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ESSAY

Drawing Boundaries: Boundary Arrangements of the IPCC Working Groups

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The present research investigates how the IPCC's Working Groups safeguard their scientific character while communicating with policymakers. Due to the different nature of Working Groups' assessments, all Working Groups make different boundary arrangements of how science is defined; what is considered as relevant knowledge; and what the division of labor is amongst Working Groups. The results show that science is a context-specific activity in a constantly changing landscape, which in turn affects the IPCC's credibility if they keep advocating that their science is policy-neutral and never policy-prescriptive.

Keywords: IPCC; IPCC Working Groups; climate change; boundary arrangements; science communication

1. Introduction

In 1988, the World Meteorological Organization and the United Nations Environment Program established the Intergovernmental Panel on Climate Change (IPCC). The purpose of the IPCC is to "prepare, based on available scientific information, assessments on all aspects of climate change and its impacts, with a view of formulating realistic response strategies" (IPCC, n.d.b). The reviews and assessments are concerned with "the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change" (IPCC, n.d.a). The IPCC is scientific and intergovernmental in its nature. The IPCC 's unique role is to provide decision-makers with rigorous and balanced scientific information. Its work is policy-relevant and yet policy-neutral, never policy-prescriptive (IPCC, n.d.a).

The IPCC releases assessment reports that contain a full scientific and technical assessment of the current state of knowledge on climate change. Generally, these reports are released in three volumes, one by each of Working Groups, together with a synthesis report (IPCC, n.d.c). Working Group I (WG I) "assesses the physical scientific aspect of the climate system and climate change", Working Group II (WG II) "assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it" and Working Group III (WG III) "assesses options for mitigating climate change through limiting or preventing greenhouse gas emissions and enhancing activities that remove them from the atmosphere" (IPCC, n.d.d). To date, the IPCC has published five complete assessment reports, of which the Fifth Assessment Report (AR5) has been released in four sections between September 2013 and November 2014.

The IPCC faces many communication challenges, especially where it needs to compete with many sources for attention of its audience. Examples of these communication challenges involve the difficulty to characterize and communicate uncertainties. Uncertainties are inherent in climate science, however, how people interpret these uncertainties differ across varies audiences (Wallsten and Budescu, 1995; Pew Center, 2009; Budescu, Por & Broomell, 2011). Furthermore, the IPCC assessment reports are subject to growing public scrutiny, which already resulted in significant scandals. The most remarkable scandals that had an impact on the IPCC's reputation were the Climategate controversy (Grundmann, 2012) and the Himalayan glacier error (Hajer, 2012).

The InterAcademy Council (IAC) (2010) acknowledges in their report that scientists have a highly complicated task to communicate their findings effectively to the IPCC's audiences without distorting them. In March 2010, the United Nations Secretary-General and the Chair of the IPCC had asked the IAC to conduct an independent review of IPCC processes and procedures, in order to help guide the processes and procedures of the AR5 and future assessment of climate change. The committee was specifically asked to focus on the IPCC's procedures for preparing assessment reports, the management and administrative structure of the IPCC, and IPCC strategies for communicating with the media and the public.

The IAC agreed to undertake the review and established an ad hoc review committee of experts from relevant fields to do it. In October 2010, the IAC released the report *Climate Change Assessments: Review of the Processes and Procedures of the IPCC*. In this final report, the committee

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presented its recommendations for possible revisions of IPCC processes and procedures to increase the IPCC's capacity to respond to future challenges and ensure the continuing quality of its reports (IAC, 2010).

The IAC's committee found that the IPCC's communication was a major weakness (IAC, 2010). Therefore, the IAC (2010) opted for a communications strategy, which was developed accordingly in October 2010. Besides a communications strategy and other issues, the IAC (2010) recommended that cross-working group interactions would be established, in order to strengthen the coordination. It argued that the structure of all four assessment reports remained consistent throughout time, except of some minor changes in the scope of Working Groups II and III. Nevertheless, it is observed that that nature of science is increasingly multidisciplinary, which asks for thorough re-evaluations of the scope and mandate of Working Groups. The IAC (2010) predicted that during the writing and reviewing of reports, issues would arise that cut across all three Working Groups. Another recommendation related to the characterization and communication of uncertainties. The IAC (2010) stipulated this latest recommendation, since it proves to be a difficult matter for the IPCC.

