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Transitions towards systemic sustainability in the Anthropocene

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Transitions towards systemic sustainability in the Anthropocene

Abstract

Human's impacts on the environment and the earth's biosphere have drastically increased during the age of the Anthropocene and the great acceleration, creating increasing uncertainty. These impacts are far-reaching and systemic. They are not only threatening to compromise past development progress, but also trigger a feedback that can create much needed renewal and systemic change. Current threats to human and planetary health take place within an institutional environment mainly designed for periods of stable and sustained growth and it is an important cause of the systemic risks that humanity is facing now in the Anthropocene. Reflexive and adaptive systemic transitions and deep institutional change via value articulation and deliberative communication are necessary for socio-ecological sustainability to occur. We present a framework to facilitate a greater understanding of the required systemic shifts and explain the how-to, through which transitions towards systemic sustainability may be achieved.

Key words: Systemic risks, reflexive institutions, deliberative communication, value articulation, Anthropocene, sustainability

Contents

Emerging systemic risks in the Anthropocene

Drastic environmental changes in speed and scale

The speed and scale of global changes have been particularly intense since the 1950s. Take population growth as an example: In the 1950s, the global total population was 2.5 billion around 30% of which is urban population; 76 cities had more than 1 million inhabitants, and the world had around 40 million cars. Today, or until 2020, there are 7.8 billion people on earth, around 70 million cars are produced per year with an estimated 1.4 billion cars in the world. In the past 100 years, urbanization increased tenfold with 56.2% (2020) of the global population,[1] or 4.38 billion people, now living in cities.[2] Other exponentially fast increases since 1950 have been recorded through a series of indicators of the socio-economic and earth systems. Some of the socio-economic indicators are: population growth, real GDP, urban population, primary energy use, water use, paper production and mobile phone subscriptions. Some of the earth system indicators are ocean acidification, domesticated land, tropical forest loss, marine fish capture, ocean acidification, methane, and surface temperature (Whitmee et al. 2015). The great acceleration (Steffen et al. 2011, 2015) is described as a situation in which human induced environmental change happens ever faster as compared to naturally occurring rates of change. Atmospheric CO^2 concentrations as a proxy for global climate change, are often used to demonstrate those aggregative environmental changes. Present atmospheric CO^2 concentrations have been reached at a rate more than ten times and possibly up to 100 times faster than any time before in the last 420,000 years (IGBP, 2015).

Increasing global interconnectedness

Due to network effects,[3] speed of change and connectedness go hand-in-hand. Globally, social and economic connectedness has increased to an extent that global environmental changes are accelerating exponentially. This is accompanied by the increasing evidence in population growth, the quantity of resources consumed, and the proportion of land transformed for human use. The increasing global connectedness is a measure for globalization, reflected by the international flows of trade, capital, information, and people, the trend for all of which is increasing, except periodic breakdowns of capital flows during the 2008 financial crisis and a slight decline in global trade due to US – China trade tensions.

The DHL Global Connectedness Index (Altman and Bastian 2020) measures globalization based on international flows of trade, capital, information, and people, from 2001 to 2020, both, as cross-border flows relative to domestic activity and as to what extent flows are distributed around the globe. Global connectedness is also used as a measure for globalization and the trend for all types of flows is increasing, with periodic breakdowns of capital flows during the 2008 financial crisis and a slight decline in global trade due to US – China trade tensions. Countries that are more connected tend to grow faster economically and the historical analysis of the DHL index shows that most capital flows are still domestic and that there is a 40% headroom for growth. The increasing global connectedness is another

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[1] https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?end=2019&start=2019

[2] World Economic Forum: https://www.weforum.org/agenda/2020/11/global-continent-urban-population- urbanisation-percent/ World Economic Forum: https://www.weforum.org/agenda/2020/11/global-continent-urban-population- urbanisation-percent/

[3] A network effect is defined as an increasing value for existing members of a network from additional members joining the network. Increasing transaction speed and speed of service provision is one benefit from the network effect.

sign that the world is becoming fuller (or the planet is becoming smaller) and that systemic risks are increasing. Take the financial sector as an example, the systemic risks increase as interrelatedness of the players and products in that sector increase, and it is "through a complex and time varying network of relationships" (Billio et al. 2012).

This current state of global human development, marked by the drastic speed of social, economic, and environmental changes and increasing global connectedness, may be best pictured by Herman Daly's description of the empty world in which we lived in the past and the "full world" in which we are living today (Daly 2005). More recently, Rockström (2015) used the picture of a 'big world on a small planet', which essentially describes the same condition of planet Earth being 'full' of artifacts and people. This recent period in Earth's history starting with the Industrial Revolution of the 1800s, when human activity had a great impact on carbon and methane in Earth's atmosphere and ecosystems, is referred to as the Anthropocene.[4] WWF's living planet report (2020), the Millennium Ecosystems Assessment (MA 2005), the Planetary Health report (Whitmee et al. 2015), and UNEP's 2019 Global Environment Outlook[5] all have the same basic message: in this age of the Anthropocene, the health of people and the planet are so closely interlinked that the impact of human development becomes a risk to itself but also becomes an opportunity for systemic change and renewal.

