International Resource Panel

PACE
PLATFORM FORACCELERATING THE CIRCULAR ECONOMY

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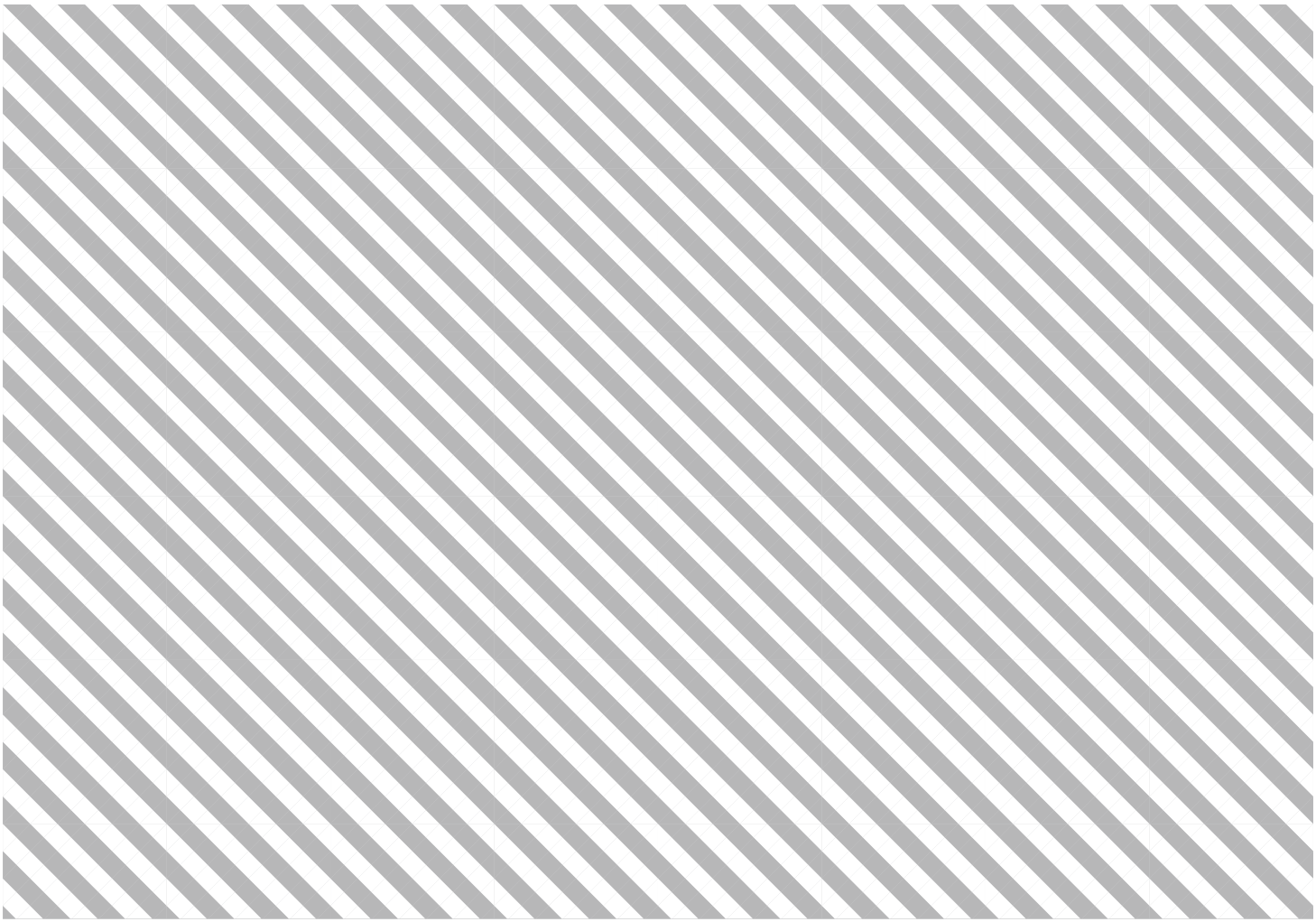
White Paper

The Next Frontier: Natural Resource Targets

Shaping a Competitive Circular Economy within Planetary Boundaries

September 2019



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Contents

Foreword

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The Sustainable Development Goals, the Paris Agreement, the Aichi Biodiversity Targets and other international agreements provide essential frameworks for action based on limiting environmental impacts. At the same time, policy-makers and business leaders are still relatively ill-equipped to systematically target the underlying drivers of these impacts, which are merely symptoms of wider imbalances.

