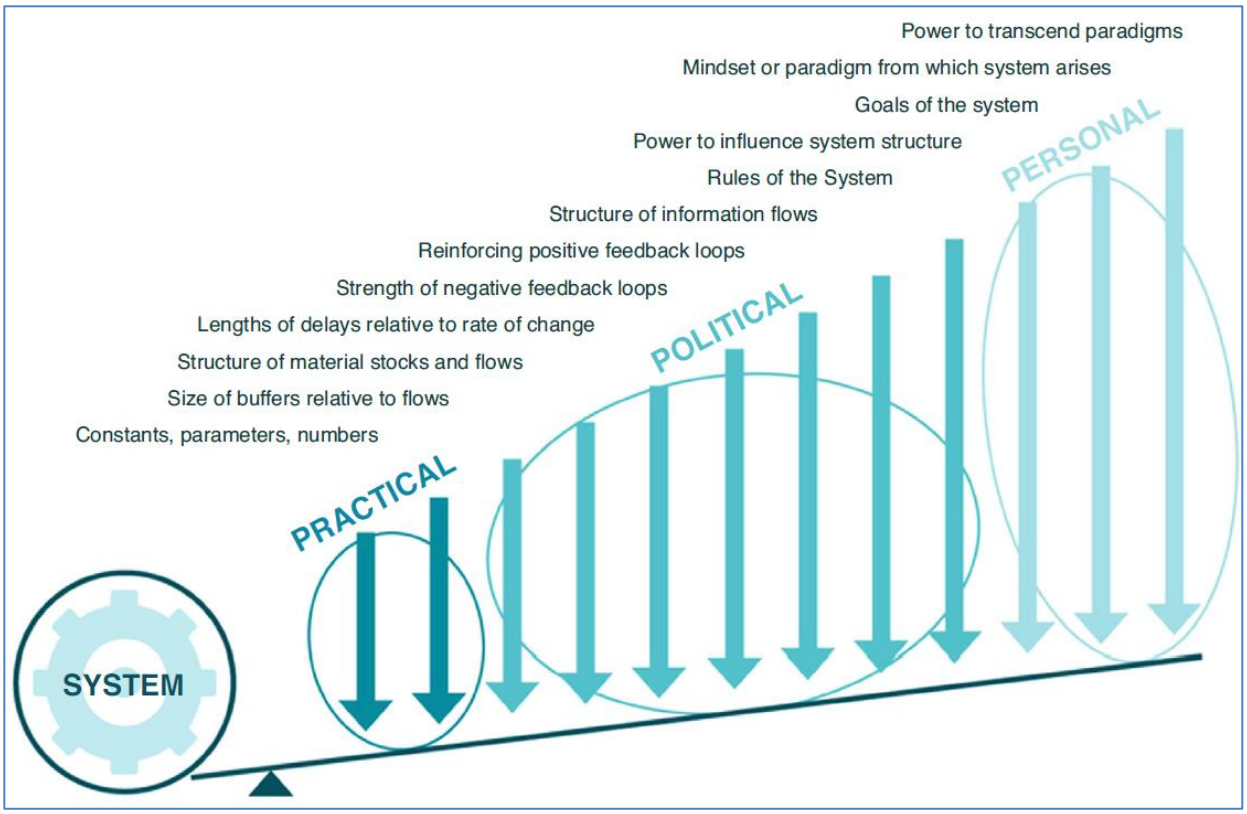


Figure 12. Clustering Meadows leverage points into three spheres of practical, political and personal spheres.

And further operationalisation of these four clusters has been carried out for instance, by Fischer et al. (2022) to unveil and investigate tipping interventions in three very rural landscapes, including Southeastern Australia, central Romania and southern Ethiopia, as shown in table 2.

Level of systemic depth	Leverage point	Example (of relevance to rural landscapes)
Parameters	Parameters	Quantity of inorganic fertilizer used
	Size of buffer stocks	Amount of livestock feed stored to cope with a drought
	Structure of material stocks and flows	Run-off dynamics of nutrients from fields into streams
Feedbacks	Length of delays	Extinction debt of forest trees persisting in recently cleared farmland
	Strength of balancing feedbacks	Extent to which a lake can absorb agricultural nutrients and remain clear
	Gain around reinforcing feedbacks	Extent poverty may cause population growth, which may cause poverty
Design	Information flows	How knowledge about various types of agricultural methods is transmitted
	Rules of the system	Policy instruments and regulations in various interacting sectors
	Power to change system structure	Ability of farmers to self-organise to sustainably use a communal pasture
Intent	Goals of the system	Maximising agricultural exports versus improving national food sovereignty
	Paradigm underpinning the system	A green revolution paradigm versus an agroecological paradigm
	Power to transcend paradigms	Conscious shift from a growth-based economy to a steady-state economy

Increasingly deep (i.e. influential) leverage points are listed towards the bottom of the table.

Table 2. An example of the identification of leverage points, according to their potential to influence the configuration of rural landscapes according to Fischer et al. (2022)

Another relevant aspect of systems dynamics to consider for developing transformative pathways, also originating from Meadows, is *directionality***:** a particular leverage point or intervention could have different or even opposed effects depending on the overall orientation and the setting in which such intervention takes place. The contribution of a given leverage point to push the system to a deliberate direction will therefore depend on the interactions with other leverage points and the overall and unique system conditions in which potential synergies or trade-offs may unfold. Hence, the effectiveness of certain interventions may ultimately depend on the previous existence of certain structural conditions or the implementation at the same time of other kind of interventions. This is why visions and evaluation procedures can help to coordinate and validate whether a combination of interventions follow a coherent strategy or, in our case, a transformative pathway.

However, the meaning and use of leverage points have evolved and changed, particularly in the last few years. For instance, Chan et al. (2020), as a component of the IPBES research, identified the following eight leverage points by conducting an iterative deliberation process that also included the nexus analysis of scenarios and pathways: 1. Visions of a good life 2. Total consumption and waste 3. Latent values of responsibility 4. Inequalities, 5. Justice and inclusion in conservation 6. Externalities from trade and other telecouplings 7. Responsible technology, innovation and investment, and 8. Education and knowledge generation and sharing, alongside five intertwined levers related to multi-actors interventions to be applied across the eight leverage points, including: (a) Incentives and capacity building, (b) Coordination across sectors and jurisdictions (c) Pre-emptive action (d) Adaptive decision-making and (c) Environmental law and implementation. This conceptualisation was then graphically expressed in Figure 13.

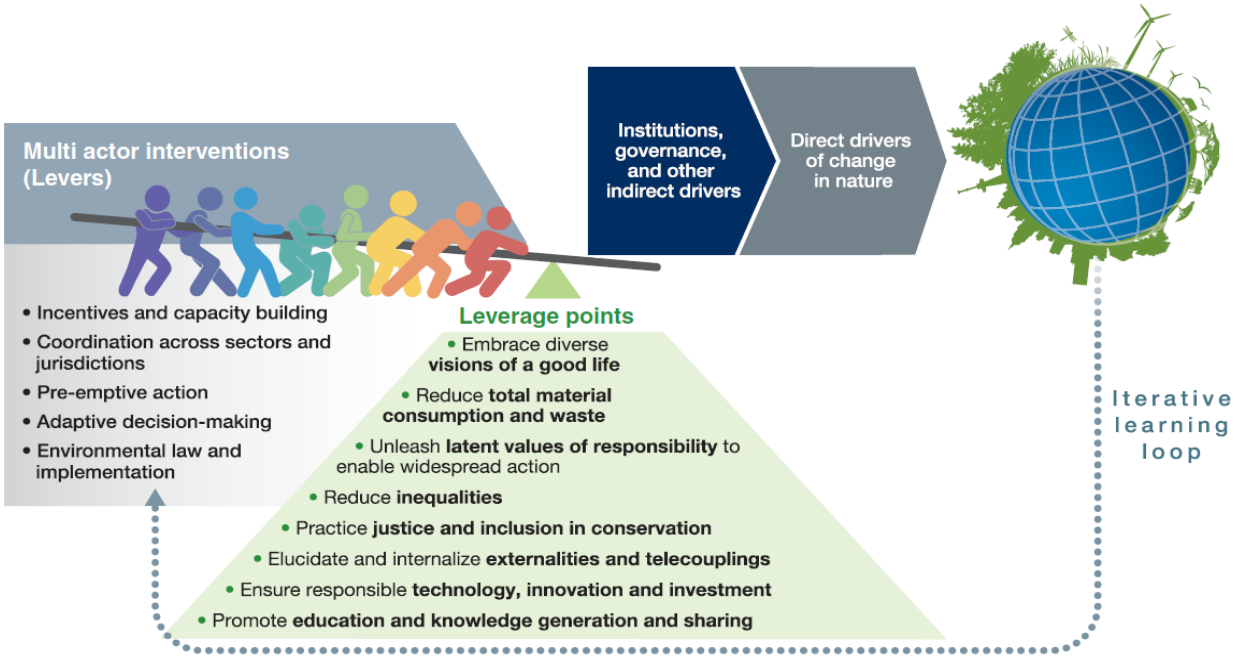


Figure 13. Levers and leverage points relevant for IPBES according to Chan et al. (2020)

Last but not least, the UN Report Making Peace with Nature (UN MPN,2021) selected the following leverage points: 1. Paradigms and visions of good life, 2. Consumption, population and waste, 3. Latent values of responsibility, 4. Inequalities, 5. Participation in environmental acting and resource use, 6. Externalities, 7. Technology and investment, and 8. Education and knowledge generation and sharing.