From increasing uncertainty to systemic risks

Such intense global changes and interconnectedness make any attempt to predict future trends highly uncertain. However, because of increasing uncertainties, those environmental changes are often misinterpreted as externalities or unwanted side-effects of imperfections in social, economic, financial, or technological systems. As the French anthropologist Claude Lèvi-Strauss puts it: due to rapid population growth, any forecast for the earth's future prohibits itself.[6] The high uncertainty contains two folds: 1) high uncertainty in individual variables or areas of change, for example, population growth, and 2) high uncertainty in the aggregation of variables or total areas of change that contribute to the profound global challenges such as climate change. Uncertainty and economic, financial, and political risk are intrinsically related, so it does not come as a surprise that Hites et al. (2018) found that the average level of a country's uncertainty is positively and statistically significantly correlated with the risks measured in the Economist Intelligence Unit (EIU) Risk Analysis. Also, the global Economic Policy Uncertainty Index (EPU) is positively associated (highly correlated) with the World Uncertainty Index (WUI) and shows an upwards trend (see Figure 1). The World Economic Forum's Global Risks Report (2020), for example, reports that the perceived risk landscape from 2007 to 2020 has transformed from economic to environmental risks. Also because of their connectedness, the impact of climate related risks dominated all other risk categories in the perception of the respondent communities which are consulted to assess the current global risks.

Figure 1. Positive upward trend of the Economic Policy Uncertainty Index 1996-2020. Source:

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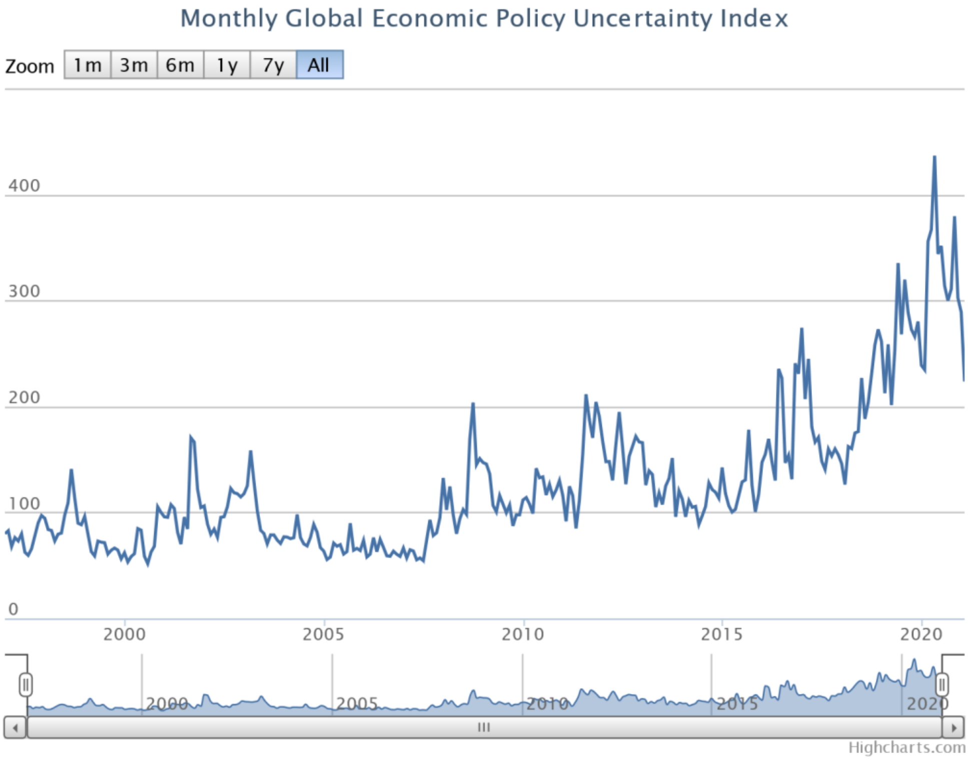
[4] National Geographic Resource Library | Encyclopedic Entry → Anthropocene. https://www.nationalgeographic.org/encyclopedia/anthropocene/#:~:text=The%20Anthropocene%20Epoch%20is%20an,the%20planet's%20climate%20and%20ecosystems.

