REIMAGINING THE HUMAN-ENVIRONMENT RELATIONSHIP

Navigating the Dynamics of People-Planet Relationships: A Social-Ecological Systems Perspective

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This paper forms part of the volume *Reimagining the Human-Environment Relationship* for Stockholm+50. This curated collection of ideas captures, interrogates, and elevates alternative paradigms of the human-nature relationship – existing and new, and from various disciplines and societies – creating a space to recast our relationship with the environment and inform future policymaking.

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Sustainable Development in the Anthropocene

Human influence on the planet has become so widespread and profound that it rivals the influence of geological forces on the Earth's trajectory. It is thus that we find ourselves in a new epoch – the Anthropocene, in which the rapid expansion of both human population and human per capita consumption of Earth's natural resources are fundamentally changing the trajectory of the planet.[1] Where the Holocene was an epoch of over 10,000 years of relative planetary stability, human impact in the Anthropocene threatens the planetary conditions required for flourishing human societies.[2] Society's impact in the Anthropocene is driven largely by efforts to increase the efficiency of resource extraction and use for short-term human gain through simplification and intensification towards ever greater efficiency of production.[3]

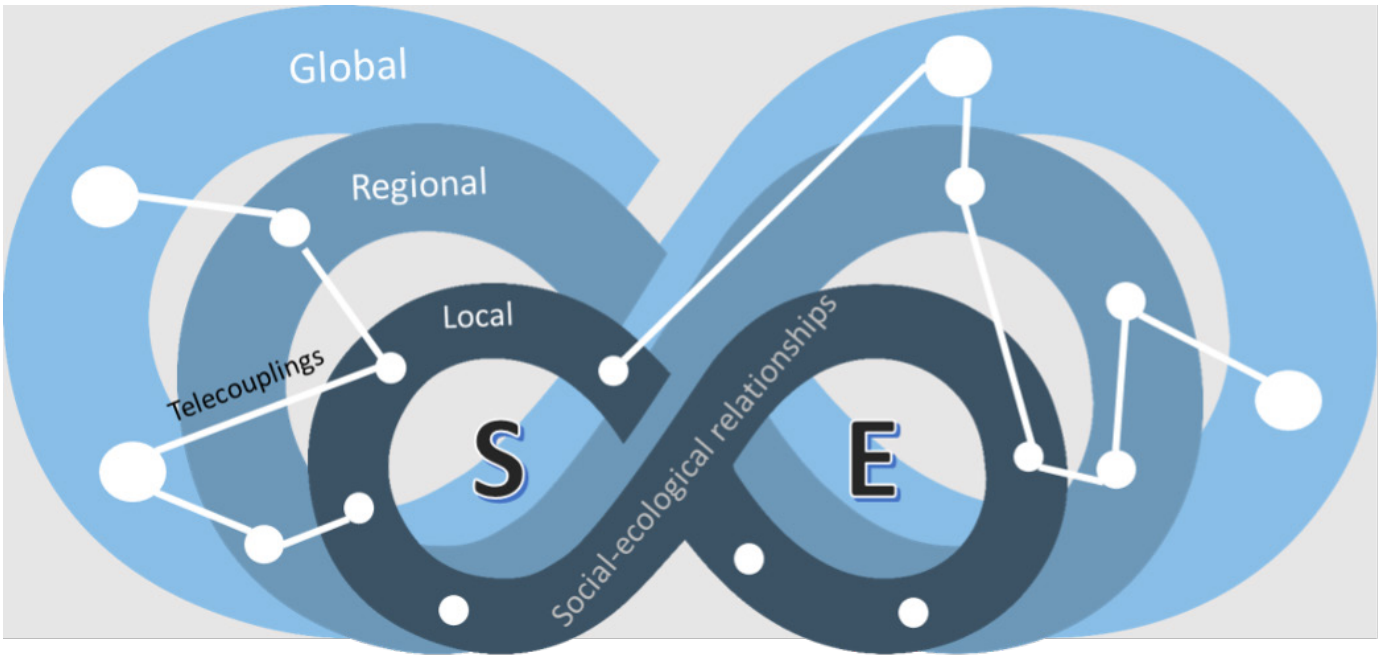
Increased intensification and consumption of the planet's resources has been made possible through another unique feature of the Anthropocene – its enhanced interconnectivity. Our world in the Anthropocene is increasingly hyperconnected through global trade, financialization, and information flows.[4] These connections link people and places in new ways, leading to novel and dynamic interactions within and among scales. Accelerating environmental changes such as greenhouse gas emissions or fertilizer use for agriculture interact across scales, leading to the emergence of new feedbacks. Some of those feedbacks feature the interaction of slow (e.g., climate change) and fast changes (e.g., forest fires), which can trigger regime shifts, including potentially irreversible ones like the substitution of savannah biome in place of the Amazon rainforest.[5] The connectivity of the world in the Anthropocene also increases the potential for the impacts of our actions to be deferred across space and time.[6] Such novel connections, new feedbacks, and time and space lags between cause and effect result in novel and hard-to-predict vulnerabilities in social-ecological systems.[7] This unequal, turbulent, and hyperconnected Anthropocene places sustainable development in a fundamentally new context from where it began 50 years ago.

