24

Boundary Objects

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Overview

Research on the interaction between climate science and policy has pointed to the production of so-called 'boundary objects' as one way in which the Intergovernmental Panel on Climate Change (IPCC) has influenced climate policymaking and broader climate discourses. By providing a common framework that enables interaction across social worlds, while still allowing more localised use by different groups of actors, such objects have been key in bringing together climate science and policy, in turn shaping the trajectory of both. This chapter reviews several concepts that have been analysed as boundary objects – such as the concept of climate sensitivity and the 2 °C and 1.5 °C targets – and explains how they have been productive of new science/policy relations. It also points to new challenges for the IPCC as climate policy development moves towards implementation and increases demand for more 'solution-oriented' knowledge.

24.1 Introduction

Much analysis of the IPCC – and indeed the IPCC's traditional self-understanding – assumes that its influence and authority is premised on a strong demarcation between science and policy. In practice, however, the ways in which the IPCC may come to influence policy development or wider public perceptions of climate change is by making connections across these two spheres of science and policy (see Chapter 22). This presents a puzzle that requires solving in order to understand the IPCC's influence: How can ideas about a clear separation between science and policy coexist with practices that constantly criss-cross or undermine the presumed boundary between them (cf. Sundqvist et al., 2018)?

One way of attending to this puzzle is by analysing the specific *objects* that bring the IPCC and its contributing scientists into contact with policymakers,

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political activists or other groups of actors on different sides of the presumed boundaries. The notion of *boundary object*, originally proposed by Star and Griesemer (1989; Star, 2010), describes some 'thing' – whether concrete or abstract – that holds together across different social worlds, allowing actors with different interests and views to act without the need for consensus on the object's precise meaning. In studies of the IPCC and its relationship to publics and policymaking, the notion of boundary objects offers a way of focusing not simply on the construction of boundaries between social worlds or on how actors on one side of the boundary influence the other. Rather, the idea of boundary objects begins to explain how these actors *produce new realities together*. Analysing boundary objects is thus a way of going beyond general assertions about 'co-production' to study what exactly is produced at the intersection of science and policy, and with what effects.

This chapter employs the notion of boundary objects to show how the work of the IPCC has been closely intertwined with climate policy development, and how this interplay has shifted over time. It reviews existing studies of boundary objects that have been important for the IPCC's influence on climate policy – and that have simultaneously worked to influence the IPCC's own assessments and the wider trajectory of climate science. Two sets of such objects are identified. The first one represents features of the physical climate system, namely the concepts of Equilibrium Climate Sensitivity (ECS) and Global Warming Potentials (GWP). These objects illustrate the influence of the IPCC on the early features of the emerging international climate policy regime.

The other set of objects is a series of future-oriented limits, targets and scenarios, which have come to strongly structure both IPCC assessments and climate policy discourse in recent years. Most prominent among these are the 2 °C and 1.5 °C targets. These objects serve to connect the IPCC more closely to policy goals and explicitly normative considerations of desirable futures. They thereby increase the potential influence of IPCC knowledge on policy development. At the same time, they challenge the idea of a strong demarcation between science and policy on which the IPCC's self-understanding has been premised. The concluding section discusses what this challenge might mean for the IPCC's future role, and how the notion of boundary objects may help in understanding the influence of the IPCC more broadly.

24.2 Climate Sensitivity and Emission Equivalents: Epistemic and Governable Things

A key challenge in assessing climate change for policy purposes is how to align a scientific understanding of climate change – as a complex and insufficiently

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understood phenomenon – with the certainty and simplicity required for policymaking and governing. Knowledge about future climate change originates in complex models that are not easily understood outside the community of modellers (see **Chapter 14**). Research on the interaction between climate science and policy has pointed to the production of boundary objects as one way in which knowledge from climate models has become stabilised and taken up in policy processes.

Van der Sluijs and colleagues (1998) analysed the concept of *climate sensitivity* as a case of a particularly stable boundary object. The IPCC defines climate sensitivity as 'the change in the surface temperature in response to a change in the atmospheric carbon dioxide concentration or other radiative forcing' (IPCC, 2021a). The concept emerged as a way of comparing and summarising model results in a way that enabled new forms of interaction between climate modellers, other scientific communities and policy actors. It was initially used as a heuristic tool for comparing different climate models, as modellers tested the sensitivity of models by comparing the temperature response of a doubling of atmospheric carbon dioxide concentration. With the need to communicate model results to policymakers through assessment reports, the concept was deployed for a different purpose – as a shorthand for summarising the expected magnitude of climate change given continued carbon dioxide emissions.

