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# Making Science Relevant: Comparing Two Science Advisory Organizations Beyond the Linear Knowledge Model

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**Abstract**
This article compares two science advisory organizations: the Intergovernmental Panel for Climate Change (IPCC) and the International Council for the Exploration of the Seas (ICES), with a special focus on how their respective policy systems absorb the knowledge delivered for use in decision processes. The science-policy processes of these two organizations differ in important respects; ICES delivers highly specified knowledge to a specified uptake mechanism, while the IPCC produces unspecified knowledge for an unspecified uptake mechanism. Since both environmental governance areas are criticized for lack of needed action, a comparison is of interest asking how this might relate to the organization of science advice. As theoretical resources for this explorative comparison we utilize two approaches from the field of science and technology studies: the co-production approach, which focuses on the entanglements of scientific and political processes, and the systems-theory-oriented multiple-worlds model, which assumes a clear difference in institutional logics between the scientific and the political field. Since the IPCC has been critically analysed by several studies utilizing resources from the two approaches, we contribute with new insights by bringing in ICES, which is a much less studied organization exposing a different science-policy structure. One important finding is that the two theoretical approaches focus on different aspects, exposing 'links' and 'integration', both of which we argue are important for analysing and assessing science advisory organizations. Moreover, these aspects can be advantageously integrated into a single theoretical framework.

**Key words** Science advice · Policy uptake of scientific knowledge · Co-production · Multiple worlds · IPCC · ICES

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## Introduction: Comparing Two International Science Advisory Organizations

Scientific knowledge is of crucial importance for understanding and finding solutions to environmental problems. In the two areas of climate change and fisheries, international scientific organizations have since long been established with clear mandates to summarize scientific knowledge for policy purposes. Since both areas are criticized for not achieving the desired outcomes of reducing greenhouse gas emissions and sustaining fish stocks at healthy levels, it is of major interest to study how the science advice they deliver is produced and taken up by decision-making bodies.

This article compares the Intergovernmental Panel for Climate Change (IPCC) and the International Council for the Exploration of the Seas (ICES), which both aim to make synthesized scientific knowledge relevant for policy and decision-making. The policy uptake organization for the IPCC is the United Nations Framework Convention on Climate Change (UNFCCC), which is the political negotiation body for global climate governance. The major clients of ICES are fisheries management organizations around the North Atlantic, including the European Commission (EC). Our primary focus is on how scientific knowledge is summarized to produce the science advice delivered by the IPCC and ICES, and how this knowledge is taken up by respective decision bodies; that is, the UNFCCC and the EC. To elucidate how knowledge is produced, and for what action, we analyse the mechanisms by which the knowledge objects are connected to the decision-making processes.

The IPCC and ICES are without doubt very different organizations. Although they are both intergovernmental, they work on different scales; the IPCC has a global reach, whereas ICES focuses on the Northeast Atlantic region. There are, however, also important similarities. Founded in 1988 and 1902 respectively, the IPCC and ICES are two of the oldest, most established, and most well-known international scientific advisory organizations. They both have a strong ambition to avoid politicization by heralding the scientific integrity of the advisory function. At the same time, they are criticized for not delivering on their foundational objectives of making the desired impacts on policy and political decisions in terms of sustainable fisheries and climate systems. For example, Peter M. Haas and Casey Stevens (2011: 142) assess climate change and fishery regimes to be the least successful science advisory organizations in international environmental regulation (cf. Wilson 2009; Glavovic et al. 2022). This conclusion sparks an interest in asking about the importance of how science advice is organized.

Important similarities and differences make a good basis for an interesting comparison. In analysing our two cases, we utilize approaches from the field of science and technology studies (STS). We agree with Justus Lentsch and Peter Weingart's (2011: 5) diagnosis, made more than a decade ago, that "up to the present there is no well-developed theory of scientific policy advice available". We also agree with the assertion by Sheila Jasanoff (2013: 62) that the field of STS, which is sometimes called "the science of science advice", can be expected to improve this situation.

STS scholarship argues for finding alternatives to *the linear model of expertise*, which implies a science-centred understanding that focuses on bridging the knowledge-action gap with improved knowledge. This model is assessed to be empirically

wrong (Beck 2011: 303; Grundmann and Rödder 2019: 3885). However, concerning how to develop alternatives, we find different approaches regarding how science and policy interact and should interact (Sundqvist et al. 2018). Our aim is to contribute to the existing literature by comparing two of the most prominent STS approaches: the *co-production* approach and the systems-oriented *multiple-worlds* model. Our overall ambition is to improve theoretical understandings and inspire increased reflexivity in the practical work of organizing science advice in relation to our two cases.

The next section elaborates on how to analyse science advice processes by presenting the two STS approaches. We focus on differences and similarities and how they can be summarized to be used in empirical work. In the two following empirical sections, we introduce the two science advice organizations, their policy uptake counterparts, and their respective links and interactions. In the section thereafter, we compare and evaluate differences and similarities between our two cases using resources from the two STS approaches. In this, we also take advantage of earlier STS studies about the IPCC. This means a double comparison using and assessing two different theoretical resources for an improved understanding of two science advice organizations. In the last section, we briefly summarize what can be learned from this comparative study, theoretically as well as practically.