However, and when thinking in the design of the TRANSPATH transformative pathways that synergize climate and biodiversity interventions, the research of leverage points still confronts many unresolved questions. Some of these challenges have to do with the role of diverse temporal scales and intersections between different systems or to the application of complex systems thinking across social and biophysical domains. In fact, as also recognised by Leventon et al. (2021), in their introduction to several research pieces on leverage points, 'what is a leverage point for one author, is a system or an intervention for another'. This is why they offer the following nine reflective questions that could help further research on leverage points: 1. What is the system of focus and what are its properties (paradigm, design, processes and materials)? 2. What are the problem framings and norms that underpin this system framing? 3. What systems is the focal system nested within (multiscale systems) or connected to (different system framings)? 4. Which system properties (paradigm, design, processes and materials) does the intervention target, in which focal system? 5. What properties are impacted over time, or space, or via indirect impacts? 6. How does that intervention influence and work in connected or nested systems? 7. Where am I in the system? 8. What are the boundary objects within this system? 9. How do I act, and what normative framings do I add to this system?

Hence, and more directly concerned with the TRANSPATH transformative pathways, a non-exhaustive list of questions could include:

- What is our system of reference within and across the TRANSPATH case studies and work packages?
- Can we directly translate insights derived from positive complex system research and the modelling of biophysical systems to understand social systems engaged in climate and biodiversity strategies? Or may we need to understand and describe them based on different ontologies and epistemologies? (see section 3.2)
- How to take into account processes of biodiversity loss and climate change that have many different structural causes of change but also many cross-scale social, temporal and spatial effects and interactions?
- How to do deal with multiple systems of reference and their interactions, with different scales or nature (each of them with different temporal, spatial and socio-economic and political scales and dynamics)? And particularly in various decision-making domains related to the TRANSPATH case studies?
- How to deal with multiple cumulative and depletive processes and socio-ecological feedbacks (positive and negative) on biodiversity and climate change? how to consider the emergence of autonomous global systems dynamics and cascading effects which cannot be controlled by deliberate agency (e.g., methane from permafrost melting)?
- How to deal with multiple potential leverage points related to climate and biodiversity at the same time? How to map out and quantify their different effects at different scales or action-domains?
- How to characterise different qualitative change and feedbacks within and across different components of social ecological systems such in institutions and social

norms (S), energy systems (E), information and knowledge systems (I), and cumulative environmental change (C)?
- How to integrate social science theories and insights into complex systems thinking and the identification of synergies between climate and biodiversity practices and interventions?
- …

Because of the large complexity and magnitude of these questions, the following section now briefly introduces the potential relevance of the current research on tipping points. This discussion is then connected to the task of supporting the elaboration of transformative pathways synergising climate and biodiversity actions respectful to social-cultural contexts and rights, given unpredictable futures over long timeframes that consider a just and safe future for humanity.

2.6.2 On positive tipping points

Deliberate transformations contributing to systems' sustainability can occur in incremental modes (otherwise known as 'transformative incrementalism') or in more abrupt, fast and disruptive ways at certain moments in time. When the latter happens, due to an additional relatively small force of change that acts within a milieu of previous other forces and cumulative effects derived from multiple interventions and diverse sources of agency (see section 2.5), we refer to such phenomena as *positive tipping points*. It has been argued that actions and strategies, aimed to deal with the present conditions of accelerated global change and risks, also need to accelerate and create new fundamentally different systems conditions addressing the ultimate causes of unsustainability. **Qualitative structural changes across many kinds of social-ecological systems, domains and scales need to be coordinated and combined to move from additive to multiplicative changes.** Therefore, research on positive tipping points is considered urgent, although still largely under-developed (Farmer et al., 2028; Tàbara and Frantzeskaki 2018, Lenton 2020; Lenton et al., 2022; Otto et al. 2020; Milkoreit et 2018, Milkoreit, 2022, Franzke 2022; van Ginkel et al., 2020). Furthermore, Tàbara et al. (2021) distinguished between positive *sectorial tipping points* that mostly relate to partial or limited-domain transitions and full-systems tipping points, that have to do with more encompassing, cross-level and deep transformative processes.

Yet, there is not a universally accepted definition of tipping points across natural and social sciences. In general, the concept of tipping points has been used to refer to those thresholds that occur when a small additional change or event provokes a sudden, self-propelling, profound and qualitative change in a system of reference. Tipping points can be either negative or positive, induced and deliberately brought about by conscious action or resulting from forces beyond human awareness, intention or reach. And when they result from human actions—such as the end of slavery or the access to women to education and political voice—they are never activated by one single action or individual. The emerge from the combination of numerous forces, previous changing conditions and interactions within many systems' components at the same time. These: 1. create the previous enabling conditions from which tipping processes and system transformations may occur; 2. facilitate the emergence of disruptive actions, interventions or systems innovation able to tip the system toward a fundamentally systems dynamics and configuration; and 3. provoke new systems configurations and dynamics aligned with transformative visions and narrative of change. Therefore, it is important to distinguish between an actual tipping point—the moment in which a small additional force creates a

large system's change—and the tipping interventions focused on creating those enabling or critical systems' conditions[3] and agents' transformative capacities for the emergence of deliberate positive tipping points (see Fesenfeld et al., 2022; Eder and Stadelmann-Steffen, 2023.). In this regard, Juhola et al., (2022) argue that the operationalisation of social tipping points, in the context of climate adaptation limits and systemic risks, would need to focus on making explicit the system boundaries and scales, the respective social agents, and the characteristics, feedbacks, and agents' responses of the social system of reference in which such tipping processes are being analysed.

Within the TRANSPATH project, positive tipping points can be defined as those moments in which a given social-ecological system moves to a fundamentally different development trajectory or system's attractor, from which self-propelling dynamics contribute to improving the human quality of life, the long-term sustainability of human-nature interactions and thus can avoid the potentially existential risks of currently accelerated global environmental change. And that such moment may emerge from the moment in which synergies created by gains in climate and biodiversity improvement are being coupled and reinforced by gains in social conditions such as equity, social cohesion, and transformative governance capacities. Therefore, the extent to which the effects of deliberate interventions, and ultimately a tipping point is defined as positive or negative depend to a large to the extent it achieves an explicit *vision* (e.g., a world free of child labour) or more generally, using particular normative criteria. These may include general values or beliefs regarding universal rights and freedoms or more specifically, the realisation of sustainable development goals (SDGs). Hence 'positive' does not mean necessarily 'reinforcing' or 'amplifying' in its consequences (nor negative meaning dampening) as it is understood in systems thinking. Thus, in TRANSPATH indicators and criteria that would define actions, pathways and potential tipping points as positive or negative will be largely contextual, e.g., case study dependent.

2.6.3 Aligning net-positive biodiversity-climate tipping points in a safe and just corridor for humanity

In a rapidly warming world heading towards a 10 billion people in just a generation and where negative Earth tipping points might have already been crossed or are about to be crossed (Armstrong McKay, et al. 2022), an integrated global systems perspective is absolutely necessary. A framework intended to create reflexivity on how to support transformative pathways needs also to identify and explore what the conditions are for supporting positive tipping points globally towards a safe and just corridor for humanity. One that can improve global equity and people capacities to engage in contributing to improving their lives within global Earth limits in a sustainable—regenerative—way. And while the framework is global, the actions are fundamentally context-specific across many different boundaries

Building on the previous discussions, we are now moving to conditions to provide an integrative conceptual framework that bring in the latest research discussions within the field of leverage points, positive tipping points, safe and just corridor for humanity and regenerative sustainability. The proposed conceptual framework suggests that

[3] For which examining the levels of *systems criticality* to fundamental change would be needed.

transformative pathways aiming to synergise climate and biodiversity actions need to map out and consider *at the same time*[4]:

- ***Multiple leverage points****:* intervening at different parts of a given system of reference and its social-ecological relationships.
- ***Multiple levels and domains of social action***: and doing so within and across personal, organisational and large-system levels; hence entailing changes in individual lifestyles, socioenvironmental practices, institutional processes as well as in political and distributional arrangements.
- ***Multiple spatial scales and time periods****:* in which individual and collective actions take place and throughout the times that their consequences materialise (in past, present and future). Transformative pathways focusing on climate and biodiversity need to consider alternative and multiple notions of time beyond only socioeconomic, linear or ecologically uncoupled notions of time; in particular, those that have to do with social-ecological cumulative processes that affect, either positively or negatively, life-support systems, such as the times left to hit certain dangerous climate thresholds (e.g., the 2°-1.5°C threshold) or/and the times left to avoid species extinction processes.
- ***Multiple notions of justice*****:** not only considering recognition, distributive and procedural notions of justice, but also taking into account more challenging approaches of *transformative justice* that combine local ideas of fairness around natural resource use and access as well as Earth System justice and the search for a just and safe operating space for humanity. This fundamentally also includes future justice.

