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doi:10.1017/S1062798725100458

A Model at its Limits: The Intergovernmental Panel on Climate Change (IPCC) from the Inside

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The Intergovernmental Panel on Climate Change (IPCC) has, over almost 35 years, developed into a model for effecting science-led governance for global environmental change. However, on the back of the sixth Assessment Report, and with preparations underway for the seventh, the IPCC arguably faces an identity crisis. With many inside and outside the IPCC perceiving a persistent disconnect between this immense scientific enterprise and meaningful political action, some argue the IPCC is failing to fulfil its social contract. At this important juncture, which could have implications for other spheres of global governance, a pilot study was conducted, interviewing IPCC authors about how they perceive the IPCC's social contract has evolved according to the interplay of key elements that IPCC members draw on to define the organization's identity and authority. Building on a long history of critical social science about the IPCC, this study found that authors discussed a weave of identity elements, which were categorized under three headings: (i) task identification and interpretation; (ii) mode of operation; and (iii) shifting key concerns. As scoping exercises ramp up for the seventh Assessment Report, IPCC leadership will need to be mindful of how groups inside and outside the IPCC are re-crafting the identity and authority of the organization.

https://doi.org/10.1017/S1062798725100458 Published online by Cambridge University Press

Introduction

This article is about how the authors of the Intergovernmental Panel on Climate Change (IPCC) perceive its organizational identity and authority to have evolved over time, to the extent that today it faces an 'identity crisis'. The IPCC was created in 1988 jointly by the United Nations Environmental Program (UNEP) and the World Meteorological Organization (WMO). It was tasked with assessing the state of knowledge on climate change, specifically to determine if and to what extent global warming is human-made and if urgent coordinated action was required. Since the IPCC's inception, the topic of climate change has occupied an ever more central position in global debates, and the organization has become a paradigmatic case for science and policy orderings for global environmental governance (De Pryck and Hulme 2022; Hughes 2024). It is important to study the IPCC because it is a setting in which many wider debates on science–society relations play out, and it is influential for how to (or how not to) organize other global governance initiatives (Hulme 2010; Miller 2004; Sarewitz 2004, 2011). Any identity crisis felt by the IPCC could have reverberations for global science-policy in other domains – e.g. on biodiversity and ecosystem services, or food – not least relative to the legitimacy and authority of science to support governance.

The reports of the IPCC – six comprehensive assessment reports (AR1–6; 1990–2023) and numerous special reports – have become points of reference in climate debates, and the IPCC is credited with elaborating a way of framing climate change that has become globally dominant (Pearce *et al*. 2018). Upon a closer look, however, the view of IPCC achievements is divided. On the one hand, the IPCC is indeed considered as highly successful in the difficult mission of setting up an effective global science–politics interface to address a major societal challenge (Hulme and Mahony 2010). On the other hand, and increasingly so over time, it is seen as having encountered limits, not least for mobilizing knowledge in a way that motivates action. Of course, the IPCC cannot carry the blame for lack of climate action, but the persistent or rather growing 'knowledge–action gap' (e.g. Knutti 2019) has even instigated calls for abandoning the IPCC task and mission altogether, given its futility (Glavovic *et al*. 2022). This can be framed as an identity crisis insofar as the IPCC authors feel the organization cannot fulfil its mission – even as societal actors appeal to 'listen to the science' (Soßdorf and Bugi 2022) – leading Glavovic and colleagues to pronounce a break in the IPCC's social contract.

At this juncture, in the context of broader debates on the role of the IPCC, we aim to: identify and analyse the elements that mutually construct the identity and authority of the IPCC for climate governance, and how these elements have interacted and co-evolved over time. More specifically, we asked IPCC authors themselves, with varying levels of experience with the organization, to reflect on these questions of identity and authority 'from the inside'. We were interested in understanding how the IPCC acquired the legitimacy to speak authoritatively on climate change, an accomplishment that was far from certain at the outset. And given the current divided view, we wanted to explore how the work of the IPCC

https://doi.org/10.1017/S1062798725100458 Published online by Cambridge University Press

evolved over time, identifying ways in which it aimed to improve its mode of operation, but also how it possibly encountered limits that were difficult to overcome. In what follows, we present an analysis of our findings under three headings: the way in which the task and mission of the IPCC was defined at the start and interpreted over time; the way in which the knowledge about climate change was approached and ordered by the IPCC; and the way in which key concerns shifted over time in the light of both the evolving knowledge about climate change and the reactions in global politics and society to the assessments provided by the IPCC. Before doing so, we briefly describe our own conceptual points of departure by situating the analysis within the larger area of science studies and report on our sample of interviews and method of analysis.