Resource extraction and processing alone cause over 90% of global biodiversity loss and water stress, and about half of the effects of global climate change.[1] About 20% of greenhouse gas emissions are caused by the extraction and processing of metals and non-metallic minerals alone. These emissions, as well as emissions from other materials such as plastics, can only partially be abated by energy technology solutions.[2]

Without business and policy model changes, resource use will more than double from current levels to 190 billion tonnes by 2060 and far exceed the planetary boundaries.[3] Decoupling prosperity from resource use must become the economic paradigm to secure a safe operating space for human activity.

Decoupling is not only a risk prevention story – it is also a big opportunity. Smart resource use and business models that do not rely on natural resource extraction are a huge untapped field for innovation and for a new model of growth. International Resource Panel modelling sees a boost of 8% in global growth above a "historical trends scenario from 2030 to 2060 through efficiency measures in construction and manufacturing alone".[4] A full embrace of the decoupling transition, namely employing it as the general innovation principle across sectors, could deliver benefits far beyond that.

While businesses and government are already making steps in this direction, much more is required. This White Paper offers initial reflections on the need and opportunity for strengthened metrics and integrating comprehensive natural resources targets to both accelerate innovation and more effectively track progress towards a circular economy. Without undermining the complexity of this task, the goal is to spark debate between academics, governments and business on the scale and scope of action required to achieve a fully circular economy that operates within planetary boundaries.

Executive summary

Natural resources: At the heart of the economy and the planetary boundaries

Natural resources are becoming a strategic concern in the 21st century, where risks emerge across resource categories. Current resource use models fail to underpin a stable economy and long-term human well-being. Risks related to increased resource use include negative effects on health and the environment, and greater price volatility of natural resource commodities. The annual World Economic Forum *Global Risks Report* highlights environmental and resource-related risks, including extreme weather events, natural and man-made disasters, the failure to address climate change and ecosystem collapse, as some of those most likely to occur and most impactful to a prosperous global economy and human well-being.

Resource extraction and processing cause over 90% of global biodiversity loss and water stress, and more than half of the effects of global climate change. Without action, resource use will more than double from current levels to 190 billion tonnes by 2060.[5] Concerted resource efficiency and sustainable resource management measures can reduce global resource use by 25% and greenhouse gas emissions by 90%, and boost global gross domestic product by 8%, as compared with a historical trends scenario, from 2030 to 2060.[6]

Smart natural resource management is important to staying within the safe operating space (i.e. within the planetary boundaries or the limits of what the planet can sustain) for human activity, as tackling the effects without strategically managing the drivers will not be effective.

Decoupling: The new economic paradigm to ensure profitable, equitable and sustainable growth in a safe operating space

For lasting competitiveness, an economy needs to be built that decouples growth from resource use and the effects on the environment by innovating technologies, business models, market incentives and policy. For businesses, embracing decoupling through resource efficient strategies, circularity and sustainable resource management is important for facing emerging disruptions of the global economy.

Decoupling is not only an effective strategy to save costs and build resilience, but is also becoming a competitive imperative and a new pathway for growth opportunities through innovations, better services and building trust.

Targets for resource use: The next big frontier in understanding economic success in the safe operating space

The decoupling transition needs clear targets for companies and governments to monitor progress in technologies and business model innovations and to support concerted action across stakeholders and value chains.

Global resource flows and impacts are complex. Deriving resource use indicators consistent with the planet's safe operating space must be guided by global science. The circular economy concept is a key tool in advancing decoupling, following important principles of preserving natural capital, optimizing use and minimizing environmental externalities.

Targets will not only be helpful as a "safety check" for business and policy decisions, but also act as a strategic guide to more systemic innovations. Setting targets for smart and sustainable use of natural resources is the next big frontier in understanding how to reach a liveable future – and how to be economically competitive in it.

Resource use: The current situation and what to consider in outlining its targets in the safe operating space

So far, most debates about climate change, biodiversity loss, water stress and other environmental areas have barely assessed resource use as a systematic cause of these impacts or discussed smart resource management as an effective lever to mitigate negative effects and create system innovations. "Planetary boundaries" is an essential conceptual guide but is not yet connected to the drivers of resource use.

At the fourth United Nations Environment Assembly held in March 2019, global leaders started to embrace natural resource use as a fundamental issue across environmental agendas. Translating the global effects that determine the safe operating space for people into target ranges for resource use is highly complex. However, the complexity must not hinder progress but spark discussion and joint ambition in science and society around the globe. At a country and business level, initial efforts in this direction are being made – with countries beginning to develop national circular economy roadmaps and companies shaping circular economy strategies. This trend presents an important opportunity to integrate measurable resource management targets and related progress indicators.