- ***Multiple positive synergies between improvements in social conditions (capitals or stocks) and improvements in biophysical ones:*** Securing the long-term viability and quality of life-support systems a world heading possibly to 10 billion people by 2050 depends to the extent that mutual benefits between both can be created and trigger self-propelling, continuous and regenerative processes of transformative change; thus, overcoming zero sum-game discourses of society-nature relationships while acknowledging justice considerations.

Fundamental deliberate transformations occur at one moment when a relatively small additional force of change alters the original configuration and dynamics of a given system—either an individual, an organisation or large systems—evolves. When these deep changes happen and follow an alternative, better-off system attractor, e.g., more aligned with sustainability principles and achieve so in a structural and enduring way—such as the access to education to women or the elimination of child labour in some societies—we can talk about *positive tipping points* in social systems. Nevertheless, the present report calls for paying special attention to those deliberate transformations and actions that:

(i) **not only focus on the social systems, but also include the biophysical ones,** and that can be referred to as social-ecological tipping points.

[4] However, this does not mean that all research efforts and pathways will be able to shed light on all this dimensions the same way or in the same domains or scales; but only the integration of several findings and research could help to its later overall integration.

(ii) **not only contribute to producing less harm** (<0), or lead to neutral outcomes (=0: e.g., carbon neutral) **but** to those pathways that eventually can lead to ***net-positive tipping points*** (>0) enhancing and restoring the social and biophysical conditions that make human life possible on Earth in the long term.

In the case of climate and biodiversity, it is suggested that TRANSPATH ought to play special attention to the discovery and assessment on **net-positive nature-climate actions, leverage points and strategies**, tipping diverse systems of reference towards biodiversity-climate resilient futures.

Furthermore, and using a whole-life systems perspective (Tàbara 2023a), this report also suggests that the paradigm of ***regenerative sustainability*** can play a central role in coordinating multiple transformative pathways oriented to synergise climate and biodiversity actions. Deliberate regenerative strategies refer to those coherent combinations of actions aimed at creating mutualistic, self-reinforcing positive dynamics within and between social and biophysical systems conditions. Because this approach is inherently systemic, multiple feedbacks across multiple time, social and temporal scales is required together with the consideration of a broad integrated framework of transformative system justice. Alternative combinations of leverage points yielding a safe and just operating space for humanity could unfold within a 'landscape of regenerative solutions' synergising individual, organisational and large-systems' level actions across short, mid and long temporal scales. Moreover, such synergistic actions and pathways ought to contribute to the building of transformative and enabling conditions necessary to achieve net-positive biodiversity-climater[5] tipping points both at local and global levels, consistent with a safe and just corridor development for humanity. This conceptual framework is synthesised in Figure 12:

[5] Here the wording 'nature-climate' and 'biodiversity-climate' are used indistinctively as synonyms only for communication purposes.

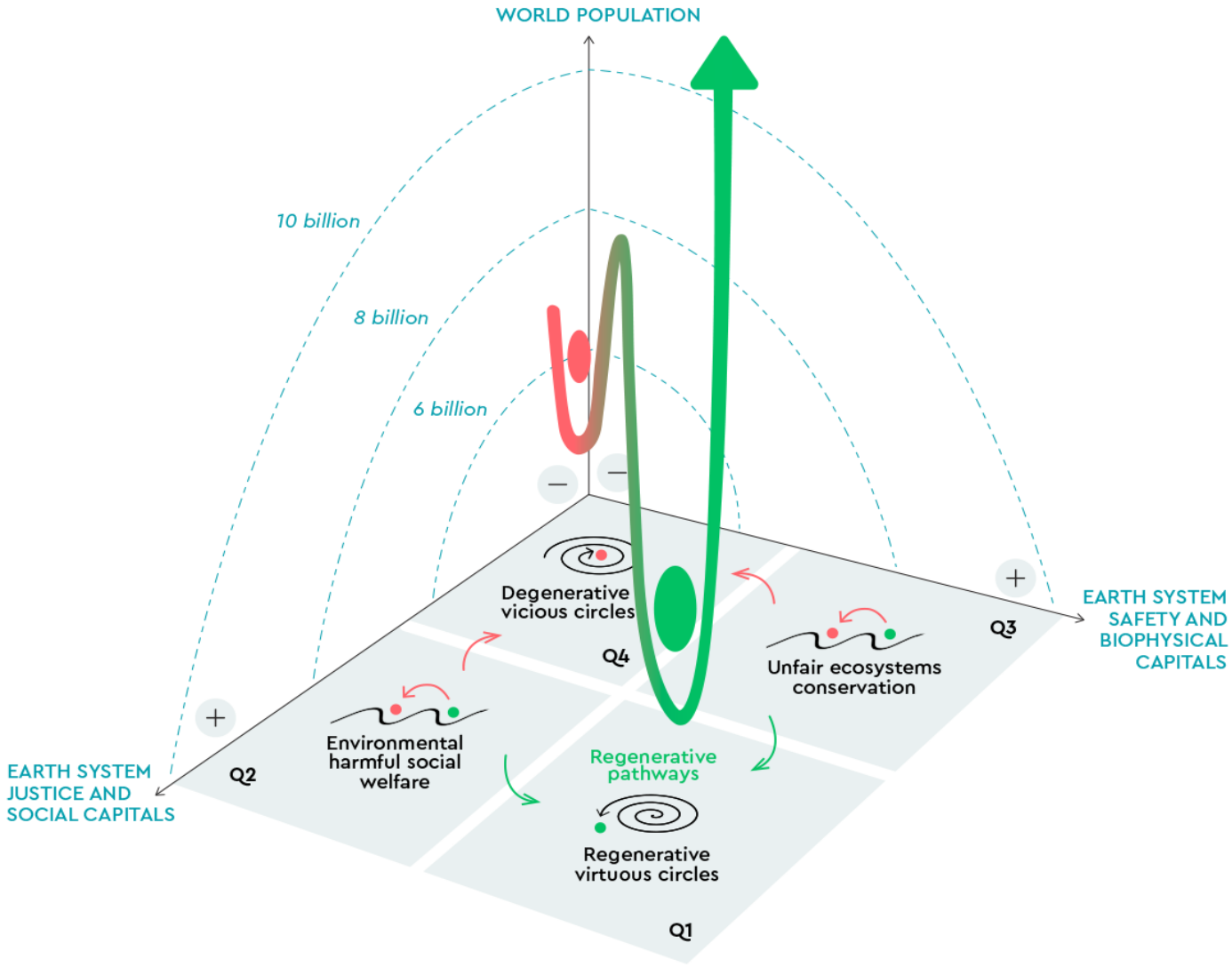


Figure 14: An integrated conceptual framework. Achieving net-positive biodiversity-climate tipping points that consider a safe and just operating space for humanity in a world moving towards 10 billion people requires synergising fast improvements in social conditions (stocks or capitals) and in biophysical ones across multiple spatial, temporal and social scales of action (Graph design by J. Tàbara, based on Tàbara 2023).

3 Conceptual engagement and mutual learning in TRANSPATH

Science to support sustainability transformations is science *in and for* a particular context; and all contexts and systems of interests are different. Whilst it is possible to find common patterns of environmental behaviours, practices and configurations and dynamics in a variety of organisational and large-scale systems, empirical research on transformative pathways necessarily calls for contextualisation. Therefore, the conceptual framework presented in this report ought to be understood only as an invitation to reflect on a series of assumptions, dimensions and possible visions, that are directly related to the actual challenge of operationalising transformative pathways in the context of global environmental change. Mentioning issues like the existence various equity criteria, or noting the social and biophysical trends of a world already exceeding various Earth tipping points, whilst at the same time providing some light of hope with a narrative of regenerative sustainability, could enrich the TRANSPATH research imagination deliberation processes with stakeholders in ways that might not have been considered otherwise.

Moreover, science for sustainability transformations is also about *doing science differently*. Because of the original transformative challenge and orientation posed by the TRANSPATH Description of the Action (DoA), such design of pathways requires processes of mutual learning or more specifically as already many authors within the transformations research this calls for second or even third order learning within the project which in turn should help to assess to which extent certain proposals, governance structures or strategies could best contribute to transformations synergising climate and biodiversity interventions. For instance, Pahl-Woslt (2009) already identified that that certain kinds of policy and governance structures and arrangements (e.g., polycentric, open to experimentation, etc) are more conducive to support second and third order learning being the latter the ones aimed to support transformations (Figure 15):

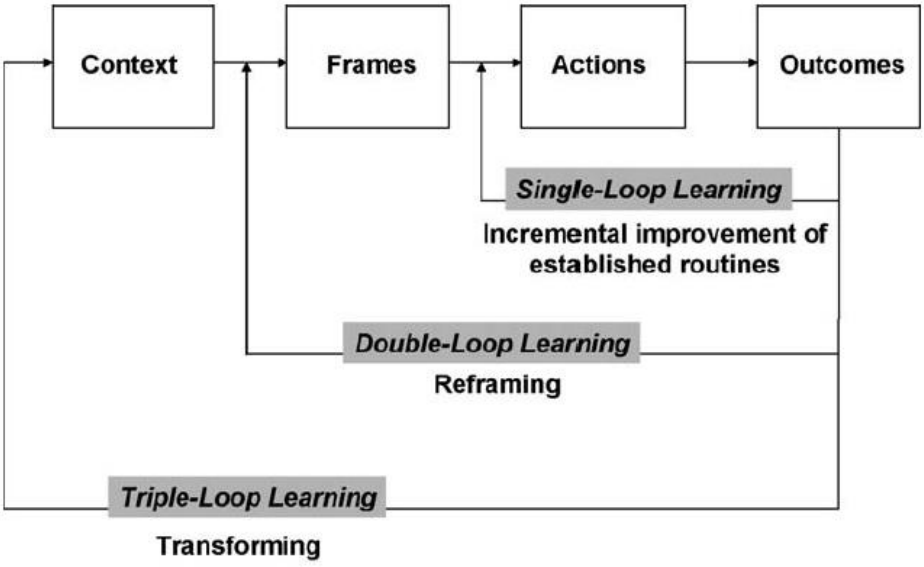


Figure 15. Transforming requires second and even triple-loop learning, whereby the latter pays special attention to the power of ethical norms and also to the processes and mutual dynamics that leads to collective reflexivity about our own worldviews so as to support transformation in values and beliefs. Source Palh-Woslt (2009).

