How the Planetary Boundaries framework can support national implementation of the 2030 Agenda

The 2030 Agenda for Sustainable Development, adopted by the United Nations member states in 2015, requires "each government (to set) its own national targets guided by the global level of ambition" set out by the Sustainable Development Goals (SDGs). This formulation leaves question marks over exactly what is the global level of ambition, and how individual countries should set national targets that are consistent with it.

Related to this, Goal 12 of the Agenda's Sustainable Development Goals (SDGs) on Sustainable Consumption and Production (SCP) – "achieving a better quality of life while minimizing the use of natural resources and emissions of pollutants" – implies that countries have a responsibility not only for their domestic environmental impacts, but also for those occurring along the international supply chains linked to goods they import for consumption.

The Planetary Boundaries framework can help to specify and quantify the global level of ambition for SDG implementation activities from an earth system and environmental perspective, and so guide national target-setting, as it defines a "safe operating space" within which the cumulative impacts of human activity should stay (Steffen et al. 2015). Planetary Boundaries downscaled to national or regional level, in combination with consumption-based environmental accounting, can furthermore inform sustainable production, trade and consumption targets across scales.

The Sustainable Development Goals and the Planetary Boundaries

A core principle of the 2030 Agenda is *universality*. While this principle can be understood in several ways, two important implications are that the Agenda applies to all countries and that the responsibility for achieving the SDGs does not end at national borders: countries, especially industrialized countries with their high per capita levels of consumption and international trade connections, must also account for the external and global environmental and socio-economic impacts of their consumption.

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Agroforestry research plots at the Horticulture and Agroforestry Research Center in New Franklin, Mo.

Policy implications

- The Planetary Boundaries framework can support defining the 2030 Agenda's "global level of ambition", as it posits a global safe operating space within which the sum of all national contributions and implementation activities should remain.
- The Planetary Boundaries, in combination with consumption-based environmental accounting, can help to operationalize SDG 12 on Sustainable Consumption and Production, in particular, by serving as benchmarks for a country's total – internal and external – environmental performance.
- Continuous science-policy dialogue is required for mainstreaming the Planetary Boundaries into national policy, in support of "vertical" or cross-scale policy coherence.

Another core principle of the 2030 Agenda is that the SDGs require *integrated implementation* – meaning in particular that implementation of any one goal or target must not compromise achievement of others. This requires coordination and cooperation not only horizontally across goals, targets and sectors, but also vertically across scales and regions.

Implementation of the SDGs will happen predominantly at the national level. But national activities inevitably have cross-border or even global impacts. This is true also for the use of natural resources such as land and water and for impacts on global public goods such as the atmosphere, the biosphere and the oceans. There are limits to how much these can be used or modified without transgressing sustainability boundaries at different scales – all the way up to Planetary Boundaries. Transgressing them may cause critical and potentially irreversible changes and regime shifts in the earth system or its subsystems, with severe consequences for human well-being.

The Planetary Boundaries framework describes global-level limits of resource use, emissions of harmful substances, and other environmental pressures – or a safe operating space – within which the earth system must remain in order to maintain its function as the life-support system for humans (Rockström et al. 2009; Steffen et al. 2015). Thus, the sum of all national activities for SDG implementation, and their associated environmental pressures, should not transgress the respective Planetary Boundaries. For example, the Planetary Boundary for climate indicates the maximum allowable global warming and by inference the maximum total global greenhouse gas emissions that can be released internationally. The forthcoming SRC discussion paper *Operationalizing the Concept of a Safe*

Table 1: Examples of SDG targets which can be informed by Planetary Boundaries

Planetary Boundary	Related SDG targets
Climate change	13.2: Integrate climate change measures into national policies, strategies and planning
Biosphere integrity	15.5: Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.
Biogeochemical flows (N & P)	14.1: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.
Global freshwater use	6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals . . .
Land-system change	15.2: By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally
Ocean acidification	14.3: Minimize and address the impacts of ocean acidification . . .
Stratospheric ozone depletion	12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.
Atmospheric aerosol loading	3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
Novel entities (chemical pollution)	12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment

Operating Space at the EU Level by Häyhä et al. describes the EU's fair share of the safe operating space for keeping within each of the Planetary Boundaries.

While the SDGs do not directly correspond to the Planetary Boundaries, Table 1 gives some examples of SDG targets that can be informed by the Planetary Boundaries.

Supporting national SDG implementation

The key pathways through which the Planetary Boundaries framework can support the 2030 Agenda's universality principle and integrated national SDG implementation are:

1. Specifying and quantifying environmental ambitions for SDG implementation.

2. Operationalizing sustainable consumption and production by linking consumption impacts to "fair shares" of the global safe operating space.

3. Continuous science–policy dialogue, which is required in order to mainstream the Planetary Boundaries into national policy and support policy coherence between different scales.