Now AR5 is fully released, it is interesting to look into how the three AR5 Working Groups processed IAC's recommendations in relation to safeguarding their scientific character while communicating with policymakers. Scientific character here refers to how each of Working Groups interpret their scientific rigor. The outcome of defining the relationships and division of tasks between science and others is referred to as boundary arrangements (Schut, van Paassen & Leeuwis, 2013). Communicating climate change means confronting a fundamental tension between the norms of scientific practice on the one hand and the need for communication strategies that actively engage with policymakers on the other (Corner & van Eck, 2014; van Eck, 2015). This tension leads in the construction of its reports and calls for compromises that need to be made for each of Working Groups. But if one takes into consideration the different nature of Working Groups' assessments, it may be expected that all three take a different stance on the matter. This assumption would be problematic in the sense that the IPCC prescribes to be policy-neutral and never policy-prescriptive, but applies different standards to the interpretation of these terms, which in turn damages its credibility.

This article presents the findings of the comparative research on the three AR5 Working Groups reports, in order to gain insight into how Working Groups' are safeguarding their scientific character while communicating with policymakers. The following three questions guided the research: (1) how do Working Groups define science for themselves? (2) what do Working Groups consider as relevant knowledge? and (3) what is the division of labor amongst Working Groups? Section 2 presents the theoretical framework that guided the research. Section 3 discusses the employed methods. Section 4 summarizes the analysis of the research. Lastly, section 5 draws a conclusion and section 6 discusses the results in relation to the wider scientific context.

2. Theoretical Framework

The IPCC is keen to express that its work should be policy-neutral. The body's ultimate goal is to provide policymakers with rigorous and balanced scientific information, which asks for communication strategies that actively engage with policymakers. The dominant understanding in debates and arguments is that science and policy are virtually mutually exclusive, but it is increasingly recognized that the science-policy interface is much more complex. The argument that scientific advice is inevitably value-laden gains ground. Particularly in debates around environmental policy this argument is salient, considering the inherent nature of political stakes and scientific uncertainties (Huitema & Turnhout, 2009). I will briefly discuss the wider theoretical debate on the science-policy interface, and subsequently present the concepts that will be applied in this paper.

In literature, divergent ideas are put forward that characterize the science-policy interface. If one acknowledges that science does not function as the supreme source of knowledge, but rather as a social activity, it raises questions about how science relates to other practices and forms of expertise. Nelkin (1975) argues that science is not just any more regarded as feeding facts into policy, but rather the other way around. Political dispute penetrates into the scientific domain, which changes the dynamics of the technical aspects and uncertainty. Jasanoff (2004) argues that simultaneous practices of demarcation and coordination occur simultaneously in the science-policy interface. She introduces the concept of co-production, in which there is distinguished between two forms of co-production, namely constitutive (how have certain arrangements of what we know and how society is organized come about?) and interactional (how is reality organized and reorganized?).

The dialogic model of framing is like Nelkin (1975) and Jasanoff (2004) concerned with characterizing the science-policy interface. Communications can comprise multiple frames, and each frame provides different perspectives. According to Tucker (1998, p. 143), "frames are familiar and highly ritualized symbolic structures which organize the content and serve to close off specific pathways of meaning while promoting others." Moser (2010, p. 39) explains that "frames are triggered by words, imagery, symbols, and non-verbal cues such as messengers, music, tone of voice, and gestures." Different frames have different effects on an audience (Morton, Rabinovich, Marshall, Bretschneider, 2011; Nerlich, Koteyko, Brown, 2010; Nisbet, 2009). The dialogic model of framing acknowledges the continuous interaction between science and policy, as it constructs a reality, shaped by cognitive and social processes. Actors in the science-policy interface continuously evoke specific descriptions of reality in order to accomplish their goals (van Bommel & Aarts, 2011). Thus, the dialogic model of framing teaches us that the IPCC its position in the science-policy interface is not as simple as being solely scientific and not political.