Second and third order learning or in our case, *sustainability learning* specifically oriented to support sustainability transformations (Tàbara and Pahl-Woslt, 2007) can be stimulated by creating regular, safe and independently facilitated spaces for interaction between diverse perspectives—regarding age, sources of expertise, gender, political perspectives and economic interests, and in which decisions taken in these spaces can be later used to support policy making. These insights must also follow criteria of representativeness, balanced competence of participants, so securing trust, equity and fairness is crucial for long-lasting engagement of stakeholders engaged in transformation processes. Transformations also take time and they need mostly to focus on 'who is the solution' (capacity building) rather than 'what is the problem'. In social learning processes, the role of initiators, community leaders and champions is crucial. In many cases such individuals may emerge in an autonomous way, depending on the opportunities for development. But in others, such opportunities may not exist, so an important task in those processes aimed at supporting transformations at local level is to identify and help the empowerment, agency and training of those individuals—and the supporting organisations networks—who could best play such a transformative role. Insights gained in various contexts (Tàbara, Takama et al. 2018) show that such recruitment and transformative capacity development tasks take a long time (months and even years) but in any case, they need to be informed by explicit visions and criteria that consider a long-term transformative and situated perspective.

Within the TRANSPATH project these reframing and learning cycles could be carried as represented in Figure 16, although the specific content and reach of these tasks will have to be further developed in the implementation of the TRANSPATH toolkit.

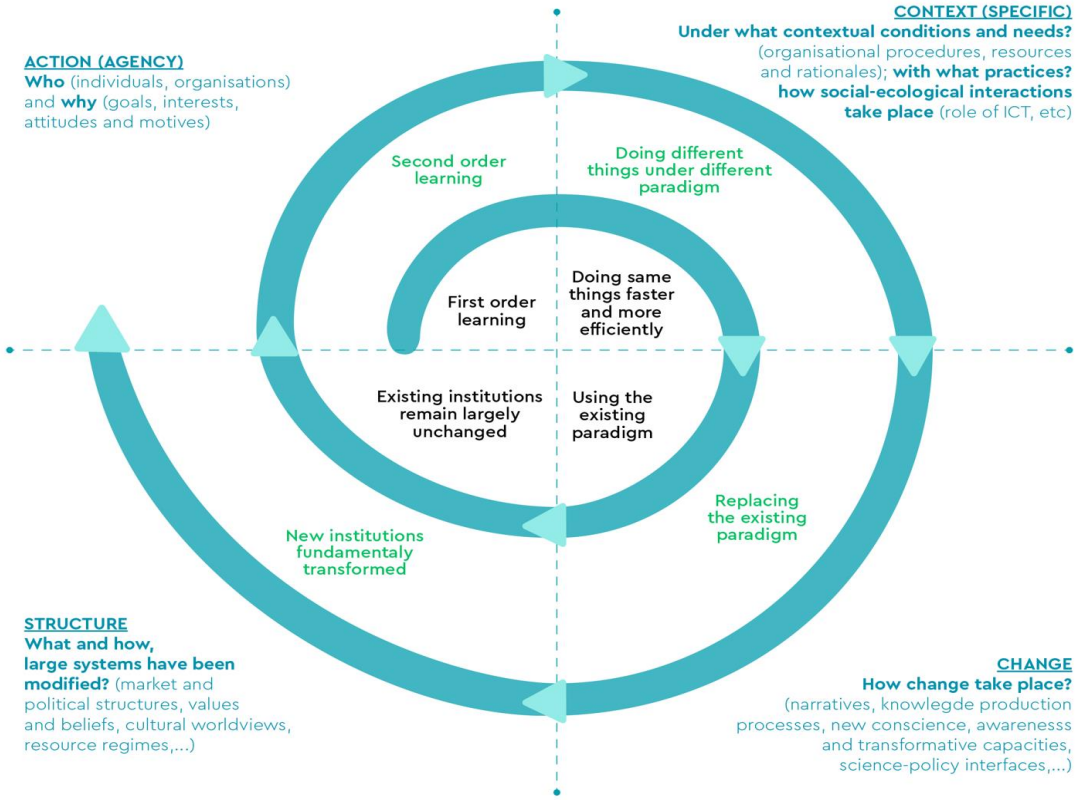


Figure 16. First and second order learning and the role of agency, context, change and structure. Adapted from Tàbara, J. D. (2005). Sustainability Learning for River Basin Management and Planning in Europe. HarmoniCOP integration report. https://www.harmonicop.uni-osnabrueck.de/

Last but not least, mutual learning could further be enhanced by addressing questions of positionality. In interdisciplinary projects there are always many different ways to frame the issues at stake, and inevitably different priorities, methods and normative stances on what is important or needs to be done. Therefore, expressing at early stage what different ontological, methodological and normative positions are can help to open up discussions aimed at reflecting, identifying and operationalising leverage and tipping points in more robust ways. Positionality can be made explicit, as it is the case of the 'discovery' of tipping points using a simple methodology, as expressed in Figure 17.

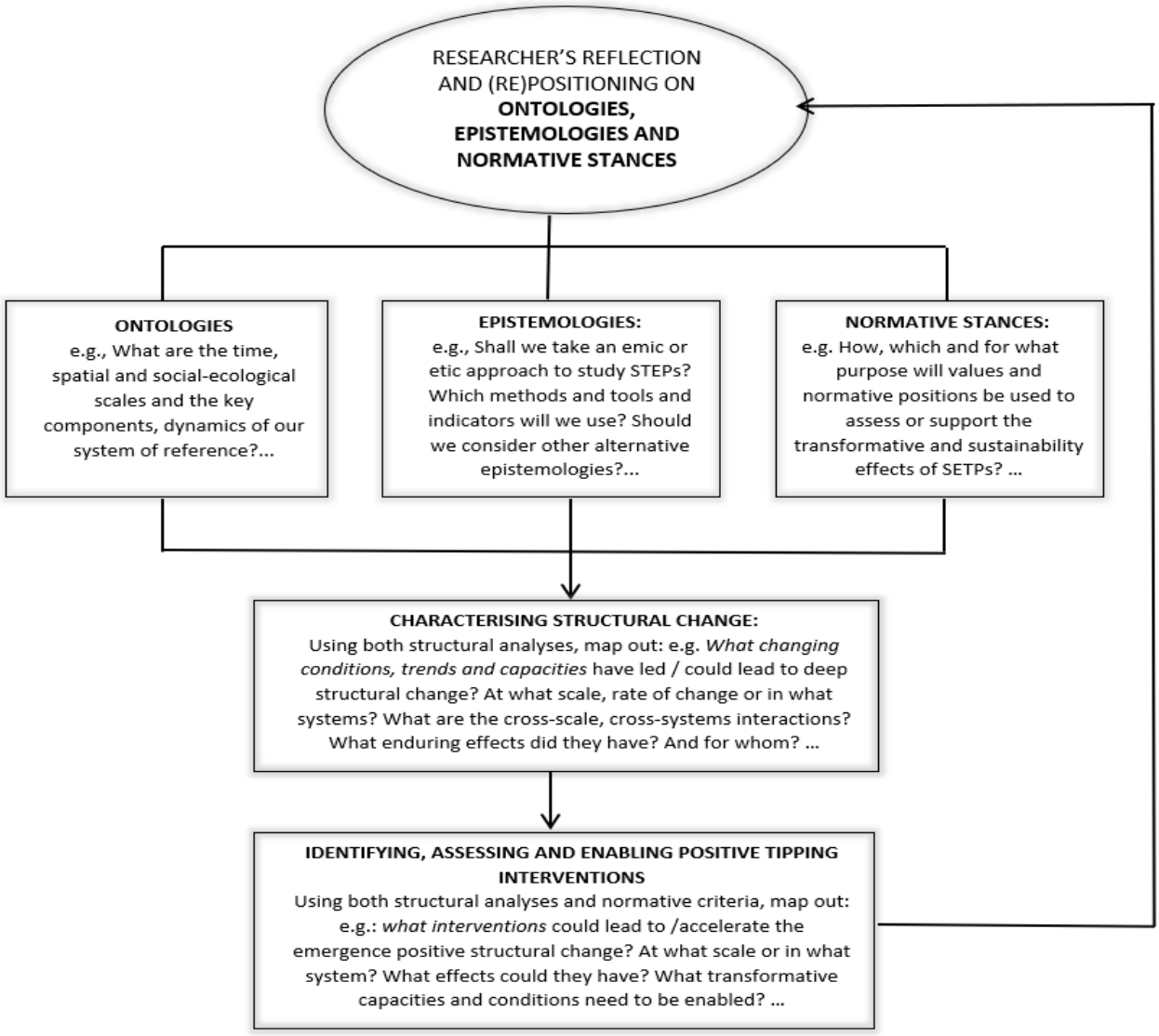


Figure 17: Expressing researchers' different positionalities at early stage can help to mutual and second order learning in the discovery of both leverage and tipping points. (Source: Tàbara et al., 2021)