Studying the IPCC's Evolving Mission, Identity and Authority: Conceptual Starting Points and Method

Connecting with Scholarship on the IPCC and its Social Contract

This article follows a long history of critical social science about the IPCC organization, dating back 30 years or more, and principally from scholars from science and technology studies, geography and political science (De Pryck and Hulme 2022; Hughes 2024; Hulme and Mahony 2010; Mahony 2014). Most of this work centres on the IPCC as a site for the mutual co-production of global science and politics, where new global governance orders are under construction (Hulme 2010; Miller 2004; Shackley and Wynne 1995). For these scholars, social processes of interaction and communication among IPCC scholars are significant for the production of knowledge. Yet the IPCC is charged not with the generation of new knowledge, but rather the review and synthesis of existing studies, so that its reports act as second-order knowledge, or knowledge about knowledge. This mission makes IPCC a rather special case in terms of the boundary between science and politics and the negotiation at that boundary, which scholars have analysed from several angles (Beck and Mahoney 2018; Hoppe *et al*. 2013; Sarewitz 2011), including the linear 'deficit' model of communicating science (Beck 2011); the organizational norms and procedures (Hulme and Mahony 2010); the tools and framing work of the IPCC (Petersen 2012); or approaches to building consensus under uncertainty (van der Sluijs 2012; van der Sluijs *et al*. 1998), to name a few main topics. As will be seen below, the key to understanding IPCC practices in this respect is the distinction between 'policy-relevant' and 'policy-prescriptive' knowledge.

This work is made more complicated in that 'climate' is a particular object of study. It is of rather recent construction and is achieved through complex means of data-gathering, setting of conventions, and modelling, as well as by bringing insights and approaches from different research areas together (Aykut 2016; Pearce *et al*. 2018). Furthermore, by measuring climate by resorting to the temperature of the atmosphere, climate research addresses a phenomenon with which human beings are inevitably entangled and from which they cannot gain distance. Thus, 'climate' is not

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an object at all in the conventional sense of the term, possibly instead a 'hyperobject' (Morton 2013), even though this term is arguably infelicitous.

One facet of the IPCC facing scrutiny (especially since the sixth Assessment Report) is its 'social contract' (Hulme and Mahony 2010). Work on science's social contract goes back (in various forms) to at least the early-twentieth century and fundamental work by, for example, Merton (1938) or Fleck (1981), with one strand going via a concern for how science relates to social problems (e.g. Ravetz 1971, 1988), to a more recent concern at the end of the twentieth century with science's role in addressing societal (and environmental) challenges. In this context, Gibbons (1999) laid out science's social contract, while Lubchenko (1998) related this contract especially to global environmental change. These scholars sketch a social contract for scientists to devote their energies to societies' pressing (environmental) challenges in a way that is socially robust, transparent and participative. Indeed, such principles have taken firm root in the scientific ecosystem, as central to ethical research conduct (see an example in the NESH and NENT guidelines of the Norwegian National Research Ethics Committee's, or ALLEA's European Code of Conduct for Research Integrity). At the IPCC, this contract stems from the role that it was established for, to distil scientific, policy relevant and responsible evidence in support of inter-governmental negotiations.

But Glavovic *et al*. (2022), following the sixth Assessment Report, proclaimed that since the IPCC was incapable of sparking meaningful governance action, then this contract is broken. The organization has lost its compass, its identity and its authority, insofar as it no longer fulfils its mission in society. This article represents one of the more recent, and explosive, critiques of the IPCC, although scholars have long, for over 20 years, questioned whether the IPCC fulfils its aims (see, for example, Sarewitz 2004; van der Sluijs *et al*. 1998), including by authors with experience working within the IPCC organization (Swart *et al*. 2009). Others responded to Glavovic *et al*. (2022) by arguing that the contract is not broken, but under re-negotiation, and that the IPCC needs to change direction towards better incorporating the social sciences and humanities, with implications for the IPCC's identity and authority. Indeed, Gibbons' (1999) claimed that science's social contract is 'a dynamic process in which the authority of science [is] legitimated again and again'. It is a stretch to proclaim that the Glavovic *et al*. (2022) article, and ensuing furore, is evidence for a widespread identity crisis in the IPCC. But as we show below, the interviewees that participated in our limited study also raised topics of shifting identities, implying that these are concerns held by at least some (central and senior) IPCC authors, and that they are worthy of further discussion.

So, considering the IPCC's evolving social contract, what has this meant for the *identity* and *authority* of the IPCC for climate governance? The scientific authority of the IPCC is a major part of its self-identity and how its members perceive its role in climate governance, so we consider these two concepts as interlinked (Hajer 2012; Mahony 2014; Miller 2004). We were interested in the elements that IPCC authors draw on to define the IPCC and their work, and its perceived authority for guiding

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international relations and global governance. Some scholars have tentatively set out elements that are relevant to identity, but rarely in discussion with IPCC authors themselves. These elements include the IPCC's claims to universality (Hulme 2010); political neutrality ensured by a demarcation model (Hoppe *et al.* 2013); a linear communication model (Beck 2011; Dudman and de Wit 2021); its framing of the science (Pearce *et al.* 2018); transparency in addressing mistakes (Hajer 2012); the quality of the information as fit for the function of decision-making (Bremer *et al.* 2021); or the degree of diversity and participation in the organization, relative to disciplines (Bjurstöm and Polk 2011), inclusiveness and modes of communication (Caretta and Maharaj 2024), or knowledge systems (Bremer *et al.* 2024).