One way to conceptualize the interaction between science-policy is boundary work, which will be the leading concept that is applied to the problem here at hand. Gieryn (1983) is the first who introduced the concept of boundary work. Essentially, he apprehended boundary work as making demarcations between science and non-science. These boundaries are socially constructed between the stakeholders who are participating in it. Drawing boundaries is seen as a strategic and context-specific activity (Huitema & Turnhout, 2009).

The concept of boundary work has proven to be an effective framework to analyze the science-policy interface concerning environmental issues (Huitema & Turnhout, 2009) and is relevant for the problem here at hand since it provides an understanding in how Working Groups' safeguard their scientific character while communicating with policymakers. Due to the different nature of Working Groups' assessments, its boundary arrangements will likely result in different ones. The arrangements consist of how science is defined; what is considered as relevant knowledge; and what the division of labor amongst Working Groups is.

3. Methodology

The method that was employed involved conducting a systematic literature review. With the leading research questions in mind, it was looked into how the different Working Groups processed the recommendations of the IAC (2010). The literature was consulted between March 2015 and May 2015 via the IPCC's official website. All documents available on the website that were produced after the IAC (2010) its recommendations were critically evaluated and synthesized, including guidance notes, outcomes of joint workshops and expert meetings, and PowerPoint presentations. These documents provided an insight into what decisions and changes were made among Working Groups with an eye on AR5. In addition, all AR5's Summaries for Policymakers (SPM) of Working Groups were examined on the themes that came forward in the former analysis, by searching for the exact same key words. These documents provided an insight into how the decisions and changes were actually implemented. Lastly, the findings of Working Groups were compared amongst each other. The quality of the assessment allowed to understand how Working Groups' balance their scientific character versus communication with policymakers.

4. Working Groups' Boundary Arrangements

In this section is made an attempt to answer the research questions posed in the introduction. But in order to gain insight into how Working Groups position themselves, it is valuable to first understand how the IPCC generally positions itself. The IPCC listed several descriptions and documents on its website that formulate a role it wants to comply to. The history of the IPCC teaches us that the task it aspired to fulfil changed throughout time. When the IPCC was established in 1988, its initial task was "to prepare a comprehensive review and recommendations with respect to the state of knowledge of the science of climate change; the social and economic impact of climate change, and possible response strategies and elements for inclusion in a possible future international convention on climate" (IPCC, n.d.b). Its first Assessment Report emphasized the importance of climate change as a challenge, leading to the creation of the United Nations Convention on Climate Change. This treaty is considered to be one of the most important international treaties that is concerned with the possible consequences of climate change (IPCC, n.d.b).

Over the years, the role of the IPCC has changed. The document 'Principles Governing IPCC Work' articulates the IPCC's current role as follows: "comprehensive, objective, open and transparent" (2013, p. 1). The documents also states that its reports should be neutral with respect to policy and be objectively applied in policies (IPCC, 2013). It is striking that the IPCC positions itself in the scientific domain solely; it only wants to provide decision-makers with rigorous and balanced scientific information. The principle emphasizes the objectivity and truth value of science, by which it stresses the importance of distance between science and policymakers. In other words, interactions between science and policy are seen as potential threats to the IPCC's objectivity.

This principle was also leading in the construction of the AR5. However, various academics already criticized the role the IPCC sees for itself and articulate that such boundary arrangements only can exist on paper (Corner & van Eck, 2014; van Eck, 2015; Lorenzoni & Whitmarsh, 2014). Accordingly, it is the question whether all of Working Groups make boundary arrangements that apply this principle accurately. In the following sections, the results are structured according the three leading questions.