## Analysing Science-Politics Interactions: Co-production and Multiple Worlds

The influential *co-production* approach was developed by Jasanoff (2004; cf. Latour 1993), who has also applied it in comparative studies on how scientific knowledge is used in national regulative work (e.g., Jasanoff 2005). A strong intermingling between science and policy is assumed: co-production implies that power is also epistemic, and vice versa. This means that scientific knowledge, or epistemic authority, is influenced by the policy context in which it is embedded, and that this context simultaneously shapes what counts and what does not count, as well as what gets attention in policymaking and politics and what does not. In a similar way, policy and politics are developed, framed, and influenced, or co-constituted, by science and technical reasoning. This means that there is no unilinear direction in the interplay, and that it is difficult, or even impossible, to demarcate science and politics, since the boundary between them is blurred and in perpetual flux (De Pryck and Wanneau 2017).

The co-production approach stands in contrast to a strong tradition in science advice, in research as well as in practice, to *separate* the science side from the policy side and hence talk about two different spheres, or worlds, and accordingly to focus on gaps, divides, and possible bridges between them (SAPEA 2019; Soneryd and Sundqvist 2023: chs 2–3). This focus on separation is often combined with a hierarchical understanding which puts science first: if the science is correct, it will automatically be transformed into policy outputs. This understanding is called *the linear model of expertise*. In a soft version, it means that scientific knowledge places restrictions on actions, while a stronger version means that scientific knowledge influences policy in an unambiguously determined direction.

STS scholars have criticized this linear model. Silke Beck (2011: 298) summarizes the model as the idea that more and better knowledge can solve political disagreements and thereby lead to better decisions. Beck disagrees with these assumptions and concludes that more knowledge often leads to more conflicts and thereby also to lack of action (Beck 2011: 303; cf. Glavovic et al. 2022). Others argue that the model totally ignores the policy side in its assumption that knowledge passes automatically and unchanged to policy and leads to political action (Weingart et al. 2000: 262). In this way, the linear model implies a post-political situation that makes knowledge the foundation of politics. According to the linear model, getting the science right becomes the inevitable start for political decision-making, and therefore science advice is of utmost importance. There is a wide consensus among STS scholars that the linear model of expertise is a dominant approach while simultaneously being empirically incorrect by its science-centred focus (Weingart 2023: 30).

Against the linear model, with its strong separation between science and politics, the co-production approach focuses on *integration*. For scientific knowledge to become influential and relevant for decision-making, it must be integrated among social actors of different kinds and also institutionalized. It needs to be translated to policy domains by public reasoning and civic epistemologies, where actors outside of science take part, in order to arrive at collective knowledge-based action (Jasanoff 2011: 140). As Jasanoff puts it, "environmental knowledge achieves robustness through continual interaction – or conversation – between fact-finding and meaning-making" (Jasanoff 2010: 248). These assumptions about a needed integration of scientific facts in society are presented as a prerequisite for how to strengthen the influence of science over politics.

In the co-production approach, we also find a normative argument for the importance of better integration of science in political decision-making, which lines up with the linear model of expertise. Proponents of the co-production approach, such as Jasanoff, state that decisions must be evidence-based for "co-producing legitimate knowledge and legitimate power" (Jasanoff 2010: 249). Otherwise, we end up in arbitrary and unfounded decisions, which is "anathema to enlightened societies" and something that democratic societies should avoid (Jasanoff 2013: 62; cf. Jasanoff 2011: 140). From this angle the co-production approach supports evidence-based decision-making but through improved integration of science in society.

Weingart (2023), a sociologist of science influential for the development of the systems-theory-oriented multiple-worlds approach, argues in line with the co-production approach that in today's Western societies, scientific knowledge has achieved strong legitimacy due to its epistemic authority. Particularly when it comes to risk issues, scientific knowledge is of crucial importance in defining the problems and influencing political agenda-setting. This implies that scientific knowledge increasingly plays the role of legitimizing politics. Moreover, Weingart (1999: 155) argues that "the 'scientification of politics' goes together with a 'politicization of science'". These opposing but connected tendencies in science advice grow stronger in today's complex societies, where more knowledge of different kinds is funded, produced, spread, and used in policy and political deliberations. This situation is contrary to what the linear model says and what Weingart explicitly argues against. However, he continues by saying that instead of making the empirical situation of blurred bound-

aries the basis for a theoretical approach, which is what the co-production approach does, STS scholars aiming to understand science-policy interactions should not be trapped by this situation but critically analyse it while acknowledging the different logics of science and politics. Instead of speaking about 'hybridisation' and 'blurred boundaries', we should understand the interaction between science and politics as 'close coupling' (Weingart 1999: 157–158).

According to Weingart, the differences between science and politics are chiefly about how the problem is perceived (rules of selectivity), how uncertainties are assessed, and specific time horizons (Weingart et al. 2000: 263), which together make up a non-hierarchical relation between different *institutional logics*. The differences are not random but systematic and lead to concrete problems in communication between the fields of science and politics, which Weingart and colleagues (2000: 280) describe as risks and disturbances. Communication between the fields is important for dealing with complex problems, and increasingly so in today's societies, but the problems (risks) of communication need to be openly discussed and acknowledged by all involved actors.

Following Weingart, Reiner Grundmann and Simone Rödder (2019: 3886) propose the model of *multiple worlds*, which assumes that science and policy follow different institutional logics: scientists present summaries of what science says, but politicians use science advice for political reasons. Communication across the worlds of science and policy is possible but difficult and constrained, they argue, and this cannot be solved by more and better knowledge. Scientific evidence does not "travel seamlessly from one world to another and linear models such as the 'evidence-first credo' are not helpful in guiding how scientists think about their link to the world of policy and politics. The multiple world-model instead calls for an acknowledgment of these communicative risks as inherent to science-policy debates" (Grundmann and Rödder 2019: 3886). From this understanding of multiple worlds and disturbed communication – based on important differences between the world of science and the world of politics – the linear model is truly wrong, while the co-production approach can be seen as hiding important characteristics concerning the different logics of science and politics and their specific *links*.