In framing this study then, we focused on the dynamic process of renegotiating the IPCC's social contract relative to the co-evolution of some key elements that underpin its identity and authority for governance. This focus was emergent, mutually guided by conceptual viewpoints in the literature (above) in dialogue with topics that arose in our interviews. That is, we did not progress from a strict a priori conceptual framework but sought to highlight elements under broad headings of identity and authority that interviewees themselves identified, and which we came to distil as seven elements (discussed under three headings). In this way, for instance, the identity crisis that we take as a point of departure is less a theoretical standpoint than one that became apparent in the interviews.

Method

This pilot study was initiated by scholars in a taskforce combining two European academies – Academia Europaea and the Young Academy of Europe – which is investigating models of science-policy for environmental sustainability. The research was designed as a set of semi-structured interviews, which was determined to be the method best fitted to eliciting self-reflections in a confidential setting, towards fulfilling the research aim. In total, nine IPCC contributors were interviewed between October 2024 and January 2025, with all interviews held virtually (given the geographical spread of interviewees), and in English, with two interviewers (the authors) in dialogue with one interviewee. The interview protocol was loosely informed by topics in the literature, and interviewees were sent the questions at least a week in advance with information about the pilot study. At the start of the interview, interviewees were asked to give verbal informed consent. Interviews were automatically transcribed, and transcripts sent to interviewees to review.

The taskforce identified potential interviewees from members of the two Academies, and via a snowballing technique, through interviewees' networks and recommendations, with the aim of securing a diverse set of perspectives on the IPCC. The areas of scholarly expertise were the following: climate and environmental physics; earth sciences and paleoclimatology; biology and earth sciences; geography; oceanography; economics and environmental science; energy economics; technology policy; science and technology studies and energy policy. While this range is rather broad, in the end the sample was skewed towards scientists in Working Group I on

https://doi.org/10.1017/S1062798725100458 Published online by Cambridge University Press

the physical science basis (WGI), with a smaller number from WGs II and III on adaptation and mitigation respectively, and towards more senior male scientists from the Global North. In more detail, five of the nine interviewees participated in WGI and two each in WGs II and III. Four of the interviewees contributed to all six assessment reports; three to reports 4, 5 and 6, and two to the fifth and sixth reports. Six interviewees are male and three female; six interviewees are based in Europe and one each in Latin America, Africa, and Oceania. We consider this set of interviews as a pilot study to be extended in a second step with further interviews, but the interviewees' range of expertise and variety of experience with IPCC lend themselves to the elaboration of a rather consolidated picture.

The following presentation of the findings concentrates on the interviews themselves, due to both their richness and the limitation of space. We opted for a narrative style that synthesizes topics raised by interviewees rather than making use of quotations that would considerably overlap. When there were significantly different opinions among the interviewees, this is pointed out, on occasion by referring to the kind of involvement of the interviewees. In this sense, almost the entire following section should be read as giving voice to the interviewees. Thus, it complements a document analysis of the IPCC reports as well as their reception, which to some degree exists in the available literature that we mentioned above. It is only in the third subsection, which deals with shifting issues in the IPCC work, that we felt compelled to cross-refer the interviewees' statements to other existing analyses of the IPCC mode of operation. Our proper analysis can be found in the concluding section on the anatomy of a crisis, in which we carve out from the interviews seven elements that emerged as under negotiation for the future work of the IPCC.

The IPCC from Inside: Task Identification, Mode of Operation, Shifting Issues

In what follows, we unpack elements that mutually constructed the identity and authority of the IPCC for climate governance, and how these elements interacted and co-evolved over time. We do so under three sub-headings, as a way of ordering the findings, and turn up seven elements that we found co-constituted the shifting identity of the IPCC. We highlight these seven elements in italics as they emerge in this section, and return to them in the fourth section of this article.

Task Identification and Interpretation: Ambition and Limitations

From the start, t*he IPCC benefited from a rather clear mission that led to the development of an identity*, in the sense of a common resource of meaning that guides action. By assessing the state of knowledge about climate change, the IPCC was to determine whether and to what extent global warming was due to human activity and whether and in what form it required urgent coordinated global action. In its First Assessment Report (AR1), in 1990, the IPCC answered the first question

https://doi.org/10.1017/S1062798725100458 Published online by Cambridge University Press

affirmatively and urged global climate action. AR1 played a decisive role in the creation of the United Nations Framework Convention on Climate Change (UNFCCC) and in the preparation of the United Nations Conference on Environment and Development (widely known as the 'Earth Summit') held in Rio de Janeiro in 1992, at which the UNFCCC was formally agreed upon.