In early climate assessments reports, the sensitivity of different models was summarised in an estimated range for climate sensitivity of between 1.5 °C and 4.5 °C for a doubling of atmospheric carbon dioxide (van der Sluijs et al., 1998: 299). When IPCC chair Bert Bolin delivered the IPCC's statement to the first Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC) in Berlin in 1995 (COP1), this estimate was among his key messages from the scientific community to the attending government representatives. In this way, the understanding of climate sensitivity as a measurable property of the physical climate system became a key reference point for climate policy discussions (van der Sluijs et al., 1998: 311).

Making the climate sensitivity relevant for policy actors in this way, impacted not only policy and public understandings of climate change. It also influenced the further scientific use of the concept, since it created a new demand for estimating and constraining climate sensitivity – not just as a metric for comparing models, but as an actually existing property of the climate system – in order to better inform policymaking (van der Sluijs et al., 1998).

Climate sensitivity originated from climate modelling, but was made relevant in new ways for policy communities. A different example from the IPCC's early years illustrates that boundary objects may also originate from a specific policy need. When international discussion about how to govern climate change began in

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the late 1980s, some countries – the United States in particular – favoured a 'comprehensive approach' which dealt not only with carbon dioxide emissions, but also with other greenhouse gases (Shackley & Wynne, 1997: 91). To address the need for a simple way of comparing the climate effects of different gases, the metric of *Global Warming Potentials* (GWP) was developed and published in the IPCC's First Assessment Report (AR1). The GWP metric allows for a conversion of gases by calculating their 'CO_2-equivalent' warming effect. The metric was later adopted by the UNFCCC to underpin quantified emission reduction commitments and international carbon trading (MacKenzie, 2009).

Among IPCC scientists, GWP was understood as an ambiguous and potentially problematic simplification (Shackley & Wynne, 1997). For example, because the warming effects of greenhouse gases differ depending on their atmospheric lifetime, the choice of time-horizon for comparing them greatly influences the result.[1] In AR1, GWPs for three different time horizons were presented 'as candidates for discussion' (quoted in Shackley & Wynne, 1997: 91). Thus scientists saw the development of GWP as opening up a scientific area of inquiry – a discussion of how gases could usefully be compared in order to inform policy. Meanwhile, in the policy arena, the GWP metric was quickly adopted and put to use as an unambiguous fact of the climate system, as a basis for calculating exact amounts of allowable emissions, or the price at which carbon credits can be sold in international markets (MacKenzie, 2009).

Similar to the concept of climate sensitivity, the GWP metric became an object that stabilised and simplified complex and ambiguous knowledge. The objects thereby enabled interaction between different social worlds, while also generating new problems and practices both in scientific and policymaking circles. Crucially, however, although both objects were flexible enough to mean something rather different in policy discussions among climate modellers, they also maintained their distinct use in both arenas (van der Sluijs et al., 1998). In this way, the boundary objects that resulted from the interaction between the IPCC and policy communities in the organisation's early years held a dual role – on the one hand enabling scientific knowledge-production about the climate system, and on the other hand underpinning new projects for governing it.

In the first role, these objects are similar to what Hans-Jörg Rheinberger (1997) has labelled 'epistemic things'. These are objects to be studied and worked on through the scientific process, which are characterised partly by the things not yet known and the questions they open up for study. In this sense, they embody an 'irreducible vagueness' (Rheinberger, 1997: 28). On the other hand, for policy purposes these objects take on a much more definitive character, representing something that is already known, and that can therefore be governed. They become objects or technologies of government, imbued with quantified precision and premised on a belief in scientific certainty and rigour (Porter, 1995; cf. Asdal, 2008).

This 'tacking back-and-forth' (Star, 2010: 601) between a 'weakly structured common use' and a 'strongly structured individual-site use' (Star and Griesemer, 1989: 393) is what makes climate sensitivity and GWP usefully understood as boundary objects. Their value lies in enabling the IPCC to interact with non-scientific actors through a common language, while at the same time meeting the requirements of each group necessary to uphold internal credibility and thereby the idea of a clear separation between science and policy.

24.3 Targets and Pathways: Dangerous Anthropogenic Objects?

The examples above show how boundary objects enabled the IPCC to influence the early stages of the international climate regime. As policy development has progressed, however, a different set of objects have emerged, which are directed less towards the physical climate system and more towards future policy action. Most prominent among these is the target to keep warming below 2 °C (and later the ambition of 1.5 °C), which has frequently been analysed as a boundary object (Randalls, 2010; Cointe et al., 2011; Lahn & Sundqvist, 2017; Morseletto et al., 2017; Livingston & Rummukainen, 2020).