Introduction

Although the use of natural resources has been the basis for the world economy, it has also been the root cause of the most urgent pressures on the environment and human well-being, stretching the limits of the planetary boundaries far beyond the safe operating space (i.e. beyond what the planet can sustain). Smart natural resource management is therefore an important tool to staying within the safe operating space. Tackling the effects – such as climate change, biodiversity loss and water stress – without strategically managing their drivers will not be effective. Increasingly, leaders are embracing the notion that, to have a chance at achieving the Sustainable Development Goals (SDGs), urgent action must be taken by decoupling economic growth from resource use and the effects on the environment. Without a clear understanding of what constitutes "sustainable resource use" in quantitative terms, however, the reference will be poor as to whether the global economy is developing within the planetary boundaries.

Science needs to provide that better reference to decision-makers in policy and society, offering a better understanding of the risks connected to certain resource pathways and outlining targets[7] for sustainable resource use.

1. Natural resources: At the heart of the economy and the planetary boundaries

Resources, from metals to water and soils to biomass, are fundamental to everything people create – from food to smartphones to real estate. No economy without energy, no cement without sand and water, no food without fertile soils: nature has been the big supply chain for economic growth.

Yet the supply of the right quality and quantity of important natural resources, long assumed to be endless and unproblematic, is by no means guaranteed over the coming decades. This is mostly due to harmful environmental effects, or sometimes because societies have not paid enough attention to allowing resources to replenish, such as with fertile soils or, in some cases, because natural resource stocks are running low.

Natural resources will be a strategic concern in the 21st century. Some important facts illustrate the growing pressures on resources:

– Commodity price volatility, also due to geopolitical and economic factors, is now higher than at any other time in the last 100 years. Supply risks are emerging across resource categories, from rare metals to fish stocks.[8]

– From 1970 to 2017, annual global extraction of materials grew from 27 billion tonnes to 92 billion tonnes. If current systems of production and the provision of major services remain unchanged, the world's population of roughly 10 billion people will require about 190 billion tonnes of materials annually by 2060, or more than double the current amounts.[9]

– The main driver of resource use is not population growth but consumption patterns. High-income countries use over 10 times more resources per capita than low-income countries.[10] The growing use of natural resources, including land, water and materials (biomass, fossil fuels, metals and non-metallic minerals) are the main cause of some of the most pressing current challenges, such as biodiversity loss,[11] climate change or air pollution.

– Resource extraction and processing are responsible for more than 90% of biodiversity loss and water stress and about half of the total greenhouse gas (GHG) emissions from the global economy (disregarding emissions from land use change).[12] About 20% of GHG emissions are caused by the extraction and processing of metals and non-metallic minerals alone. These emissions, as well as emissions from other materials such as plastics, can only partially be abated by energy technology solutions.[13]

– Resource use can negatively affect health and can manifest, for example, as air pollution (e.g. through coal combustion) or water contamination (e.g. through metal processing). While end-of-pipe technologies (those used in the last stage of processes), such as water or air filters, still have big potential to improve health in some countries, the remaining emissions can still be high and lead to severe health problems, even in countries with modern equipment.[14] As a consequence, the focus must be on switching to cleaner fuels and materials, sourcing high-quality raw materials and increasing pretreatment, specifically on innovative economic models that use fewer resources.[15]

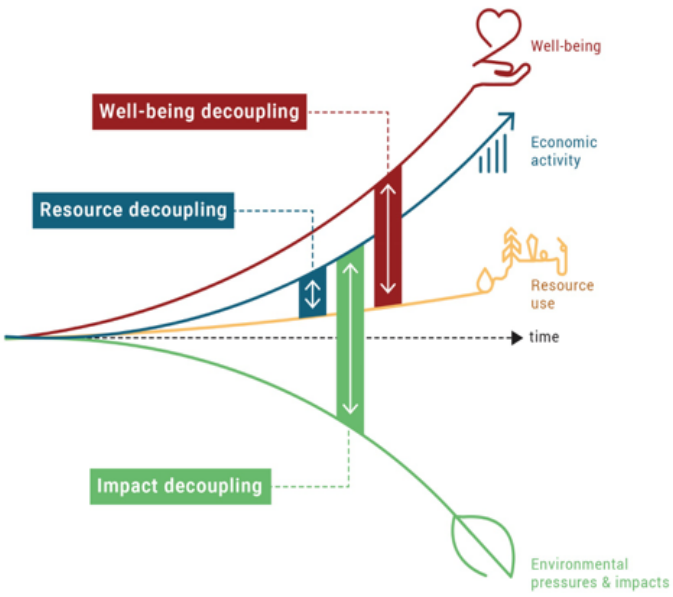
Tackling the effects, including climate change, biodiversity loss and water stress, without strategically managing their drivers in terms of resource use in the economy will not be effective. Therefore, a truly sustainable economy will need a systems view of the still hidden dynamics of resources.