The Anthropocene and its complex sustainability challenges are also linked to profound inequality and growing power asymmetries among people. A few regions or groups have benefited from the changes wrought on the planet through intensification of resource use, emissions of greenhouse gases and other pollutants, while other regions and groups are most exposed to the negative impacts of these changes like climate change or pollution.[8] For example, the economies that grew by emitting greenhouse gasses are not the same as those that now suffer the worst consequences of climate change.[9] Even within countries, there are asymmetrical patterns of those who have benefited most from environmental exploitation versus those who are now paying the cost.[10]

If sustainable development is to remain relevant in the Anthropocene, new approaches, thinking, and paradigms will be required to match the novel and evolving context of connectivity. Current approaches to sustainable development that focus on static goals and outcomes, and that assume a relatively predictable and easily manipulated planet and processes, will not suffice for achieving sustainable and equitable futures in the Anthropocene in the light of increasingly turbulent, complex, and globally interconnected challenges.[11] In the best case, such approaches will be ineffectual; in the worst, they might undermine recent sustainability gains, erode resilience, and increase vulnerability.[12] Today's sustainable development challenges must be addressed in ways that take the tightly-coupled, cross-scale, dynamic, and uncertain nature of the Anthropocene into account.

Social-ecological systems (SES) science suggests how we might transform sustainable development towards an approach that better aligns with the new challenges of the Anthropocene. SES research is founded on the theories of complex adaptive systems and intertwined perspectives of people-in-nature.[13] The theories and perspectives of SES highlight the fundamental role of nonlinear and cross-scale dynamics, irreducible uncertainty, and emergent behaviours. From such foundations, SES research offers new insights, practices, and novel opportunities that can help us address the challenges of sustainable development in the Anthropocene. In this chapter, we explore insights from SES research, identifying examples of practice and policy that suggest innovative ways forward for more sustainable development in the Anthropocene.

Figure 1: Conceptual figure of SES and relationships connecting across scales from local to global in ever changing ways (adapted from Reyers et al. 2018).[14]



Accounting for Scale in the Anthropocene: Multilateralism and Local Action in a Globally Intertwined World

Chief among the challenges presented by a hyperconnected Anthropocene is its scale. It is common to attempt to address global or large-scale problems at the global or international level. From a sustainable development perspective, this usually means establishing multilateral environmental treaties among nation-States (e.g., the UN Framework Convention on Climate Change) and subsequent international agreements (e.g. Paris Agreement). In this way, the action takes place at the same primary scale at which the problem is perceived to exist, or at the largest scale possible in order to confer a large-scale result. However, outcomes from these international and global efforts have been much slower, less effective, and less participatory than desired.[15] A vast literature has pointed out problems with global-scale action, including the free-riding and burden-shifting that happens among nations in addressing climate change, a classic collective-action dilemma given the lack of an international body in place to enforce agreements.[16]

Additionally, in the globally connected context of the Anthropocene, it is not safe to assume that the global outcome will be the additive product of national efforts or outcomes. While global assessments often present frameworks as an “orderly pile of duplicates,”[17] the reality is that interactions of varying strengths across scales lead to much more complex outcomes. It is not true, for example, that if 90 per cent of all countries solve the problem of peacebuilding that we will have addressed 90 per cent of global peace. Leaving anyone behind risks leaving everyone behind. Nor can we assume that if a problem is resolved in any one country that this is only a small win for global sustainable development. Solutions in one country can have positive spillover effects elsewhere. For example, the global cost of solar energy has declined dramatically in recent years, in part due to German investment in solar power, which grew the market and accelerated the learning process.[18] In other cases, solutions focused on a single locale can have negative impacts elsewhere, such as when efforts to reduce European deforestation increased deforestation in the Amazon.[19]