4 Conclusion

This report has provided an original conceptual framework advancing the state-of-the-art research on how to construct transformative pathways, respectful to social contexts and rights. Its purpose is to synergise climate and biodiversity actions and take into account the moral imperative of keeping human societies within a safe and just Earth System development trajectory. This heuristic tool suggests the need to combine multiple kinds of leverage points, systems of solutions or sensitive tipping interventions with the goal to tip a given system of reference towards a new structural dynamics or better-off system's attractor. Acknowledging that not only one single system needs to be transformed—e.g., the global one—but endless kinds of diverse systems nested within the global system and operating a different individual, organisational and large-scale levels, the proposed framework suggests that a coordinating vision or cognitive and moral paradigm is necessary. This report suggests to focus not only on supporting 'less-harm' or 'neutral' outcomes, but most importantly those that can eventually yield net-positive ones and that are necessary to restore the social-ecological conditions that make human societies possible on Earth in the long term. The regenerative paradigm offers an opportunity to reflect and frame the making of transformative pathways using a novel narrative, one that intends to move away from partial or transition-based approaches—that tend to disregard complex interactions, feedbacks and cumulative processes between social and biophysical systems—toward a more holistic and potentially disruptive one based on a whole-life systems perspective.

The suggested framework is, however, not an end-point nor simply 'a frame' that constrains or limits our scientific imagination. Neither is it a recipe that can be applied in different contexts of case studies unreflectively. On the contrary, it would be better to be seen as a heuristic—or conceptual installation—to prompt joint discussions and questions about the meaning of transformative pathways in the context of accelerated global change. Although the kinds of questions to be addressed may differ in different work packages, contexts and kinds of methods to be used within the TRANSPATH project, these could include, as a next step, to explore some of the following: what do we mean by transformative change in my research context? To which extent can a particular leverage point or intervention contribute to *fundamentally* altering the dynamics of our system of reference? How could these interventions be combined in time as to move from incremental or additive strategies towards multiplicative and disruptive ones? How and under what criteria is justice being defined by the stakeholders we are interacting with? How are the temporal scales of certain interventions connected to biophysical processes such as carbon budgets or biodiversity extinction rates? How could multiple leverage points intervening at different system's levels—individual, organisation, large-systems ones—-eventually lead to net-positive biodiversity-climate tipping points? How can synergies between social and biophysical capitals or conditions be enacted as to create the necessary enabling conditions for positive social-ecological tipping points? What could be the implications of following (or not) a global regenerative development pathway that also considers the conditions for a safe and just Earth System?...

These are only just some of the few questions that the proposed visual and analytical tool may trigger. However, the knowledge that will eventually lead to the identification of specific measures and actions synergising climate and biodiversity actions and that eventually will be combined to constitute the different transformative pathways will need to be co-produced with stakeholders and all the people involved in the definition of the issues at stake in each work TRANSPATH package. How we can do this is the one of the themes in deliverable 1.2. that emphasises the need for deliberation across diverse range

of stakeholders given that such complex policy targets and transformative pathways cannot can't be defined just by scientists. For this is only the beginning of a common journey.

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Annex 1: Glossary

TRANSPATH WP1 GLOSSARY,

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Introduction

The objective of this document is to select some key terms upon which WP1 can use create a common understanding of their meaning in a way that can support interaction with other work packages. It does not intend to be a comprehensive list of all the possible terms that may be useful in the future. But only those that are most urgently needed to have such common understanding, taking into account that such meaning will always be situated and will evolve depending on the uses, learning interactions and contexts in which they are to be used. We reckon he usefulness of this document will be directly proportional to the extent it is kept to the most limited number of terms, but if you feel that there are some absolutely essential that are missing, please let us know.

Selected terms

AGENCY: The capacity for individuals to act freely and make their own choices in a way that can deliberately affect the configuration of the contexts in which they operate. These choices are made in conjunction with, constrained or advanced by, social structures that are continually being made and re-made. The relationships between agency and structures also influence the kinds of interactions that humans engage with biophysical systems, and therefore cumulative anthropogenic changes (e.g., GHGs, loss of biodiversity) also affect the options and free capacities to influence the social-ecological systems in which individual live.

REFLEXIVITY: Reflexivity can refer to i) a researcher's or research team's awareness of their own positionality(ies), values and objectives in relation to their field, context or subject of research; and ii) an explicit unpacking or understanding of the relationships between causes and effects. In social science research, reflexivity is encouraged to make transparent the relationship between critical frames of analysis or research objectives, and the values and goals of researchers. In economics, reflexivity refers to the effects of prices on underlying processes of extraction, processing, and production. In this respect Pickering, (2019) presents *Ecological reflexivity* as a conscious antidote to unsustainable path dependencies, and argues that it provides a useful heuristic device for guiding the deliberative processes. He defines ecological reflexivity as : "the capacity of an entity (e.g. an agent, structure, or process) to: *recognise* its impacts on social-ecological systems and vice versa; *rethink* its core values and practices in this light; *and respond* accordingly by transforming its values and practices" (Pickering, 2019, p. 1150)

POSITIONALITY: an explicit awareness and where appropriate, communication of researcher's standing, roles and position in relation to the purposes, programme and participants engaged in a research. Positionality can broadly be clarified by making explicit: 1.What kind of contexts, practices or systems researchers consider as object or

subjects of study (ontologies) 2. How or with what methods are going to be used (epistemology) or 3.Which values or normative criteria will be used to assess their results or for what purposes (normativities) (Tàbara et al. 2021). It is also related to whether researchers want to take and obtain an emic ('from the inside') or etic ('from outside') perspective or engage in an action-research or more distant analytical stance regarding their contexts, object and agent of study.

LEVERAGE POINTS: Donella Meadows (1999:1) originally defined leverage points as 'places within a complex system (a corporation, and economy, a living body, a city, and ecosystem) where small shift in one thing can produce big changes in everything". She defined tipping points tas 'places to intervene in a system', being in increasing order of effectiveness, the following: 12. Constants, parameters, numbers (subsidies, taxes, standards) 11. The sizes of buffers and other stabilising stocks, relative to their flows, 10. The structure of material stocks and flows (such as transport networks, population age structures, 9. The lengths of delays, relative to the rate of the system change, 8. The strength of negative feedback loops, relative to the impacts they are trying to correct against 7. The gain around driving positive feedback loops 6. The structure of information flows (who does and does not have access to what kinds of information) 5. The rules of the system (such as incentive, punishments, constraints) 4. The power to add, change, evolve, or self-organise system structure 3. The goals of the system 2. The mindset or paradigm out of which the system -its goals, structure, rules, delays, parameters- arise and 1. The power to transcend paradigms. Notice that such there is a hierarchical understanding on these leverage points in so far that the more influential one condition and determine the potential for change of the less influential ones.

