Expert Assessment as a Framing Exercise

The controversy over green macroalgal blooms' proliferation in France

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Abstract:

This paper contributes to unraveling the "paradox of scientific authority", i.e. the fact that despite the loss of authority of scientific expertise, policy-makers still resort to expert advice. Reexamining the role ascribed to expert assessment in the policy-making process in controversial contexts in particular, the paper succeeds in demonstrating that one of the crucial roles of expert evaluation is to establish a more compelling definition of the problem to be dealt with by policy-makers. Taking the scientific controversy surrounding the proliferation of green algal bloom on Brittany beaches (France) as a case in point, I show that expert assessment conceived as a framing exercise is, however, a two-way process: it is as much about framing for the sake of settling an expert dispute with sound scientific categories than about solving public problems in a sufficiently consensual way, taking into account the distribution of power more generally in society.

1. Introduction

Evoking a "paradox of scientific authority" in the policy-making sphere, Bijker et al. (2009, 1) claim that: "cases in which science-based advice [to policy makers] is asked most urgently are those in which the authority of science is questioned most thoroughly". The long-lasting scientific controversy surrounding the expert assessment on the proliferation of green algal bloom on Brittany beaches (France) illustrates this paradox very well. The controversial aspects are of little surprise in such a regulatory science context, i.e. a context of scientific knowledge being produced for public policy. As Jasanoff (1987, 195) clearly stated: "Knowledge claims are deconstructed during the rule-making process, exposing areas of weakness or uncertainty and threatening the cognitive authority of science". Yet, what might appear more surprising is the fact that despite the enduring nature of the scientific controversy, public authorities have persisted in commissioning new expert assessments, often to the same experts, in a bid to address the issue of "green tides" on the public agenda. We will see that, beyond the issue of "green tides", it is the high-profile issue of pollution from intensive farming, set on the public agenda for the past thirty years that is ultimately at stake.

Literature focusing on such controversial contexts usually concentrates on the ways in which a controversy can settle, at least temporarily.[1] This literature highlights the importance of procedural aspects (Joly 1999). In particular, some authors (Granjou 2003; Collins and Evans 2007) show how public deliberation and a procedural model of expertise has been favoured in order to address the trust crisis of citizens vis-à-vis science following major catastrophic events in the 1960-70s. A first sight, it seems to be the case here too. Indeed, in a typical French technocratic tradition, it is an expert assessment originating from ministerial general inspectorates that ended the controversy. In this paper I however argue that one

should rather pay attention to substantial aspects in the closing of controversies. Several authors have touched upon such substantial aspects and on framing activities in particular. For instance, within the realm of public policy analysis, specialists of public problem construction have done extensive research on the impacts of framing processes in public debates on science-related topics (Schon and Rein 1994; Benford and Snow 2000). Yet, they usually consider the production of knowledge itself as a black box unlike the Science and Technology Studies' (STS) tradition. As for studying framing processes within the STS literature (Miller 2000), most STS works are most likely to deal with "public understanding of science", highlighting questions of public meaning and the issue of trust in particular (Wynne 2003). Apart from a few notable exceptions (Wynne 1989; Shackley and Wynne 1995), it focuses on the public: it is about "how publics know" (Jasanoff 2005, 16) and about citizen engagement with science and less about the production and validation of knowledge within the context of the policy-making process.

However, I argue that paying attention to this aspect of knowledge validation within the context of the policy-making process, emphasizing policymakers as prime targets and users in the framing activities attached to expert assessment, is of paramount importance. Such a perspective helps us better understand the paradox of scientific authority described earlier, i.e. the fact that "despite the loss of authority of scientific expertise, policy-makers do not abandon their reliance on existing advisory arrangements […]" (Weingart 1999, 151). I show that it is because it helps policy makers establish a more compelling and manageable definition of the problem to be dealt with within the policy-making arena.

When STS authors specifically consider the role of expert assessment in the decision-making process, they have a tendency to remain a bit elusive regarding the so-called framing effects of expert advice. Joly for instance alludes to how "expert evaluation can contribute

first and foremost to actually defining the problem […]' (Joly 2009, 118) but the author does not specify the modalities of this framing power. Actually, one can question how this statement is supposed to apply to contexts in which the authority of science itself has been compromised, i.e. in scientifically controversial contexts. In this paper, I intend to be more explicit about the "framing" effect of expert assessments, showing how it concretely operates in controversial settings. In the public policy literature, "framing" refers to a complex process of bridging and aligning two or more unconnected frames in a bid to create a common one. In our case, I posit that framing thus refers to the alignment of frames between expert assessments and public problems. In addition, I argue that "framing" has to be conceived as a two-way process, meaning that it is about framing for the sake of settling an expert dispute with sound scientific categories but also for the purpose of solving public problems in a sufficiently consensual way. In a bid to develop this proposition further, I borrow and discuss Bouleau and Deuffic's concept of common categorization (2016). Following Jasanoff's (1990, 2004) postulate about the 'co-production of science and the social order', and operationalizing the co-production concept even further, these authors consider, more specifically, the design of ecological indicators and the framing of public problems as a co-construction process. They highlight in particular, how the production of a common category in the sphere of scientific assessment and in the sphere of public problems represents a critical achievement in the assertion of expertise. It appears in our case though that not all common categorizations are equal but depend upon the balance of power within society. This is understandable since as a two-way process, "expert assessment as a framing exercise" has to be able to settle both a scientific controversy with sound scientific categories but also has to be able to solve public problems in a sufficiently consensual way. The success of a common categorization depends on its ability to respond to this double constraint and the specific factors attached to these arenas.