However, the co-production approach does not need to be interpreted as fully rejecting the possibility of a separation between science and policy. While there is still a strong public image of science as being something separated from policy, which co-productionist STS scholars often acknowledge, science as detached from politics, they argue, is never the full story. As Bruno Latour (1993) suggests, processes of purification (the separation of science and policy) always occur together and in parallel with processes of hybridization (co-production) (cf. Jasanoff 1990: 236–237). However, processes of hybridization are considered primary and thereby he concludes, as the title of his well-known book indicates, we have never been modern (separated).

Grundmann (2017: 43), nevertheless, maintains the importance of keeping a conceptual separation between science and politics. If this separation is obscured, it becomes difficult to study the links between them and patterns in their relationship. Moreover, empirically there are specific ways in which the interplay between science and politics is institutionalized, which, he argues, many co-productionists, such

as Latour, are ignoring (Grundmann 2017: 35). Jasanoff's interest in how scientific knowledge is embedded in political cultures, e.g. civic epistemologies, is precisely about this interplay (Jasanoff 2005). However, she is not interested in discerning the components of specific worlds when focusing on integration and the outcomes of the interplay between science and policy, which are understood as hybrids of 'facts' and 'meaning', as mentioned above.

In elaborating on the theoretical approaches, which we prefer to see as complementary (cf. Maasen and Weingart 2005: 8, 10), we focus in the sections below on how science advice and policy uptake mechanisms are organized. Taking advantage of our two cases in this comparative theoretical work we try to identify how the interplay between science and politics can be recognized as processes of co-production *and* as risks of communication between two worlds, when focusing both on integration and links. However, first we show how the science advice and its uptake mechanisms are organized in our two cases.

## Science Advice and Policy Uptake in Global Climate Governance

The IPCC was established as a UN body in 1988 with the mandate "to provide the world with *a clear scientific view* on the current state of knowledge in climate change and its potential environmental and socio-economic impacts" (IPCC 2024, our emphasis). This ambition is very general; it does not explicitly ask for relevant advice, nor does it mention possible response strategies and solutions. One important reason for this broad and vague mandate is that at the time of its creation, there was no political counterpart acting as a receiver for the knowledge generated by the IPCC. The recipient was no more specific than "the world", and the IPCC was just an organization for gathering scientists around the topic of climate change (for the history of the IPCC, see Bolin 2007; De Pryck and Hulme 2023).

In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was signed by 154 states at the United Nations Conference on Environment and Development in Rio de Janeiro. It entered into force in 1994, and today has 197 member states. The UNFCCC is the political negotiator of the member states (called parties) based on the ultimate objective of stabilizing "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UNFCCC 1992: Article 2; cf. Oppenheimer and Petsonk 2005). Since this time, the aim of the IPCC has implicitly been transformed into a task of delivering science advice ("a clear scientific view") on how to understand and define "dangerous anthropogenic interference", which became the basic regulatory object, and to deliver synthesized scientific knowledge to help global political negotiations to "prevent" this from occurring. The IPCC now had its policy uptake organization in place, i.e., the Conference of the Parties (COP) meetings where member states meet once a year to make "the decisions necessary to promote the effective implementation of the Convention" (UNFCCC 1992: Article 7).

### The IPCC Knowledge Object: Comprehensive Reports of Synthesized Knowledge

The IPCC's ambition to deliver a coherent *knowledge object* – a clear scientific view on the state and consequences of climate change – is handled by its three working groups. Working Group I (WGI) is responsible for assessing *the climate system*, including climate change and its causes. The second aspect of the knowledge object is an assessment of the *consequences* of ongoing global warming, which is the focus of WGII. The third aspect is concerned with *response strategies* (the task of WGIII), comprising measures and solutions that could help in achieving the aim to "prevent dangerous anthropogenic interference with the climate system".

The IPCC's science advice is presented in comprehensive reports, synthesizing (assessing) published results from a wide area of scientific disciplines, but historically giving priority to the natural scientists in WGI, which is the group with the highest authority. The IPCC's reports, produced in cycles of six to seven years, have increased in complexity and length, implying that more issues are being dealt with by more experts (Jabbour and Flachsland 2017). There seems to be no limit on how much knowledge could be summarized in the IPCC assessment reports and there is a striving to include more researchers representing more countries and disciplines (De Pryck and Hulme 2023).

The IPCC has no ambition to intervene in political negotiations, but instead has a desire to keep politics at arm's length. Its aim is to deliver scientific facts to the UNFCCC and to the world, and since the beginning of its work, this has been codified in the self-imposed aim of being "policy-relevant and yet policy-neutral, never policy prescriptive" (IPCC 2024).

However, this is not the full story. As is clear from its name, the IPCC is an *intergovernmental* organization. The work is led by the Panel, which is the decision body that meets in plenary sessions once or twice a year (IPCC 2013). All the IPCC's 195 member governments are members of the Panel and can send representatives to the annual sessions. The Panel makes decisions about the production of reports, including outline, review, approval, and line-by-line approval of the shorter reports known as Summaries for Policymakers (SPMs). This means that government representatives make important decisions about the knowledge object. However, the work of synthesizing the research, between outline and review and approval, is performed independently by the authors, who are researchers nominated by their national governments. Generally, the political influence is clear, and government representatives and researchers work closely together at some points during the review and approval processes.