These complex cross-scale people-planet interactions lead to a new and growing need to account for complex interactions of problems and solutions across scales. Indeed, multilateral policies are likely necessary but not sufficient to address global collective action problems because neither the challenges nor transformative change are linear.[20] Sustainability challenges in one part of the world cannot be addressed without consideration of the leakages, co-benefits, or other impacts of such policies on other parts of the world.

In response to some of these shortcomings of global, top-down policies, the world has seen rapid growth in local, bottom-up actions for sustainable development.[21] Such local action is important for a number of reasons: at a smaller scale, action can often take place relatively quickly, and be more participatory and therefore more equitable and context sensitive. The modularity of action in many different locales means that it is easier to experiment and adapt in ways that would be hard or even impossible to do at larger scales or higher levels of jurisdiction. And such experimentation improves the potential for response diversity, a range of different techniques that result in the same outcome, thus lending functional redundancy to a situation to correct for any errors.[22] Local action also results in better conditions for adaptive management because it is easier to connect action and response, cause and effect, and thus to understand which practices work and which do not, and to adapt to that reality.

However, local action is not without its problems. Perhaps most importantly, the impact of most local action is primarily local, and it can be hard to scale up to facilitate larger impact or to have an impact on a global stage through only local action. Another well-known issue with local action is leakage or compensation, which can happen across space, time, or user groups. Location leakage, for example, happens when an activity that would have occurred in one place shifts to another place, without any reduction in overall harm (and sometimes an increase). These sustainability blind spots or off-stage burdens[23] have occurred when policies to reduce deforestation in Europe were effective, but led to increased deforestation in Latin and South America, with many similar examples in other parts of the world.[24] It can also be difficult to know how local action in one place will impact other places and other, non-target outcomes due to the complexity of the system. Finally, most locales do not have authority over others, making coordination across places a significant issue for local action that strives to scale up.

To address these shortcomings of single-scale approaches to sustainability, some have proposed a multi-scale approach that takes system complexity into account.[25] But what does a multi-scale

approach entail, and is it able to contend with the complexity of sustainable development in the Anthropocene? What other features of the Anthropocene need to be considered to govern towards a sustainability transformation? In the next section, we explore insights from SES science about how to reorient sustainable development towards a cross-scale perspective.

Insights from SES Science for Sustainable Development in the Anthropocene

Attempts to separately adjust the parts of a complex system, and then trying to reconstruct a functioning whole, is well known to be problematic, but it remains a central tendency in sustainable development, where social, economic, and ecological components are acknowledged to be integrated, but are often treated as separate and substitutable. For example, the United Nations' 2030 Agenda for Sustainable Development acknowledges the indivisibility at the heart of sustainable development, yet still presents the world with 17 goals and 169 targets, breaking the indivisible whole into many parts. Not only is sustainable development regularly broken into separate sectors and goals, but it is also often split according to political boundaries (e.g., nation-States) and scales (e.g., local and global). However, because of features of the Anthropocene noted above (the inseparability of people and planet, the ubiquitousness of cross-scale and cross-sector interactions, and the dynamic nature of these interactions and relationships), approaches that take only one place, one sector, or one scale into consideration are unlikely to lead to successful transformation towards a sustainable Anthropocene.

Even well-understood system components can lead to unexpected outcomes when coupled in complex systems that interact across sectors and scales. The features of SES that lead to unexpected outcomes have been explored in several reviews.[26] Across these reviews, it is clear that the coupled nature of SES – the interactions and interdependencies connecting people and planet – must come to the fore if sustainable development is to reorient itself for the reality of the Anthropocene. Specifically, the cross-scale and dynamic nature of people-planet relationships, and the possibilities and challenges afforded by the ever-evolving reconfiguration of these relationships, provide the key to identifying and pursuing pathways to sustainable development.

SES science suggests that when systems feature cross-scale interactions and dynamic relationships, traditional management that treats place, sector, or scale as independent cannot work because it tries to separate the inseparable and assumes what is truly dynamic as static. Below we explore instead what SES science suggests for sustainable development.