[5] Notible, in its chapter 17 on systemic policy approaches, the report recognizes, that "The physical, social, economic and health impacts of climate change, especially on the most vulnerable communities, require urgent adaptation approaches that are systemic, multidimensional and transformative" and also that "A transformative approach for climate change adaptation needs to deal with uncertainties and complexities arising from climate change impacts…"

[6] https://museudoamanha.org.br/livro/en/10-vivendo-no-antropoceno.html

https://www.policyuncertainty.com/index.html



Due to those developments, the latest Global Assessment Report of the UNDRR (2019: 36) has focused on systemic risks and notes that "With increasing complexity and interaction of human, economic and political systems within ecological systems, risk becomes increasingly systemic" and, further, that "Despite technical and analytical capabilities and the vast webs of information about social and Earth systems, human society is increasingly unable to understand or manage the risks they create." That means, we are in a situation in which the human impact on earth and its complex consequences and repercussions on society itself, is beginning to be so increasingly complex and uncertain that humans might not yet have the capacity to fully understand them, let alone properly control or manage them.

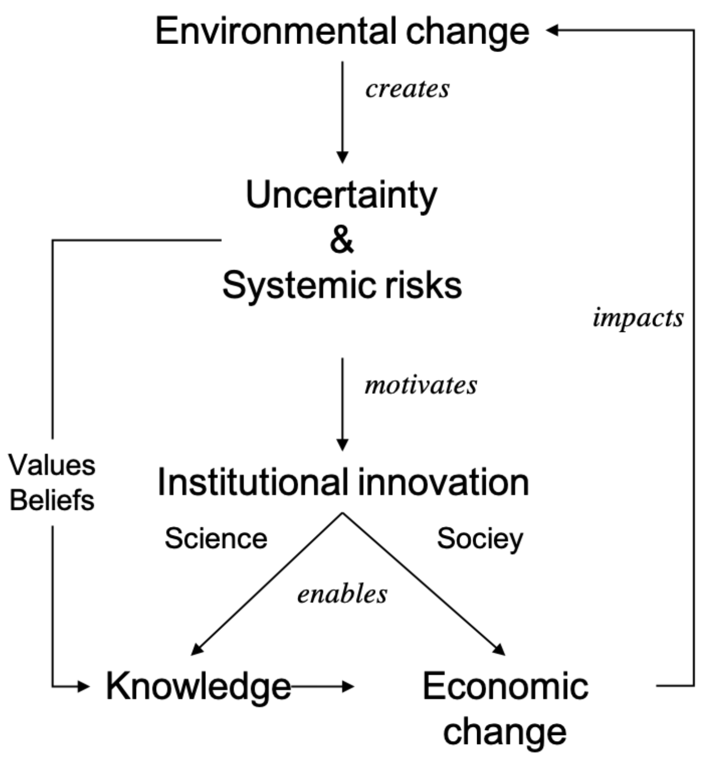
The risks created by a development that is at risk of compromising its own achievements, as latest Global Assessment Report of the UNDRR indicates, are referred to as systemic risks. Systemic risks threaten system functioning and increase the probability of the collapse of interconnected social, economic, and ecological systems (IRGC, 2018). Systemic risks differ from conventional risks (IRGC, 2018: 12), in that they are risks in a broader context of complex interconnected systems. However, systemic risks are not only a threat but also an opportunity for renewal and reconfiguration of just those structures which have defined the functioning of a system now being perceived as a threat. From a more objective viewpoint, systemic risks could therefore indicate the necessity for systemic change through institutional innovation, which can potentially "reduce uncertainty or convert it into risk" (North 2005: 3).

For the clarity of the flow of arguments, we find it useful to put environmental change, uncertainty, systemic risks, institutional innovation, knowledge[7] and economic activity into a

[7] In conditions of uncertainty, a consensus on values and beliefs help humans to construct positive and normative models of reality in a "non-ergodic world" (North 2005: 13), which, together with institutional innovation in science, creates knowledge.

framework (see Figure 2) which shows how they could influence another. It helps us understand systemic risks as an opportunity for deliberating on transition pathways for social and economic change towards systemic sustainability as elaborated in the following sections. After we have provided evidence of the planet as becoming increasingly vulnerable or uncertain with its biophysical, climatic, and ecological systems, in the next section, we turn to ask how human societal institutions have developed and why they seem to have difficulties mitigating the increasing uncertainty.

Figure 2. Flow of arguments: systemic risks and uncertainties motivate institutional innovations which impact the environment and (over time) create new systemic risks and uncertainties.



Institutions for the Anthropocene

What are Institutions

Uncertainty "has been the underlying condition responsible for the evolving structure of human organization throughout history and pre-history" (North 2005: 14) and at the same time it has been the "origin of human predictable behavior" (Heiner 1983). Confronted with uncertainty, humans will construct rules to restrict the number of choices into a smaller set of actions. Such rules are known as institutions Institutions have been defined as the rules of the game (North 1990: 3-4). Rules define and constrain human interactions and simultaneously also define the incentives that (together with the other constraints) determine the choices that individuals make. Institutions affect transaction and transformation (production) costs and thereby shape the performance of societies and economies over time. Institutions include values, norms, conventions, contracts, property rights, and prices (Williamson 2000) and they can be placed into a hierarchy, where prices are fast, and values and norms are usually slow changing institutions. While institutions have been portrayed as the rules of a game, governance is the play of the game and includes coordination mechanisms and strategies. By establishing institutions, humans have improved their ability to control the social and ecological environment and make it more predictable and peaceful (North 2009).