The following Assessment Reports confirmed the initial assessment with an ever-greater degree of certainty and also specified the significance of the increase in global temperature through enhanced historical and current data and improved climate modelling. Thus, it tends to be forgotten that the early success of IPCC in framing the global climate debate and stimulating global climate action could not be taken for granted. Climate scepticism was widespread at the time, if by this term we mean that doubts were raised about all steps of the reasoning: whether global warming was indeed happening; if it was happening, whether it was due to human activity rather than planetary factors; if it was due to human activity, whether it required urgent coordinated action to mitigate climate change. When affirmative evidence consolidated on all three questions, such justified scepticism partially transformed into what came to be called 'climate denialism'. By the latter, one refers to rejection of credible evidence for reasons of interests broadly understood, which can be the profit and revenue motives for businesses and states, but also a reluctance to consider changes to citizens' ways of life.

For an extended period, the IPCC was subjected to fierce criticism by climate sceptics of various kinds, sometimes present within IPCC but more publicly visible when it came from the outside, and often supported by organized interest groups or governments. Such criticism was questioning the findings directly by raising doubts about the methods, or it was aiming at the degree of certainty with which the findings could be expressed, underlined by the IPCC practice of indicating intervals of confidence with which statements are made. With the evolving knowledge that confirmed the initial assessment, though, outright climate denialism has been reduced to pockets in debates around the IPCC. By the time of AR5 in 2014, which triggered the Paris Agreement of 2015, the evidence presented was so overwhelming that the interpretative space for climate denialism had been considerably reduced (leading to a shift in debate that will be addressed below).

From the interviews it became clear that most (though not all) of the scholars involved in IPCC – let us label them 'climate scientists' – had none of the doubts raised by sceptics. For them, it was rather the existing state of knowledge, at the outset, that led the UNEP and WMO to take the initiative to create the IPCC in the first place. Thus, it becomes clear that the IPCC indeed had a double mission: beyond surveying and synthesizing the evolving state of climate knowledge, its task was to convey this knowledge and its significance to governments. In the latter regard, the IPCC is a convenor of global climate debate among climate scientists and office-holding politicians rather than a mere producer of comprehensive 'state of the art' reports.

This insight directs attention to the way in which the boundary between science and politics was defined and practised in the IPCC. With public attention focused on

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the ARs, the IPCC appears as a knowledge-providing institution. From one AR to the next, the media tend to present the evolving state of knowledge, often focused on the predictions for future global warming. Arguably, though, the more significant achievement of the IPCC with each AR is to reach a consensus with all participating governments about the state of climate knowledge. This consensus becomes explicit in the Summary for Policymakers (SPM) that accompanies each AR and is approved line by line by all participants.

The creation of the SPM shows the ongoing boundary work meant to distinguish science from politics. The draft SPMs are scrutinized in detail, and contestations are frequent, in particular regarding the statements about carbon dioxide emissions and fossil fuels. It is thus evident that the SPM is seen as a political document, in particular but not only by (certain) governments. At the same time, it is a 'summary' of the three working group reports that constitute the bulk text of an AR, and these reports are by definition scientific, as they assess the state of published academic knowledge on climate change. By common understanding, therefore, the SPM cannot contain any statement that does not have a basis in the working group reports. Moreover, it cannot contain any statement that contradicts working group findings. This understanding provides a basis for arguing against requests to change the draft SPM, altering, adding or – more typically – deleting phrases. Participants in the working group on the 'physical science basis', in particular, underline that this way of conceiving the link of the SPM to the more detailed assessment thwarts politically motivated attempts to water down the SPM.

There is, though, another component of the IPCC mission that can be seen as protecting politics from science. The IPCC is held to assess the existing knowledge on climate change in a 'policy-relevant' but not 'policy-prescriptive' way. This distinction was frequently cited by interviewees demonstrating its significance as a defining element of the IPCC mission. While it was mostly stated matter-of-factly to start with, subsequent discussion often showed an ambivalent attitude to this distinction. By delimiting the range of the sayable, the distinction creates a boundary that can serve to orient the work and provide task security. Furthermore, this boundary also supports the claim to authority of the IPCC. Interviewees tended to agree that the distinction was important in enhancing the legitimacy of the IPCC work.