Focus on the relationships and interdependencies among parts, rather than on the parts themselves

The teleconnected Anthropocene features increased interdependence across locales, creating novel and difficult to foresee vulnerabilities, which often appear unrelated due to large spatio-temporal distances between cause and effect, feedbacks, or other aspects of the complexity of relationships and causality.[27] In such systems, it is the flows, interactions and interdependencies that connect the social and ecological that ultimately determine sustainable development pathways and outcomes. For this reason, engaging with the **relationships** that connect system parts can lead to better insights into the system and its behaviour.[28] Failure to recognize these couplings and

feedback effects has, in the past, led to both significant environmental problems, and to the failure of some proposed solutions.[29]

While social-ecological systems science has made good progress in highlighting the importance of the interactions connecting social and ecological systems, less progress has been made in developing and implementing practical approaches to sustainability that accommodate, or even feature, the interdependencies and the complex and dynamic relationships between people and planet.[30] Instead, the interactions connecting the social and ecological are often depicted in uni or bi-directional ways. That is, a study or policy might be focused either on the impact of people on planet, such as through pollution, land use change, or climate; or one might be focused on the impact of planet on people, such as through the delivery of ecosystem services.[31] Some work has developed a more coupled approach in which people-planet interactions are depicted as co-produced by social and ecological factors and interactions.[32] At the extreme, the distinction of social and ecological is done away with and the focus becomes the relationship between social and ecological rather than on either of the components.[33] The latter, the adoption of relational approaches to sustainable development, has been suggested as a fundamentally different way to approach sustainability science and practice in a way that also moves away from historic reductionist tendencies inherent in the concept and practice.[34]

Example: Sustainable development indicators as relationships and practices

There has been a considerable amount of work on sustainable development indicators.[35] Most current indicators lean either towards social factors and processes, or towards ecological factors or processes.[36] Recently, a new set of indicators is emerging from indigenous and community monitoring systems that feature the relationships connecting people and nature, such as indicators that measure the condition of the human-biodiversity relationship[37] and indicators that monitor relationships and feedbacks between social and ecological components of a system.[38] Importantly, such monitoring systems do not treat the social and ecological parts as separable, but focus instead on what connects them. Additionally, the monitoring itself is treated not as a separate activity but as part of daily practices such as harvesting. This resonates with Haider's et al. proposal that social-ecological relationships manifest and are observable through daily practices.[39] As Darnhofer et al. suggest in their work on family farms: "To focus on relations, to convey the interdependency of farm, farmer and context, it seems helpful to refer to 'farming' … [putting] the emphasis is on relations and dynamics, rather than on separateness and stability."[40]

Most of these examples suggest a local scale focus where it is relatively easy to identify the interrelated parts of any social-ecological system and focus on practices and activities that connect social and ecological. As one zooms out, tracing linkages and flows becomes more indirect and multi-scale and therefore challenging. However, recent advances in methods such as systems dynamic modelling and causal loop diagrams present an avenue to continue this focus on relationships beyond the local scale.[41] For example, Downing and colleagues analyse the impact of reforestation programmes in China on other countries supplying forest and agricultural commodities to China using a multi-method approach which first identifies distal trade flows using a telecoupling framework, then analyses change in social-ecological (SE) dynamics through the design of causal loop diagrams and finally links these processes of change to the sustainable development goals (SDGs).[42] Their findings highlight the limitations and negative consequences of a national scale

focus on sustainability targets like reforestation. It further provides a novel cross-scale method for use at multiple scales for tracking global-level impacts of national sustainability initiatives.

Pay attention to cross-scale relationships and avoid treating places as isolated from the system

Through focusing on the relationships or on the material and non-material interactions, interdependencies, and feedbacks connecting the parts of sustainable development, it becomes abundantly clear that the boundaries of SES are fluid and porous, even more so in the current hyperconnected reality of the Anthropocene. Said differently, sustainable development challenges such as inequality or climate change are driven by a collection of social and ecological processes that happen in localities, but with causes and consequences at multiple spatial, temporal, and sociopolitical scales.[43] In these "radically open systems,"[44] it is no longer possible to isolate the "local" or even the "global". Instead, in globally intertwined SES, sustainable development efforts need to identify, and account for, **cross-scale** influences on any aspect of the system's behaviour, including far lying, regional and global systems thatt can affect, and be affected by, the system of interest.[45] Indeed, many cross-scale dynamics are linked to important threshold effects with significant consequences including tipping points, cascading crises, and the risk of irreversible change.[46]