In 2007, the IPCC was awarded the Nobel Peace Prize (together with former US Vice President Al Gore). Its ambition to summarize global scientific knowledge through scientific consensus in a field of great complexity and with high relevance has been praised. As a scientific summarizer of global knowledge, consensus-builder, and agenda setter, the IPCC has become a role model admired by many (Lidskog and Sundqvist 2015; De Pryck and Hulme 2023).

### UNFCCC as the Policy Uptake Mechanism of IPCC Knowledge

The IPCC has no formal influence over how its reports are used in political negotiations during the annual COP meetings (De Pryck 2018: 206). In fact, the UNFCCC organization has no clear policy uptake mechanism for the IPCC knowledge object. However, there are organizations between the IPCC and the UNFCCC, which work on behalf of the UNFCCC, for instance, the Subsidiary Body for Scientific and Technological Advice (SBSTA) (UNFCCC 1992: Article 9; cf. Miller 2001). The task of the SBSTA is to present relevant and timely information and advice concerning scientific issues, in a way that is understandable and useful for decision-making in COP meetings (De Pryck 2018: 203). The SBSTA holds a position as a broker between the IPCC work and the COP meetings; in practice, however, the role is hard to assess since there are no mechanisms guiding the work and no obligations for government representatives to use the SBSTA information in political negotiations. Overall, national government representatives attending COP meetings can use the IPCC knowledge, summarized in long reports, in short reports, and by the SBSTA, according to their own preferences (De Pryck 2018: 207).

The Paris Agreement, decided in 2015 at COP 21 in Paris, is the current specification of the work of the UNFCCC. The basic structure of the Agreement consists of two combined parts. One is national, and based on what the member states voluntarily decide about reduction of greenhouse gases, and the other implies a global target, well below 2 degrees Celsius, which the total emission reductions of the member states should lead to. The Agreement has been called a national turn in global climate politics, but it is not clear how global scientific knowledge could support these ongoing national processes of strengthening mitigation (Hermansen et al. 2021). Social scientists have argued that the IPCC should focus more on giving advice to national governments to influence improvement of the national commitments (Lidskog and Sundqvist 2022; cf. Turnhout and Lahsen 2022).

### Interactions Between the IPCC and the UNFCCC: Match or Mismatch?

Regarding the interactions between the knowledge object and the policy uptake mechanism in global governance of climate change, we find three main characteristics.

Firstly, the IPCC has a broad mandate of assessing available scientific knowledge about the climate system, the consequences of climate change, and possible response strategies. These assessments are published and delivered to the UNFCCC as comprehensive and extensive scientific reports, including short summaries for policymakers. No interventions are made, and an arm's-length distance is promoted by the aim of not being policy prescriptive. The message is without direction in relation to action.

Secondly, the work of the UNFCCC is of a broad character but today codified in the Paris Agreement, which has a scientific basis in its temperature target to prevent dangerous anthropogenic interference with the climate system (Guillemot 2017). However, the Agreement is nationally driven by voluntarily formulated ambitions without clear connection to temperature targets. The UNFCCC lacks a clear policy

uptake mechanism, and there is no guidance on how to take care of the IPCC assessments in the political negotiations.

Thirdly, the IPCC and the UNFCCC have broad ambitions and mandates, and the connections between them are unspecified. The IPCC presents a knowledge object like a smorgasbord of many dishes, which decision-makers can choose from according to their national preferences. In this sense, there is a match between the knowledge object and the uptake mechanism since both are unspecified. The connection between the IPCC and the UNFCCC is weak and the interaction unpredictable since the UNFCCC and national government representatives can choose not to listen to or act on the IPCC assessments and they do not have to tell why.

### The IPCC Assessed by STS Scholars

As already mentioned, the IPCC and its policy uptake has been scrutinized in many STS studies (see De Pryck and Hulme 2023 for a summary inspired by the co-production approach). Since this is a contrast to ICES, we briefly summarize some important results from these studies before presenting the fisheries case. We start from the approach of co-production followed by studies applying the multiple-world approach.

Scholars inspired by the co-production approach argue that the IPCC work is based on a linear model of expertise and that this is one important reason for political inaction. The ambition to give science a prominent position leads paradoxically to the politicization of scientific results and thereby to paralysis and inaction (Beck 2012: 221). The recommended alternative to this science-centred view means to "develop appropriate procedures for proceeding in global governance that can bridge culturally divergent styles of reasoning that are deeply embedded in national political cultures" (Beck 2012: 236). This means to focus on how scientific knowledge becomes *integrated* in governance and decision-making processes. Concerning the IPCC knowledge, this institutional capacity is not in place, and a reason for this is the IPCC itself, which consciously stays away from political action using the mantra of being "policy neutral" and "never policy prescriptive". This focus is criticized by STS scholars for being too narrow, too scientistic, and relying too heavily on consensus (De Pryck and Hulme 2023).

Clark Miller (2023: 254–255) suggests that the IPCC should be re-imagined to be fit-for-purpose for the tasks ahead, i.e., to deliver systematic action for a climate-neutral future by 2050. The way for the IPCC to do this means to help "diverse actors mobilise or build distributed capacity for the knowledge and expertise necessary to understand how the world's diverse energy systems work… what it will take to transform them to achieve a climate-neutral future" (Miller 2023: 260). In short, the IPCC's summaries of scientific knowledge need to be better integrated in society in order to be part of not only global but also national and local decision-making processes.

The multiple-worlds model agrees with the co-production approach that the linear model is a problem for the policy impact of the IPCC knowledge. While being widespread, the model creates paradoxical consequences when the ambition to delete political issues in the assessments (policy prescriptions) leads to a politicization of

the results (Grundmann and Rödder 2019: 3887). "The result of this depoliticization is a lack of progress in climate policy as science has taken centre stage but is unable to offer political solutions" (Grundmann and Rödder 2019: 3889).

