Policy dialogues in integrated assessment modelling (IAM) to strengthen climate change mitigation and adaptation

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KEY MESSAGES

- Current integrated assessment modelling (IAM) results are biased towards mitigation in emerging and developing economies, and towards market-based policies like carbon taxes.
- Pathways in SR15 are not explicitly based on preferred policies of national governments, industry groups, or NGOs.
- Low-carbon transition policies are more likely to be made for reasons tangentially related to climate change, including job creation and public health.
- IAM needs to take a more facilitative and bottom-up approach to modelling, with indicators that speak to the intended audience.
- Researchers need to approach policy assessment using IAM as a continuous policy dialogue that begins by discussing the policies and measures that stakeholders are willing, and able, to implement.
- The 'fit-for-purpose' IAM approach outlined in this brief will be especially needed in coastal areas and cities, where many human and natural systems compete.

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1. Introduction

Integrated Assessment Models (IAMs) are an integral part of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5°C (SR15)[3] and the IPCC Assessment Reports before it, providing a framework to compare different possible measures to limit the level of global warming that is currently anticipated. In this briefing note, we describe how IAMs could be more effectively applied to support the design and assessment of low-carbon emission strategies, using a transdisciplinary approach that starts from the policies and measures that stakeholders are willing, and able, to implement.

In section 2, we discuss the IAM used in SR15. In section 3, we propose a new 'fit-for-purpose' modelling approach. In section 4, we highlight areas and themes that could benefit from our new approach, and in the final section 5, we summarise and present final conclusions.

2. Integrated assessment models in SR15

SR15 suggests that global warming can still be kept below 1.5°C, and that this would make the UN Sustainable Development Goals (SDGs) much more achievable.

However, this is an unprecedented task and will require an intense effort of rapid decarbonisation across many sectors. Various pathways are possible for achieving this, but the overall message to all stakeholders is that global greenhouse gas (GHG) emissions must be cut by half before 2030 compared to 2010, with the long term aim of net zero carbon dioxide (CO_2) emissions by 2050. SR15 also states that Carbon Dioxide Removal (CDR) technologies that lead to 'negative' emissions will need to be deployed in the second half of the century, especially if global temperatures temporarily overshoot the 1.5°C limit. However, the report does not describe a business model through which these 'negative' emissions might be funded.

The various pathways in SR15 are variants of model scenarios, with coherent 'assumptions regarding future trends in population, consumption of goods and services (including food), economic growth, behaviour, technology, policies and institutions' (chapter 2, section 2.1.1). They are used in SR15 to explore many different technological and behavioural changes needed to limit climate change, often at an *aggregated* scale, and reflect on the economic and environmental impacts of those changes[4]. These changes include electrification of transport and heating, efficiency increases in industrial process and appliances, reduced food loss and waste, and promotion of sustainable behaviours and lifestyles (e.g. increased use of non-motorised and public transport).

However, the scenarios in SR15 do not represent how decisions on climate change policy are actually arrived at. In reality, low-carbon transition policies are more likely to be made for reasons tangentially related to climate change, such as job creation or improving public health. They are also highly dependent on the local context.

[3] *Global Warming of 1.5°C, an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.*

[4] Huppmann, D. et al. (2018) IAMC 1.5°C Scenario Explorer and Data. https://data.ene.iiasa.ac.at/iamc-1.5c-explorer.

There can be no single global blueprint, and every community – with its own local priorities and considerations – will require a tailored policy portfolio.
The root cause of this mismatch between the scenarios in SR15 and realities on-the-ground is the modelling work that underpins the basis of the report (and, more generally, the research within the IPCC's Assessment Reports). The modelling approach taken is often from a global perspective, and conceptualisation of scenarios is undertaken by a small community of IAM experts.

In general, the IAM community has proposed 'optimal' low-carbon scenarios since before the IPCC's First Assessment Report of 1990. Specifically, the pathways are designed around aspects for which IAMs provide relevant information. As 'optimal' is usually implemented as global least-cost or maximum utility within a specific emissions budget, current IAM results are biased towards mitigation in emerging and developing economies, and market-based policies like carbon taxes. While these model scenarios provide useful background information and 'what-if' explorations, the results are rarely reproduced in real-world policymaking. This is especially true for modelling on energy and general economic developments.

