



Pathways to achieve a set of ambitious global sustainability objectives by 2050: Explorations using the IMAGE integrated assessment model



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ABSTRACT

In 2012, governments worldwide renewed their commitments to a more sustainable development that would eradicate poverty, halt climate change and conserve ecosystems, and initiated a process to create a long-term vision by formulating Sustainable Development Goals (SDGs). Although progress in achieving a more sustainable development has been made in some areas, overall, actions have not been able to bend the trend in critical areas (including those related to the so-called food-water-energy nexus). Here, we analyze how different combinations of technological measures and behavioral changes could contribute to achieving a set of sustainability objectives, taking into account the interlinkages between them. The objectives include eradicating hunger, providing universal access to modern energy, preventing dangerous climate change, conserving biodiversity and controlling air pollution. The analysis identifies different pathways that achieve these objectives simultaneously, but they all require substantial transformations in the energy and food systems, that go far beyond historic progress and currently formulated policies. The analysis also shows synergies and trade-offs between achieving the different objectives, concluding that achieving them requires a comprehensive approach. The scenario analysis does not point at a fundamental trade-off between the objectives related to poverty eradication and those related to environmental sustainability. The different pathways of achieving the set of long-term objectives and their implications for short-term action can contribute to building a comprehensive strategy to meet the SDGs by proposing near-term actions.

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1. Introduction

In June 2012, world leaders, policy makers, NGO representatives and scientists came together at the United Nations Conference on Sustainable Development (UNCSD) in Rio de Janeiro (Rio + 20). One purpose of this conference was to evaluate progress in moving towards sustainable development.

Twenty years earlier, also in Rio de Janeiro, the UNCED conference (the United Nations Conference on Environment and Development) adopted the so-called Rio Declaration on Environment and Development (UNCED, 1992). In this declaration, countries worldwide agreed on a set of key ambitions in achieving sustainable development, including environmental protection (Principle 4) and poverty eradication (Principle 5), while also three conventions related to responding to climate change, biodiversity loss and desertification were adopted. Since then, many more related sustainable development goals have

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been agreed on internationally, including freeing people from extreme poverty and multiple deprivations (Millennium Development Goals, UN, 2000), climate targets (UNFCCC, 2010) and the objective to halt biodiversity loss by 2020 after a failure to realize this goal by 2010 (CBD, 2010). Documents in preparation of the Rio + 20 conference, showed that despite some progress, actions have not been able to bend the trend for critical issues such as access to sufficient food and modern forms of energy, preventing dangerous climate change, conserving biodiversity and controlling air pollution (UNEP, 2012). Therefore, the Rio + 20 conference also intended to secure renewed political commitment for sustainable development and agree upon a further set of actions.

By now it can be concluded that while the Rio + 20 conference reiterated the ambition to achieve sustainable development, countries did not really manage to agree to additional actions in a strong and meaningful way (Bernstein, 2013; GEGP, 2012; Hanrahan, 2012). Arguably, the conference's most important decision was to develop a set of so-called Sustainable Development Goals (SDGs) for 'pursuing focused and coherent action on sustainable development' (UN, 2012). The SDGs should formulate a universal agenda applicable to all countries, integrating the social, environmental and economic dimensions of sustainability. The process to formulate SDGs has merged with the process to formulate the post-2015 development agenda, the new development agenda that should succeed the Millennium Development Goals (MDGs) when they expire in 2015, to address both poverty eradication and sustainable development. The MDGs had a similar role earlier, although focusing primarily on poverty eradication, promoting action to achieve a set of human development-related targets. Furthermore, similar to the MDGs, the SDGs should be accompanied by targets and indicators to measure progress towards the achievement of these goals (Bernstein, 2013; Evans and Steven, 2012; Ivanova, 2013).

The process of selecting a set of SDGs is now well underway (although it has been argued that the lack of a consistent vision has complicated the process of developing SDGs (Bernstein, 2013)). Ideally, the SDGs strike a balance between near-term action and long-term ambition. Studies that depict pathways that relate near-term actions and a long-term vision could help implementing the SDGs by 1) providing a link between a long-term inspirational vision to a medium-term set of sustainable development goals (say by 2025 or 2030), 2) showing what efforts would be needed to realize the goals and 3) providing information on the inter-linkages (synergies and trade-offs) between the achievement of the goals. The first two points are particularly important given the separation of many international policies between long-term ambitions and short-term actions (Klein, 2013; Riahi et al., 2015). The current paper describes an analysis that looks into the question how different pathways (or scenarios – see Methods Section) could evolve that aim at achieving a long-term sustainability vision. We concentrate on the sustainable developed challenges related to the energy-food-water nexus which lies at the hearth of the world's sustainability problems (see for instance recent international assessments such as UNEP's Global Environmental Outlook and the IPCC reports). The pathways in this paper fully address these three key areas of sustainability and their interactions – and as such form an unique contribution to the

existing literature on response strategies and scenario analysis: integrated assessment models did not analyse before such scenarios addressing such a wide set of issues. These pathways are designed to all achieve the same set of targets in 2050 related to the energy-food-water nexus, but by different (contrasting) combinations of technological measures and consumption changes. The key questions of the paper are:

- How would different pathways evolve aimed at achieving a broad set of sustainable development targets in 2050?
- What do such pathways tell us on the level of (near and medium-term) action consistent with achieving these targets?

From earlier environmental assessments (e.g. MA, 2005; UNEP, 2012), the conclusion can be drawn that (closely connected) clusters of issues (the so-called nexus) play a critical role in the sustainable development debate: 1) ensuring sufficient food supply while conserving biodiversity, and 2) ensuring a modern energy access for all while limiting global climate change and air pollution. We have organized the discussion in these two clusters, but it should be noted that our analysis is in fact integrated, and analyzes how goals can be achieved simultaneously. The paper also briefly discusses the relations with measures implemented in the two focus areas with water scarcity, imbalances in the Earth's nutrient cycles, and human health loss. In our analysis, we account for the technical and physical limitations that play a role in achieving long-term targets. At the same time, we leave the question whether achieving the set of targets is feasible from a political perspective aside to provide full insight into potential options. An essential aspect of the sustainability challenge is that it covers a very wide range of related issues. Therefore, it is not always possible to present the underlying details of our analysis, for which we refer at places to earlier, more detailed, work and a more extensive report (PBL, 2012).

The structure of the paper is as follows: First, in Section 2 we discuss the methods that have been applied in this paper. Second, in Section 3 we discuss the main scenarios and their results for land-use and related issues and energy use and related issues. Finally, in Section 4 we draw conclusions.

2. Methods

2.1. Modeling approach

In the study, we applied a model-based scenario approach in which scenarios are used to analyze what is needed to achieve a set of 2050 sustainability objectives.¹ Often, scenarios are designed to be forward-looking: i.e. explore how the future could evolve on the basis of a preset storyline (a set of assumptions), also referred to as explorative scenarios (van Vuuren et al., 2012a). The purpose of the exercise, here, in contrast, is to explore the characteristics of scenarios that are designed to achieve a set of future objectives. Such scenario approach is often referred to as normative scenarios or as backcasting. It should be noted that in analytical sense, the

¹ In order to avoid confusion with the SDGs, that tend to be formulated for a shorter time frame, we avoid the word goals for 2050 but instead stick to the words targets and objectives.

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