Cross-scale interactions have been radically increased and transformed by human action in the Anthropocene.[47] Global trade, international institutions, financialization, and communication and information flows are key forces shaping global SES and therefore sustainable development outcomes, yet they remain largely ignored in global policies such as the SDGs.[48] Indeed, global changes in financial systems and increased global trade have created new teleconnections across regions that now drive many local and global sustainability outcomes.[49] Such far-flung influences necessitate sustainability pathways that explicitly focus on relationships across scales.

Example: Shifting the focus of adaptation and vulnerability from local symptoms to globally intertwined causal pathways

In a review of climate change adaptation projects, it was found that most projects reinforced or redistributed vulnerabilities rather than reduced them.[50] One major reason for this was the focus of most interventions on addressing the symptoms at the local scale, thus ignoring the globally entangled multi-scalar causal pathways of vulnerability and climate change impacts. This focus on the local scale where the impact emerges, while useful for mitigating impacts, does not actually address the cross-scalar causes of vulnerabilities. As Reyers et al. point out, this requires a shift from the traditional focus of current adaptation programmes and policies where funding, project design and evaluation only focus on a local and spatially bounded scale.[51] A shift is required to be able to target interventions and changes at the root causes by tracing flows, adopting cross-scale lenses and negotiating boundaries. While there are participatory and robust methods with which to do this, the major barriers to such shifts lie within the implementing and funding organizations who force the local scale focus. As Eriksen et al. point out, this requires changing "the knowledge and learning processes that take place *within* implementing organizations, funding structures, and research" rather than requiring marginalized groups themselves to change their practices and knowledge.[52] Similarly, Hooli in their work on flood vulnerabilities in Namibia argues that the focus of resilience-building requires redirection to the broader sociopolitical processes creating the

vulnerability to flooding in the first place such as poor spatial planning and resource management, uncontrolled urbanization, and ultimately the larger development issues related to poverty and inequality. Efforts to invest in the community's coping and adaptive capacities while having some benefits. only minimizes the consequences and fails to address the risk of flooding in the first place.[53]

Be aware of dynamics and avoid assuming static outcomes

Importantly, the relationships that connect the social and ecological across scales are **dynamic**. The dynamic, cross-scale nature of these relationships leads SES to be somewhat inherently unpredictable and uncontrollable.[54] Furthermore, the self-organizing nature of SES often results in complex behaviours, emergent properties, and thresholds. These features of SES – their dynamic nature, the importance of cross-scale interactions in driving sustainability outcomes, and the inseparability of people and planet – together indicate that sustainability will be about pathway navigation rather than control, and about process rather than achievement. SES research suggests that successful pathways towards sustainability will mandate a shift away from focusing on events or symptoms such as a drought or short-term economic goals such as GDP and towards focusing on understanding, and sometimes changing, the dynamics that created the problem (e.g., inequality or food insecurity) in the first place. In fact, it is often cross-scale dynamics such as marginalization, elite capture, or market capitalism that have caused interlinked unsustainability and inequality outcomes in the first place.[55]

Thus, while it is important to imagine global outcomes such as the SDGs, it is equally vital to recognize that these goals and targets are not an end in themselves because there is no such thing as 'achieving an SDG' once and for all. Instead, efforts towards sustainable development pathways must be founded on an embrace of the uncertain and on prioritizing robust collaborations and learning rather than on achieving particular quantitative outcomes. SES science further suggests that any complex system be it a community, a forest or a country cannot be *managed* in the traditional sense. That is, "command and control" style management – in which a problem is identified, a desired future determined, and a plan to achieve that future described and pursued – is unlikely to succeed in producing the desired outcome in a complex system. It may even result in poor outcomes for people and planet because command and control assumes a clearly-defined, well-bounded, simple problem that is linear with respect to cause and effect;[56] and yet the world is complex, nonlinear, and that cause and effect are difficult to disentangle.