The solution according to this approach means to put more focus on politics: to acknowledge that the logic of politics is to make problems solvable by political decision-making, to make them urgent and relevant for the current legislative period and not possible to postpone to the next (Weingart et al. 2000: 263). Political parties judge scientific results based on political purposes by applying a political logic and therefore the relevance of science must be understood from the logic of the political world (Grundmann and Rödder 2019: 3887).

However, the IPCC has hitherto not placed much emphasis on supporting action, it has not assisted in the work to carve out actionable paths and policy design more generally, and thereby has not produced *practical knowledge*, i.e., knowledge that leads to effective policies with regard to what is intended to be achieved (Grundmann 2018: 437; Stehr and Grundmann 2012: 38). The links to political decision-making are not there, and the reason is the ambition of not being policy prescriptive. The alternative proposal to focus on politics seems to be close to what proponents of the co-production approach understand as better integrated science. We will return to the similarities and differences between the two approaches after presenting science advice in fishery governance.

## Science Advice and Policy Uptake in North Atlantic Fisheries Governance

We now bring in another science advice organization that is far less studied than the IPCC. Since it differs from the IPCC in important respects, it is of interest for comparison, especially because it seems better *integrated* with policymaking in that *decision-making* is a clear task in the uptake mechanism. In short, the *links* between science and politics are much closer and more specified. But does this mean that ICES delivers *practical knowledge* (cf. Stehr and Grundmann 2012)?

ICES is the world's oldest intergovernmental science organization, established in 1902 by eight European countries. It was established to orchestrate international marine and fisheries science among its member countries, and to give recommendations to national and international fisheries management organizations. Since its beginning, ICES has been preoccupied with a "tension between the pursuit of new scientific knowledge and the societal uses intended for that knowledge" (Rozwadowski 2004: 42). The reason for this tension is that the knowledge which ICES creates "about the marine environment and its inhabitants has been intended, from the start, to maximize the exploitation of the sea's resources" (Rozwadowski 2004: 42). Hence, science and political decision-making have been intimately entangled for a specific purpose – to maximize fish catches – and the science under ICES is a consequence of this policy objective.

Today, ICES has 20 member countries on both sides of the North Atlantic and is part of a complex institutional framework that was established after WWII for international fisheries management. The design and initiation of this policy framework

involved several influential and path-dependent developments between the 1950s and 1970s. Discussions in two existing North Atlantic Fisheries Commissions during that time, including ICES, led to the establishment of a quota-based management system for fisheries (Gezelius 2008). The conclusion that catch quotas should be used to regulate and manage fisheries was implemented from the 1970s onwards, and quotas in the form of Total Allowable Catches (TACs) became the cornerstone of fisheries management around the North Atlantic. TACs were later also used in the EU's Common Fisheries Policy (CFP) system which was put in force in 1983.

Today, the mandate of ICES is about "producing advice based on the best available science that is characterized by quality assurance, developed in a transparent process, unbiased, independent, and is recognized by all parties as being relevant to management" (ICES 2018: 1).

### The Knowledge Object of ICES: TAC Advice

The primary advisory output of ICES is the so-called "recurrent advice" for annual TACs related to a huge number of individual fish stocks. The scientific basis for this advice is developed through standardized procedures within ICES expert groups (Linke et al. 2023). An advice-drafting group prepares the advice based on outcomes from the expert groups, the advice is finalized and approved by ICES Advisory Committee (ACOM), and finally the advice is delivered to the clients (ICES 2021).

Specific procedures for *annual fish stock assessments* were developed during the 1950s and 1960s. These assessments enable ICES scientists to calculate the size and growth of individual fish stocks via statistical analyses using age classes (cohorts) entailing natural mortality and actual fishing mortality (Gezelius 2008; Holm and Nielsen 2007). By knowing the stock size and how much is removed from a specific fish stock every year, it is possible to model the population dynamics and to set a catch limit for the following year, and thereby (ideally) control fishing activities in a biologically sustainable manner. The scientific procedures of stock assessment are based on biological models derived from extensive research on fish population dynamics, including a modelling technique called virtual population analysis (VPA).

The VPA allows scientists to make sustainable catch predictions in the form of TAC advice, which then enables managers and decision-makers in the EU or other governments to set quotas for protecting fish stocks from overexploitation. Despite various problems with the VPA method – for example, its uncertainty treatment has been characterized as "guesstimation" (Holm and Nielsen 2007: 180) – it has become the dominant assessment tool for fisheries management around the North Atlantic. The key reason for this is that the VPA enables a scientific knowledge object – TAC advice – which feeds into the intervention mechanism on the policy side: TACs, i.e., decisions on fishing quotas.

### The Policy Uptake Mechanism for Fisheries Management: TACs

Historian Helen Rozwadowski (2002: 188) describes the interplay between the scientific assessments (VPAs leading to TAC advice) and policy (TACs: decisions based on TAC advice) as fitting each other like "hand in glove". However, it is important to

underline that the advice from ICES is not just outputs from stock assessments, but concrete TAC advice (maximum sustainable catch limits) based on specific policy objectives such as the maximum sustainable yield and the precautionary principle. In this sense, the science advice from ICES is presented as policy recommendations.