IAMs, by necessity and by design, do not seem to reflect diverse, context-specific priorities, even at the national level, or the social and institutional barriers blocking transitions to low carbon societies. This is reflected in figures 1 and 3 in the Summary for Policy Makers (SPM) of SR15, which show many pathways to limiting global warming to approximately 1.5°C. However, none of these pathways are explicitly based on the preferred policies of national governments, industry groups, NGOs and others. Many of those policies would lead to global warming (far) above 1.5°C, but the current modelling paradigm obscures this fact.

We assert that the real-world applicability of IAM could be enhanced by improving the process by which it is carried out (as opposed to improving the models themselves). This would make IAMs more fit for their professed purpose: to assess and help design policy strategies that address climate change and other global problems.

"The real-world applicability of IAM could be enhanced by improving the process by which it is carried out."

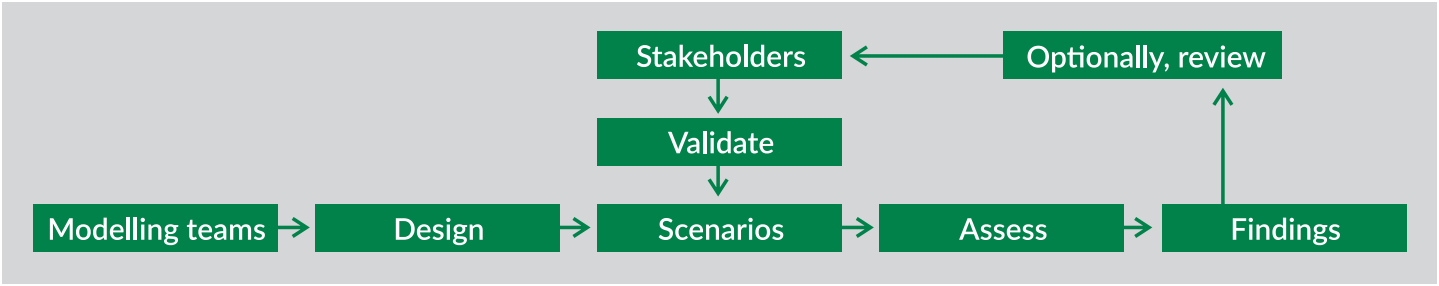
3. Improving the national and international policy relevance of IAMs

The first requirement for improving the national and international policy relevance of IAMs would be to use the most appropriate model for the relevant question. That is, the model(s) should be selected based on the questions that need to be answered, rather than fitting the question to the model(s), as is common practice today. Models are inherently a simplification of reality, and no model fits every topic and context. However, the scope and detail of IAMs and their simulations vary greatly. Those that best cover the themes and context of a specific policy strategy can be extremely useful for exploring specific questions and options relating to low carbon transitions. Choosing the most suitable IAM(s) is a first step for modellers to present convincing, consistent and coherent illustrations of possible future developments.

Using specific models to answer context-specific questions about proposed policies requires that stakeholders explicitly ask those questions[5]. Answering stakeholders' questions about policies also requires suitable indicators that speak to the intended audience. For example, local stakeholders in an industrial town will have limited interest in national GDP projections, but will be more concerned about projections of jobs created and lost in specific industries (see Box 1 below on Biogas in Indonesia). Incorporating the issues raised by stakeholders into policy assessment has been found to widen the range of negative outcomes and barriers to policy implementation that can be taken into account by some 75%[6]; if we only rely on experts, these issues would be left unaddressed.