Specifying and quantifying environmental ambitions for SDG implementation

The Planetary Boundaries can specify the global level of ambition (for the SDGs and their targets) or a global environmental benchmark not to be exceeded by the aggregate sum of all national implementation activities (called Nationally Determined Contributions in the case of the climate boundary). For example, the global target of limiting average global temperature rise to 2°C means that no more than about 1000 gigatons of CO_2 can still be emitted into the atmosphere, after which zero net emissions are required globally. Similarly, the Planetary Boundary for freshwater use sets a limit of 4000 km^3 global consumptive water use per year, and the Planetary Boundary for nitrogen sets a limit for global anthropogenic production of reactive nitrogen of 62 megatons per year (Steffen et al. 2015). In the case of the climate boundary, the global level of ambition is also time-sensitive, requiring zero net emissions by mid century and hence temporally explicit reduction pathways for staying within the safe operating space.

While most countries have adopted national greenhouse gas emissions targets relating to the global 2° target, only very few countries have begun to look into national-level targets related to the other Planetary Boundaries. The report on operationalizing the Planetary Boundaries by Häyhä et al. begins to translate all the Planetary Boundaries to the level of the European Union and its member states. This translation requires spatially explicit downscaling of the Planetary Boundaries, and fair allocations of the global safe operating space to individual regions or countries. It has to be based on state-of-the-art earth system science (e.g. van Vuuren et al. 2016) and on normative decisions about fair allocations (see e.g. Steininger et al. 2015). For several of the boundaries, it also involves an alignment with context-specific bottom-up sustainability criteria, in order to mainstream information related to the Planetary Boundaries and inform national policy-making and SDG implementation.

Operationalizing sustainable consumption and production

SDG 12 on sustainable consumption and production points to the links between national consumption, trade and environmental (and socio-economic) pressures in sometimes distant production regions. Emerging supply chain analysis and consumption-based environmental accounting methods make it possible to track the total internal and external environmental pressures associated with a country's domestic consumption and related imports of goods and services. Figure 1 shows the percentages of consumption-based demand for arable land met externally (through imports) and internally (through domestic

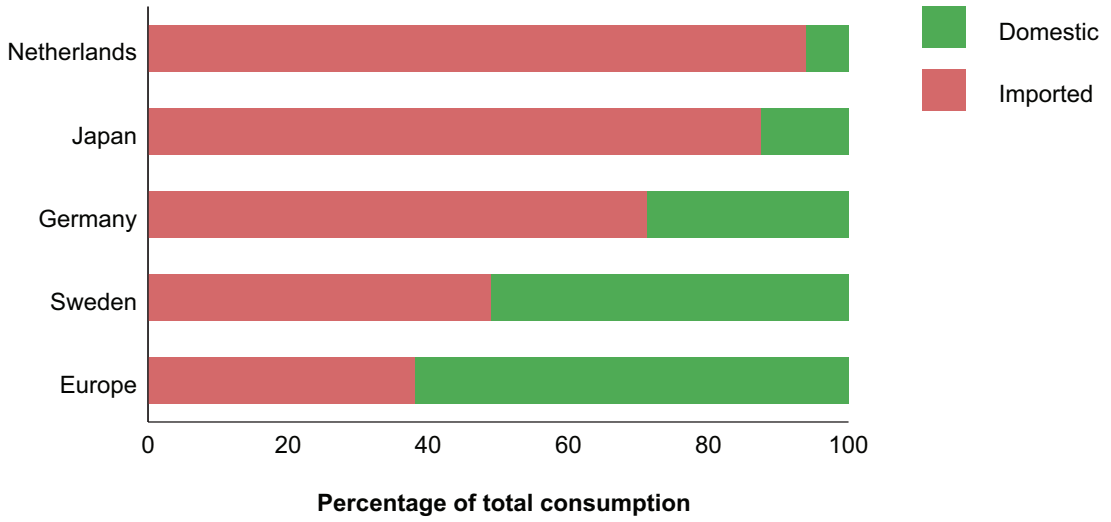

Figure 1: Living off the land: shares of consumption-based demand for arable land met through imports and through domestic production, for selected countries, 2013

Source: Data on global arable land trade flows, based on EXIOBASE version 3.3, supplied by Martin Bruckner, Vienna University of Economics and Business.

production) for a selection of countries, all of which are large net importers of virtual land (due to biomass imports).

Combining such consumption-based environmental accounting with Planetary Boundaries makes it possible to compare the total environmental pressures (internal plus external) associated with a country's consumption with its fair shares of the relevant Planetary Boundaries, and thus national responsibility in terms of SCP. Moreover, Target 12.1 requires developed countries to take the lead in SCP, which includes improving the sustainability of their supply chains. It is therefore very appropriate that countries such as Sweden, Switzerland and Germany, as well as the EU, are taking the lead in operationalizing the Planetary Boundaries in support of SDG implementation and SCP.