The evolution of social orders in human history

The first human social revolution, as described by North (2009), coincides with what Christian (2008) refers to as complexity threshold in the big history context: agriculture led to first permanent human settlements, settlements evolved into cities, populations in cities increased and societies increased in organizational complexity. That first type of social order occurred when agriculture led to first permanent human settlements, settlements evolved into cities, populations in cities increased and societies increased in organizational complexity, what David Christian (2008) refers to as complexity threshold in the big history context.

The predominance of personal relationships, especially among powerful individuals, and a sense that not all members of society are equal, characterizes the first, so-called 'limited access order' or the 'natural state'. The institutions of what North describes as the 'natural state' coincide with the institutions in the Holocene (Dryzek 2014) or the institutions prevalent when the (human) world was small, and the planet's capacity to provide goods and services for human society and absorb its waste was big (Rockström 2015). With the advent of agriculture and much later the industrial revolution, institutions were then foremost designed to control access and dominate nature, rather than being sensitive to ecosystemic changes. Eventually, technological advances decoupled people from local resource limitations in the Holocene, which humans considered beneficial for survival, therefore, the institutions designed to control access and dominate nature were kept and reinforced.

The second type of social order emerged as the human society entered the industrial revolution beginning at the 1800s, also often referred to as the epoch of Anthropocene. Personal relationships still mattered, however, societies increasingly evolved to host members who were not previously related to one another. This process prompted new institutions, such as the establishment of private property rights to emerge in order to organize increasingly diverse economic activities and information exchange.

societies opened to members who now needed to meet the requirements of impersonal criteria. This transition from the limited to open access order was accompanied by increasing organizational diversity, free movement of goods and individuals, protection of property rights, and prohibitions on the use of violence.

Institutional complexity increased and the strong correlation between political and economic development in liberal democracies, seemed to provide evidence of "the end of history" (Fukuyama 1992) – the final and dominant form of political and economic organization, into which some (developed) countries seemed to have made the transition, while the majority of the world's population continued to live in limited access orders. As North (2005) argued, societies with open access orders, also seemed to be better in adaptive efficiency by constructing effective responses to novel problems, due to an institutional framework that encourages trial and error: "Open access increases the possibility of stumbling onto better policies that solve or mitigate problems" (ibid: 252). However, the implicit ecological contract these societies had and on which the institutions of the Holocene were built, was marked by human domination over and exploitation of nature (Dryzek 2014).

At the same time however, this successful transition to the second type of (open access) social order, and the idea of the end of history, may well have been the result of an illusion or failure to predict change in ourselves (Quoidbach 2013). The end of history illusion is very similar to what Taleb (2012) has referred to as the turkey problem and typical for limited systems intelligence: "A turkey is fed for a thousand days by a butcher; every day confirms to its staff of analysts that butchers love turkeys "with increased statistical confidence". The butcher will keep feeding the turkey until a few days before Thanksgiving. Then comes that day when it is really not a very good idea to be a turkey."

In addition, the success of those countries that made the transition was built on a set of institutions which have supported economic development at the expense of the natural environment on other territories. Although institutions were created with the intention to reduce violence between humans in the transition towards the second social order, environmental violence (Zimmerer 2014, Kool 2019, Salcedo 2015), was not. Further, the dimension and quality of environmental and climate change has outgrown the dimension of change imaginable at the beginning of the industrial revolution when the earth's ecological absorption capacity was not (yet) questioned and now are the cause of currently experienced biodiversity extinction rates which are significantly higher and accelerating during the Anthropocene (Ceballos et al. 2017).

Institutional path dependency in the Anthropocene

Other continuities complicate institutional transition in the Anthropocene due to path dependency. The concept of planetary boundaries, prominently popularized by Rockström et al. (2009) suggests, that if humanity manages to remain within those boundaries, they will remain within safe operating spaces. Such a static view of ecological limits seems inappropriate for the Anthropocene in which humans are highly active players within a dynamic earth system. For example, the geoengineering option to inject sulfate aerosols into the upper layers of the atmosphere to help block solar radiation (Santos 2020), supposedly, should enable stretching the boundary of 350 parts per million (ppm) ratio of CO^2 molecules to all the other molecules in the atmosphere (also considered as the safe level of carbon dioxide by many climate experts). Such a prescription to stay within planetary boundaries, argued by Dryzek (2014: 4), is "a plea to maintain (or return to) the conditions of the Holocene, and prevent humanity entering the Anthropocene." In comparison, Norgaard's (1988) co-evolutionary perspective which explains the mutually reinforcing changes between the social and ecological systems seems more appropriate and relevant for institutions of the Anthropocene.