Example: Scaling up

A global transition to sustainability will likely emerge from the interactions among a patchwork of geographically distinct, but interacting, pathways of change.[57] Across regions, outcomes of actions aggregate in a variety of different ways, with markedly different outcomes. Such a transition is likely to be emergent and therefore difficult to predict with any precision: instead, key aspects of regional sustainability shifts, and how they interact across locations, are likely to be novel, difficult to influence, or unpredictable.[58] Successful pathways are likely to involve exploration and experimentation, combined with continuous assessment of outcomes (successes and failures), and a focus on learning, adapting, and information sharing.

Designing policy for complex systems – their dynamic nature, emergent behaviours, and unexpected outcomes – is challenging in that it requires us to shift from a focus on sustainable development as sectoral parts and goals to sustainable development as a continuously unfolding and evolving process, where goals or outcomes shape process which in turn shapes outcomes.[59] Sustainable development in the Anthropocene requires a transformation of the global system and approach to sustainable development from one focused on national and global sectorally separated targets and indicators, to one with mechanisms to make visible and address the relationships connecting people and nature, and the cross-scale dynamics driving inequality, unsustainability, and marginalization.

Transformative Change Reconfiguring People-Planet Relationships

From the above insights and examples from SES science, it is clear that sustainable development needs to move away from a focus on static, scale-independent, siloed targets and indicators and instead account for the nonlinear, cross-scale dynamics and relationships shaping the realities in which sustainable development efforts play out. Below we explore what such a dynamic, relational, and cross-scale perspective looks like and what it has to offer sustainable development, specifically in the increasingly popular and important arena of transformative change.

Transformative change in sustainable development policy, research, and practice has gained new favor in part in response to the shortcomings of approaches founded on linear change and incremental improvements in the social, ecological, or economic dimensions of sustainable development. These older approaches assumed that doing more (or less) of the same within largely similar social and economic institutions of today would achieve sustainability. It is increasingly apparent, however, that such incremental changes will not be sufficient to achieve sustainability outcomes in the Anthropocene. Such changes may, in fact, be maladaptive, undermining SES properties such as resilience or equity.[60] Recognizing the limits of incremental change and the locked-in nature of currently untenable SES, transformative change fundamentally reconfigures or rewires the system of focus. Such fundamental reconfiguration includes not only the building up of something new, but also involves the breaking down of something old and problematic.[61]

In highlighting the relational, cross-scale, and dynamic nature of systems, SES science helps to clarify that transformative change is not a linear process that can be controlled by an individual or an organization working at a single scale. Indeed, SES research has shown that when there is an intervention in a system, the system does not usually respond in a linear and isolated fashion. Rather, true change is often manifested as a fundamental reorganization in the structure and functioning of the SES.[62] Due to cross-scale feedbacks and dynamics, such reorganizations in SES are linked to other systems across scales, suggesting that reorganizations can cascade across regions, down to smaller scales or up to larger ones, in both cases driving transformative changes in interlinked places globally.[63] Such linkages mean that transformative processes may start in one place or at one scale, but often lead to change at multiple scales in multiple different parts of an SES.[64] The cross-scale nature of transformative change is thus an important challenge and a key opportunity for sustainable development not only due to the cascading effects of transformative changes, but also due to the need for actors and capacities to cross scales and alter cross-scale feedbacks.[65]

Example: Fellowship programme on crossing scales

Work by Moore et al. designing and evaluating a global fellowship programme for social innovation and transformation revealed insights about critical transformative capacities that were built by the fellows. Capacities that were found to be essential included the ability to identify micro–macro or cross-scalar relationships. This relates to abilities to "see" the potential impact of factors and dynamics from other scales may have on their local transformation process. Another essential capacity included the ability to see the consequences that could result across scales other than the focus scale.[66]

Transformations to sustainability are not just a reorganizing of the structures or functions of a system but also reflect changes in mental models, values and norms, governance, and resource flows.[67] In these deeper changes to systems, an emphasis on the relationships between people and planet are key. SES research has emphasized that transformations in people–planet relationships are needed if we are to create a sustainable and equitable future.[68] As Moore et al. argue, it is "the capacity to see, interrogate, and reimagine" these people–planet relationships that will create the disruptive and radical changes needed for transformations to sustainability." SES science therefore puts these relationships and their importance and potential for reconfiguration at the forefront of sustainable development.[69]