2. Decoupling: The new economic paradigm to ensure profitable, equitable and sustainable growth in a safe operating space

Rising consumption, increasing effects on the environment and health, and rising prices, coupled with greater price volatility for natural resources, are clear trends. They are evidence that the current resource use model is becoming a major risk for a stable and prosperous global economy and human well-being.[16] If the resource base of products is not guaranteed, robust returns cannot be expected. Redesigning the economic system to ensure achieving the broadly agreed policy goals of the SDGs will require an economic paradigm of decoupling (see Figure). Only an economy that decouples growth from resource use and effects on the environment can create global prosperity for the world's projected 10 billion people in 2060.

Relative decoupling takes place when resource use grows at a slower rate than economic activity, while absolute decoupling is when resource use declines and economic activity continues to grow. Absolute decoupling must be the aim of high-income nations, with strategies needed to lower average resource consumption. Conversely, relative decoupling is an important strategy for developing economies and economies in transition to raise average income levels with minimal detrimental effects.

Figure: The concept of resource decoupling



Source: United Nations Environment Programme, International Resource Panel, *Global Resources Outlook 2019: Natural Resources for the Future We Want*, 2019

The 21st century has yet to witness any progress leading to improvements in overall resource productivity, mainly due to a structural shift of global production from more resource-efficient to less resource-efficient countries.[17] Decoupling suggests that resource productivity must improve immensely, leading to a huge domain for innovation and notably a completely different model of providing goods and services. Decoupling is based on a strategy that accounts for and completely rethinks the role of natural resources in the design and use of products and practices. New collaboration across the value chain and policy-making are required to enable circular and resource-decoupled markets.

Pursuing decoupling has incentives beyond just avoiding problems, as it can also create co-benefits for the global economy, individual sectors and companies. Current modelling results from the International Resource Panel (IRP) show that ambitious resource productivity policies combined with climate change policies could reduce global extraction by up to 25%, decrease global GHG emissions by 90% and increase global gross domestic product (GDP) by 8%, as compared with a historical trends scenario, from 2030 to 2060.[18] Other estimates show that implementing a comprehensive list of resource efficiency technologies by 2030 would save private investors $2.9 trillion per year.[19]

Therefore, efficient and sustainable use of natural resources is crucial to building a long-lasting competitive advantage by boosting profitability, generating new avenues for growth and considerably reducing exposure to risks. According to McKinsey & Company, resource productivity must indeed be a, if not the, top priority of industrial manufacturers around the world.[20] This is true not just for material-intense sectors like manufacturing or construction, but also for food production and retail. Decoupling could be the essential paradigm for a new economy that promotes more equitable and sustainable growth.

Decoupling strategies for resilient and successful businesses

Strikingly, most of the technologies and techniques (or know-how) for achieving significant levels of resource productivity – up to between five- and ten-fold improvements – already exist and can be leveraged through smart business strategies.[21]

Decoupling strategies for businesses do not have to be costly. The 2016 report *Delivering on Sustainable Infrastructure for Better Development and Better Climate* predicted that a shift to low-carbon infrastructure would increase investment needs by as little as 5%, and those higher capital costs could potentially be fully offset by lower

operating costs, such as from reduced fuel use over the infrastructure lifecycle.[22] Adoption of decoupling strategies for businesses can be quickly translated into cost reductions and improved margins. This is evident particularly in circular production models. For example, manufacturers of industrial printers, vehicle parts and heavy-duty and off-road equipment in the United States save 18-44% in the cost per unit through remanufacturing and comprehensive refurbishment strategies, compared to the same product made from new materials. Remanufactured products are equivalent in quality while saving up to 98% on new materials input, reducing production waste by 90%, and avoiding up to 99% of embodied material emissions and up to 87% of process emissions.[23]

Circular economy principles essential for sustainable resource management as drivers of innovation and economic growth

Including sustainable resource management in business strategies, in addition to building resilience and long-term success, can also generate innovation through the development of new products and services that can potentially restore growth to plateau or slow-growth market segments.

A good example of this is the new business models enabled by the Fourth Industrial Revolution and the new opportunities provided by digital technology and consumer behavioural shifts. Digitally enabled car-sharing models, for example, are booming around the world, from ATzuche in China to Drivezy in India, Times 24 in Japan, BlueLA in California (USA) and MOIA in Germany, among many other examples. While these models are new and their systems-efficiency effects will still be evaluated, these service-based businesses have great potential in decoupling value creation from mass material use and towards efficiently meeting societal needs.