But the distinction was also seen as constraining. At times, interviewees felt that findings clearly indicated the actions that need to be taken, but the 'relevant-not-prescriptive' distinction prevented them from saying so explicitly. Some shift in evaluating this ambivalence over time can be observed. Early on, the belief could be held that the evidence of the findings would lead almost by necessity to adequate action, by sheer force of reason. However, the experience that such action persistently fails to occur can suggest to scholars that they may have to – and should be permitted to – spell out which course of action needs to be taken. Or, in other words, while it may have been seen at the outset as sufficient to provide and strengthen evidence of anthropogenic climate change, the urge to become

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policy-prescriptive arises given the lack of action that would be required in the light of the policy-relevant knowledge.

At least implicitly, the boundary between science and politics in the case of the IPCC is underpinned by some notion that the knowledge is already there and only needs to be presented in synthesis, whereas the course of political action still needs to be decided upon and taken. This notion, though, underestimates the extent to which knowledge needs to be collected, ordered, and organized before it can be presented in synthesis. These are social processes that would be ill-conceived if they were seen as being fully determined by a knowledge that is already 'there'. It is to these processes within IPCC that we now turn.

Mode of Operation: Organizing Knowledge

From its beginning and until the present day, the work of the IPCC has been divided among three working groups, dealing with the 'physical science basis' (working group I – WGI), 'impacts, adaptation, and vulnerability' (working group II – WGII), and 'mitigation of climate change' (working group III – WGIII) respectively. The working groups operate relatively independently of each other and present separate reports, which are then brought together in a 'synthesis report' and, with further synthesization, in the SPM. While a division of labour appears necessary given the complexity of the issue, and the chosen sub-division seems quite plausible, any such separation of tasks raises questions and potentially creates problems of coordination.

Given the initially prevailing understanding of the task, the findings of WGI have tended to dominate the reception of the IPCC work. It was there that it was determined that global warming is happening and that it is anthropogenic. WGI is highly 'policy-relevant' in the sense that its findings underline the urgent need for climate action. In turn, it is in WGII and WGIII that the course of such climate action is at stake, in terms of measures to adapt human societies to climate impacts and in terms of measures to mitigate the further rise of global temperatures, respectively. With its focus on the 'physical science' basis, the members of WGI are mostly based in the earth and climate sciences, which itself is an area of knowledge that, if it has not precisely been brought into being by the rising climate concerns, it is at least strongly shaped by them. Among the members of WGII and WGIII, concerned with the human response, scholars from engineering disciplines and from economics have a stronger role. The presence, or lack thereof, of scholars from wider areas of the social sciences and the humanities is a topic under debate (to which we will turn below).

Over time, the division of labour between working groups has become consolidated, or indeed somewhat petrified. Consequently, concern has arisen about issues and areas of knowledge that are not adequately covered because they do not fall clearly under the remit of any one of the working groups. IPCC has tried to deal with such concerns by elaborating 'special reports' – such as on cities, land, and oceans as well as a report dedicated to the target of limiting temperature increase to 1.5°C – or setting up mechanisms for 'handshakes' across working groups. Nevertheless, there

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is considerable cost in the separation of tasks, visible when one working group adopts concepts that are not adopted by another one or one group divides the globe in different world-regions than another one, in both cases decreasing the comparability of statements.

With an exponential explosion in the number of climate research studies to assess, the IPCC has witnessed a strong increase in the number of scholars participating in its activities. Therefore, the task of assessing the state of knowledge has become much more complex. If the task has remained somewhat manageable, this is at least in part due to the elaboration of practices and a mode of reporting on which every new assessment cycle can build. As such, an ongoing process, by now extended over more than 30 years, *the IPCC does more than assess an evolving state of knowledge; it inadvertently (and even quite deliberately) intervenes in the process of knowledge generation*.

Taken together, the contributors to IPCC reports as authors or reviewers occupy leadership roles in the global community of climate scientists (in the broad sense of this term, which rather means a set of sub-communities in different disciplines and specialty areas). When their assessments characterize a state of knowledge, they also – implicitly and sometimes explicitly – mark areas in which more knowledge would be desirable, including to impart greater certainty than currently exists. Returning from IPCC work to their own workbench, these scholars are generators of knowledge, and they may well be inclined to address their research efforts (or those of their colleagues) to those questions which IPCC assessment marks as crucial. In this way, the IPCC gives direction to knowledge production, even quite directly through a scholarship programme (financed by the Nobel Peace Prize presented to the IPCC in 2007). Such knowledge production is particularly prevalent in connection to controversy in public and political debate. For some time, for instance, the stability of the past climate was doubted with a view to claiming that current global warming may just be a climate fluctuation that occurs without human impact. Research in paleoclimatology was instigated to address this controversy and disprove this claim.