How then, can institutions cope with the challenges of the Anthropocene, avoid path dependency, and change towards systemic sustainability?[8] An important aspect of institutions is that they always constrain and facilitate, inhibit, and enable, at the same time. Path dependence is kind of inherent to institutions, because institutions serve the purpose to create reliability and certainty in human interactions.

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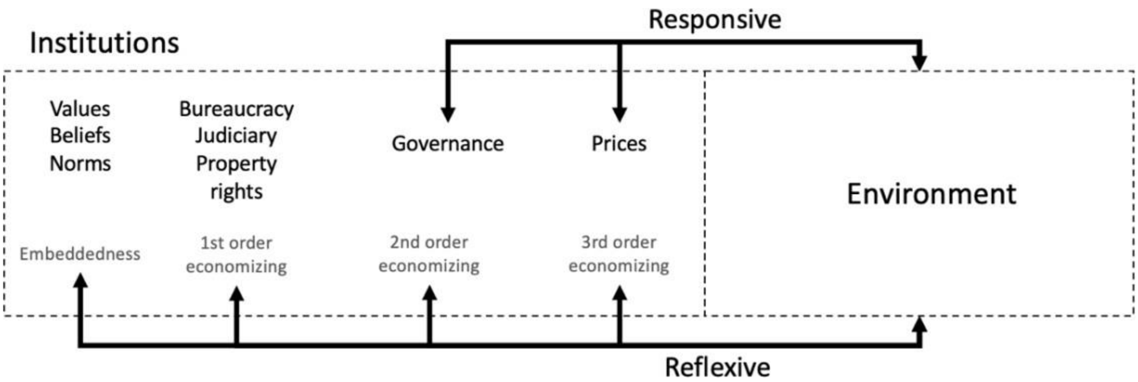
[8] Systemic sustainability is here defined as the condition of a social-ecological system which can sustain itself, either through adaptation or transformation, depending on the circumstance which allow for or require a specific type of change. While adaptation improves the resilience of a system, transformational change and institutional leaning facilitates system change to a different, more complex type of system, which has incorporated the knowledge from past changes.

Responsive and reflexive institutions

To avoid or to reduce path dependency, a critical and much needed quality for institutional arrangements is called the reflexiveness of institutions. [9] High level of institutional reflexiveness allows a system not only to address environmental changes effectively, but also adapt itself and thereby allow higher level of institutional complexity to form and to cope with increasing level of environmental change complexity.

The difference between a responsive versus a reflexive feedback towards environmental change is illustrated in Figure 3. Williamson (2000) suggests a hierarchy of institutions from the level of continuously changing prices at, what he refers to as, the "3rd order economizing", to the embeddedness level, where he locates very slow changing institutions like values, beliefs and norms. Institutions at all levels, from the embeddedness level to the 3rd order economizing [10] (Williamson 2000) are directly or indirectly involved when acting on the environment. In Figure 3, the feedback for the responsive kind of change, does not change deep underlying and slow changing values and belief systems and property rights. A responsive feedback within an existing institutional system can be useful to protect and prevent a system from collapsing every time a change in the environment occurs. This responsive feature underlines the original purpose of rules in a society, which is to create stability and reliability of social interactions.

Figure 3: While responsive institutional change addresses relatively fast changing institutions at the 3rd and 2nd level, reflexive institutional change also changes deeper lying and slower changing institutions.



Throughout the limited access orders of the Holocene, there was little knowledge about the limits of natural resources on Earth, let alone the need for protecting the rights of nature. In such setting, a 'dominion over nature' set of values could emerge and contributed to the

[9] Reflexivity is the opposite of path-dependency. It refers to the ability of a structure, process or set of ideas to change itself in response to reflection on its performance within its environment (Beck et al. 1994). Reflexivity is the capacity of an agent, structure or process to change in the light of reflection on its own performance.

[10] Williamson (2000: 599) refers to "getting the governance structure right" as second order economizing where structural reorganization takes place. Governance structures (e.g., markets, communities, bureaucracies) are at the 2nd order economizing, vary in organizational complexity and define the policy making process. They are shaped by institutions, formal and informal rules at the 1st order economizing level (property rights) and the embeddedness level (values, beliefs).

creation of human wealth. And as efforts made to agree on the rules of a society are costly, the sunk cost effect explains path dependency. Investing in institutional arrangements which create social order is costly and therefore there is a disincentive to change them frequently, especially institutions at the the embeddedness level. "Actors develop material stakes in stable institutions and institutions arrange feedback that reflects their own necessity" (Dryzek 2014:5). In other words, social or political systems consist of actors who have a self-interest in the functioning of the system they are part of[11].

In the Anthropocene, there are more direct and faster environmental impacts societies experience themselves from the impact they have on the environment. It therefore now becomes obvious that humans causing harm to their environment, also cause harm to themselves.