Downscaling the Planetary Boundaries and integrating the downscaled boundaries with bottom-up local or regional sustainability criteria can also help to identify particularly critical or vulnerable regions as well as those regions that currently have greener, more resource-efficient production. Advanced scientific methods employed for supply chain analysis and consumption-based environmental accounting include lifecycle analysis (LCA), material flow analysis (MFA), and multiregional input-output (MRIO) modelling (which produced the data used in Figure 1). The PRINCE project (www.prince-project.se), for example, is linking an MRIO model with national and international statistics to track the domestic and external environmental pressures from Swedish consumption. Meanwhile, the global System of Environmental-Economic Accounting (SEEA; http://unstats.un.org/unsd/envaccounting/seea.asp) is harmonizing environmental and economic data between countries. A combination of these methods can provide the quantitative underpinning for operationalizing sustainable consumption, trade and production and eventually more sustainable sourcing.

Science–policy dialogue

In order for the Planetary Boundaries to support national SDG implementation in the ways described above, and for aligning national policies with the global safe operating space ("think global – act local"), close and continuous science–policy dialogue is needed. Such dialogue makes it possible to cogenerate new and policy-relevant knowledge and to improve vertical policy coherence (called for in SDG Target 17.14) between scales.

One example of such cogeneration of policy-relevant knowledge is the application of the Planetary Boundaries to the development of Germany's Integrated Nitrogen Strategy. The Planetary Boundary for nitrogen[1] (a biogeochemical flows boundary that sets a global limit on the anthropogenic production of reactive nitrogen) has been downscaled to identify how much reactive nitrogen Germany could produce while staying within its fair share of the global safe operating space. In close dialogue with policy-makers, the scientifically derived downscaled boundary has been compared with existing and planned regulations at subnational, national and European levels, to guide better vertical integration and policy coherence.[2] Similarly, the Planetary Boundaries add a global environmental perspective to other strategies or programmes, such as the new German Sustainable Development Strategy (German Government 2017) or the new German Integrated Environment Programme (BMUB 2016).

Such science–policy dialogue is also well suited to address normative and equity issues related to the downscaling of Planetary Boundaries, in particular how to fairly apportion the global safe operating space between countries – whether on the basis of equal per capita allocation, historical responsibility, the right to development, differentiated capacities, cost efficiency or other criteria.

Conclusion

The universal and integrated implementation of the 2030 Agenda and the many different SDG targets is a major challenge. The Planetary Boundaries can in particular support

1 The nitrogen boundary is reflected also in the SDGs, e.g. in target 2.4 which requires to "improve land and soil quality" and in target 14.1: "reduce marine pollution … including nutrient pollution"

2 From "Anschlussfähigkeit der Planetary N-Boundary für eine integrierte Stickstoffstrategie in Deutschland" (Connectability of the N Planetary Boundary for an integrated nitrogen strategy in Germany). Unpublished report for the Germany Environment Agency by Hoff et al., 2017.

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vertical coherence between scales in SDG implementation and more general policy-making, by specifying and quantifying the global environmental ambitions (as in the case of the 2°C climate target) of any sustainability transition. Spatially explicit downscaling of the Planetary Boundaries, moreover, can help to identify global production regions that are critically vulnerable and those that are more favourable for export production. In combination with consumption-based environmental accounting, this can guide coherent SDG implementation and SCP, and sustainable sourcing.

In a world rapidly growing more interconnected – with persistent or even growing human insecurities, resource scarcities and environmental pressures – the alignment of sustainability goals between levels, scales and regions, taking into account critical interlinkages ("teleconnections") such as trade or foreign direct investment, is urgently needed. Science–policy dialogue that seeks to harmonize the scientific earth system perspective with national policies, development plans and social metabolism pathways, will be vital.

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References

BMUB (2016). *Shaping Ecological Transformation: Integrated Environmental Programme 2030*. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), Berlin. http://www.bmub.bund.de/en/service/publications/downloads/details/artikel/shaping-ecological-transformation/.

Rockström, J., Steffen, W. L., Noone, K., Persson, Å., Iii, C., et al. (2009). Planetary Boundaries: exploring the safe operating space for humanity. *Ecology and Society*, 14. http://pdxscholar.library.pdx.edu/iss_pub/64.

Steffen, W., Richardson, K., Rockstrom, J., Cornell, S. E., Fetzer, I., et al. (2015). Planetary Boundaries: guiding human development on a changing planet. *Science*, 347(6223). 1259855–1259855. DOI:10.1126/science.1259855.

Steininger, K. W., Lininger, C., Meyer, L. H., Muñoz, P. and Schinko, T. (2015). Multiple carbon accounting to support just and effective climate policies. *Nature Climate Change*, 6(1). 35–41. DOI:10.1038/nclimate2867.

van Vuuren, D. P., Lucas, P. L., Häyhä, T., Cornell, S. E. and Stafford-Smith, M. (2016). Horses for courses: analytical tools to explore planetary boundaries. *Earth System Dynamics*, 7(1). 267–79. DOI:10.5194/esd-7-267-2016.

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