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Safe and just operating spaces for regional social-ecological systems

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ABSTRACT

Humanity faces a major global challenge in achieving wellbeing for all, while simultaneously ensuring that the biophysical processes and ecosystem services that underpin wellbeing are exploited within scientifically informed boundaries of sustainability. We propose a framework for defining the safe and just operating space for humanity that integrates social wellbeing into the original planetary boundaries concept (Rockström et al., 2009a,b) for application at regional scales. We argue that such a framework can: (1) increase the policy impact of the boundaries concept as most governance takes place at the regional rather than planetary scale; (2) contribute to the understanding and dissemination of complexity thinking throughout governance and policy-making; (3) act as a powerful metaphor and communication tool for regional equity and sustainability. We demonstrate the approach in two rural Chinese localities where we define the safe and just operating space that lies between an environmental ceiling and a social foundation from analysis of time series drawn from monitored and palaeoecological data, and from social survey statistics respectively. Agricultural intensification has led to poverty reduction, though not eradicated it, but at the expense of environmental degradation. Currently, the environmental ceiling is exceeded for degraded water quality at both localities even though the least well-met social standards are for available piped water and sanitation. The conjunction of these social needs and environmental constraints around the issue of water access and quality illustrates the broader value of the safe and just operating space approach for sustainable development.

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1. Introduction

1.1. Rationale and motivation

The planetary boundaries framework (Rockström et al., 2009a,b) has significantly influenced the international discourse on global sustainability. In short, it proposes nine interlinked biophysical (hereafter referred to as ecological) boundaries at the planetary scale (Fig. 1a) that global society should remain within, if it is to avoid "disastrous consequences for humanity". The proposition of planetary boundaries has provoked discussion in the science and policy communities. Recently published commentaries include refinement of the boundaries for phosphorus (Carpenter and Bennett, 2011), nitrogen (de Vries et al., 2013) and freshwater use (Rockström and Karlberg, 2010); the proposal of a potential state shift in the global biosphere (Barnosky et al., 2012); a new approach to defining land-related boundaries using net primary plant production (Erb et al., 2012; Running, 2012); analyses of the governance implications (Biermann, 2012; Galaz, 2012; Nordhaus et al., 2012); and critical assessment of the nature of the proposed planetary boundaries (Brook et al., 2013). Raworth's (2012) extension of the planetary boundary concept to include social objectives in the context of sustainability policy and practice has produced a framework that has become known as the 'Oxfam doughnut', with an explicit focus on the social justice requirements underpinning sustainability (Fig. 1b). This allows multi-metric 'compasses' to be elaborated for directing decision-making. In this paper, we develop the 'doughnut' idea at the regional scale in terms of the levels of societal wellbeing and conditions of ecological processes that co-exist within regional social-ecological systems, using the terms 'social foundation' and 'environmental ceiling' to represent the social and ecological boundaries. In doing so, we define the regional safe and just operating space (RSJOS).

Our main motivation is to show how the concept of ecologically safe and socially just planetary boundaries can be adapted and applied at regional levels, for example: watersheds, national parks, sub-national administrative divisions, and nation states. Because critical transitions can occur at any scale (Scheffer et al., 2001; Folke et al., 2004; Lenton, 2013), the original planetary boundaries framework recognized that the effects of crossing multiple thresholds at regional scales can aggregate to become a global concern (Rockström et al., 2009a,b). But the cascading effects of environmental degradation (Peters et al., 2011) can have critical consequences for the sustainability of regional systems themselves, well before the effects are obvious at the global scale. This means that global sustainability requires both regional and planetary dimensions to be addressed. Hence our view is that concepts sharpened by consideration of regional scales can feed back iteratively to help refine or redefine planetary boundaries.

The argument for considering regional-scale boundaries is reinforced by an equally strong equity and governance rationale. In the planetary boundaries framework, protecting human wellbeing is the rationale for the scientific assessment of how to limit the use and degradation of natural resources in order to avoid critical transitions in Earth system processes. At the same time, human wellbeing depends fundamentally upon each person having claim to the natural resources required to meet their physiological needs such as food, water, shelter and sanitation (Folke et al., 2011). It follows from these fundamental equity considerations that social foundations (sensu Raworth, 2012) should be considered alongside planetary and regional boundaries. Traversing the scales to regional boundaries requires explicit attention to both the human drivers of change and social distributional issues, bringing new transdisciplinary, conceptual and ethical challenges to the planetary boundaries concept.

Many nations and regions face significant and urgent challenges in ensuring that available resources are used to meet the needs of all, emphasizing the sustainable use of regional resources for human wellbeing. In particular, while agricultural intensification in developing countries is widely seen as promoting rapid economic growth and poverty alleviation, evidence exists to show that the associated degradation of ecosystem processes may be unsustainable (e.g. Tilman et al., 2002; Dearing et al., 2012a). Natural resource management takes place predominantly at regional scales as part of national and regional development planning. Therefore, analytical tools that map the condition of ecological processes at these scales are more likely to have relevance and traction for policy design and resource governance.

Above all, there is a need to counter the limitations of current political-strategic timeframes that are too often aligned with short term 'discounting' perspectives that place emphasis on near future decisions. An ability to identify and stay within ecological boundaries over longer timescales would help to ensure intergenerational sustainable resource use. A longer timeframe is also in tune with "perfect storm" projections for converging trends by mid-century (Godfray et al., 2010; Dearing et al., 2012b). For communities in regions that already occupy dangerous operating spaces, a new framework that captures multiple timescales could provide a scientifically informed prioritization of restorative action.

1.2. A regional framework

A regional boundaries framework can be designed in alternative ways, depending on its motivation. One approach would be to calculate the regional share of global resource use (e.g. water) and

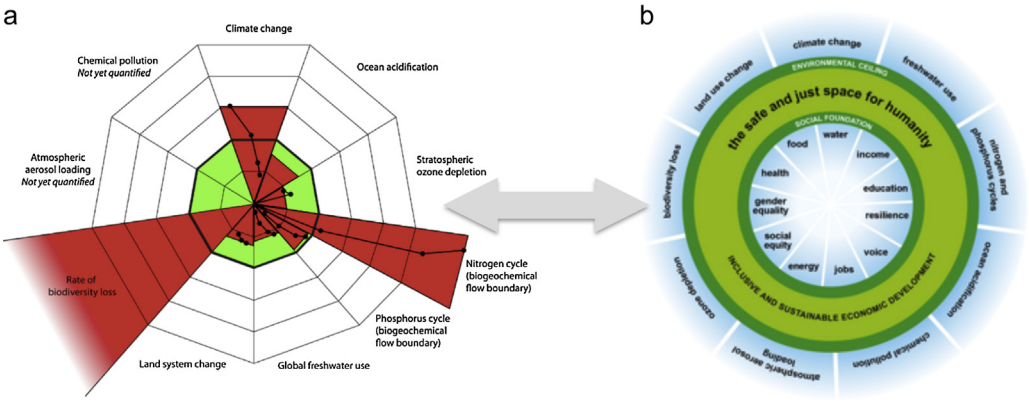

Fig. 1. Merging (a) the planetary boundary framework (Rockström et al., 2009a,b) and (b) the social 'doughnut' framework (Raworth, 2012) into a new framework and tool for defining safe and just operating spaces for sustainable development at regional scales.