The "hand in glove" metaphor captures the intimate relation between science and policy in fisheries management. While the "TAC is the end of the VPA calculation" (Rozwadowski 2002: 190), TACs are concurrently the starting point for VPA-based stock assessments since the TAC approach has favoured the historical development and use of VPAs. As described above, these stock assessments enable scientists to make concrete catch forecast predictions (TACs in tonnage), which are preferred by policymakers because they are regarded manageable. The process follows a yearly chain of events: ICES produces stock assessments and gives advice on TACs, the EC receives this advice, consults several other bodies, including the EU Parliament and an EC-owned expert committee, and then prepares a proposal for the EU Council of Ministers, which finally makes the political decisions on TACs.

These Council decisions have been described by an EC insider as "horse-trading", ending up in a "reality of negotiation" in which "red lines [set by the EC] were often ignored" (Penas Lado 2016: 264). However, while the science-policy interactions resulted in TACs as the main regulation tool for fisheries management, this was not made because TACs were seen as the best solution for managing fisheries from either an ecological, an economic, or a social perspective. Instead, when the pros and cons of controlling efforts or outputs for fishing activities were discussed by the Fisheries Commissions in the 1960s, TACs emerged as the preferred tool of managers because they mirrored the political constraints of the time; that is, the political context of finding a suitable measure to decrease overfishing. As Stig Gezelius (2008: 35) puts it, "the TAC-based model was recommended largely because it was better suited to meet the practical political demands for feasible allocation and administration".

In the 1960s and 1970s, VPAs and TACs, due to their co-constituency, experienced an institutionalization in the form of quota-based fisheries management. Consequently, TAC decisions on catch quotas became the policy uptake mechanism for North Atlantic fisheries management. The first TAC quota was applied to the George Bank haddock in 1970, which at this time was under heavy fishing pressure from international fleets. Despite various problems with both the VPA (high model uncertainties and interpretative flexibility due to limited data reliability) and the TACs (problems in calculating and enforcing quotas due to having control of landings rather than actual fishing activity at sea), the TAC-based management regime became the dominant intervention tool (Holden 1994). Already in 1977, TACs were used to manage 70 fish stocks in the North Atlantic (Rozwadowski 2002: 191), and today ICES gives yearly advice for around 200 fish stocks.

### Science-Policy Interactions in Fisheries Management: the TAC Machine

Petter Holm and Kåre Nielsen (2004) use the term "the TAC Machine" to describe the interplay between fisheries science, in the form of fish stock assessments such as VPA, and the policy-uptake mechanism whereby TAC advice is used for decision-making on TACs. This 'machine' is an example of the mutual constitution of

scientific knowledge and policy developments. This system has institutionalized a co-dependence between a scientific advisory system and its policy counterpart, with precisely defined tasks for the science community (ICES) and for the clients (the EC and others) who request scientific services for policy- and decision-making (Gezelius 2008; Holm and Nielsen 2004, 2007; Penas Lado 2016). In practice, this interface enables a clear-cut separation with well-defined divisions of labour for the realms of science and political decision-making, where science is tasked to produce and deliver a specifically formalized knowledge object (TAC advice) that translates directly into the policy-uptake mechanism: the management of fishing via quotas (TACs). This is the TAC machine.

The TAC machine allows both an assessment of fish in the sea and a projection of catch options for distributing fishing rights among multiple members (fishing countries). The distribution of TACs among these members follows a politically agreed principle of so-called "relative stability", which means allocating the relative share of quotas according to historic catch levels (Penas Lado 2016: 26ff). Historical political and economic interests are strong, and the TAC machine presents an organizational mode of regulating among these without major political conflicts, because each fishing party (i.e., each state) gets a certain percentage of the quota that has been decided.

The institutionalization of the TAC machine implies a densely packed annual work programme for ICES, to ensure the timely delivery of the contracted advice by a specific date. The EU Commission, as the most important client of ICES, signs a Memorandum of Understanding as a formal agreement for the provision of the advice, including details of financial compensation (Ballesteros et al. 2018; Delaney and Hastie 2007). Regarding the *interaction* between science advice and policy uptake, we can detect both close interaction and strong separation between the realms of science and politics, enabled through the specific interface where science advice is delivered to the policy side in the form of numbers based on scientific assessments, which are feasible for policy actors to decide on as quotas.

## Comparison of Two Science Advice Organizations and Two Theoretical Approaches

In this section, we do three things. First, we summarize our two cases presented above in the light of the linear model, which is considered to strongly influence the two science advice organizations. Second, we return to the analyses of the IPCC made by the two theoretical approaches and focus on differences and similarities, specifically on *links* between science and politics and on the *integration* of science in wider policy processes. Third, we apply the two approaches on ICES, which seems to be organized more in line with what both approaches suggest.

The two cases show important differences in relation to both *science advice* and *policy uptake mechanisms*. The chief knowledge object of fisheries, delivered by ICES in the form of sustainable catch limits (TAC advice), is specified and produced in reaction to certain requests by clients such as the EU Commission, with whom ICES signs agreements. ICES' knowledge object hence serves a clear political purpose: to maximize fish harvests without impairing the reproductive potential

of fish stocks. This specific knowledge object stands in sharp contrast to the vague and unspecified knowledge output from the IPCC. If we in this case can at all speak of a knowledge object in the strict sense, it consists of a process that serves a broad accumulation of knowledge aimed at presenting a global consensus on what science knows about climate change. This knowledge object is a possible resource for the political negotiations under the UNFCCC, but without any specifications on how it should be used to "prevent dangerous anthropogenic interference with the climate system" (UNFCCC 1992: Article 2).