Working with stakeholders would also allow modellers to validate both the inputs and outputs of their models before the results are used for policymaking. As modelling is a specialist craft, this requires organised and repeated interaction to build both the personal rapport and the professional understanding needed for modellers and stakeholders to ask each other the right questions. The entire process is summarised in Figure 1 below. The end results will not only be assessments that

Traditional modelling from global context:



'Fit-for-purpose' modelling in context:

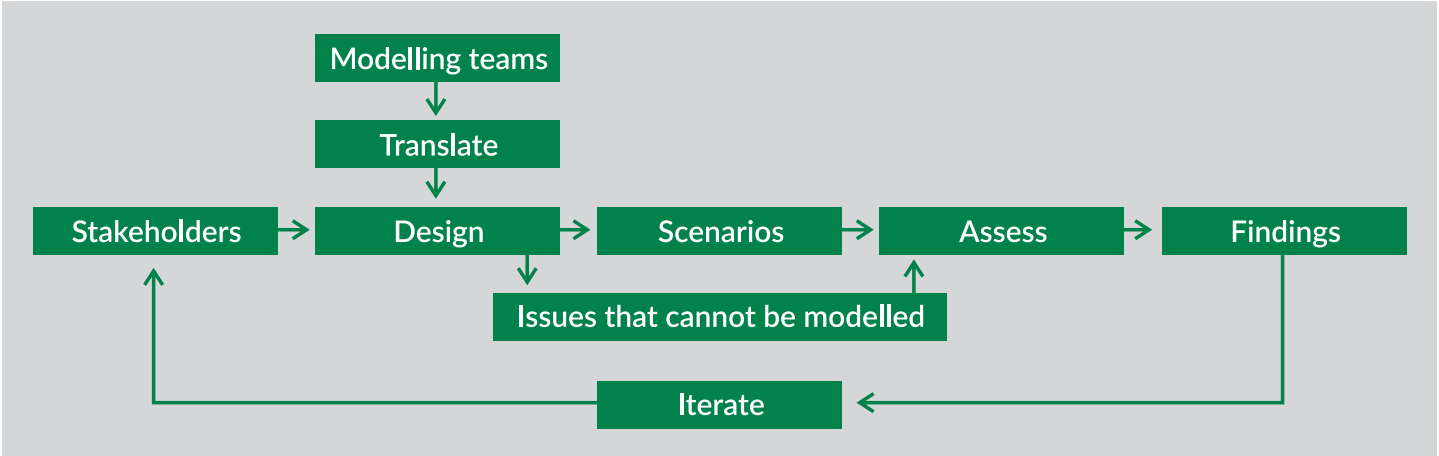


Figure 1: Traditional compared with 'fit-for-purpose' integrated assessment modelling

[5] Prell, C. et al. (2007) If you have a hammer everything looks like a nail: traditional versus participatory model building. *Interdisciplinary Science Reviews*, 32(3), 263–82. https://doi.org/10.1179/030801807X211720

[6] van Vliet, O.P.R., et al. (in review) The importance of stakeholders in scoping risk assessments – lessons from low-carbon transitions. *Environmental Innovation and Societal Transitions*.

are fit for their stated purpose, but also a deeper understanding for the researchers and stakeholders of the trade-offs in policymaking. Furthermore, any questions on policies and measures that cannot be answered with models should still be included in the assessment by other means, using known qualitative methods that complement the modelling.

If low-carbon transitions are to be voluntary and inclusive of the interests and viewpoints of a diverse range of stakeholders, as SR15 suggests they must be, then modelling should follow suit. The days when modelling could only focus on drawing up optimal pathways, working backwards from one single goal to the present day, have passed. Instead, a truly transdisciplinary approach is needed, integrated with a continuous policy dialogue that begins with discussing the policies and measures that stakeholders are willing and capable of implementing. Such a modelling effort needs to be grounded in the here-and-now, and provide modellers and stakeholders with an opportunity to grow new solutions that stretch and expand their ambitions to limit climate change and achieve other SDGs. This transdisciplinary approach matches the ambitions set for international policy, just as the Paris Agreement promotes constructive cooperation and synergies.

"The need for stakeholder-driven, 'fit-for-purpose' IAMs is particularly apparent in coastal areas and cities."