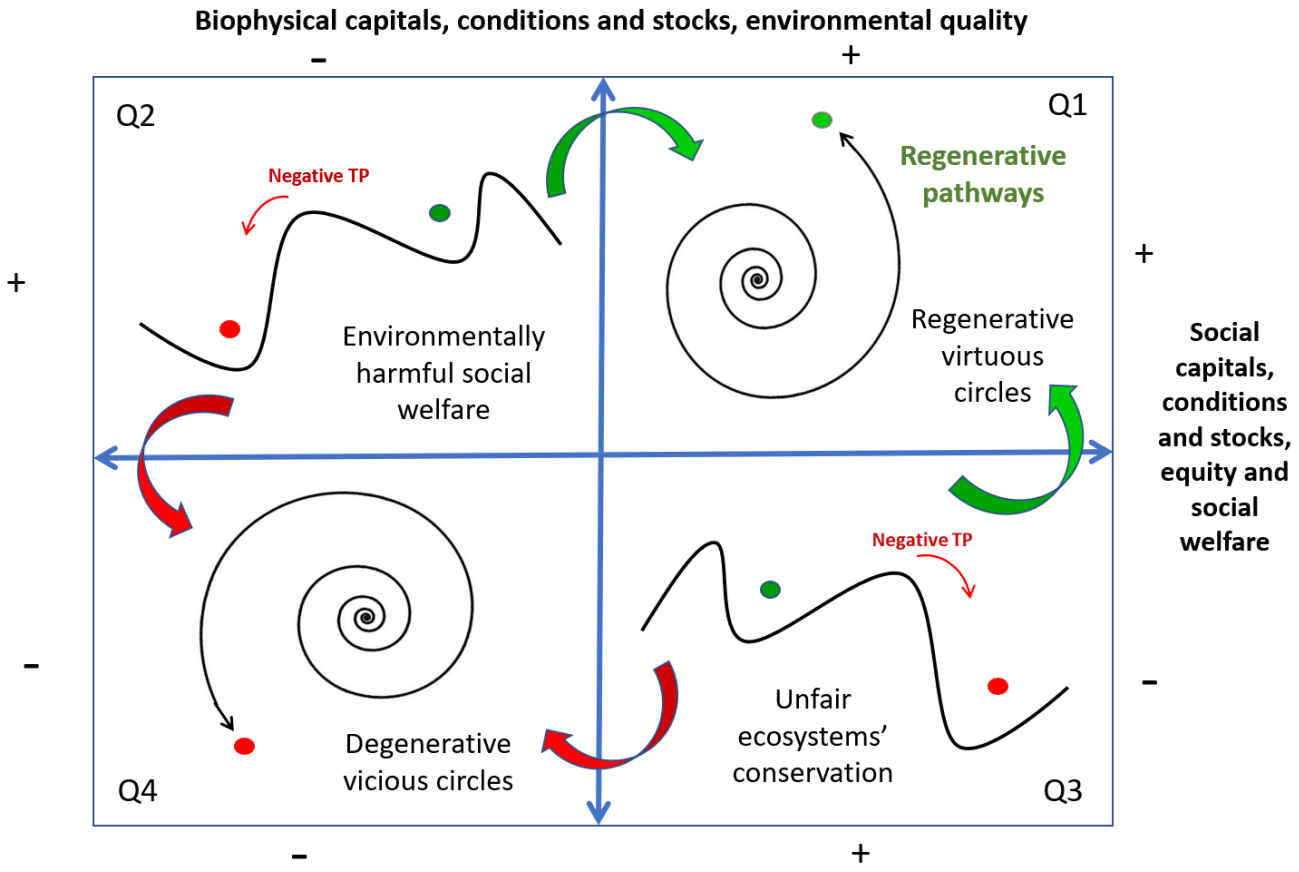
It is important to underline that Donella Meadows used a general notion of *complex systems*, that in her mind included for instance, 'a corporation, an economy, a living body, a city, an ecosystem', in which common system properties could be identified. This conceptualisation would not only encompass any kind of social or biophysical system, but also it was based on the assumption that dynamics identified and occurring on certain biophysical or technological systems could also help to understand also dynamics in social or symbolic ones, although such distinction between both had not been made explicit. A system would have both stocks and flows ('inflows and outflows') and their dynamics would be determined by the relationships of these with its overall structure, system parameters and feedback processes among them. Notice that in the system language that she used, 'positive' meant reinforcing feedbacks and 'negative' meant dampening ones, and therefore such words did not have any normative or aspirational connotation. However, the meaning and use of leverage points have evolved and changed particularly in the last few years, as it has been the case with the UN Report Making Peace with Nature (UN MPN,2021) where the following leverage points were selected: Paradigms and visions of good life, 2 consumption, population and waste, 3. Latent values of responsibility, 4. Inequalities, 5. Participation in environmental acting and resource use 6. Externalities, 7. Technology and investment 8. Education and knowledge generation and sharing.

TIPPING POINTS: There is not a universally accepted definition of tipping points across natural and social sciences. Nevertheless, in general tipping points have referred to those thresholds that occur when a small additional change or event provokes a sudden, self-propelling, profound and qualitative change in a system of reference. Tipping points can be either negative or positive (Tàbara and Frantzeskaki 2018, Lenton 2021; Biggs et al. 2018;Wilkemann et al. 2021), induced and deliberately brought about by conscious action or resulting from forces beyond human awareness, intention or reach. They are never

induced or activated by one single action but emerge from the combination of numerous forces and previous changing conditions within many social-ecological systems components. These may also be then the result of relatively slow processes that once combined activate abrupt, fast and larger systemic changes. We can also talk of social-ecological tipping points when we refer to abrupt changes that occur in the interaction of social and biophysical systems *at the same time.*

POSITIVE AND NEGATIVE, in social-ecological systems transformations: Transformations can be positive or negative, or a combination, and the same can be said of tipping points. This will depend on the normative criteria used to assess the system's change, that at the same time will influence the kinds of indicators used accordingly. Therefore, the extent to which the effects of deliberate interventions, and ultimately a tipping point is defined as positive or negative depend to a large to the extent it achieves an explicit *vision* (e.g., a world free of child labour) or more generally, using particular normative criteria. These may include general values or beliefs regarding universal rights and freedoms or more specifically, the realisation of sustainable development goals (SDGs). Hence 'positive' does not mean necessarily 'reinforcing' or 'amplifying' in its consequences (nor negative meaning dampening) as it is understood in systems thinking. Thus, in TRANSPATH indicators and criteria that would define actions, pathways and potential tipping points as positive or negative will be largely contextual, e.g., case study dependent.

CAPITALS: Different notions and scientific uses of the notion of capital exist and are not limited to the use of financial capitals. The reference to social and biophysical capitals can be helpful as a transdisciplinary concept to bridge different kinds of knowledges, indicators and perspectives across different disciplines and methods. Social capitals can be understood as those individual and collective capacities derived from past learning interactions and processes that allow for the continuous building of necessary conditions for human dignity, self-realisation and welfare. These social conditions include dimensions like social trust, governance capacities or other socially constructed mechanisms that help create further social cohesion, inclusiveness and cooperation. On the other hand, biophysical capitals relate to the biophysical conditions that enable all life forms to flourish; and in particular with regard to social-ecological systems, ensure the continuation of human societies on Earth. Nevertheless, the conceptual distinction between social and biophysical capitals is only a methodological heuristic, because ultimately the building of regenerative conditions of sustainability will depend on the extent to which hybrid, dynamic socio-environmental practices can be brought together and realised. The actual definition and operationalisation of such capitals will require situated dialogues and of indicators – e.g., on basic dimensions such as equality or environmental quality- that can be generally accepted and actionable by the contexts in which the TRANSPATH case studies are to be designed or applied (Tàbara, 2023a):



TRANSFORMATIONS: According to the IPPC (2012: 436), transformations entail "a fundamental qualitative change… that often involves a change in paradigm and may include shifts in perception and meaning, changes in underlying norms and values, reconfiguration of social networks and patterns of interaction, changes in power structures, and the introduction of new institutional arrangements and regulatory frameworks" Transformations can be distinguished from transitions in that they are open-ended, non-linear and entail reconfigurations in worldviews and across individual, social and organisational practices as well as in large systems. Such deep reconfigurations are considered necessary to cope with major threats to humanity such as from climate change, as conventional strategies will not suffice. Transformations are needed in many domains, including in science practice dealing with the production of climate-solution oriented knowledge (Tàbara, Jäger et al. 2018). The domains in which the literature argues that systems transformations are most urgent varies, for instance, in the MPN report they mention: 1. Economy and finance, 2. Food and water, 3. Energy 4. Human settlements 5. Human health, equity and peace, 6. Environment. The Earth Commission (Gupta, Bai et al. , submitted) has selected eight planetary boundaries (seven of which are considered that have been surpassed) and link them to the identification the kinds of transformations needed to achieve a just and safe Corridor for humanity. In particular four kinds of systemic transformations have been identified to ensure living within this corridor: in consumption, economic, technologies and governance systems.

REGENERATIVE SUSTAINABILITY: In order to move from discourses that associate sustainability progress only as 'doing less harm' (<0) or achieving (e.g., carbon) 'neutral impacts' (=0), achieving net-positive (>0) sustainability outcomes in a world of possibly 10 billion people in just a generation becomes an imperative. Thus, it can be argued that the

only way to ensure human life of Earth in the long term is to adopt integrated strategies and practices able to restore, improve and synergise substantial improvements in both social and biophysical capitals (Tàbara, submitted). Within the TRANSPAT project regenerative concepts and pathways may be explore in specific context and research process to explore how to synergise socio-economic, climate and biodiversity actions. Regenerative sustainability is based on relational whole-life system worldview and paradigms in which human beings and their activities are seen as a continuum of natural systems dynamics where socio-economic and biophysical systems are co-evolutionary and interdependent. This is a shift to holistic systems thinking across the social and biophysical at local to large- scales (Reed, 2007). Thus, the idea of regenerative sustainability is based on the assumption that not all anthropogenic cumulative impacts on Earth need to be negative (or neutral) but can also be positive and help restore global social-ecological systems.

TRANSFORMATIVE PATHWAYS: TRANSPATH initially conceptualized transformative pathways as integrated sets of actions and strategies purposely and reflexively designed to achieve rapid biodiversity net gains and carbon neutrality respectful to human rights and ethics and that will evolve and be refined over time. In this regard, the IPPC (2014) defined transformations pathways as "consistent sets of possible futures of GHG emissions, atmospheric concentrations, or global mean surface temperatures implied from mitigation and adaptation actions associated with a set of broad and irreversible economic, technological, societal and behavioural changes. This can encompass changes in the way energy and infrastructure are used and produce, natural resources are managed and institutions are set up and in the pace and direction of technological change". Moreover, the GEO-6 report stated that 'transformations emerge from the co-evolution of multiple interdependent factors and the active engagement of diverse stakeholder' (UNEP, 2019).

