Patchwork Earth: Navigating pathways to just, thriving, and sustainable futures

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Abstract

15 Creating a sustainable and just future necessitates a transformation in how people interact with the Earth system and one another. Yet there is no “one-size fits all” approach; different regions with different contexts and values are likely to follow different pathways. These will give rise to both tensions and opportunities as the outcomes of those regional pathways interact. To navigate these multiple and diverse transitions, we need a better understanding of how local
20 pathways interact with global processes to produce outcomes for people and nature. Here, we suggest how science and policy can increase capacity to navigate towards a sustainable future by envisioning diverse desirable futures, nurturing seeds of sustainability, and navigating emerging pathways to sustainable and just futures.

25 The future - and the present - emerge from a diverse patchwork of interacting pathways

Creating a sustainable and just future will require a major shift in how humans live in, and interact with, the Earth system and one another (Leach et al. 2018). But how this shift could take place, the pathways it could follow, and its ultimate outcomes, remain vague. Further, visions of sustainable futures differ widely, from a world of community-based green
30 stewardship to a technologically-driven, eco-efficient planet (Bennett et al. 2009). While either of these visions might achieve the globally-agreed-upon Sustainable Development Goals, these alternative futures imply different outcomes for other social values, such as racial justice, gender relationships, and societal equitability, as well as different sets of winners and losers. Envisioning desirable futures is a critical step toward creating such futures: we cannot work
35 towards creating what we cannot even envision. Yet there is no “one-size fits all” approach; different regions and contexts, with different prioritizations of values, are likely to follow

different pathways that result in a variety of different outcomes. These pathways and outcomes in different regions may interact, creating both tensions and opportunities. Navigating these tensions, while respecting planetary limits and the need for context sensitivity, will be central to achieving a transformation to sustainability at broader global scales.

Many key aspects of regional sustainability shifts, and how they interact across locations, are likely to be novel, difficult to influence, or unpredictable (Westley et al. 2011). For example, climate change may make North Africa warmer and wetter, suppressing dust emissions and thereby reducing nutrient deposition in the Amazon, where these nutrients play an important role in primary productivity and the sequestration of carbon dioxide (Barkley et al. 2019). Navigating these potential interconnections presents a major challenge for science and policy, as it requires deep understanding of how context influences outcomes in a place, the interactions between places and across scales, and how they “add up” to outcomes for a global Earth system. This challenge necessitates integration of insights from across disciplines, the development of tools that enable people to govern for emergence, and an embrace of uncertainty and surprise rather than efforts to avoid it.

Historically, global changes, such as the spread of agriculture or the industrial revolution, resulted from an interacting patchwork of diverse social-ecological interactions that emerged from connections across geographic locations and networks ((Liu et al. 2015), Figure 1). Even as globalization has led to a more homogenous world in many ways, the changes that result from global trade, technology, and financial markets, are shaped by both global forces and specific local and regional contexts in ways that produce different outcomes in different places. For example, climate change and migration are experienced in different ways in London, England versus in Dhaka, Bangladesh due to differences in the histories, institutions, ecologies, and geographic context in these two places. London’s vulnerability is relatively low, with substantial mobility of its residents, while in Dhaka, many people are more exposed to sea level rise and cyclones, compounded by low mobility. And while these places and their responses to global drivers are distinct, their intertwined histories of colonization, migration, and trade connect

them to one another, ensuring that their dynamics are entangled in complex ways that are difficult to disentangle. Effective strategies to cope with climate change and migration must be adapted to the different local manifestations of these global problems as well as the contexts in which these strategies must be developed and implemented (Adger et al 2020).