Fast-growing urbanization provides huge opportunities in innovation and growth for resource-efficient businesses. Urban governance is increasingly incorporating circular economy principals and adopting a resource efficiency lens in strategic planning, such as in New Delhi, India or Medellin, Colombia, where developers are switching their focus from fuel substitution and end-of-pipeline approaches to innovative spatial, functional planning and urban mobility. The new approach has led to a more effective decrease in costs, better control of air pollution and improvements in socio-economic functionality. Business opportunities arise for a range of innovators, including shared mobility providers or industries engaging in waste heat reutilization for district energy.[24]

The circular economy concept is proving to drive innovation in most contexts: new bio-benign materials, products designed for disassembly and reuse, pay-per-use models, material databanks and nutrient recovery are activities growing faster than GDP.[25,26]

Sustainable management of natural resources to mitigate risks

The sustainable management of natural resources is a strategic pathway for governments and businesses to mitigate risks linked to natural resources. The proactive monitoring and management of resource input, processing and use along different sectoral value chains will be essential, particularly when governments tighten related environmental regulations, and will result in revitalized and regenerated ecosystems with improved productivity.

Governing bodies, such as the European Commission, have already taken proactive action. The Commission's long-term plan or "Strategy" covers "a vision of the economic and societal transformations required, engaging all sectors of the economy and society, to achieve the transition to net-zero greenhouse gas emissions by 2050" and highlights the important role of a competitive resource-efficient and circular economy.[27] A proactive resource productivity strategy for businesses is an effective way to reduce GHG emissions and could help to anticipate upcoming regulations.

Moreover, volatile world market prices for natural resources have become a dominant feature of resource trade,[28] while an increasing share of governments are also closing borders to undesired waste imports. Reducing dependency on virgin natural resources through resource efficiency measures increases companies' resilience towards this volatility.

3. Targets for resource use: The next big frontier in understanding economic success in the safe operating space

While companies and economies can already reap financial and environmental benefits of pursuing a smart resource use strategy, it is still difficult to know what level of decoupling will truly be sustainable – that is, consistent with the safe operating space and future competitiveness. Global resource flows and impacts are complex. Companies and policy-makers will need a dashboard for resource management to monitor flows and impacts and to manage their sustainability. Ultimately, they need a practicable set of resource targets underpinned by the best available science.

Using targets would therefore facilitate a more integrated assessment of business models as well as technological innovations for progressive business leaders. Targets can help innovators in promoting their role as drivers of change and potential shapers of market preferences, as their achievements could be better measured and clearly communicated to investors and policy-makers. Resource use targets could help set reliable objectives, monitor performance and report at both company and country levels. In addition, targets could promote a shared understanding of resource dynamics, which in turn can facilitate collaboration in international and cross-sectoral priority setting.

The still recent but successful experience of science-based targets for GHGs supports the case for target setting. Since 2015, more companies are increasingly setting consistent GHG targets of capping warming at 1.5°C or 2°C. The Science Based Targets initiative, a group including the United Nations Convention on Biological Diversity, the World Resources Institute, the World Wide Fund for Nature and the United Nations Global Compact, has been facilitating the process, developing and training in the widely renowned target-setting methodologies. Companies are clearly picking up on the trend and realizing the benefits of setting such targets (see the box below). Currently 611 companies have committed to setting targets with the initiative.

The benefits of science-based targets for carbon dioxide

The Kellogg Company committed to a 15% reduction in emissions (tonne of carbon dioxide equivalent per tonne of food produced) by 2020 from a 2015 base year and committed to reducing absolute value chain emissions by 20% from 2015 to 2030.[29] Kellogg is a pioneer in setting holistic targets for all its suppliers; it reported the targets are boosting collaboration between its logistics, distribution and manufacturing departments. By facilitating mutual support between the actors in the value chain, Kellogg further benefits its brand recognition and enables for better communication with governments.

The retailer Tesco set targets in 2017 and underlines the benefits of targets to communication and collaboration across the supply chain, as well as the effect of motivation on employees.[30]

Dell reports that the new targets are making its engineers even more innovative.[31] The possibility to scale the problem and measure performance, together with the reinforced mandate, has boosted innovation.

Although setting climate targets is important, doing so without a resource productivity lens can miss truly future-proof innovation and synergies with other impacts to be managed.