4.1 Definition of science

How the different Working Groups draw the line with respect to what is considered as rigorous and balanced scientific information is of interest if one wants to understand their particular arrangements. As mentioned in the introduction, WG I is concerned with assessing the physical climate system, mostly addresses the natural science disciplines, such as meteorology, hydrology, oceanography, ecology, and cryospheric science. In contrast, WG II –concerned with the impacts of climate change and strategies for adaptation– and WG III –concerned with mitigation options– mostly cover the social sciences, including geography, economics, political science, and sociology (IAC, 2010). Due to variety across disciplines regarding the nature and maturity of the science, Working Groups rely on different sorts of scientific expertise. According to the IAC, WG I relies on "observations, global models, and peer-reviewed literature, and can draw on large numbers of practitioners with a long history of collaboration." (2010, p. 3), whereas WG II and III rely on "non-peer reviewed literature [sometimes called grey literature] and involve a smaller, more diverse set of experts who may have less experience working on large international projects." (2010, p. 3).

Rigorous and balanced scientific information means for the Workings Groups something different, with regards to the scientific expertise they rely on. The quality and extent

to which grey literature data is peer-reviewed varies a great deal, ranging from reports from UN bodies to indigenous knowledge (IAC, 2010). WG II and III draw the line different from WG I, as they are more flexible in including grey literature next to white literature. Their definition of science reaches beyond WG I's definition of science, due to the type of scientific expertise they rely on.

After having defined the type of scientific expertise, it is of importance how this scientific expertise is characterized and communicated. As a matter of fact, all Working Groups followed the same approach. The characterization and communication of uncertainties was formulated as follows in all SPMs:

> *"The degree of certainty in key findings in this assessment is based on the author teams' evaluations of underlying scientific understanding and is expressed as a qualitative level of confidence (from very low to very high) and, when possible, probabilistically with a quantified likelihood (from exceptionally unlikely to virtually certain). Confidence in the validity of a finding is based on the type, amount, quality, and consistency of evidence (e.g., data, mechanistic understanding, theory, models, expert judgment) and the degree of agreement. Probabilistic estimates of quantified measures of uncertainty in a finding are based on statistical analysis of observations or model results, or both, and expert judgment. Where appropriate, findings are also formulated as statements of fact without using uncertainty qualifiers."* (2013, p. 4; 2014, p. 6; 2014, p. 4).

This collective approach indicates that Working Groups draw the same boundary with respect to the characterization and communication of their scientific information, to be precise, a form that attaches words to scientific data in order to make sure that policymakers all interpret the WGs findings in the same way.

4.2 Relevant knowledge

How the different Working Groups draw the line with respect to what are considered as issues to discuss and in what form is of interest if one wants to understand their particular arrangements. One of the identified cross-cutting themes comprises of the carbon cycle, including ocean acidification. The science of ocean acidification has advanced rapidly. The result of the joint workshop between WG I and WG II on the topic resulted, among other issues, in the recommendation to have a coherent reference for 'ocean acidification'. In AR4, the WG I definition "requires an anthropogenic cause and requires that addition of CO_2, be the cause", whereas the WG II definition "might be interpreted as including cases where a change in ocean circulation briefly causes a local increase in CO_2 concentration." (Field et al., 2014a, p. 39). Accordingly, WG I and II followed the recommendation and defined ocean acidification similarly in their glossary.

Although, the definition was the same, but Working Groups discussed the issue in different forms. Working Group I asserted the following in their SPM:

> *"The atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years. Carbon dioxide concentrations have increased by 40% since pre-industrial times, primarily from fossil fuel emissions and secondarily from net land use change emissions. The ocean has absorbed about 30% of the emitted anthropogenic carbon dioxide, causing ocean acidification"* (2013, p. 11).