In comparison, a reflexive institutional change can be characterized as 'transformational' or 'systemic' and in theory it should reach down to the embeddedness level of institutions (Fig. 3) and trigger established orders to changing themselves – to be different, not just do things differently. "Because we shape everything, from the upper atmosphere to the deep seas, there is no more nature that stands apart from human beings. There is no place or living thing that we haven't changed. Our mark is on the cycle of weather and seasons, the global map of bioregions, and the DNA that organizes matter into life. It makes no sense now to honor and preserve a nature that is defined by being not human, that is purest in wilderness, rain forests, and the ocean. Instead, in a world we can't help shaping, the question is what we will shape" (Purdy 2015). In other words, in a world in which there is no non-human nature left, what counts as much as changing behavior towards nature is redefining human nature itself. Those are the deep, reflexive changes we have been discussing.

The difference between responsive and reflexive institutional change can also be understood from the 'governance and complexity' conceptual framework introduced by Duit and Galaz (2008), which looks at institutions of governance from the lens of complex adaptive systems. The authors make a difference between exploitative and explorative governance strategies. While exploitation is about activities which are characterized by reducing transaction costs, "refinement, choice, …, (and) efficiency, …"; exploration is about learning, self-monitoring, and experimentation. The former makes use of an existing institutional structure and therefore would qualify as "responsive", while the latter makes investments into searching for strategies for possible but largely unpredictable futures, which qualifies as "reflexive". The combination of both types of activities defines more rigid, robust, flexible, or fragile types of governance. The key to sustainable governance strategies is a sufficient degree of learning which enables the adaptive capacity of a system to respond but also re-invent itself.

Building reflexivity through value articulating institutions and deliberative communication

The question that surfaces now from these discussions, is how people make choices and whether people are free to make choices which do not effect themselves. Is it simply a matter of sufficient data and rational choice, or do circumstances of increasing radical uncertainty make it necessary to shift from a well-informed and individually rational, to a deliberative-communicative decision-making mode. That shift coincides with the shift from an individual to

[11] "The system defends itself" (against change) (Marchandise 2018).

a social or communicative Habermasian[12] rationality (Vatn 2005) and a respective deliberative process - a process which is reflexive in the sense that underlying values and practices of a society are not assumed to remain constant but re-thought. It needs to fundamentally reposition the human society within the biosphere and fundamentally redefine human-nature relations. Such a shift is necessarily accompanied by a shift in science as explained by Funtowicz and Ravetz (1993) who call for the need of a post- normal science as we enter an epoch of radical uncertainty. A post-normal science accepts the new conditions of the Anthropocene in which facts are uncertain, values are in dispute, stakes are high, and decisions are urgent. In such conditions, not only experts define facts and values to be considered in the rational decision-making process. Other stakeholders are included as extended peer community in a deliberative process in order to improve the quality of decision making under uncertainty.

The concept of anti-fragility (Taleb 2012) also builds on a system's capacity to learn and improve as a result of shocks, collapses or failures. In contrast to a resilient or robust system that adapts but essentially stays the same after a shock, an anti-fragile system changes itself and gets better after a shock.[13] This, of course raises the question to which degree a system can change its network structure of connectivity and adaptive capacity before it changes itself and becomes a new system. With reference to the institutional perspective of reflexivity and response presented earlier (Figure 3), a reflexive change of a system is a change that marks the beginning of a new system.

When operating within planetary boundaries, integrating, decentralizing or centralizing institutions are currently the predominant institutional responses to achieve efficiency gains and to keep up with increasing levels of complexity. Here however, we argue that integration, centralization, or decentralization are not sufficiently reflexive for institutions of the Anthropocene. Institutions of the Anthropocene must innovate themselves and they can do so by deeper learning and reaching higher levels of intelligence.

As a (living) system becomes intelligent, it develops the capacity to transform data into information, information into knowledge and eventually knowledge into action and wisdom. And, as Swetnam et al (2016) argue, increasing intelligence is driven by emotion, which is also the source of curiosity, creativity, and novelty and which drives a system to learn and explore. The inclusion of emotions, social rationality and deliberative communication in decision- making is therefore required for more intelligent outcomes in decision-making contexts of increasing complexity, as compared to the simplified contexts assumed in conventional economics (Gowdy 2010). Including emotions can not only lead to the rethinking of fundamental values but also helps avoiding "abnormal decision-making resulting from a cognitive malfunction" (Damasio 2009: 11, 2010).

To conclude, due to the increasing interconnectedness of social and ecological systems, socio-ecological complexity increases, and human's destructive environmental impact triggers the need for institutional innovation that needs to be reflexive and not just responsive. Social and ecological systems have become so closely interwoven, that acting on the natural environment has immediate effects on the social system from where actions are performed. Nature is no long 'out there' and adverse environmental impacts can no longer be externalized. They have a direct impact on ourselves and therefore it is necessary to think and act as if the environment

[12] Jürgen Habermas was a German philosopher whose major contribution was the development of the theory of communicative reason, which differs from the rationalist tradition.
[13] Some definitions of resilience overlap with the concept of anti-fragility.