The tendency for innovations, investments, and actions related to transformative change to only focus on the social or ecological and the negative consequences of such a focus disappears by focusing on relationships. As Olsson et al. point out, without a focus on relationships, emphasis will continue to be placed on market-based growth or narrow trade-off thinking that perpetuates environmental degradation, dangerous feedbacks, and negative people-planet relationships.[70] Examples of endeavors which ignore people-planet relationship, with dire outcomes are rife and range from protected area establishment without consideration and consultation of local and indigenous groups;[71] or agricultural technology interventions (fertilizers or seeds) to enhance food production without considering the long-term environmental consequences and their impacts on vulnerable groups, adaptive capacities of local people, and impacts on cultural practices and ties to land.[72] In research exploring persistent poverty traps, unless the social and ecological and their interactions are included, important causes of and pathways out of poverty are excluded.[73]

Recognizing the multi-scalar causal pathways involved in sustainable development challenges also points to a fundamental rethink of what is meant by the term "scaling" of transformative changes. There is often an implicit assumption that scaling implies doing something that worked somewhere at a local scale, again and again in more places, thereby growing the size and "scale" of the impact. This notion of replication or scaling *out* is indeed one way to grow the impact of a project. But SES research points to new ways of understanding the system of interest and how the problem under consideration is created or perpetuated by people-planet relationships including those that cross scales.[74] This understanding of the systemic cross-scalar nature of the problem and how it "scales" helps identify whether the transformative change required is one that scales *up* to impact the level of policy and law (e.g., to engage with the impacts of mining on a local community) or one that scales *deep* impacting the "cultural roots" of the problem embedded in values and beliefs systems (e.g., to shift from an instrumental value system for nature to one that is more relational). This expands our understanding of how transformative changes scale to form a stronger basis of contextual understanding of a place and how it is shaped by other scales.

What Does this Imply for Sustainable Development in the Anthropocene - 50 Years On?

Fifty years ago, the UN Conference on the Human Environment in Stockholm set out to generate a new period of global cooperation on environmental development. It sparked new conversations and catapulted the global environment, and global environmental problems, into the spotlight. Countries began working together to address what were seen as important problems. Now, 50 years on, Anthropocene presents us with a fundamentally different context in which to envision, and create, a transformation to sustainability. Today, we recognize the Anthropocene's dynamic linkages across sectors and scales, driven by the evolving relationships between people and nature, and resulting in a complex planetary system that isn't easily controllable or predictable.

One of the results of this new complexity-oriented perspective on the world and SES is that it has become clear that there is only very limited utility in a single scale perspective with static goals, or indeed in arguments on global vs. local-scale efforts. In the Anthropocene, there is no local and there is no global – everything is connected across scales. A single well-functioning global institution to right environmental wrongs will not be able to solve the environmental issues of the Anthropocene. A series of excellent watershed-based community-scale management operations will also not fix what ails us.

Instead, what is required is robust and equitable collaboration, learning, and transformation among actors operating across scales and sectors.[75] Successful approaches in the Anthropocene will be explicitly cross-scale, relational, and will acknowledge and even embrace the dynamic nature of SES. Successful approaches must do more than just adopt systems approaches that map static interactions or aim for singular fixed goals. Instead, successful approaches will focus on a holistic understanding of the inseparability of social-ecological relationships, and acknowledge that these relationships that connect people and places change over time in ways that are sometimes expected and other times wholly unanticipated.[76]

Globally, international institutions have an important role to play in this shift. While local action provides a source of natural "experiments", international institutions can help by mobilizing, collecting, synthesizing, and sharing the information and knowledge gained through a great number of these local sustainability efforts and from diverse knowledge systems. International institutions can also look across local efforts to reduce leakage and other blind spots and off-stage burden (or situations where efforts that are positive in one place or for one sector are negative for another place or sector) and encourage synergies. International institutions can also build better strategies for facilitating and empowering translocal diffusion and tackling the often far distant root causes of sustainability challenges and political and economic asymmetries. In addition to this coordination role, international institutions can play a key role as information clearing-houses for local-led action.