To achieve national and company-level GHG targets, the importance of tackling the energy system and a few energy-intensive materials is well known. However, mineral and metal resource consumption, as well as chemicals (including plastics), needs more attention. The carbon intensity of resource use is likely to decline with a more renewable electricity system. The processing of many resources, however, still requires fossil fuels and releases unavoidable direct emissions, such as carbon dioxide emissions from chemical reactions in the cement production process (mainly from limestone calcination). The future of innovation, therefore, lies particularly in the efficient design and use of materials (e.g. construction materials low in clinker content or wood structures) and their end products (e.g. more intense use of buildings) following circular economy principles. Such actions can be fostered through natural resource targets.

Even in the renewable energy sector, business, investors and policy can benefit from a resource lens. For example, renewable energy technologies rely on several functionally important metals, such as silver, indium, tellurium and rare earth elements. Demand for these materials will increase significantly, especially given competing uses associated with the 1.5°C scenario. Moreover, technological innovation is progressing fast – modularity and viability for upgrading remanufacturing can help products stay up to date longer. Solutions include materials efficiency, modularity and remanufacturing, material recycling, material substitution and alternative technologies.[32]

The resource productivity lens, facilitated by science-based targets, can help achieve the GHG targets faster and in a more cost-effective and innovative way, which can lead to new growth for businesses and economies.

4. Resource use: The current situation and what to consider in outlining its targets in the safe operating space

Interestingly, most of the future resource use will not be limited by direct scarcities in physical stocks but by the detrimental effects of resource use that will affect society in unacceptable ways.[33] Therefore, the first layer of necessary targets sits on the impact level; limits need to be set on the effects, such as on global warming, biodiversity loss or air pollution, to ensure human well-being. In addition, restorative measures are needed that ensure resource use trajectories are within the limits of the operating space.

Some resources are also scarce in physical stocks. Fossil groundwater resources, for example, are non-renewable and are depleted in many watersheds; land productivity (as a property of land or soils) is another example. Finally, resources differ in quality, and depletion of high-quality resources will leave future generations with lower-quality resources. This may concern ore grades as well as contaminated resources (e.g. cadmium- and uranium-containing phosphorous resources).

Impact-level targets most often refer to indirect limits, representing unacceptable consequences to society. These targets need to be translated into targets on the use level to become actionable for decision-makers in business and policy. Resource use targets would most likely refer to the use of land, water and materials (biomass, fossil fuels, metals, non-metallic minerals) and need to be formulated in metrics that can be used in regular decision-making by most actors. This translation cannot be done by the individual organization, not only because it would be complex and inefficient, but also because one of the great benefits of targets is to encourage shared understanding and a consensus on priorities. Hence, efforts should strive for broad collaboration towards a global consensus on these science-based targets, while recognizing the targets might be different depending on regional and structural contexts. Science, civil society and global policy are beginning to set targets.

What is the status of setting targets on the impact level?

On the global policy radar, general resource issues are largely missing as an explicit topic. A range of conventions implicitly or partially addresses natural resources, such as the United Nations Framework Convention on Climate Change, the United Nations Convention on Biological Diversity (CBD) or the United Nations Convention to Combat Desertification. Resource use, however, is mostly a side note and sustainable resource use is barely specified. While the 2015 framework for the global SDGs includes references to resource issues in several places, it falls short on presenting a clear method or path to natural resource monitoring or on outlining sustainable levels of resource use. Integrated resource monitoring in policy and the economy is critical to avoid "waterbed effects" (optimizing in one area to the detriment of another) and to strategically enhance synergies.

Important starting points can be found in the scientific area. The planetary boundaries that demarcate a safe operating space are increasingly used as scientific targets for delimiting environmental impacts.[34] For example, the European Environment Agency commissioned a review and operationalization concept of the safe operating space.[35] The concept is not yet comprehensive, however, and not yet linked to the driver dimensions in resource use.

The task of defining comprehensive impact targets is potentially more complex than that of setting the "well under 2°C" target (or 1.5°C respectively) for global warming. In contrast to climate change, the impact of land use depends on where land is used and how it is managed. If the aim is, for example, to preserve valuable ecosystems and prevent species from going globally and irreversibly extinct, regional ecosystems should not be impaired beyond a certain limit to ensure their performance even if they have no unique ecological value. Context-specific targets are thus needed, which need to be defined at various scales, such as regionally and globally.[36]

The new CBD targets being discussed, following up on the Aichi Biodiversity Targets, could be a first step in this direction. But even if successful, they will not completely cover all the consequences related to resource use. More research is needed to define comprehensive impact targets that are global yet context-conscious.

What is the status of translating impact-level targets into practicable targets for resource use?

Scientists and civil society have begun suggesting actionable resource use targets consistent with the related impact-level targets; however, efforts need to be further developed and aligned with global governance.