In both cases, the policy uptake mechanism is linked to, and partly shapes, the knowledge object. In the fisheries case, the policy uptake mechanism for decisions on fishing quotas (TACs) presents the endpoint of the scientific knowledge process. The catch advice from ICES (in tons for specific fish stocks) translates directly into the decision process on TACs, also specified in tons. If politicians in the EU Council of Ministers fully adhere to the science advice, the decision would entirely mirror the scientific advice from ICES. However, unsurprisingly for liberal democracies, this is not the case. Political decisions in fisheries management, and most of all in the EU, have been criticized for not attending to the scientific advice, which is seen as a main cause of unsustainable fisheries (Wilson 2009: 24). The UNFCCC, while similarly criticized for not listening to the science – as addressed by public protests from the climate movement in connection to COP meetings (Cassegård et al. 2017) – has no specified uptake mechanism for any specific scientific knowledge object. Neither the UNFCCC nor its national government representatives at COP meetings have a formalized reason to pay attention to the information presented in the IPCC assessment reports.

Concerning *interaction*, we can conclude that both fisheries and climate governance have a *match* between their science advice and uptake mechanism. The climate case reveals a broad knowledge object that is developed together with a broad uptake mechanism, while the fisheries management case shows how a highly specified knowledge object is co-constructed with a specified policy uptake mechanism (the TAC machine). We also find that the two science-advice organizations are partly responsible for this situation. ICES has been an important actor for establishing the TAC machine, while the IPCC has been reluctant to engage in the design of a more concrete policy.

Despite the importance of the political context, i.e., maximizing sustainable fish harvests and preventing dangerous anthropogenic climate change, the two science advice organizations are caught within a linear model of thinking and an 'evidence-first credo' (Grundmann and Rödder 2019). The IPCC and ICES aim to just deliver the facts without prescriptions (Linke et al. 2023; Mahony 2023). This science focus implies disguising what is of crucial importance; that is, the basic reasons for the scientific work carried out. Scientific assessments and advice within fisheries and climate change have been part of normative agendas from the start. They respond to perceived threats – overfishing and anthropogenic climate change – and they only exist because of these political contexts. The adherence to the linear model disguises this important mutual interplay between science advice and political processes, which from our two theoretical approaches reveal the existence of both co-produc-

tion *and* close links between multiple worlds. Shortly we will further develop these conclusions.

We now return to how the two STS approaches analyse the case of the IPCC. Both approaches focus on political processes to which the science advice should come closer. Studies performed by the co-production approach focus on how scientific knowledge could become better embedded in governance and thereby contribute to build institutional capacity to act. Studies by the multiple-worlds approach argue instead that the different logics of science and politics should be better understood and given a more prominent place. The ambition should not be to lower political barriers to make science flow more smoothly to politics, which is the ambition of the linear model, but to understand the relationship between science and politics as a genuine communication problem between two different systems, or with Weingart et al.'s (2000) formulation as "communicative risks". This means, first, to understand politics from the perspective of politics and not from science, and then, second, try to make science useful for politics.

The focus on political processes is a similarity between the two approaches. However, the difference between 'integrated science' and 'close links' between the two worlds of science and politics needs to be scrutinized in more detail.

Regarding co-production, we have already stated the obvious: without perceived political and environmental concern about climate change, the IPCC would not exist as a UN-body. This implies that the organization is integrated in a political context, in which it needs to navigate and find its role. In searching for what gives legitimacy, the IPCC decided early on that policy neutrality serves this purpose. However, according to a co-production understanding, the myth of 'pure science' rests on a political culture that makes this myth possible (Jasanoff 1990: 236–237). This culture includes interactions and contacts between different worlds, which according to the myth itself should not exist. Our analysis also shows a close interaction between scientific experts and political decision-makers, for instance, in the work of SBSTA and in the approval plenary sessions when the most wide-spread reports, the SPMs, are reviewed and agreed line-by-line among scientists and policymakers together. These activities exemplify a mutual interplay between knowledge and power, which results in almost blurred boundaries. The work of the IPCC is hence more political than its self-description as 'policy-neutral' and 'never policy prescriptive' would make us believe (Grundman and Rödder 2019: 3886–3887). But do these processes of co-production also mean that the IPCC is sufficiently integrated?

The IPCC must be understood as integrated in a wider political context and specifically in the work of the UNFCCC. This integration is what scholars of co-production ask for in order for scientific knowledge to influence policy and politics. But this does not seem to work well enough in the IPCC case. The integration is too weak; decision-makers do not seem to be sufficiently influenced by the work of the IPCC to propel action. As we have already seen in an earlier section, scholars of co-production conclude that IPCC knowledge is at a distance from decision-making processes and not fit-for-purpose to support these on regional, national, and local levels. The linear knowledge model, resulting in policy neutrality, is not a useful resource for reorganizing the IPCC work (De Pryck and Hulme 2023). In short, a

clarified integration of the IPCC knowledge assessments into policy and in society at large is not (yet) in place.

According to the multiple-worlds approach, better integration of science still means a science-centred perspective. What is missing is an understanding of the different logics of science and politics (Grundmann 2017: 32–35; cf. Hulme 2018: 333–336). Deleting the demarcation between science and politics by focusing on co-production and better integration is thus not a preferable solution. As we have seen earlier, the problem with the IPCC from a multiple-worlds approach is its disinterestedness in political processes, including how to design policy. Thereby it cannot deliver practical knowledge with the capacity to support decisions.

We can now conclude that there are separated worlds of science and politics in the global governance of climate change, including clear 'risks of communication'. However, we can also identify how these separate worlds rest on co-produced processes that installed the global governance of climate change in the first place and that have nourished it ever since. Yet, for the multiple-worlds approach it is important to keep the specific characteristics of the two worlds of science and politics as distinct entities in order to be able to analyse and evaluate the links between them and not lose sight of them in studies of co-production and blurred boundaries. From a co-production approach, a too strong focus on existing demarcations, separate worlds and stable characteristics means that the mutual influences and co-dependencies between the two institutions are not sufficiently acknowledged.