Therefore, transformative pathways entail full-systems reconfigurations in social-ecological systems and encompass fundamental changes in the kinds of institutional arrangements that condition cultural, socio-economic, political and environmental interactions. Within the TRANSPATH project, positive tipping points can be defined as those moments in which an additional relatively small action or strategic intervention makes a given social-ecological system to move towards a fundamentally different development trajectory or system's attractor. At this threshold, self-propelling dynamics contribute to improving the human quality of life, the long-term sustainability of human-nature interactions and thus can avoid the potentially existential risks of currently accelerated global environmental change. It is assumed that such moments may emerge from synergies between climate and biodiversity improvements and more generally by reinforced by mutual gains in social conditions such as equity, social cohesion, and transformative governance capacities and in the biophysical conditions of life-support systems.

SAFE AND JUST CORRIDOR FOR PEOPLE AND THE PLANET, CONSIDERING PLANETARY BOUNDARIES: According to the Earth Commission "a safe and just corridor for people and the planet is where (a) biophysical stability of the Earth system is maintained and enhanced over time, thereby safeguarding its functions and ability to support humans and all other living organisms, and (b) nature's benefits, risks and related responsibilities are equitably shared among all human beings in the world. […] *Safe* in the sense that the Earth's life support systems remain sufficiently stable and able to support all life; *just* in the sense that human needs are equitably met, particularly for the most vulnerable; and a *corridor* in the sense of setting clear bounds on which pathways of future

human development are both safe and just over time. Safe and just also implies that the Earth's natural resources, such as budgets for carbon, nutrients, water and land, are finite and have to be shared between people and with nature." However, the Earth Commission is moving toward defining Earth Systems Justice that considers three 'i's: intergenerational justice, intragenerational justice and interspecies justice (Gupta, Livermann et al. 2023). Planetary boundaries refer to thresholds on the levels of human negative interference in various the Earth systems that ought to not be surpassed for a safe and just future for people and planet. Safe is often defined as a distance from such dangerous levels at global scale, but determining them also requires normative judgements (Rockstrom et al. 2009).

Annex 2: Questionnaire

The following questionnaire was sent to all the partners in order to get their views on the meaning and different understandings of transformations and transformative pathways. Below the responses collected up till October 2023.

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Dear colleague,

TRANSPATH Work Package 1 has the objective to build a dialogic toolkit that can help us to reflect upon our positionalities as researchers in our efforts to build knowledge aimed at contributing to sustainable transformations — and more generally, to synergising climate and biodiversity leverage points and identifying global safe and just futures together with our stakeholders.

To this aim we have developed the following questionnaire asking for your views on **what** kinds of contexts, practices, organisations or systems you think that your work may contribute to transform; **how** you think your work could do so; **when** and **with whom** you expect to interact ; and **why** you think these interactions and activities will lead to the changes aimed for. We hope this exercise will also help us improve our own relational, dialogic and transformative capacities within the project as a whole. But most of all, enjoy!

1. **Please list between 5-10 key words that are most closely associated with your research objectives and interests?**

   Responses:

   co-creation, pathways, energy-land-food nexus, scenarios, Eastern Europe, Sustainability, poverty, development, inequality, climate justice, sustainable lifestyles, stakeholder participation, co-creation methods, sustainability transformations, leverage points, transformation labs, EU climate and biodiversity policies, Scenario analysis, Narratives, Pathways, Scenario assumptions (quantitative/qualitative), Interventions/levers, Synergies & trade-offs, Target-, policy-screening scenarios, Biodiversity, Climate change.

2. **How do you characterise your context, object and subjects of research in which transformative pathways are to be identified?**

Here, for instance, could you reflect on: how would you characterise transformations in your research? With what indicators? at what time, spatial or social scale you will be focusing? and who are the main agents/stakeholders that you will consider (or not) in your research context? Moreover, you may also consider what your position will be in relation to the people, context and topics that you are researching (see Glossary on positionality).

Responses:

- I understand transformation as a continuous process where fundamental elements of societal functioning are gradually re-thought, re-designed and re-created. In these terms, transformation is not a revolution, instead it is a comprehensive process that is mindful about diverse injustices existing across diverse scales and spaces. With this in mind, our research process builds on in-depth case study of transformation pathways co-creation in energy-land-food nexus for the Czech Republic. The outcomes of the Czech case study will be scaled on the Eastern European level. At the same time, other researchers will be carrying out the same in-depth case study for the Netherlands, that will be scaled on the Western European level. Having two regional case studies will later on allow us to scale their outcomes on the more general European level. This approach should allow us to co-create transformation pathways that are building on elements from two, often completely different, contexts. As mentioned above, our work is centred around co-creation of transformation pathways. To this end, we will engage with transformation actors /change makers who are active in one or more elements of the above-mentioned nexus. We will also ensure that the stakeholders engaged in the process will include those who represent marginalized voices.
- At the moment we are working with stakeholders that are aiming for a transformation along an energy-food-land nexus in the Czech Republic. Only some of them, however, are aiming for deep leverage points (at the level of shifting power structures, paradigms, and mindsets). Sustainability transformations are not much of a topic yet in the Czech Republic and is generally unpopular in this context. We'll be working with a local/national and later on also regional scale.
- As a researcher, my plan is to contribute to the body of evidence supporting the sustainable transformation of consumption and production patterns. This transformation can originate at the individual and household levels or be influenced by regulatory measures, such as government policies at the local, regional, or national levels. Most likely, it will result from a combination of interventions and behavioral changes. Measuring these transformational changes presents challenges, but some literature has made progress in this area. For instance, there is a focus on assessing the 'degree of circularity' in production processes, which measures the extent to which materials used in a production process can be recycled and used as inputs themselves. Regarding behavioral changes by consumers or households, indicators revolve around waste generation and efforts to adopt a sustainable lifestyle. This includes actions like avoiding fast fashion and single-use plastics, just to provide a couple of examples.
- We follow the IPBES (2019) definition of transformative change "as a fundamental, system-wide reorganization across technological, economic and social factors, including paradigms, goals and values, needed for the conservation and sustainable use of biodiversity, good quality of life and sustainable development", acknowledging that the ongoing assessment on "Transformative change" might suggest/proposal/results in a modified definition. Against this background, in our understanding, a *pathway* is a *future scenario*, that is constructed in such a way, that it can fulfil different sustainability goals in the future (according to SDG, the GBF Montreal-Kunming Framework, the Paris Agreement). *Transformative pathways*, thus, take these two concepts and provide insights into the future impact of the combination of different interventions on various system components. Modelling allows the quantification of these changes and their impact on the socio-ecological system by calculating generalized indicators for various nexus elements, such as indicators for biodiversity (e.g., mean species abundance), climate change (e.g., GHG-emissions),

human development (e.g., human development index, health, poverty, food security), water stress (e.g., number of people at risk of severe water stress), or flood risks. In WP3, we focus on policy-screening, or target-seeking scenarios modelled on a global scale, covering the period up to 2030, 2050, or 2100 (depending on the scenario) for our literature synthesis. At a later stage, we also plan to look at scenarios at a European and/or continental scale. For the modelling and quantification of our final transformative pathways, we can produce annual/five-yearly results from the present to 2100 (depending on the indicator), on a global and regional scale (we can quantify impacts for 26 pre-defined regions). The final transformative pathways will be based upon the scenario synthesis and from results from WP2. The consideration of societal transformation is only possible in a simplified manner, specifically, the integration of heterogeneity (actors, institutions, politics), and justice principles is only implemented in a very simplistic way. As our findings have relevance on the global and continental scale or the EU level, we see high-level decision-makers and science policy processes as relevant *agents or stakeholders* (IPCC, IPBES, ...).

3. What tools and methods will you use to identify and assess transformative pathways?

Here, for instance, you could reflect on: to which extent do you intend to approach agents and stakeholders directly? And if you do so, for what purposes? What main tools and methods will you use? How can your methods be integrated with other disciplines to support transformative pathways (or do you envisage challenges in this area?)? Moreover, are there any specific ways that you require information or guidance from WP1 to support you in the design of participatory transformative pathways in your work package?

