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Analysis

Reprint of “Can Earth system interactions be governed? Governance functions for linking climate change mitigation with land use, freshwater and biodiversity protection” ☆

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ABSTRACT

Earth system interactions, as highlighted by the planetary boundaries framework, occur within and across natural, social and economic systems and shape global environmental change. This paper addresses the multi-level governance problem of coherently addressing key interactions between four Earth sub-systems – climate change, freshwater use, land use and biodiversity – taking into account concerns over problem shifting. After discussing possibilities for regional downscaling of the boundaries, we explore challenges for the EU region to coherently address this particular set of interacting Earth sub-systems and reduce the risk of problem shifting. This analysis demonstrates that Earth system interactions can be governed, but that they likely require comprehensive packages of governance responses across both sub-systems and levels. Three overarching governance functions are tentatively identified that directly or indirectly address Earth system interactions: reduction of system stress, risks and vulnerabilities; triggering and navigation of transformation of economic activity; and development of a diversity of options. Finally, the paper briefly discusses political and institutional challenges for developing, enabling and stabilising these governance functions.

1. Introduction

The central theme in this special issue is how to govern the Earth system in ways which avoid crossing critical biophysical thresholds — what have been called “planetary boundaries” by Rockström et al. (2009a,b). They propose quantified limits for concentrations of greenhouse gases (GHGs) in the atmosphere, atmospheric aerosol loading, ocean acidification, biodiversity depletion, freshwater use, nutrients cycling, ozone depletion, chemical pollution and land systems change. Respecting such boundaries presents a formidable governance challenge, for several reasons. Even when these boundaries are viewed separately, today's governance frameworks are far from effectively steering society within them. There are several cases of non-regimes (Dimitrov et al., 2007), for example for ocean acidification, the nitrogen and phosphorous cycles, global freshwater use, and atmospheric aerosol loading. In cases of some existing regimes, new scientific evidence suggests that more stringent targets than those currently agreed are needed (e.g., the greenhouse gas (GHG) concentration boundary at 350 ppm CO_2 equivalent; a quantitative biodiversity boundary). There are also varying degrees of implementation deficits in all the existing regimes. An additional challenge is that the Earth sub-systems also interact, which means that change in one will have repercussions on others. Literally hundreds of important interactions between the planetary boundaries that were outlined in Rockström et al. (2009a,b; see also Foley, 2010) can be identified, some of which are mitigated and others exacerbated by policy responses.

Most observers agree that more and better governance of the Earth system is needed, at and across geographical levels. What is needed is, simply put, “[e]ffective cooperation, facilitated by better-designed institutions” (Walker et al., 2009, p. 1345). The challenge to govern the Earth system as a whole more effectively has been a long-standing interest in the environmental governance literature. One strand has focused on institutional interplay between existing international environmental regimes (i.e., not cases of non-regimes) (Chambers, 2008; Oberthur and Gehring, 2006; Pittock, 2011) whereas another has focused on organisational architecture for better policy integration (Biermann et al., 2009b). Yet another strand has taken an interest in conditions for knowledge and information transfer at the global level and between international institutions

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and their administrative bodies (Clark et al., 2001; Galaz, 2009). Questions of integration of environmental issues into other policy sectors (environmental policy integration) have been examined primarily at the national and regional levels (Jordan and Lenschow, 2008) although with some discussions also at the international level (Nilsson et al., 2009b; Persson, 2009). At the international policy level, there has been a parallel recent surge in the interest regarding how to govern interactions between land, water, and energy systems, in what has become known as the "nexus perspective" (Hoff, 2011).

Whilst the literature on institutional architecture and interplay tends to study integration at the international level only, and actors directly involved in multilateral environmental agreements, a strong parallel trend is the interest in governance involving non-state actors, and circumstances of multi-level governance more particularly. For example, the study of climate governance has expanded from intergovernmental negotiations and the design and effectiveness of treaties (see e.g., Aldy and Stavins, 2007; Barrett and Toman, 2010; Sugiyama and Sinton, 2005) to analysis of agency "beyond the state" and "bottom–up" governance initiatives for global environmental change (see e.g., Biermann et al., 2010a; Rabe, 2004; Stripple and Pattberg, 2010). Increasingly, scholars are taking a more comprehensive view on Earth system governance; across levels and scales (Andonova and Mitchell, 2010; Gupta, 2008; Young, 2005), across actors (Biermann et al., 2010b) and via incremental 'building blocks' rather than one-off global deals (Falkner et al., 2010).