In contrast to what Working Group I asserted, Working Group II asserted in their SPM:

> *"For medium- to high-emission scenarios, ocean acidification poses substantial risks to marine ecosystems, especially polar ecosystems and coral reefs, associated with impacts on the physiology, behavior, and population dynamics of individual species from phytoplankton to animals (medium to high confidence)."* (2014, p. 17).

The difference between the two descriptions is that WG I focused more on numbers than WG II. WG I referred to 800,000 years and 40%. WG II did not take ocean acidification as a result, but as starting point. It referred to substantial risks and impacts, which is a clear difference. This difference is not surprising in itself considering the focus of the reports, but it shows that WG II involves a higher degree of human subjectivity by referring to risks and impacts. In the SPM of WG III the word 'ocean acidification' was absent, like other references made in WG II's SPM in relation to ocean acidification.

Another identified cross-cutting theme that shows that WG II and III extend the scope of what is considered as relevant knowledge is concerned with issues related to article 2 of the UNFCCC. The subject of article 2 is the concept of dangerous anthropogenic interference with climate system. In previous IPCC assessments it was established that the word "dangerous" involves value judgments. To a certain extent the previous assessments addressed components by scientific assessments, but not full coverage (IPCC, 2009). The IPCC's chairman vision on a scoping meeting for AR5 stated the following: "An important issue, therefore, is whether the AR5 can provide enough knowledge and information by which the work of negotiators can be facilitated in defining what would be 'dangerous"' (2009, p. 5).

Thus, how did Working Groups deal in AR5 with defining what would be "dangerous"? WG I simply did not use the term dangerous in their SPM. WG II provided an assessment box in which they explain that the WG's report is concerned with assessing risks across context and through time, in order to provide a basis for judgments about the level of climate change at which risks become dangerous. WG II established five integrative reasons for concerns, including (1) unique and threatened systems; (2) extreme weather events; (3) distribution of impacts; (4) global aggregate impacts; and (5) large-scale singular events (IPCC, 2014).

WG III dealt differently with the term dangerous as it addressed the concern in its chapter 'approaches to climate change mitigation'. It acknowledged that mitigation and adaptation policies involve value judgments and ethical considerations. Accordingly, the analyses of the report involved social, economic, and ethical analyses, by for example including human wellbeing, cultural values, and non-human values. The difference between the two definitions is that both Working Groups come up with parameters to define 'dangerous'. However, the parameters differ in into what extent it involves value judgments and ethical considerations. By the inclusion of value judgments, the boundary arrangements shift, since it relies to a greater extent on assumptions as relevant knowledge.

Next to identified cross-cutting themes, cross-cutting methodologies show how the Workings Groups manage a different strategy regarding relevant knowledge. One methodology that is deployed in WG II and III's assessments involves economic analyses of the costs and benefits of climate change. In the Expert meeting on this topic with WG II and III were, among other issues, the ethical dimensions of adaptation and mitigation policies discussed (Fields et al., 2011b). They concluded that issues such as historical responsibility, efficiency, and capacity are important drivers in the discussion around economic analyses and that it is important for ethical analysis that value commitments are made explicit; not only in economics, but also in the physical science of climate change (Fields et al, 2011b).

However, terminology that is related to value commitments remains virtually absent in WG I. To the contrary, WG II adduces the term 'capacity', for example in: "Increased capacity, voice, and influence of low-income groups and vulnerable communities and their partnerships with local governments also benefit adaptation" (2014, p. 18). Moreover, WG III explicates in its SPM value commitments, by for example stating the following: "Efficiency enhancements and behavioral changes, in order to reduce energy demand compared to baseline scenarios without compromising development, are a key mitigation strategy in scenarios reaching atmospheric CO_2 eq concentrations of about 450 to about 500 ppm by 2100." (2014, p. 19).

The terminology that is used throughout all the three assessments of Working Groups differs with respect to how they use value judgments and make them explicit. Thus, once Working Groups choose its methodologies, they automatically make different boundary arrangements. Working Group II and III widen the scope of methodologies, as they involve methodologies which are based on value judgments.