Despite this capacity to generate knowledge, IPCC reporting is constrained by the state of published academic knowledge at a given moment. Given the amount of available research, selectivity is unavoidable, and this may open spaces for interpretation, such as hinting more strongly at some policy actions as adequate than at others. Nevertheless, the demand for presenting the full range of knowledge persists, which can lead to *a conservative bias in reporting, with 'conservative' here meaning a tendency to underestimate the extent and impact of climate change.*

A case in point is climate modelling. It is widely known that the modelling results depend both on the available and used data and on the assumptions made about the relations between them, often leading to considerable divergence between models or within a model when operated under different assumptions (see the contribution by Phoebe Koundouri *et al*. to this issue). But there is also broad agreement that climate modelling has been considerably improved over the past decades of climate research on both grounds, more and better data and more reliable modelling of their relations.

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As a consequence, the degree of confidence with which IPCC reports climate projections has increased over time. More recently, though, the argument has been made that climate observations tend to exceed considerably, and negatively, the expectations of climate models. Asked about this discrepancy, interviewees point to the fact that individual climate models indeed have those recent climate occurrences within their range. But the IPCC reports a summary view of modelling predictions and thus cuts the 'tails', that is the more extreme findings, from models.

Beyond the organizational constraint of only summarizing certified knowledge, one can witness here an attitude of what we may call epistemic conservatism. IPCC scientists apply a principle of prudence by prioritizing knowledge that shows a high degree of certainty, tending toward presenting more conservative estimates of change (Wynne 2010), anchored in past estimates (van der Sluijs *et al.* 1998), underlining findings by scholars 15–25 years ago. By implication, though, applying this attitude at a science–politics interface invites violations of the principle of prudence in action (see, for example, Shue 2015), which may demand action precisely because of uncertainty in the face of possibly disastrous consequences.

Shifting Key Concerns: Acquired Knowledge and Still Required Knowledge

As mentioned above, the assessment of the 'physical science basis' tended to dominate the work of the IPCC as well as its reception at the start. The reporting from WGI persistently confirmed the existence of anthropogenic climate change and the dangers arising from it. If one takes a very broad picture, one may well say there is nothing dramatically new in these reports between AR1 in 1990 and AR6 in 2022. As also already mentioned, climate scientists who were involved from the beginning and, in some cases, did research on the topic even before the founding of the IPCC, often hold that the basic contours of climate change were already known in 1990 or before. This may well lead to the conclusion that the mission of the IPCC, or at least of its WGI, is accomplished and that the work can be discontinued. Such voices can indeed be heard, joining this insight with the frustration of continuing with an enormous amount of (unpaid) work that has a limited effect in terms of climate action. On closer consideration, though, interviewees often added that the findings of WGI do get increasingly refined. The knowledge basis is widened, and the degree of confidence with which one can speak about the causes and consequences of climate change increases.

Regardless of their disciplinary background, interviewees tended to underline that the evidence is unequivocal. And the implication is that the need for action is similarly unequivocal, even though the types of adequate action may be debated. In this sense, the way the IPCC frames climate knowledge remains important for shaping global climate debates. But the reasoning suggests something like a 'hard' limit to the 'social construction of knowledge', in the sense discussed in Science and Technology Studies, or Social Studies of Knowledge. Human beings experience

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changing temperatures and may observe changes in 'nature', especially those who engage with 'nature' through farming or fishing, for instance. But 'climate change' needs to be constructed through techniques of measurement and systematically explored though models that connect measures, and both of these could have been done in different ways (Hulme 2009). Talking about 'unequivocal evidence', though, suggests that fundamental findings would be the same regardless of the knowledge techniques that were employed. Climate change, therefore, invites not only analyses of the human impact on the planet but also new reflections on how 'reality' resists being subjected to human action (see, for example, Wagner 2022).

Significantly, the knowledge basis has widened, not merely because more research was done on the 'same' phenomenon. Climate change is a moving target, and the period since 1990 has witnessed an acceleration of global warming due to the accumulation of greenhouse gases, in particular carbon dioxide, in the atmosphere, and to the inaction with regard to limiting further greenhouse gas emissions. The 35 years during which the IPCC has been active, its mission notwithstanding, has been a period of accelerated climate change. Over time, therefore, IPCC reporting moved from a focus on a 'static' determination of the causes and consequences of climate change to an understanding of the ongoing climate dynamics.

While the central role of the carbon dioxide concentration in the atmosphere on global warming had long been recognized, the 'static' approach suggested one could aim at a stabilization of the concentration by keeping ongoing CO_2 emissions at an equilibrium level, to be reached by carbon pricing. Such approach was encouraged by the economic argument that effective climate action has a cost, to be measured in a reduction of economic growth, which needs to be weighed against the benefit, or avoidance of harm, achieved by limiting global warming. While the basic assumption appears valid by virtue of being trivial, the approach has increasingly been seen as violating both principles of prudence. It has drastically underestimated the cost of burning fossil fuels, thus violating the principle of epistemic prudence, an error that economists keep trying to correct by steadily raising the adequate carbon price in their modelling. And it has violated the principle of prudence in action by making a rather static assumption on ecological damage by failing to consider the effects of reaching tipping-points.