Figure 1. Pathways to sustainability are likely to differ between regions, due to differences in histories, context and values. *Boxes below the landscape depict interacting factors that influence the landscape, changing its shape and making some outcomes more likely than others (though chance still plays a role in where the ball, which represents the state of the system, will travel). The interactions of those boxes are themselves influenced by the current state of the system in their own region and in other regions. A transition to sustainability at the global level will have to emerge from the combined effects of these regional pathways, including important potential interactions that may lead to unexpected effects. Based on figures in (Waddington 1977) and (Steffen et al. 2018).*

Since many historical global changes resulted from diverse regional interactions, any global sustainability transition should also be expected to emerge from the interactions among a patchwork of geographically distinct, but interacting, pathways of change. Local changes can combine into global changes through aggregation, compensation, learning, or contagion (Figure 2). Aggregation happens when changes can simply be added together to a global total. For example, if all places in the world shift away from fossil fuels, the total global reduction in fossil fuels is an aggregate of all local actions. Local actions can also produce a compensatory response elsewhere. For example, afforestation in Europe, North America, and Japan, alongside continued demand for wood products, contributed to the displacement of deforestation to the tropics (Meyfroidt et al. 2018). In such a case, the global impact of local actions may be less than the sum of local actions. Where local actions enable shared learning, they can catalyze action elsewhere, for example by lowering the costs and enhancing the uptake of new technologies. In such cases, local actions will result in more change than expected from simple aggregation. Finally, local actions can be contagious, for example the Arab Spring and Black Lives Matter movements both started in specific contexts and then spread to other places.

A global transition towards sustainability will be more than the sum of myriad local changes. The global outcome will emerge from the combined effects of aggregation, compensation, learning, and contagion of different actions in different places. Consequently, there are many unknowns and uncertainties regarding the form and outcomes of sustainability transitions, at both regional and global scales. While there are aspects that may be somewhat predictable, the history of societal transitions suggests that the most important effects are unknowable, and will have to be made sense of and navigated as they arise.

Figure 2. Four different ways that local changes combine to result in global outcomes: aggregation, compensation, learning, and contagion.

The role of scenario planning in exploring diverse futures and pathways

Scenario development can be a useful tool for exploring a variety of possible, yet unknowable, futures by investigating potential pathways at variety of scales, as well as the factors and chance events that may influence how these pathways interact, resulting in different futures.

The scenario development process provides an opportunity for people to collectively discuss diverse futures, the pathways that might get us there, and uncertainties and chance events that might reshape those pathways (Kahane 2012). Global scenario development efforts have played an important role in sustainability analysis, planning, and policy setting by enhancing researcher, policy-maker, and funder understanding, and by assisting in the exploration and consideration of uncertainties in the Earth system (Kanie et al. 2019). For example, the Intergovernmental Panel on Climate Change uses scenarios to predict the greenhouse gas emissions associated with a variety of possible future developments, helping clarify potential impacts of global agreements. Similarly, the Millennium Ecosystem Assessment scenarios usefully explored a variety of contested philosophies about achieving a better future.

However, a focus on global policies and a desire to use well-established global models means that these futures have emphasized global and regional processes and commonalities at the expense of national and local dissimilarities, questions, and challenges (Kok et al. 2017). Some historically important dynamics that are more difficult to model, such as the struggle for gender equality (Raudsepp-Hearne et al. 2019) or the emergence of infectious disease (Cumming et al. 2005), have been largely overlooked by global scenario modelling efforts. This global perspective often assumes that it will be possible to have globally coordinated and orchestrated actions that propel the Earth system towards one path or another, or that global goal-setting will suffice to produce change (Stirling 2015). Ultimately, these approaches to global scenario building may hide as much as they reveal.

The world is complex and contradictory, with a patchwork of local and regional contexts shaping the way drivers play out in different places, producing a world where global forces create different on-the-ground outcomes. Thus, global futures that tell a single, globalized story of a transition in which the dynamics of Earth systems are products of global forces such as globalization, sustainability, or populism may need to be complemented by other approaches to better understand, navigate, and foster the complexity of real transitions. Addressing the challenge of navigating a complex emergent future with multiple possible constituent pathways

and outcomes requires new approaches for exploring and creating the future, that can complement existing global scenario modelling work. We must broaden our dominant global planning and forecasting approaches to include a plurality of desirable futures, a greater variety of pathways towards achieving those visions, and greater rigor and depth in our treatment of the outcomes of interactions among places and people (Bennett et al. 2016). This will require participation and sense-making by a wide range of actors involved in on-the-ground initiatives and policy-making towards better futures at all scales (Westley et al 2013).