In conclusion, Working Groups make different decisions with respect to what issues are considered as issues to discuss and in what form. Although the definition of the issue might be the same, the form in which it is discussed varies across Working Groups. Working Group I does not discuss themes or deploy methodologies that involve value judgments, Working Group II to a greater extent, and Working Group III most. By the involvement of value judgments, there is space created to influence. Nonetheless, it remains unclear whose value judgments are involved, those of policymakers or scientists?

4.3 Division of labour

How the different Working Groups draw the line with respect to what Working Groups consider as their role with policymakers is of interest for one that wants to understand their particular arrangements. Identified cross-cutting themes show the extent to which Working Groups appeal to forms where policymakers have an influence on. One cross-cutting theme involved ice sheets and sea-level rise, which was in the associated workshop identified by Stocker et al (2010) as a policy relevant topic. Moreover, Lowe, Pardaens, and Howard claim (supplemented extended abstract in the same paper as Stocker, 2010) that sea level rise is of importance for policymakers as they serve as considerations for mitigation policies.

WG I argued, among other things, the following about ice sheets and sea-level rise:

> *"The rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia (high confidence). Over the period 1901 to 2010, global mean sea level rose by 0.19 [0.17 to 0.21] m"* (2013, p. 11).

Whereas WG I dedicated a special chapter to sea level rise, WG II argued throughout their report about sea level rise. For example:

> "***Due to sea level rise projected throughout the 21st century and beyond, coastal systems and low-lying areas will increasingly experience adverse impacts such as submergence, coastal flooding, and coastal erosion (very high confidence)****. The population and assets projected to be exposed to coastal risks as well as human pressures on coastal ecosystems will increase significantly in the coming decades due to population growth, economic development, and urbanization (high confidence). The relative costs of coastal adaptation vary strongly among and within regions and countries for the 21st century. Some low-lying developing countries and small island states are expected to face very high impacts that, in some cases, could have associated damage and adaptation costs of several percentage points of GDP"* (2014, p. 17).

How Working Groups report about sea level rise varies qualitatively. Whereas WG I does not involve aspects policymakers *directly* have an influence on, WG II refers to "economic development, and urbanization", "adaptation", and impacts for low-lying developing countries.

In the SPM of WG III there was not spoken about sea level rise and ice sheet instabilities. Nonetheless, there was *inter alia* built on the urbanization component of WG II, by stating the following:

> *"Urbanization is a global trend and is associated with increases in income, and higher urban incomes*

> *are correlated with higher consumption of energy and GHG emissions. (medium evidence, high agreement).*" (2014, p. 25).

The fact that urbanization is here related to high energy consumption rates is significantly different from arguing that global mean sea level rose by 0.19 over the period 1901 to 2010, since it involves human processes in contrast to natural processes.

The cross-cutting theme ice sheet instabilities and sea-level rise shows how Working Groups appeal in a different way to policymakers. Working Group II and Working Group III to a greater extent discuss the theme in such a way that policymakers can act upon it in a *direct* manner. For example, human processes, in contrast to natural processes, have a component in itself that policy has an influence on. Another example, WG I does not involve aspects policymakers directly have an influence on, while WG II refers to "economic development, and urbanization", "adaptation", and impacts for low-lying developing countries.

Next to cross-cutting themes, cross-cutting methodologies were identified that show the extent to which Working Groups appeal to forms where policymakers have an influence on. The key conclusion and recommendations to UNFCCC of the Expert meeting on the current status of the science of alternative metrics were particularly interesting, because it shows the thin line the IPCC balances on: being policy-relevant and yet policy-neutral, never policy-prescriptive. According to Plattner et al., in order to make sure that (alternative) metrics are effective, potential future policy goals are required: "one metric might be more appropriate for guiding global emissions to an agreed-upon concentration or radiative forcing stabilization target in a cost-effective manner." (2009, p. 4).