As both the emissions and concentration of CO_2 kept increasing, attention was refocused on the durable accumulation of CO_2 in the atmosphere, thus on the cumulative effect of ongoing emission activity. In this light, a notion of a 'carbon budget' was formalized that added the amount of carbon dioxide that has already been emitted (historical carbon budget) to the one that could still be emitted (remaining carbon budget) if one wanted to avoid exceeding a specific temperature target. With reference to ongoing climate research, this conceptual shift was explicitly taken within IPCC between AR4 and AR5 (see Lahn 2021). The IPCC underlines that available data allow the calculation of carbon budgets with a high degree of precision, but that the calculation of the remaining carbon budget depends on the political choice of a target of temperature increase since the late nineteenth century. In the light of this debate, such a political choice was made by setting a

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target of 2°C, ideally 1.5°C, of warming in the Paris Agreement of 2015. An IPCC special report of 2018 spelt out the requirements for meeting this target.

Interviewees with long-term experience of the IPCC refer to this period, between 2015 and 2018, as a turning-point, with some of them seeing a more gradual evolution over the longer term, while others identify a more pronounced rupture. *This turning point in the IPCC's identity was described in terms of a re-framing of the scientific research*. The sharpening of the concept of a carbon budget and the introduction of a target for temperature increase focused the political debate. The significance of this change is underlined in the interviewees' way of speaking about the present time – as the budget having been spent and time having run out. The notion of a limited available carbon budget increases the urgency for action, with a sharpening or even polarization of global climate debate outside of, but influenced by, the IPCC. The acceleration of a global climate movement during this period is plausibly related to the IPCC's and UNFCCC's change of perspective (as explicitly in the case of *Fridays for Future*; Lahn 2021: 14). In parallel, debates at the annual Conferences of the Parties (COP) of UNFCCC have become increasingly focused on a struggle over terminologies such as 'phasing-out of fossil fuels' or 'transition away from fossil fuels', while the presence of fossil-fuel interest groups at these meetings is increasing, with some interviewees speaking of a 'capture' of the COP process by business and governments invested in fossil fuels.

Within the IPCC, this shift has had several consequences. First, it arguably enhanced the sense that the 'physical science basis' is sufficiently solid. Second, given the urgency, it increased frustration that insufficient action is being taken despite this solidified knowledge basis. Third, it shifts attention to the remits of Working Groups II and III regarding adaptation and mitigation, respectively. Or maybe, more adequately, it sharpens the focus on issues that crosscut the existing working group structure. Once one assumes that a 'transformation' is urgently necessary, then the specification of this transition is required, often under the heading of a 'just transition'.

The notion of justice contributes to refocusing the global climate debate on to the questions of responsibility for climate change and the capacity to act with regard to it, with an attendant shift toward focusing on adaptation (WGII) and mitigation (WGIII). Justice had accompanied the broader climate debate from early on, such as in the principle of common but differentiated responsibilities and respective capabilities (CBDR), adopted by the UNFCCC, but with limited impact on global policy and action. While the principle could be relatively easily accepted at the start of the global climate debate, once one needs to move closer to action, it calls for specifying the meaning of the terms 'differentiated' and 'respective', and ways of attributing impactful meteorological events to climate change.

For interviewees, advances in the relatively new field of attribution research have enabled linking individual weather events – droughts or heatwaves for example – to global climate change. Extreme weather events, which have measurable damage as a consequence, until recently could not clearly be causally related to climate change. As interviewees pointed out, such attributability had long been considered a

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desideratum. The development of tools for attribution of specific events to global warming enables, as a next step, an evaluation of damage and loss in such events due to global warming. This new element of climate change assessment potentially opens up a legal path of climate action, which is being increasingly pursued by climate action groups (Aykut *et al*. 2024).

Attribution research links the occurrence of specific weather events causally to global climate change, but it cannot link these events to specific, say, carbon dioxide emitters. Thus, while the broad concept of historical responsibilities for carbon emissions is accepted, it still requires other knowledge tools, to avoid that its application keeps failing in the face of economic and geopolitical interests. In this light, a world–regional differentiation is required, moving beyond that strand of climate science that focuses globally on the atmosphere to understand the features of climate change in specific regions. Furthermore, the principle of historical responsibilities requires greater involvement of the social sciences and of forms of local or indigenous knowledge for delineating the contours of regional change. Such a process is under way in current debates, but it risks deepening already existing divides between different understandings of rigorous and robust knowledge across scientific disciplines.