One attempt to engage with multi-scale complexity in scenario development is the '[Seeds of Good Anthropocenes](#)' project (Bennett et al. 2016). In the scenario development method pioneered in this project, participants develop radical positive visions of the future based on existing real-world 'seeds' of a better future (Pereira et al. 2018). Such seeds are existing innovations that aim to address social-ecological challenges, but are not yet mainstream, such as urban community gardening initiatives or blockchain technology. Scenario development begins with sets of seeds that are different in their worldviews, problematization of the current state of the world, and approaches to achieving a better future. Participants then imagine the outcomes if these seeds were fully mature and mainstream, including exploring how different seeds would interact (synergistically and in conflict), to develop visions of the future that are positive, realistic, and pluralistic. This approach combines the Mānoa method for amplifying 'weak signals' to generate scenarios (Curry and Schultz 2009) and the Three Horizons Framework for considering transformational change (Sharpe et al. 2016), both of which are widely used in local scenario practice, but not typically applied to explore global environmental futures. This scenario method has now been used in a variety of settings around the world (Raudsepp-Hearne et al. 2020; Falardeau et al. 2019; Pereira et al. 2018), primarily at regional scales, to develop scenarios that are more pluralistic, diverse, and radically alternative than mainstream scenarios (Hamann et al. 2020). Currently the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is using some of these approaches to develop a pluralistic cross-scale approach to global Nature that articulate possible pathways to alternative sustainable futures. (Pereira et al. 2020).

Navigating towards more desirable futures

There are change-makers working in government, civil society, and business that are passionate about creating better futures. Enabling people inhabiting different places, who embrace different values, to imagine ways their efforts to build better futures could help one another requires new ways of thinking about the future. Pathways to sustainable futures that more fully account for regional complexity and emergent dynamics provide space for these actors to imagine how they might act to help create better futures, and can foster action towards those futures. To increase capacity to navigate towards a more sustainable future, we propose that science and policy should do a better job of envisioning diverse desirable futures, nurturing seeds of sustainability, and navigating emerging pathways.

1. *Envision diverse desirable futures.* Given the scale of the sustainability challenges we face and the diversity of values held by people around the world, we need greater plurality in our understanding of what might constitute a desirable future for different people in different places, and a better understanding of the potential conflicts, opportunities, trade-offs and synergies between pursuing different visions in different places. Broadening the participants engaged in processes to imagine possible futures can expand the perspectives considered and enlarge the range of envisioned futures. We must also consider the interactions among different places and how those interactions might impact the trajectories being pursued by different regions.

2. *Nurture seeds of sustainability:* Transformative change requires that new structures and organizations supplant existing ones that are no longer working. We need to nurture the growth of seeds of desirable futures and deconstruct the institutions and organizations that impede their growth. Developing policies to enable these changes requires research on transformative change to evaluate, support, and connect a diverse array of sustainability initiatives. Considering integrated futures and interactions across seeds and possible futures

is key; solutions to one problem that create new problems or make other problems worse need to be avoided (Iwaniec et al. 2020).

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3. *Navigate emerging pathways together:* Navigating emergent pathways demands ongoing processes of knowledge co-production, reflection and action. Rather than scientists figuring out how things work and then policy-makers acting on that knowledge, the world needs scientists, policymakers and practitioners to work together in ongoing processes of adaptive action, learning, and reflection that can identify and engage with unexpected surprises, conflicts and trade-offs as they emerge. Enabling these processes requires investment in new organizations to bridge knowledge and practice, new approaches to policy that account for complexity, and better support for scientists to engage in ongoing policy processes.

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215 The complexity of the world is both a challenge for envisioning how to enable transformation to a more sustainable and just future, and a source of hope. The world is changing in ways that are both predictable and surprising. Recent surprises such as the emergence and spread of the Coronavirus, and people's responses to it, are an excellent example. Complexity means that control is imperfect and surprises are to be expected, which implies that it may be difficult to describe and navigate a precise path to a sustainable future, but also that oppressive systems can fall apart and unexpected successes can grow. Any "global" transition to sustainability will be almost certainly be made up of the emergent outcomes of multiple pathways in different places that don't always align, and involve trade-offs and conflicts between different regions and places (Rosa et al 2017), but also present opportunities. Incorporating more of the diversity and complexity of the world in our thinking about the future, and better understanding the opportunities and tensions that may arise can help increase our collective capacity to transform towards a more sustainable and just world for all.

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