According to WG II in the vision paper of the Chairman, alternative metrics can also do justice to regional aspects of climate change, since "regions vary in important determinants of vulnerability, and they often (but not always) share constraints and opportunities from climate similarities, socio-economic status, infrastructure, etc." It offers opportunity to choose to develop coordinated policies if the regional aspects of climate change are emphasized (Pachauri, 2009).

WG I appeals to regional changes in their SPM frequently, by stating for example: "There has been some improvement in the simulation of continental- scale patterns of precipitation since the AR4. At regional scales, precipitation is not simulated as well, and the assessment is hampered by observational uncertainties." (2013, p. 15). Moreover, it added a chapter 'Future Global and Regional Climate Change'.

WG II is also very specific in naming out regional aspects of climate change. For example, the SPM provided examples of adaptation across regions concerning "Adaptation experience is accumulating across regions in the public and private sector and within communities (high confidence).Governments at various levels are starting to develop adaptation plans and policies and to integrate climate-change considerations into broader development plans." (2014, p. 8). Furthermore, WG II's SPM outlined regional key risks and potential for adaptation.

The SPM of WG III goes beyond outlining risks and potential for adaptation. It provides a chapter on 'Sectoral and national policies', in which specific policies are assessed. For example, one of the findings is "Sector-specific policies have been more widely used than economy-wide policies" and another one: "In some countries, tax-based policies specifically aimed at reducing GHG emissions—alongside technology and other policies—have helped to weaken the link between GHG emissions and GDP" (2014, p. 28). Thus, all of Working Groups discuss regional aspects of climate change and use their own metrics, which results in different boundary arrangements. WG II and WG III to a greater extent, involve aspects where policymakers have a *direct* influence on. Moreover, the various possible policies show that Working Group III tailors their data more to the *direct* use of policymakers than the other Working Groups.

Socio-economic scenarios lend itself more than other methodologies to tailoring data to the *direct* use of policymakers. This cross-cutting methodology involves: "qualitative narrative and quantitative descriptions of potential socioeconomic and ecosystem reference conditions that underlie challenges to mitigation and adaptation" (Edenhofer et al., 2010, p. 1.) According to Edenhofer et al.: "This approach facilitates investigation and comparison of different policies, something that was challenging under previous scenario framework." (2010, p. 2). In AR5, another type of scenarios was used than in AR4, but in all of Working Groups' SPMs scenario analyses were present. Working Groups all drew the same boundary, by all presenting policymakers with all sorts of scenarios.

In conclusion, Working Groups draw different lines with respect to what Working Groups consider as their role with policymakers. WG II and WG III even more discuss aspects that policymakers have a more *direct* influence on than aspects discussed in WG I. This given relates to the fact that Working Groups tailor their data differently to the use of policymakers. Again, WG II and WG III even more provide policymakers with data that is *directly* concerned with policies. Clearly, WG I is much more reluctant to outline and assess policy potentials.

5. Conclusion

The IPCC is an organization that faces ongoing communication challenges, since it is confronted with a fundamental tension between the norms of scientific practice and needs for communication strategies that actively engage with policymakers. The question is how the different Working Groups safeguard their scientific character while communicating with policymakers. After the release of the IAC's (2010) report, the boundary arrangements of Working Groups were explored. The boundary arrangements were analyzed on the basis of Working Groups' definition of science, determination of relevant knowledge, and division of labor. The results showed that it proved to be true that all Working Groups take a different stance on this matter, due to the different nature of their assessments.

Working Groups all draw a different line with respect to what is considered as rigorous and balanced scientific information, with regards to the scientific expertise they rely on. WG II and III are more flexible than WG I in including grey literature next to white literature. Their definition of science reaches beyond WG I's definition of science, due to the type of scientific expertise they rely on. However, their definition of science may differ in the type of expertise they rely on, but the characterization and communication of science is unified. Working Groups' found an arrangement that involves attaching a certain set of words to scientific data, in order to make sure that policymakers all interpret the WGs findings in the same way.

