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OPINION

Projecting progress in sustainable development goals vis-à-vis climate action in climate-economy models

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Introductory comments

The year 2015 was an important milestone in the world's struggle for sustainability. Although mostly remembered for the landmark Paris Agreement, which formalised and operationalised a mechanism for globally coordinated and cooperative efforts to address the climate crisis, it also featured the UN-wide adoption of the 2030 Agenda for Sustainable Development, embodied in seventeen distinct yet highly intertwined dimensions—the Sustainable Development Goals (SDGs). These *inter alia* include poverty and hunger elimination, alleviating social and gender inequalities, fostering peace and the development of strong institutions, making production responsible, environmental and biodiversity protection, and achieving good health and well-being.

The scientific community has since attempted to actively support the assessment of progress and prospects/trends towards sustainability using an array of tools as interdisciplinary and diverse as the SDG agenda itself. When it comes to quantitatively assessing progress per SDG indicator by country and/or globally, scientists have drawn on the latest available data to estimate the gap in achieving each SDG indicator (e.g., [1]). However, such studies are mostly static and capture an overview of how far we still need to go; in other words, they are not forward looking in that they cannot project where each country (or the world) is headed along each SDG towards 2030 or later, or what needs to be done to bridge the identified gaps.

To address this need, climate-economy models—i.e., the quantitative systems models typically used to evaluate or support the design of climate policies, also called Integrated Assessment Models (IAMs)—have increasingly been used to offer quantified projections of SDG progress into the future, in tandem with mitigation effort [2]. This is largely for two reasons: (a) climate action (SDG13) has long been documented to interact vividly with all other SDGs [3], and (b) these models have been found well-equipped to extract insights into SDG-related metrics among their numerous quantitative outputs [4] as well as into the interactions of climate action and other SDGs [5].

Getting the most of climate-economic models in projecting SDG progress

This piece discusses six ways, in which the capacity to evaluate progress in SDGs vis-à-vis efforts to mitigate climate change using IAMs is currently being enhanced to offer robust and actionable policy prescriptions that may place climate policy in a holistic sustainable development context.

First, considerable efforts have been made to facilitate the extraction of insights from IAM exercises, by mapping SDG indicators onto typical IAM variables [6]. Modellers can thus employ, build on, and even expand on this formalised target space to provide standardised outputs that can be inter-compared in the literature. However, the coverage of the established SDG target space in IAMs remains limited, while many of the identified indicators are only proxies of a subset of the official SDG spectrum, and issues of scalability, inter-dependencies, or underdeveloped modelling capacity may pose challenges.

Especially regarding the latter, a second line of research lies in developments and instrumental upgrades in IAMs themselves. There currently exists a large ecosystem of IAM development research and innovation projects (such as DIAMOND, PRISMA, WorldTrans, TRANSIENCE, etc.), all tasked with creating new and mostly open-source capacities in existing or new IAMs, with explicit considerations for assessment of SDG-related progress. Despite the promise lying within this ecosystem of research initiatives, the envisaged updates do not markedly stray from the state-of-the-art modelling practice in that they are mostly incremental; the need to achieve SDGs already by 2030 is not well aligned with the lifecycle of these projects (most of which span until the latter half of this decade) and thus the timeline of the expected IAM upgrades; while IAM developers' perceptions of the need to expand SDG coverage capacity appears anchored to the existing capabilities of their models [7].

A third prospect lies in developing customised IAM frameworks, based on soft links between IAMs and other modelling tools, to enhance the representation of SDG indicators beyond IAMs' typical output variables. Even though such efforts enable scientists to cover an impressive diversity of the SDG spectrum (e.g., [8]), the coverage of (sub-)indicators within each SDG remains limited.

Similarly, a fourth line of research employs integrated modelling frameworks, either in model inter-comparison settings where different IAMs are employed in parallel to increase the robustness of and confidence in resulting model insights (e.g., [9]), or in multi-model settings in which several IAMs, sectoral models, and/or other modelling tools are soft-linked with one another to expand the aggregate capability to represent different SDGs (e.g., [10]). However substantial, the benefit of this approach in terms of larger coverage of SDG indicators does not expand the SDG coverage by orders of magnitude and comes at the price of extensive harmonisation efforts across the employed models to reduce response heterogeneity—which is in itself challenging [11].

Critically, none of these routes escape the limitations of the 'job description' of an IAM, which usually is to quantify the cost-optimal way of achieving a climate (policy) objective. To move from the decarbonisation-oriented accounting of SDG progress in IAMs onto the optimisation of progress in SDGs, a fifth avenue lies in economically integrating (internalising) SDG progress within the least-cost, environmentally-constrained IAM solution process, by means of hard links between IAMs with other modelling tools (e.g., [12]). This practical way of optimising SDG performance also comes at a high price in terms of development efforts and resources; most importantly, it also implies a focus on a particular SDG.

Along these lines, a final approach to identifying optimal portfolios that optimise climate action in parallel with performance in other SDGs includes establishing soft links between IAMs and multi-objective optimisation algorithms [13]. Although such approaches help to identify policy portfolios that achieve simultaneous progress in the SDG agenda, by maximising co-benefits and minimising trade-offs of mitigation with other SDGs (e.g., [14]), its potential in building on all above ways to boost the internal capabilities of IAMs to represent SDG indicators is severely constrained by the number of indicators that can be meaningfully selected to avoid computational challenges associated with multi-objective optimisation.

Concluding remarks

Linkages between mitigation pathways and progress in SDGs permeate—and are systematically assessed in a dedicated chapter of—the entire 6th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) on climate change mitigation [15]. There is no doubt that the trend of projecting SDG progress in tandem, and/or quantifying SDG interactions, with climate action will consume increasing chunks of the IAM community's research efforts onwards. This will also be reflected in the scenario literature underpinning the IPCC's upcoming 7th Assessment Report that is expected by the end of this decade—just in time to stocktake SDG progress against the original timeline of the UN's Agenda for Sustainable Development and inform the way forward. The IAM community should collaborate on progressing along—and combining efforts in—all six avenues discussed.

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