Responses:

- We will engage directly with the stakeholders as we understand them as partners for the co-creation of the transformation pathways. To this end, the stakeholders will be part of long-term science-policy-practitioners labs (or transformation labs) that will consist of series of interviews and co-creative workshops. An essential component of the transformation labs is the constant communication of the outcomes of the process with the engaged stakeholders. While our approach is mainly qualitative, we would welcome incorporation of quantitative modelling into the process of transformation labs. The process of transformation labs faces numerous challenges, especially in how to ensure that the stakeholder engagement will be carried out in just and safe environment to prevent stakeholder fatigue. Although our team is experienced in similar processes, consultations with WP1 on the ethical and other aspects of transformation labs will be very helpful.
- We started with scoping interviews during the summer and approached stakeholders directly after assessing their transformative potential in the Czech context. We're using stakeholder analysis and for further interactions (e.g., workshops and other interviews) will apply the snowball method. During workshops we plan on using Fuzzy Cognitive Mapping to get a deep insight into stakeholders' views and perceptions of transformative pathways. It would be useful to get some guidance from WP1 on how to create "safe spaces for deliberation", especially during workshops when transformative pathways will be co-created with the stakeholders.
- Understanding the impact of a particular intervention and its causes is an arduous task. There are several reasons for this. Firstly, it is not always possible to isolate the effect of a specific intervention on the outcome of interest since several other factors may also have an impact. Moreover, there is the risk of confounding due to the existing correlation between some variables which might not necessarily be a causal link. These challenges become even more crucial when we talk about transformational change because this concept entails a rather broad set of interventions. However, a way to tackle these challenges is by complementing quantitative research with mixed

methods. This approach allows us to investigate the hypothesis that we are testing at a deeper level

- WP3 identifies synergies and trade-offs for archetypes (consisting of target-seeking/policy screening scenarios) and between biodiversity, climate change and sustainability through a *literature synthesis* of existing assessments that examine biodiversity/climate change/sustainability impacts (Task 3.1). Based on this, WP3 will distil promising pathways with potential for transformative change and quantify one to two of those using the IMAGE-GLOBIO modelling framework (Task 3.2). To this end, WP3 will first build a scenario database (consisting of policy-screening and target-seeking scenarios) to collect information on the scenario narratives, their underlying qualitative/quantitative assumptions, the interventions applied within the scenario and their impacts on biodiversity, climate change and sustainability (SDGs). This will form the basis for the literature synthesis and a qualitative or, if possible, quantitative trade-off/synergy analysis, with the aim of identifying promising interventions or combinations of interventions that offer more synergies than trade-offs for different impact categories (biodiversity, climate change, sustainability). Second, based on these results and the results of WP2 and WP4, WP3 will construct one to two promising pathways with potential for transformative change to conduct a novel simulation study that quantify this transformative pathway using the IMAGE-GLOBIO modelling framework. Thirdly, we do not aim to engage directly with actors and stakeholders in our work package, but we aim to share our findings with the other work packages and build the final pathways in an exchange and on the outcome of their stakeholder workshops and case studies.

4. How do you see the role of normative criteria and values in your research?

Here, for instance, you could reflect on: How and to what extent will you address normative values and criteria in your research? To which extent do you plan to explore issues regarding justice and fairness with stakeholders in your research? To what extent are you familiar with the concepts of planetary boundaries and safe and just operating spaces? Do you have any specific opinions or concerns with these concepts and/or their interrelations?

Responses:

- Normative values and criteria are embedded in the process of transformation labs and related co-creation of transformation pathways. The issues of justice and fairness will be an integral element of the transformation pathways co-creation in multiple ways: 1) special attention will be paid inclusion of marginalized voices during the initial stakeholder mapping and invitations to ensure the presence of wide range lf viewpoints as well as normative values in respect to transformation; 2) the process of transformation pathways co-creation will critically assess justice and fairness through the related activities and questions; 3) when identifying action points in the pathways, their impact on the issues of justice and fairness will be explorer with engaged stakeholders. I am aware of the concept of planetary boundaries but never activelly worked with it or engaged with it in deeper manner.
- I am not really sure how we'll be addressing normative values and exploring justice issues yet, I suppose this will get clearer as the project goes on. I am quite familiar with the concepts of planetary boundaries and SJOS – specifically with the policy dimension (EU climate and biodiversity policies). As for my concerns – I think that policies at any level will never properly reflect the urgency and need we are facing right now at the global level, especially EU policies that allow Member States to implement specific policies according to national circumstances, which can quite often lead to inadequate impact of the policies.
- The topic of justice and fairness in the context of transformational pathways is of utmost importance for several reasons. Firstly, it is undeniable that the planet's current

environmental risk is a consequence of the actions of the most developed countries today. This raises the crucial question of who should bear the costs, as we require action in both adaptation and mitigation. More precisely, is it just for developing countries to bear the financial burden for environmental degradation, climate change, or biodiversity loss? Even more challenging is the question of whether it is fair for these developing countries to have the right to pursue a development path reliant on intensive natural resource use, similar to what developed countries did several decades ago, or if there is an alternative pathway that should be considered. I think these are critical questions that we need to consider when we think about normative criteria (i.e., how things should be?).

- For the literature synthesis, we are limited by the scope of previous analyses (on a global scale, a quantitative description of justice/fairness plays a minor role in the current modelling scenario literature). Integrated assessment models (IAMs), such as the IMAGE-GLOBIO modelling framework, use exogenous narratives to incorporate societal assumptions that do not interact with other technical, environmental, or economic factors in the model (Trutnevyte et al., 2019). To account for societal changes, complex issues are often simplified and expressed as equations with a lack of information (Trutnevyte et al., 2019). This is one of the reasons why models are often criticised for integrating heterogeneity (actors, institutions, policies). Furthermore, the decision-making process within IAMs varies widely in terms of the level of detail of implementation (Keppo et al., 2021). As most IAMs originally emerged from the climate change community (Beek et al., 2020), they have been built for different purposes, specialising in the assessment of climate change (Beek et al., 2020). Thus, principles such as equity are only implemented in a very simplified way in these models (Rivadeneira & Carton, 2022). Recent approaches (Rockström et al., 2023) have attempted to define safe and just planetary boundaries based on the 3I justice criteria (Interspecies, Intergenerational, Intragenerational (Gupta et al., 2023). To do this, we would need to define limits/tipping points/criteria, in particular indicators that quantify when the safe and just operating space is exceeded. This will be a very demanding challenge and we are not sure that we will be able to meet it within the TRANSPATH framework. It may be possible to explore our final quantitative analysis of transgressing the safe and just planetary boundaries proposed by Rockström et al. (2023), but we are limited to the output indicators that can be calculated by the IMAGE-GLOBIO modelling framework (see the list of indicators circulated by WP3).Finally, in TRANSPATH, our goal is to identify leverage points and interventions that can have a synergistic positive impact on sustainability, with a focus on equity, climate change and biodiversity. While the Planetary Boundaries framework considers biodiversity within the defined biosphere boundaries at a very coarse resolution, we recognise the importance of emphasising more detailed biodiversity outcomes in our investigations within TRANSPATH. We therefore consider whether we may need to delve deeper into impacts on biodiversity to ensure a comprehensive understanding of its role in our sustainability efforts.

5. Identifying leverage points and tipping interventions to support transformative pathways.

Acknowledging that your research is still at a very early stage, here, for instance, you could reflect on: what kind of interventions do you expect will be the most effective to accelerate deliberate systemic transformations in your research? What kinds of human or institutional capacities and enabling conditions would be needed to discover or even implement these?

Responses:

- Since our approach to transformative pathways is co-creative and stakeholder driven, the identification of interventions is not very much in our hands. On the other hand, I

expect that engaged stakeholders will acknowledge the need for the major paradigm shifts but, given the Eastern European context and path dependencies, they will be hesitant on rapid or fundamental changes.

- I believe that in the Czech context the most effective interventions will be at the national/state level – many of the environmental and social issues Czechia is facing at the moment stem from badly implemented policies (e.g., agricultural subsidies) and unwillingness of the government to do anything about it. Also, Czech society is pretty conservative and any bigger changes are always unpopular – another reason why the government is quite passive
- I believe that a combination of regulatory measures and behavioral changes can contribute to transitioning towards a safe and just operating space. However, even more importantly, I think that a shift in mindset or paradigm— encompassing its goals, power structure, rules, and culture (as mentioned in the glossary)— is paramount to achieving a transformational level of sustainability that can endure over time.
- Structural or technological solutions such as carbon taxes, carbon capture and storage (CCS) or carbon capture and removal (CCR), renewables and fossil fuel phase-out can have a large positive impact on carbon neutrality and climate change, while their impact on biodiversity loss or, for example, social equity between countries may be questionable. We expect that paradigm shifts in areas such as nutrition, circular economy approaches (e.g., improvements in waste management) or energy consumption can offer great potential for synergies and address several nexus elements simultaneously without trade-offs.

Additional comments:

Additional references:

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Annex 3: publications

This deliverable is based and expands the research carried out and published in the following paper:

- Tàbara, J. D. 2023. Regenerative sustainability. Towards a relational model of possibilities for the emergence of positive tipping points. *Environmental Sociology*. https://doi.org/10.1080/23251042.2023.2239538

ABSTRACT:

Global environmental change problems are relational problems, so individual and collective actions aimed at dealing with them need to address fundamental changes about how we relate to social and biophysical systems. In this contribution, I suggest that current attempts to theorise and act on sustainability transformations would benefit from a relational perspective characterising individuals, organisations and societies as coupled social-ecological systems set in the context of accelerating global environmental change. Using a whole-life-systems' non-exemptionalist worldview, a conceptual model is presented to help explore the theoretical possibilities for creating regenerative sustainability pathways. Learning to restore and improve the life-support conditions that ensure long-term sustainability will require enacting positive synergies between social and biophysical capitals as well as reframing anthropocentric conceptions of agency and of individual emancipation. In particular, regenerative sustainability pathways entail synergising different kinds and levels of agency in non-dualistic ways and tackle at *the same time* transformations in: social and institutional arrangements (S), energy and natural resources (E), information and knowledge systems (I) and accumulated environmental change (C) -the SEIC model.