Similarly, Working Groups make different decisions with respect to what is considered as relevant knowledge. The cross-cutting themes and methodologies showed that although the cited definition might be the same, Working Groups varied in to what extent they involved value judgments in their choice of themes and methodologies. WG II to a greater extent than WG I, and WG III most, include value judgments in their 'science'. Although it remains unclear whose value judgments are involved, it creates a space to influence as there is decided which values are valued most.

Working Groups safeguard their scientific character while communicating with policymakers differently. It became evident that WG I draws narrower boundaries with respect to the definition of science, determination of relevant knowledge, and division of labor than the other Working Groups. WG II is more flexible in these arrangements, and WG III is most flexible. After the recommendations of the IAC (2010), Working Groups were asked to sharpen their boundary arrangements, which they acted upon differently due to their different nature. The results show that science is a context-specific activity, as boundary arrangements shift according the landscape it is embedded in. So the boundary arrangements of the IPCC Working Groups shift, which offers opportunity in relation to the future of the IPCC.

6. Discussion

Questions are raised about how the definition of science shifts if one considers science as a content-specific activity. The changing political, social and cultural environments that affect climate change call for reconstitution and transparency (Beck et al., 2014). The inclusion of grey literature highlighted how indigenous perspectives now also broadened our understanding of climate change and policy interventions (Ford, Vanderbilt & Berrang-Ford, 2012). Due to the fact that Working Groups now also rely on scientific expertise obtained from grey literature, Beck et al. (2014) suggest that different protocols for expert deliberation across different knowledge domains may be needed as well as increased public transparency on how these protocols work in practice.

Besides the definition of science, the definition of relevant knowledge shifts as well. The discussion around value-free science is one that descents years ago. The Value Free Ideal, which according to Betz (2013) is in a sense applicable to the IPCC's work, is debunked by John (2015) who argues that this ideal is problematic in a world where we expect scientists not only to tell us what we must care about, but also what we should care about. The IPCC's set of values is contested, which is not solely distinctive to climate science (Jax et al., 2012). John (2015) suggests that we need to change our perception of what science can do, instead of using contested value judgments. Corner, Markowitz & Pidgeon (2014) argue that active engagement only can be established by speaking to the values of the audience. Now, the IPCC includes values judgments in their themes and methodologies, but values in hermeneutic form are absent. Corner & van Eck (2014) put forward the idea to interweave the science with narratives about people who experience climate change. What is regarded as relevant knowledge and what the role of value judgments is in this is an area open for exploration.

That science is a context-specific activity is also reflected in the tailoring of data to the needs of policymakers. Beck et al. (2014) declare that information needs of primary audiences change continuously, which asks for changes in order to maintain its policy relevance. Earlier Beck advocates for another approach that moves away from the scenario-based approach centre-staged: "'Stop debating science': from an 'excess of objectivity' to a spirit of 'professional humility'" (2011, p. 304). It seems like her recommendations are accepted in AR5 by the opening up of the debate on adaptation. Research is more focused on providing information that is useful for addressing regional and short-term problems, which she believes "would help decision-makers to explore the implications of different scenarios in a rigorous way and to evaluate what sorts of actions work to reduce vulnerabilities and enhance resilience." (2011, p. 305). The changing needs also relates back to the discussion around relevant knowledge, as science needs need to be well attuned with the knowledge needs of its audience (Turnhout, Neves & de Lijster, 2014; Corner & van Eck, 2014).

The IPCC is an organization that has proven to be open for change, not drastically, but open to minor changes. It needs to accept its position in a world that continuously changes. Needs are determined by political, social and cultural worlds, which in turn have an impact on the definition of science, the determination of relevant knowledge, and the division of task within the IPCC. It would damage the IPCC's credibility if it would keep pursuing the ideal of having policy-neutral and never policy-prescriptive science instead of acknowledging that science is a context-specific activity. Hence, the IPCC needs to carefully tune to these needs, by being on the front foot in observing changes in the landscape.

Competing Interests

The author declares that they have no competing interests.

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