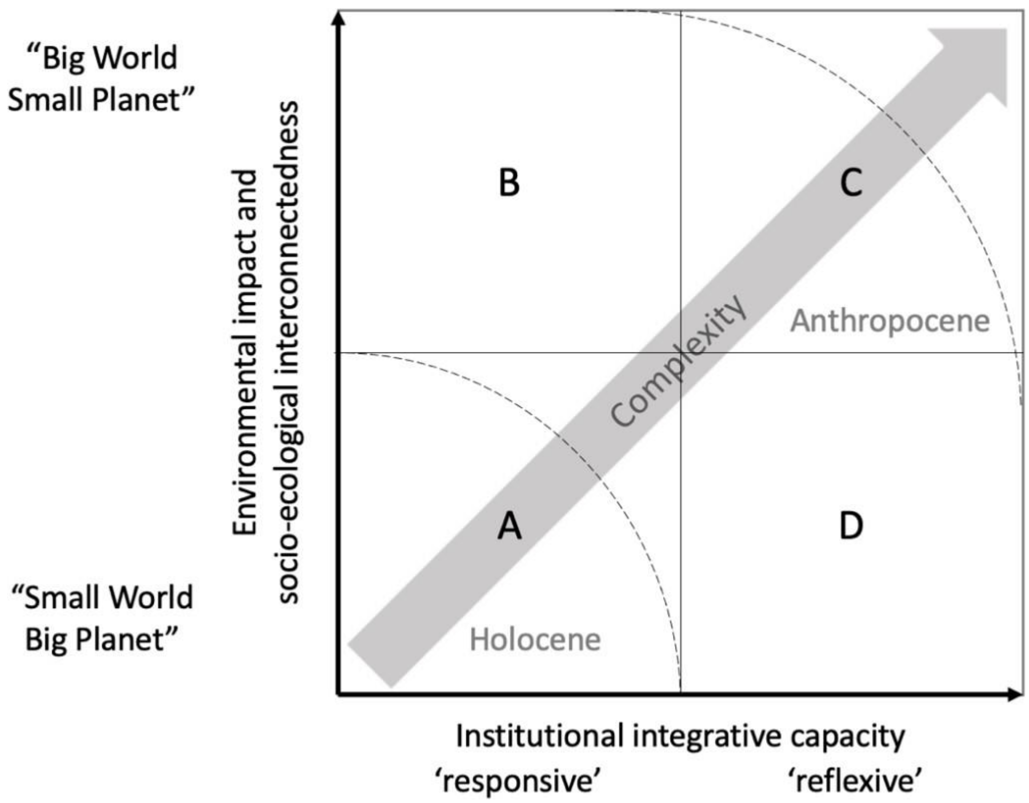
is our extended self. That is in essence, what reflexivity is about. In an increasingly ‘big world’ in which social and ecological systems are more interconnected than ever, reflexivity must trigger institutional innovation which rethinks the value roots on which they have been built. A process of deliberative communication that takes emotions into account can lead to collective intelligence, enabling us to make better decisions in more complex decision-making situations.

Transition pathways towards systemic sustainability

Part of the deliberative process facilitating reflexivity that can lead to higher levels of intelligence is about a shared understanding of where in the system the human actor is positioned, and which condition the system is in - a shared vision of the systems’ status quo. To facilitate that self-positioning process, we bring together the institutional and ecological dimensions of change in a framework defined by the human impact on the natural environment and the capacity of institutions to cope with increasing socio-ecological interconnectivity and human’s destructive impact on ecological life-support functions. We believe that positioning oneself in such framework can be an initial step for defining pathways towards systemic sustainability.

The patterns that emerge from positioning oneself (as an individual, company, city, or country) within a larger (local, regional, global) environment overlap with those defined by the adaptive loop introduced by Gunderson and Holling (2002) in the Panarchy concept. The adaptive loop intends to explain social and eco-systemic change. In that process, different types of learning are identified that correspond to types and speeds of change: incremental, abrupt, or spasmodic, and transformational learning (ibid: 102). Critical to reflexive system change is transformational change--learning that happens at critical junctures and can induce systemic shifts that meanders and at certain tipping points either leads to collapse or renewal.

Figure 3. Scenarios for defining pathways to systemic sustainability.



Quadrant A pictures a systemic condition of the Holocene – a period beginning around 12,00 years before present (BP) and marks the beginning of agriculture and social as well as technological innovations that allowed humans to extract more resources from a given area of land.[14] Agriculture triggered population growth,[15] intensification and specialization and thus facilitating (or forcing?) a residential life in towns and cities. Increasing population densities required more complex institutions to address the emerging social coordination problem. This also stimulated collective learning accelerated the pace of technological and social change. Farming could now support 50-100 times as many people as could foraging (Christian 2008). Denser settlements created new social and organizational problems that required new institutions to govern larger and more complex social structures. In this period, many societies changed from being kin-based, egalitarian to hierarchical. "Tribute (tax) tacking states" emerged and institutionalized power that enabled an elite to gain control over people, resources, and energy. Institutional integrative capacity coincides with the emergence of more complex institutions able to solve problems of increasing socio-ecological interconnectedness, e.g., solving issues over ownership and property rights.