At the fourth United Nations Environment Assembly, held in 2019, global leaders started to embrace natural resource use as a fundamental issue across environmental agendas.[37] In its *Global Resources Outlook 2019*, requested by the United Nations Environment Assembly, the IRP offers a first comprehensive assessment of the resource use drivers of climate change, biodiversity loss, water stress and air pollution. The assessment is an important starting point for comprehensive target development.

Some initial attempts to suggest resource use targets have also been made. An IRP 2014 report, for example, proposed an interim target of 0.20 hectare of cropland (1,970 m2) per person in 2030 for the consumption of food and non-food biomass.[38] For materials, a range of 6-8 tonnes per capita per year in domestic material consumption has been proposed as an indicative target.[39]

For sound targets, to name only a few of the challenges, scientists and practitioners will need to analyse the potential of the various types of resources used within industry and society, in particular various degrees of resource use efficiency. They will need to consider local and regional differences in the impact of further resource use to distinguish between production and consumption impacts and to consider equity aspects.[40]

To strengthen the relevance for decision-makers, targets should outline necessary progress with a midterm time perspective, for example; should contextualize quantitative targets with a set of guiding principles for acting on resource efficiency in business and policy; and should refer to resource use indicators as well as regeneration indicators where relevant. Importantly, some progressive countries already follow clear targets for resource use. For example, the Netherlands pursues the target to reduce natural resource consumption in its economy by 50% by 2030, while the country's target for 2050 is a fully circular economy.[41] Scientific orientative targets can evaluate good examples and should aim to further inform front runners.

As the relationship between resource use and impacts is highly complex, the target-setting institutions or coalitions must ensure iterative and self-reflective processes that can react to changing factors, including patterns in production and consumption and technological innovations.

Conclusion

Developing scientifically sound and practicable targets for the broad use of resources is clearly a big task, but it must be tackled.

The need is clear and momentum is growing as progressive companies are already approaching science and civil society organizations to seek support in setting targets – for example, for their use of nitrogen, land, water or materials. Discussions at the fourth UN Environment Assembly showed keen interest in the further clarification of the safe operating space and its connection to resource use.

Some institutions are already beginning to develop targets. The Global Footprint Network has been working on the concept of limits of sustainable resource consumption for over a decade.[42] An important consortium of scientists, civil society and business leaders has recently started to look into the development of comprehensive targets for the environment on global and corporate levels. The Earth Targets Platform was created in 2017 out of the Global Commons Initiative[43] that itself was initiated by the Global Environment Facility, the International Institute for Applied Systems Analysis, the International Union for Conservation of Nature, the Stockholm Resilience Centre, the World Economic Forum and the World Resources Institute. Part of the platform is the Earth Commission, whose mission is to "provide the scientific insights needed to set science-based targets"[44] for a stable and resilient planet.

In cooperation with other relevant initiatives and its strategic partners, the IRP is starting a workstream on the safe operating space of resource use, while the Platform for Accelerating the Circular Economy (PACE) has initiated efforts to assess the metrics required to measure progress towards the circular economy, as a necessary precursor to establishing resource management targets. The importance and complexity of this big task will benefit from independent scientific assessments and close collaboration.