BOX 1: 'FIT-FOR-PURPOSE' MODELLING: BIOGAS IN INDONESIA

Several research groups are supporting biogas development and deployment scenarios in Indonesia. There are multiple co-benefits associated with biogas, in addition to cutting back on the use of fossil fuels (e.g. coal being replaced by biogas electrification plants, and liquified petroleum gas (LPG) being replaced by household biogas digesters). Expanded use of biogas will also reduce: i) government subsidies to support fossil fuels; ii) the amount of organic waste produced; iii) ineffective sanitation in urban areas; iv) effort spent on firewood collection by women and children; and v) indoor house pollution (which globally kills more people than malaria and HIV together). The latter benefits are tightly connected to the SDGs, both of Indonesia and developing countries more widely.

IAMs can be used to accurately explain and understand these multiple benefits. In Indonesia, scenarios for biogas development were developed out of a policy dialogue with the Indonesian government and a range of local partners. IAMs were used to make the scenarios easier to understand, specifically the interconnected impacts from the different policies and measures that could be taken to support biogas development.

"The scenarios in SR15 do not represent how decisions on climate change policy are actually arrived at."

4. Potential areas of focus

The need for stakeholder-driven, 'fit-for-purpose' IAMs is particularly apparent in coastal areas and cities. In these regions, many human and natural systems collide and compete even more than anywhere else in our complex world. Coastal areas and cities have higher population densities than elsewhere, leading to more pressure on ecosystems and the services that they provide, while they are also most vulnerable to adverse effects of climate change, including floods and heat waves. Modelling approaches that can provide insight into the complex interconnections between measures and impacts in these areas will be invaluable to resolve the concurrent challenges they face, while minimising negative impacts on vulnerable people and the surrounding environment.

One example of how the assessment of climate change mitigation and adaptation policies could be made more applicable by including existing IAMs in a different process, is to examine issues that the IPCC has so far not investigated in detail for political reasons. Some local stakeholders actively promote investigation of these issues, including:

- Inertia as a result of incumbent power (e.g. fossil fuel companies, dictatorships).
- Removing market-based economic structures that are counterproductive, e.g. poorly-designed carbon markets and investment subsidies for fossil fuel extraction (in addition to removing subsidies for carbon-intensive technologies and resources).
- Promoting human development beyond increasing GDP and consumption (e.g. increased emphasis on well-being, education, and employment).

Making these three issues explicit in policy assessments that use IAMs may open up new and constructive options to limit climate change and support the SDGs.

5. Conclusions

The new IAM paradigm we propose – 'fit-for-purpose' modelling – does not necessarily require the use of new models, but it does require a new, *more facilitative and bottom-up approach to modelling*. It needs to start from interactions with communities rather than impose targets that have not factored in local priorities. As different policies are connected, a holistic systems approach should be taken to design applicable strategies for deep mitigation and effective adaptation. This requires a process that involves a wider range of scientific disciplines and a wider range of stakeholders than is current practice in IAM.

Researchers should revise their modelling approaches to take on the improvements suggested in this brief, in general and specifically for the preparation process of the IPCC's Sixth Assessment Report (AR6)[7] and later iterations, and the Global Stocktake[8] under the Paris Agreement. The 'fit-for-purpose' modelling we propose is conceptually simple but will take a lot of practical work to implement. Doing so would require the institutions who provide resources for IAM projects (such as the European Commission) to acknowledge that a transdisciplinary IAM paradigm entails a different effort from previous projects, and to specifically incentivise and call for such a transdisciplinary approach.

Shifting to transdisciplinary, 'fit-for-purpose' modelling is hard work, but this is a small price to pay for climate policy assessments that make better real-world sense.

[7] Early drafting on the AR6 has already started, and the report is due for release in 2021. See https://wg1.ipcc.ch/AR6/AR6.html.

[8] Article 14 of the Paris Agreement requires its members to periodically take stock of the implementation of the Paris Agreement and to assess collective progress towards mitigation of and adaptation to climate change. This process is called the Global Stocktake. For more information, see https://unfccc.int/topics/science/workstreams/global-stocktake-referred-to-in-article-14-of-the-paris-agreement.

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