From these critical insights about the IPCC, ICES seems to be organized more in a way the two theoretical approaches are asking for. In this organization, we find a clear and close link between science advice and political decision-making. Moreover, a distinct logic of politics is obvious: to maximize (sustainable) fish catches. Hence ICES seems to deliver what Stehr and Grundmann (2012: 34) call *practical knowledge*, i.e., knowledge as a capacity to act. For knowledge to be practical it must be connected to situations where room for action exists, and it must be adapted to decision-makers' demand (Stehr and Grundmann 2012: 38–39). This appears to be fully in line with the advisory work of ICES.

However, despite this 'hand-in-glove' situation between advice and potential decisions, ICES' science advice has often failed to compel decisions for protecting fish stocks, notwithstanding extensive research and sophisticated advisory procedures. As shown above, scientific knowledge in fisheries is in a much stronger position to directly impact political decisions than science in the climate regime. However, although science advice in fisheries is far more integrated in the political decision-making system and the coupling between science and politics is much stronger, this is obviously not enough to make science fully compelling for political action.

How can we explain this policy failure? From the STS critique of the linear model, we should not be surprised, nor assess such mismatches between science and decisions necessarily as a failure. Rather, we can see this non-adherence to science as 'democracy in action' where science advice is "disregarded for socio-economic reasons" to avoid political unpopularity (Holden 1994: 70). Something more seems needed than tight *links* and *integration* for making fisheries governance delivering sustainable fisheries. Proponents of the multiple-worlds approach argue that science is not necessarily the most compelling component when politicians make their deci-

sions (e.g., Grundmann 2013: 372). They also state that scientific experts could adapt to this political situation and try to influence politics by delivering more practical knowledge (Stehr and Grundmann 2012). While ICES certainly strives to adapt, its deliberate stance to avoid any political standpoint prevents this expert organization from taking such a more engaged role vis-à-vis policy and politics.

From the co-production approach we can therefore conclude that ICES advice is still not sufficiently integrated in the broader societal and political processes that it serves, despite its aims to include fishing industry, NGOs, and other stakeholders in ongoing procedures (Ballesteros and Dickey-Collas 2023). The fact that such a broader integration of ICES advice, which would attend more specifically to the practical usage of science, is not yet in place and that an 'evidence-first credo' remains dominant, can be seen as a reason for ongoing unsustainable fisheries governance.

## Conclusions

In this study, we have combined a comparative empirical analysis of how science advice is connected to policy uptake mechanisms in the work of the IPCC and ICES with a theoretical ambition to further existing conceptualizations of science-policy interactions beyond the linear model of expertise.

We found in our two cases concrete mechanisms that exemplify separate worlds with different logics, entailing risks of disrupted communication between them. However, we also found that processes of co-production serve as underlying foundations to establish the institutional roles for science and policy within the respective regular frameworks, thereby providing organizational grounds for meaningful divisions of labour between the two domains. The TAC machine of fisheries management is an iconic example of such an ensemble of co-production and separation, showing how clearly separated moments and mechanisms for science advice and policy-uptake are woven together in a regulatory framework. A tightly co-produced system has determined concrete tasks and obligations for science and policy, enabling a practical division of labour through an (invented but real) boundary between the two domains. In the climate case, the IPCC's self-imposed ambition to keep a clear distance from political negotiations never gives a true presentation of the actual situation, since there is ongoing cooperation between scientists and government representatives. Nevertheless, this ambition of separation is used strategically to survive in a hostile world of strong fossil fuel interests. Sticking to 'pure science' is both a response to this situation and an example of how a division of labour between separate worlds is the result of processes of co-production.

We end our conclusions with four points that provide an assessment of the comparison of the theoretical approaches. First, the focus on 'links' (multiple-worlds) and 'integration' (co-production), respectively, make an important contrast between the two theoretical approaches, and summarize in a neat way their main difference. Both approaches are interested in both links and integration, while the difference between them is about priority. For the multiple-worlds approach, the existence of two worlds containing different characteristics is important to maintain when studying science-policy interactions. Therefore, the focus is on the links between them, which can

be of various kinds. If the worlds are not understood as separate, the links will be unrecognized. How these worlds and links are embedded in a wider societal context is secondary. The opposite goes for the co-production approach, which prioritizes how science and politics become entangled without focusing on strict boundaries.

Second, both links and integration are important aspects to analyse in studies of science-policy interactions, and according to our two approaches, they are critical aspects. Lack of links and lack of integration means risks of policy failures. From the two approaches, it is possible to formulate factors and criteria about what links and what integration are fruitful, effective, democratic etc. This highlights the need that the two approaches should be combined (see point four below).

Third, compared to the multiple-worlds approach, the co-production approach risks to reproduce the linear model due to less interest in political decision-making, i.e., the logics of politics. This is due to the assumption that a better integrated science would lead to more entrenched and inclusive politics.

Fourth, we want to argue from this study that the two approaches are not necessarily contradictory but can be applied as complementary and eventually possible to integrate into one single framework. Links and integration are two important aspects when understanding, studying, and improving science advice and its policy uptake. They help to explain different aspects of existing interactions between science and politics. A combination can help in explaining critical questions in science advice and its policy uptake and contribute to an improved STS-influenced 'science of science advice' (Jasanoff 2013). To our knowledge, such a focus on links and integration has not yet been applied in the same analysis of science advice organizations.

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