Quadrant B depicts a socio-ecological system condition in which the rate of institutional (and technological) innovation cannot keep pace with societies' environmental and health impacts. The result of that mismatch is that periods of growth were always followed by periods of political and demographic collapse. The maybe most prominent example for political collapse was the fall of the Roman Empire, or other civilizations like the Rapanui of Easter Island (Diamond 2011). Christian (2008: 162) provides other examples: "…Estimates of populations in Mesopotamia over 7,000 years show two periods of sudden decline. The collapse early in the 2nd millennium B.C.E. was almost certainly caused by overirrigation leading to salination and declining harvests. According to one estimate, Mesopotamian populations fell from over 600,000 in 1900 B.C.E. to about 270,000 by 1600 B.C.E., not to rise again for at least a millennium. A similar pattern of growth and decline would be repeated early in the second millennium C.E.".

The reason for avoiding Malthusian collapses is that institutional and technological innovation was able to keep pace with population growth and the impacts it has on the natural environment. Quadrant C scenarios accordingly picture system conditions in which growth continues and society's institutional capacity to integrate or internalize the pressures on the environment also improves. Collapse is avoided by "continuous cycles of paradigm-shifting innovations such as (…) digital information technology… Unfortunately, however, (…) the time between successive innovations must systematically and inextricably get shorter and shorter" (West 2017: 48). Understanding scenario C is essential for determining transition pathways in the current Anthropocene. In such systemic condition accelerated learning must lead to efficiency enhancing adaptations, but also to deeper institutional changes that reach to the embeddedness level of institutions.

System conditions in quadrant D can be understood as conditions during or after a collapse. Institutional complexity is still high from previous periods; however, human environmental stress factors have caused an ecosystemic response in form of diseases or disasters, which

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[14] The conditions in quadrant A also represent earlier periods of the Pleistocene when the human impact (of mainly hunter-gatherer's) on earth was minimal. We start here with the Holocene to capture the dramatic changes which took place in more recent human history.
[15] Population doubling every 1,600 years, as compared to every 6,000 years in the Upper Paleolithic era.

resulted in population declines. Ideally, people build on the lessons learnt from previous cycles to rebuild and re-organize themselves.

Conclusions

In the epoch of the Anthropocene social and ecological systems increasingly and rapidly overlap. In that process, life- supporting functions of ecological systems become less distant and adverse environmental impacts have a more immediate effect on the health and wellbeing of people and the planet. This condition of overlapping social and ecological systems creates a renewed awareness of people being part of and dependent on nature instead of dominating over it. The current perceptions of increasing risks and uncertainties seem to confirm the widening gap between human environmental impact and the institutional capacity to keep those impacts within safe operating spaces of planetary boundaries. Deep institutional change is required to improve that capacity, however, it cannot keep pace with the accelerating speed of global environmental changes, thereby increasing systemic risks.

Instead of merely a responsive approach, increasing uncertainties and systemic risks call for an institutionally reflexive change, which rethink the value base on which institutions are built. Due to a lack of existing knowledge, and despite plenty of data, deliberative and communicative rationality needs to be applied in the process of institutional innovation. While scientific measuring and monitoring the human impact on planet Earth is necessary to seek adaptation strategies and push the boundaries of ecosystemic collapse, this muddling through strategy is not sufficient for sustainable development and the kind of transformational change called for today. For that, another (higher) level of institutional complexity is required, which includes a new consensus[16] on commonly held values, a process of collaborative learning, and building collective intelligence across multiple cultures.

Communicative rationality is here not proposed to play into the hands of any one ideological model, neither that of the West or the East. The majority of humanity has benefited from growth and has contributed to creating the Anthropocene, while most of its institutional history stems from the relatively stable conditions of the Holocene and early periods of the Anthropocene when the externalities of growth could be absorbed by nature. Today, those systemic conditions have changed. It is suggested that communicative rationality will evolve from conditions of increasing uncertainty, and that reflexive institutional capacity - the capacity of institutions to change by reflecting on their own performance - can be made use of to create new forms of collective intelligence to cope with the increasingly complex challenges of the Anthropocene.

We introduced a framework that enables a self-reflective positioning of the systemic conditions a society is in and on which its transition trajectories are currently found. We argued that systemic risks can maybe be delayed but not be prevented by merely making systems more resilient or adaptive, which would be considered a responsive feedback. To achieve higher levels of collective intelligence, reflexive institutional change is inevitable.

[16] "While consensus can be very hard to secure, but it is possible to make progress in its absence" (Dryzek 2021).

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