Yet, so far relatively little attention has been given to the actual aims and functionality of such comprehensive and multi-level Earth system governance, in particular as it concerns interactions between Earth sub-systems, as opposed to institutional properties. The overarching research question of this paper is; can Earth system interactions be governed? More specifically, could a set of core governance functions be identified, together with key actors and instruments?

The aim of this paper is to address these challenging questions in three steps. First, we seek to explain why a *multi-level governance* rather than purely international perspective on planetary boundaries and their interactions is warranted, whilst also discussing 'downscaling' issues. The regional level is taken as an entry point into such multi-level governance and we illustrate our analysis in the remainder of this paper with examples from EU policy and governance. The EU region is a useful case, first, because it has considerable agency in addressing several Earth system interactions and, second, because it has initiated an agenda for policy coherence across Earth sub-systems, which includes the external dimension of its policies.

Second, we aim to demonstrate how Earth system interactions can be addressed in practice and within current approaches to environmental governance by using the planetary boundaries as a *policy assessment framework*. In particular, we focus on stated EU policies in relation to four boundaries; climate change, land use, biodiversity, and freshwater. Such an analysis can reveal whether there is policy coherence with respect to strategies to stay within individual boundaries, i.e. whether they are compatible or even synergistic, or whether there is incoherence and the result is problem shifting rather than problem solving of the planetary boundaries as a whole (Nilsson et al., 2012).

Third, we wish to broaden the perspective on governance of Earth system interactions away from narrowly focusing on specific policy assessment and coordination procedures (as above) or indeed proposals for specific institutional reforms, by proposing a set of core *governance functions*. We argue that a wide variety of (multi-level) governance approaches and modes under these core functions can be geared towards better governance of Earth system interactions.

The structure of this paper is developed as a sequence of analytical steps. First, relevant Earth sub-system interactions related to the four planetary boundaries are identified. Downscaling of these boundaries to the regional (EU) level is discussed. Second, we map out relevant, as well as missing, policy targets that have been set in relation to the sub-systems and examine what interactions need to be governed and for what purpose. The following section proposes three overarching governance functions. It should be noted that our governance discussion takes as a starting point already existing and known arrangements and does not attempt to articulate a theoretical model or ideal types. Finally, the paper discusses the need for more analysis into underlying political and institutional challenges.

2. Earth System Interactions and the EU Challenge

2.1. Key System Interactions

Among the nine planetary boundaries, Rockström et al. (2009b) suggest that the GHG concentration in the atmosphere must remain below 350 ppm CO_2 equivalents; that the loss of biodiversity should not exceed an annual extinction rate of 10 species per million species; that global freshwater consumption should not exceed 4000 km^3 per year; and that no more than 15% of global ice-free land may be converted to cropland. Estimating boundaries is complicated since the systems interact, as Rockström et al. note (extracted from Table 1):

> "Freshwater: Primarily slow variable affecting moisture feedback, biomass production, carbon uptake by terrestrial systems and reducing biodiversity
>
> Land systems: Primarily acts as a slow variable affecting carbon storage and resilience via changes in biodiversity and landscape heterogeneity
>
> Biodiversity depletion: Slow variable affecting ecosystem functioning at continental and ocean basin scales. Impact on many other boundaries — C storage, freshwater, N and P cycles, land systems"

However, the authors described only a very small subset of interactions and many more can be identified than would be possible to discuss in a single paper. In addition to the purely biophysical interactions, the systems often interact through policy responses (see Section 2.3). For example, taking the planetary boundaries of GHG concentration, freshwater use, land system change and biodiversity depletion, important interactions include:

- Loss of grasslands and wetlands has a negative impact on biodiversity (MEA, 2005) and climate change (Parish et al., 2007). Increased forest cover, on the other hand, positively contributes to climate mitigation through sequestration of carbon and provision of biomass for energy which can replace fossil fuels (Nabuurs et al., 2007). It may increase green water and evapotranspiration at the expense of blue water availability in certain areas, though (van Dijk and Keenan, 2007). GHG emissions from croplands depend on the agricultural methods and technologies used (Smith et al., 2007).
- Ongoing climate change will compromise agricultural productivity in many places, with implications for the use of agricultural inputs such as pesticides and fertilisers as well as land use change (Easterling et al., 2007). A changing climate is going to entail longer growing seasons but also the use of new plant varieties (EEA, 2008). This will influence how lands are used and possibilities for introducing of new pollinator species. In Europe, a warmer climate is also likely to shift crop production northward (a shift which has been on-going for decades already).
- A changing climate has implications for ecosystems and biodiversity at both species and ecosystem level (EEA, 2008; Fischlin et al., 2007). One example is the migration of alien species in