The UNFCCC in 1992 established the goal to avoid 'dangerous anthropogenic interference' with the climate system, yet without specifying at which level climate change would be considered 'dangerous'. Partly informed by the concept of climate sensitivity – which summarised the climate system in the metric of temperature rise – discussions about how to define 'dangerous' and 'tolerable' levels of climate change came to centre on a global temperature limit (Randalls, 2010). The EU adopted the 2 °C limit in 1996, and was its main proponent internationally until its formal adoption in the UNFCCC in 2010 (Morseletto et al., 2017).

The EU adopted the 2 °C target based on 'trust in the underlying scientific content' (Morseletto et al., 2017: 661), regarding the target as derived from scientific knowledge about climate impacts. In public discourse, it has also been widely represented as a 'scientific' target, often with implicit reference to the IPCC (Shaw, 2013: 567). In the scientific literature, however, it is usually considered a political target, and has even been critiqued as not sufficiently scientifically grounded (e.g. Knutti et al., 2016). In other words, while the target provides an intuitive and simple metric capable of bringing together a range of actors, its precise meaning varies widely among them.

The IPCC has arguably played an important role in enabling and upholding this multiplicity of meaning. Although IPCC reports have never endorsed any specific temperature limit as a marker of ‘dangerous’ climate change, they have increasingly been framed around temperature increase as a unifying metric. This is seen, for example, in the so-called ‘Reasons for Concern’ framework, which was introduced in the Third Assessment Report (AR3) and lent credibility to the idea of considering climate impacts in relation to global temperature rise (Mahony, 2015; Asayama, 2021; see Chapter 21).

In this way, the 2 °C target became established as a unifying object that is ‘neither scientific nor political in essence, but instead co-produced by both’ (Livingston & Rummukainen, 2020: 10). Its influence on climate policy discourse has been such that even criticism of it came to be framed in the same terms. Thus, developing countries or activists arguing that 2 °C represents an ‘unsafe’ level of warming did not criticise the framing of IPCC reports around temperature targets. Rather, they asked for alternative targets such as 1 °C or 1.5 °C to be included for scientific analysis and policy debate, both in IPCC assessments and in UNFCCC negotiations (Cointe et al., 2011: 18; Lahn, 2021: 21; for more on the 1.5 °C target, see Guillemot, 2017; Livingston & Rummukainen, 2020).

The formal adoption of 2 °C in 2010, and the further inclusion of 1.5 °C as an additional ambition in the Paris Agreement, marks a (provisional) end to discussions about how to define ‘dangerous anthropogenic interference’. Attention has thereby shifted from overall goals towards scenarios, pathways and technologies that may achieve those goals. Bringing together policy goals and scientific knowledge in a common representation of futures to be achieved or avoided, such as pathways and scenarios, may well be seen as new boundary objects in the making (cf. Garb et al., 2008).

Examples of such new boundary objects are the Representative Concentration Pathways and the Shared Socioeconomic Pathways, which have been produced for, but organised independently from, the IPCC (see **Chapter 15**). The goal of these new scenarios is explicitly to provide a common framework through which different groups within the IPCC can work together, thus producing an ‘epistemic thing’ that links (for example) climate modelling, integrated assessment modelling and research on climate impacts. At the same time, as Beck and Mahony (2018a, 2018b) have shown, the new pathways also bring new governable objects into being. By legitimising new technologies such as bioenergy with carbon capture and storage (BECCS), they serve to make some mitigation measures ‘politically legible and actionable’ while potentially obscuring others (Beck & Mahony, 2018a: 8).

This double character makes the new pathways similar to the boundary objects from the IPCC’s early years, as described earlier. However, in contrast to concepts such as climate sensitivity – which came to be seen as a feature of the physical climate system – the future-oriented and goal-directed character of the pathways make them explicitly ‘anthropogenic’ in origin. They are directly implicated in the ‘world-making’ work of rendering certain futures more or less thinkable or desirable. For this reason they challenge any notion of a clear-cut divide between scientific fact and political or societal values – thus ‘raising new questions about the neutrality of climate science’ (Beck & Mahony, 2018a).