International institutions can also help by promoting robust and dynamic assessment and modelling of SES to support informed policy and planning. Approaches such as scenario analysis and horizon scanning can enable robust planning[77] because these processes identify alternatives that perform acceptably under a wide range of potential future conditions. But the Anthropocene suggests that we must go beyond that to dynamic planning, which aims to identify adaptation policies that respond to situations experiencing long-term changes, which include extremes and thresholds with multiple sources of interacting uncertainties.[78] That is, dynamic planning explicitly incorporates

the dynamic nature of SES in the Anthropocene by focusing on relationships, networks, and feedbacks rather than on the components of the system. Such relational approaches focus on dynamic relationships that shape sustainable development outcomes (e.g., network approaches), and advances in measuring relationships, including innovations in qualitative social capital metrics. Social-ecological relationships remain a key gap – most work is limited to material and energy flows (static feedbacks), often ignoring intangible and dynamic relationships.

Because of the cross-scale nature of transformative change in the Anthropocene, these approaches must involve diverse perspectives and knowledge systems as well as challenge entrenched power asymmetries and dynamics of marginalization. This makes the careful design of participatory and inclusive processes key to sustainable development. “Given the recognition that any transformation process should not reproduce the inequalities and ecological degradation that created the need for transformation in the first place, existing transformation efforts have focused on participatory, collective, and co-creative approaches.” Transformational changes are required that recognize and reconfigure people-planet relationships and seek to empower and mobilize existing relationships which have been marginalized by current dominant models of development.

Conclusion: Reimagining People-Nature Relationships

People-planet relationships at all scales lie at the very heart of sustainable development. These relationships, and the general disregard of them in the dominant models of development, have shaped the current systems and structures that give rise to sustainable development challenges of the Anthropocene. But it is in these relationships, and our capacity to make them visible and to reimagine them, that sustainable futures lies.[79]

Over the past 50 years of sustainable development, great strides have been made in recognizing that sustainable development is about the interdependence of nature and people, rather than one or the other.[80] SES science now suggests a further shift in this perspective or paradigm by highlighting that acknowledging this complexity of people-planet relationships can actually lead to a simple path forward.[81] Approaching sustainable development with an intertwined SES perspective and a relational paradigm, even existing and reductionist methods and data can be used differently and more effectively. That is, just seeing the world as complex, the same data can be interpreted differently, resulting in new understanding and new pathways forward. From this perspective, new ways of knowing that prioritize relationships and processes over parts and goals emerge.

In the words of Donella Meadows: “there’s nothing physical or expensive or even slow in the process of paradigm change. In a single individual it can happen in a millisecond. All it takes is a click in the mind, a falling of scales from eyes, a new way of seeing. Whole societies are another matter — they resist challenges to their paradigm harder than they resist anything else.” Here her advice still resonates: “In a nutshell, you keep pointing at the anomalies and failures in the old paradigm … you insert people with the new paradigm in places of public visibility and power. You don’t waste time with reactionaries; rather you work with active change agents and with the vast middle ground of people who are open-minded.”

Box 1: Scale Terminology

Scale: The term 'scale' is used in various ways across multiple disciplines. Here we follow Scholes et al. who use the word scale and its implications for ecosystem and human wellbeing assessment as specifically relating to physical dimensions, in either space or time, to which the analysis or action applies.[82] In ecology and geography, scale is usually defined in terms of spatial and temporal dimensions.[83]

Resolution: (the interval between observations, or the smallest possible observation) and extent (the full size of all observations) are two aspects of scale.

Level: Often used in social discussions to indicate the unit of analysis or action located at different positions on a scale.[84] For example, policy can be created at the municipal or national level.

Multi-scalar: Happening at two or more scales. Multi-scale analysis implies the analysis or study is repeated at multiple scales, independently and often in parallel.[85] Multi-scale analyses are used to test if findings or patterns are the same or different across scales e.g., is water demand exceeding supply? Many natural phenomena occur at multiple scales,[86] such as the importance of landscape heterogeneity on the distributions of a variety of species.

Cross-scalar: When processes at one scale affect those at larger or smaller scales[87] often involving social-ecological cross-scale flows or telecouplings (such as the ecological footprint of a city or the impact of one region's agricultural subsidies on local changes in land use and management practices or changes in patterns of consumption and their distal social-ecological consequences). In cross-scale analyses, the scales are not treated as independent and instead focus is on the interactions or cross-scale dynamics that connect different scales. This relies on several iterations analysing processes at one scale, and their impacts at another.[88] New methods offer avenues to trace social-ecological flows in and out of a focal system to iteratively identify the many cross-scale dynamics between the system of interest and the rest of the world.[89]

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