Topics of justice have also become more prominent in the organization and operation of the IPCC. Several interviewees voiced dissatisfaction that the IPCC's work has historically been disproportionately steered by senior male physical scientists from the Global North. Substantively, they argued this imbalance brings a 'bounded rationality' that provides a partial view on the issue and tends to marginalize certain regions of the world. Normatively, it imposes a form of epistemic colonialization of the issue and denies a voice to scientists from countries that are most vulnerable to climate impacts. And instrumentally, by limiting consideration for more diverse ways of knowing – of indigenous communities for example – the knowledge base is less easily implemented in climate action. In response, interviewees noted fifth and sixth Assessment Report authors began to pay more attention to the scientists invited as IPCC authors, opening up to more female, early to mid-career scientists from the global south, with one interviewee asserting that that was why she was invited to co-author the sixth Assessment Report (in addition to her well-recognized expertise). Going further, the past two Assessment Reports have included an appreciation for a broader spectrum of knowledges, including indigenous and local knowledge, for example. And interviewees expressed a desire to upset power hierarchies, complaining that IPCC meetings were still dominated by certain authors, based on seniority or English proficiency, for example.

The shift in significance from WGI to WGs II and III also reopens the question about the relation between adaptation and mitigation measures. In earlier debates, mitigation was the priority for many scholars and activists for combating climate change at its source. On the other hand, some business and political actors preferred a focus on adaptation measures, because mitigation demands more radical social and economic change, not least a move away from a fossil-fuel based economy and society. Since re-framing the debate around a limited carbon budget, discussion

https://doi.org/10.1017/S1062798725100458 Published online by Cambridge University Press

turns, rather paradoxically, to a point where the focus can now only be on adaptation because it is too late for mitigation. The interviewees, though, generally rejected a debate in any such terms because adaptation without mitigation would necessarily fail because of the increasingly severe consequences of global warming.

Lastly, there is a widespread sense that the scope of ecological debate needs to be broadened, an insight that itself is based on experiences with the IPCC, to the extent that its success is based on narrowing down a broad ecological issue. Climate change could be framed rather concisely in terms of temperature increase related to fossil-fuel use, as the foci of global debate. However, this framing has also cut off climate debate from other concerns to which it is intricately related, such as biodiversity or food security and sustainability. Within the IPCC, the focus was at times so narrow that draft contributions to reports could be criticized for including questions of development, whereas they should only deal with climate.

Conclusions: The Anatomy of an Identity Crisis

We started this article by noting that the IPCC, often held up as a model science-policy instrument for the governance of global environmental change, faces an identity crisis. Most vocally this is based on an assertion that the IPCC is failing to fulfil its social contract to facilitate 'climate action'. But we have taken the position that this contract is under renegotiation, and much of this revolves around IPCC authors' own re-appraisal of the organization's identity and legitimacy, and how they see its mode of operation having changed over the period of 35 years; that is, how do IPCC authors perceive their identity is changing vis-à-vis society, and with what implications for the IPCC's contract with society? This study spoke with IPCC authors and highlighted seven overlapping elements of the IPCC's identity that are under renegotiation, both 'internally' within the organization itself, and 'externally' with groups external to the IPCC.

Relative to the *tasks, roles and ambitions* of the IPCC, there are questions regarding (i) the IPCC's role or mission for reviewing scientific evidence of dangerous, anthropogenic climate change, and, by extension, establishing science-based global environmental governance; and (ii) the so-called 'boundary work' of the IPCC to protect science and politics from inter-contamination by synthesizing 'policy relevant but not prescriptive' science.

Relative to the IPCC's *organization of scientific knowledge*, authors discuss (iii) the siloing effect of the division of labour across working groups, and the conflicting cultures this creates; (iv) whether the IPCC's role is limited to reviewing the evidence, or extends to guiding the production of new scientific research to address knowledge gaps; and (v) the epistemic conservatism of the IPCC when faced with uncertainty, tending to 'cut the tails' off projections of dangerous climate change.

Relative to the IPCC's *matters of concern*, IPCC authors discussed (vi) the historical dominance of physical science in that organization, and how the 'unequivocal' evidence provided by WGI has seen a shifting emphasis over to

https://doi.org/10.1017/S1062798725100458 Published online by Cambridge University Press

adaptation (WGII) and mitigation (WGIII), and also an emphasis on justice relative to who is permitted to speak as the IPCC. To this latter point, there is work to include more early career scientists, and scientists from the global south for example, and to pay attention to the power hierarchies in the organization. Our interviews also saw IPCC authors discuss (vii) the framings of scientific research (such as the carbon budget concept), and the scientific advances (such as attribution research) that facilitate climate action.

Acknowledgements

The authors of this article would like to acknowledge the IPCC authors who were so generous with their time in agreeing to talk to us. Only a fraction of the rich stock of insights they shared could be reported on in this article. SB had support from the CALENDARS project, which has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement 804150).

Conflicts of Interest

The authors declare they have no competing interests.

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