Following international agreement on how to define ‘dangerous anthropogenic interference’, then, a new class of ‘dangerous anthropogenic objects’ are rising to prominence in the work of the IPCC. What makes them ‘dangerous’ to the IPCC is not so much that they make scientists engage more explicitly with policy goals in a ‘solution-oriented’ mode. Rather, the danger lies in how they challenge the IPCC’s self-understanding based on a strong demarcation between science and policy, thus potentially forcing a reassessment of the IPCC’s role in relation to policy development. This is illustrated in the controversy that arose around the Bali Box (see Box 24.1).

Box 24.1
The Bali Box controversy

In the Fourth Assessment Report (2007) (AR4), the IPCC presented a box quantifying the emission reductions that would be required by developed countries as a group in order to achieve the 2 °C target. The numbers became key to discussions about equitable effort-sharing between developed and developing countries during the UNFCCC negotiations in Bali, and was subsequently dubbed the ‘Bali Box’ (Lahn & Sundqvist, 2017).

In their analysis of the Bali Box as a boundary object, Lahn and Sundqvist (2017) show that the numbers of the box initially enabled a relatively broad group of actors to come together around a common understanding of effort-sharing. However, the IPCC scientists who developed the numbers later published an analysis that also quantified emission reductions required by developing countries. At this point, the numbers were contested from an equity perspective and the Bali Box became a source of controversy both in UNFCCC negotiations and in the scientific literature.

The disagreement that ensued can be seen as a form of ‘ontological controversy’, as described in Chapter 16 – a disagreement over the underlying values and presuppositions of scientific findings. The result was that the Bali Box – initially successful in bringing together actors around a shared understanding of a difficult issue – did not retain its authority when the interdependencies of science and policy became exposed. It thus eventually failed to do the coordinating work of a successful boundary object.

24.4 Achievements and Challenges

As the examples above have shown, the IPCC's influence has in part been enabled by the establishment of boundary objects that allow different groups of actors to interact while maintaining their distinct identities and commitments. The notion of boundary objects, however, also points to a broader understanding of 'influence' than a simple one-way transmission of scientific knowledge to policymaking. Indeed, the objects described in this chapter produce new realities in both spheres, simultaneously raising new scientific questions and enabling new forms of governing.

An important aspect of several boundary objects reviewed in this chapter is that they have allowed for close interaction and mutual influence between science and policy, while still permitting an understanding of the two spheres as clearly separated. With new demands being placed on the IPCC for solutions and roadmaps for achieving societal goals, this may no longer be the case. Rather than upholding the idea of separation, new boundary objects emerging in the post-Paris terrain of climate science and policy – such as pathways towards global or national targets – may instead prompt recognition of how climate science and policy are intricately interlinked. This presents an obvious challenge to the IPCC's traditional self-understanding (Hermansen et al., 2021).

Beck and Mahony (2018b) have suggested that the IPCC could deal with this challenge by substituting its self-understanding as 'neutral arbiter' with the goal of producing 'responsible assessment'. This would include 'opening up to a broader and more diverse set of metrics, criteria and frameworks' for assessing responses to climate change (Beck & Mahony, 2018b: 6). Analysing the IPCC from the perspective of boundary objects shows that influence and relevance is achieved through mutual adjustment and the development of shared meaning across various groups of actors. However, as the controversy around the Bali Box illustrates, such achievements stand in danger of being eroded if the interdependencies between science and policy are denied or ignored. This suggests that the IPCC should be more reflexive about how it helps bring about new science–policy realities. It should therefore think through what kinds of objects might result from a new and more 'responsible' assessment mode in the future.

Note

1 The time-horizon for GWPs refers to the length of time over which the radiative forcing effect on climate of the respective gas is integrated. Thus the ratio between GWPs of two given greenhouse gases – and hence their relative importance for climate change – will vary depending on the time-horizon selected.

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Three Key Readings

van der Sluijs, J., et al. (1998). Anchoring devices in science for policy: the case of consensus around climate sensitivity. *Social Studies of Science*, 28(2): 291–323. http://doi.org/10.1177/030631298028002004.

This article provides a classic study of an early boundary object in climate science/policy, i.e. the concept of climate sensitivity.

Lahn, B. and Sundqvist, G. (2017). Science as a 'fixed point'? Quantification and boundary objects in international climate politics. *Environmental Science & Policy*, 67: 8–15. http://doi.org/10.1016/j.envsci.2016.11.001.

This article examines the so-called Bali Box as a case of a failed boundary object.

Beck, S. and Mahony, M. (2018). The politics of anticipation: the IPCC and the negative emissions technologies experience. *Global Sustainability*, 1: e8. http://doi.org/10.1017/sus.2018.7.

This article discusses the challenges ahead for the IPCC as a result of the increasing demand for 'solutions-oriented' knowledge.