Endnotes

1. United Nations Environment Programme (UNEP), International Resource Panel, *Global Resources Outlook 2019: Natural Resources for the Future We Want*, 2019.
2. Energy Transitions Commission, *Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century*, 2018.
3. UNEP (2019), op. cit.
4. Ibid.
5. Ibid.
6. Ibid.
7. The term "targets" has been contested: targets agreed in societal processes are different from target (ranges) suggested by science. Potential policy targets must be set in legitimate sociopolitical processes, a prominent example being the Paris Agreement negotiations resulting in the "well under 2 degrees" target for global warming. Science can show the risks related to certain levels of resource use and suggest target ranges to inform decision-makers in policy processes as well as private governance processes. For simplicity, this White Paper uses the term "targets" in a broader sense, while acknowledging the different mandates in target setting.
8. von Weizsäcker, E.U., de Larderel, J., Hargroves, K., Hudson, K., Smith, M., Rodriques, M., *Decoupling 2 technologies, opportunities and policy options*, UNEP, Working Group on Decoupling to the International Resource Panel, 2014.
9. UNEP (2019), op. cit.
10. Ibid.
11. Maxwell, S.L., et al., "Biodiversity: The ravages of guns, nets and bulldozers", *Nature*, vol. 536, no. 7615, 2016, pp. 143-145.
12. UNEP (2019), op. cit.
13. Energy Transitions Commission (2018), op. cit.
14. UNEP (2019), op. cit.
15. Ibid.
16. United Nations Environment Programme (UNEP), *Responsible Resource Management for a Sustainable World: Findings from the International Resource Panel*, 2012.
17. United Nations Environment Programme (UNEP), International Resource Panel (IRP), *Assessing global resource use: A systems approach to resource efficiency and pollution reduction*, 2017.
18. UNEP (2019), op. cit.
19. Ekins, P., Hughes, N., et al., *Resource Efficiency: Potential and Economic Implications*, IRP, UNEP, 2016.
20. Hammer, M. and Somers, K., "Manufacturing growth through resource productivity", March 2015, https://www.mckinsey.com/business-functions/operations/our-insights/manufacturing-growth-through-resource-productivity.
21. von Weizsäcker, E.U., et al. (2014), op. cit.
22. Bhattacharya, A., Meltzer, J.P., Oppenheim, J., Qureshi, Z., Stern, N., *Delivering on Sustainable Infrastructure for Better Development and Better Climate*, Brookings Institution, The New Climate Economy of the Global Commission on the Economy and Climate, and Grantham Research Institute on Climate Change and the Environment, 2016, https://www.brookings.edu/research/delivering-on-sustainable-infrastructure-for-better-development-and-better-climate/.
23. Nasr, N., Russell, J., Bringezu, S., Hellweg, S., Hilton, B., Kreiss, C., von Gries, N., *Redefining Value – The Manufacturing Revolution: Remanufacturing, refurbishment, repair and direct reuse in the circular economy*, IRP, UNEP, 2018.
24. Swilling, M., Hajer, M., Baynes, T., Bergesen, J., et al., *The Weight of Cities: Resource Requirements of Future Urbanization*, UNEP, 2018.

25. Stuchtey, M., et al., *A Good Disruption: Redefining Growth in the Twenty-First Century*, Bloomsbury Publishing, 2016.
26. Nasr, N., "How the circular economy can become a reality", *ISE Magazine*, vol. 49, no. 9, September 2017.
27. European Commission, *A Clean Planet for all: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy*, COM(2018) 773 final, 28 November 2018.
28. UNEP (2017), *Assessing global resource use*, op. cit.
29. Science Based Targets, "Science Based Targets Case Study: Kellogg", 2018.
30. Science Based Targets, "Science Based Targets Case Study: Tesco", 2018.
31. Science Based Targets, "Science Based Targets Case Study: Dell", 2018.
32. Suh, S., Bergesen, J., Gibon, T.J., Hertwich, E., Taptich, M. *Green Technology Choices: The Environmental and Resource Implications of Low-Carbon Technologies*, UNEP, IRP, 2017.
33. UNEP (2019), op. cit.
34. Rockström, J., et al., "Planetary boundaries: exploring the safe operating space for humanity", *Ecology and Society*, vol. 14, no. 2, 2009; Steffen, W., et al., "Planetary Boundaries: Guiding human development on a changing planet", *Science*, vol. 347, no. 6223, 13 February 2015, pp. 1259855-1–1259855-10.
35. Häyhä, T., et al., "From Planetary Boundaries to national fair shares of the global safe operating space – How can the scales be bridged?", *Global Environmental Change*, vol. 40, September 2016, pp. 60-72.
36. Ibid.
37. United Nations Environment Assembly of the United Nations Environment Programme, *Mineral resource governance*, UNEP/EA.4/L.23, 9 March 2019.
38. Bringezu, S., Schütz, H., Pengue, W., O'Brien, M., et al., *Assessing Global Land Use: Balancing Consumption with Sustainable Supply*, UNEP, IRP, Working Group on Land and Soils, 2014.
39. Swilling, M., et al. (2018), op. cit.
40. Bringezu, S., et al. (2014), op. cit.
41. Potting, J. and Hanemaaijer, A. (eds), *Circular Economy: what we want to know and can measure*, PBL Netherlands Environmental Assessment Agency, 2018, https://www.pbl.nl/sites/default/files/cms/publicaties/pbl-2018-circular-economy-what-we-want-to-know-and-can-measure-3217.pdf.
42. Global Footprint Network [website], "Earth Overshoot Day", https://www.footprintnetwork.org/our-work/earth-overshoot-day.
43. The Global Commons Initiative was based on the following working paper: Nakicenovic, N., Rockström, J., Gaffney, O., Zimm, C., "Global Commons in the Anthropocene: World Development on a Stable and Resilient Planet", WP-16-019, International Institute for Applied Systems Analysis, 2016, http://pure.iiasa.ac.at/id/eprint/14003.
44. Earth Commission [website], "We Need Targets – Guided by Science", https://earthcommission.org/.

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