Hence, this paper embraces Gusfield's seminal work (1981) on the authority of science within policy-making but also extends it to take into account new considerations. With Gusfield, it acknowledges that if science gives policies the cast of being grounded in nature, in actuality, scientific facts are not immediately reflective of reality but are being screened and pre-selected beforehand by policy frames. In contrast to Gusfield's approach though, it considers that, first, framing is not only about symbolic means but also implies structural factors at play. Second, that framing is not only about instrumentalizing scientific knowledge for the benefit of pre-formulated policies, but, as a common categorization exercise, is about taking into consideration the constraints imposed by the scientific arena on the framing activities as well. In other words, policy frames cannot unilaterally dictate which scientific facts to retain and which ones to ignore, irrespective of scientific rules.

I begin this paper by presenting the immediate public issue at stake. In the second section, I also describe the terms of the scientific controversy and how it developed over time, analysing the alignment efforts between the scientific and the policy arenas. Hence I show that a mismatch between the scientific category (ecological indicator or else) and the public problem on the agenda can, indeed, prove challenging for a specific expertise to be recognized. In the third and fourth sections, I introduce the broader socio-political context and public problem at stake. Eventually, I deal with the conditions for success of common categorizations, demonstrating that not all attempts at producing common categorizations are equally successful. I emphasize how sometimes specific categories might appear uncomfortable for powerful interest groups and re-ignite controversies because of the potential policy implications of expert assessments. Hence, policy makers cannot rely on them to guide public policies and their solutions since they prove too contentious. In the last section, I emphasize the idea of framing as a two-way process. Addressing the "paradox of

scientific authority", I show how scientific assessments help policy-makers tackle public problems that would, otherwise, have proven too costly for them to regulate. In other words, I show how policy-makers use expert assessment to frame public problems in a way that they can be managed.

The methods used include: a case study approach; a literature review; the analysis of scientific documents and collection of field data (field observation). The analysis is based on 25 semi-structured interviews carried out between July 2008 and September 2015 with representatives from research institutes (IFREMER, CEVA, INRA, CNRS, National Museum of Natural History) and universities, the river basin water board (*Agence de l'eau Loire-Bretagne*), water authority, environmental NGOs, associations like the *Institut scientifique et technique de l'environnement et de la santé*, ISTES (Scientific and Technical Institute for Health and the Environment), civil servants from the national Ministry of Ecology (Directorate on Water and Biodiversity) and from the Ministry of Agriculture's regional office, senior civil service (*grands corps*) engineers (*Conseil général de l'Alimentation, de l'Agriculture et des Espaces Ruraux*), staff from the local chamber of agriculture (*chambre d'agriculture des Côtes-d'Armor*) and local politicians. A media review was also carried out, particularly for the study of the mobilization and opinions of the agricultural organizations. Finally, this study benefited from previous PhD research on the pollution of water resources by agriculture in Brittany, during which 150 interviews were conducted. This previous work afforded me a better understanding of the policy-making process and the actors' configuration surrounding the issue of green macroalgal blooms.

2. Alignment and misalignment of frames

In this section I, first, introduce the public issue around macroalgal blooms on the French public agenda. I, then, present the scientific controversy, describing the terms of this dispute and how it was eventually resolved in the 1990s. I show how initially the evaluation assessment built on existing scientific categories. Subsequently, I illustrate the early impediment caused to initial expertise when expert categories did not match or worse, when they ran counter to the political agenda. Later on, I evoke how it was eventually overcome, and how IFREMER researchers managed to convince to use nitrogen rather than phosphorous as the relevant ecological indicator (scientific category).

2.1. The issue of green macroalgal blooms on the French public agenda (2008-present)

At the start of the latest episode in the scientific controversy surrounding macroalgal blooms in Brittany, there was the sudden death of two dogs in 2008 and, one year later, the death of a horse followed by the near death of its rider, on the beach of St-Michel-en-Grève (Brittany, France). This triggered a crisis that resonated to the national level. The beach was notorious for being covered with green algae[2] for several months of the year. These incidents were later related to the unexplained deaths of a municipal employee while collecting algae a few years earlier and of a jogger on the beach back in 1989. In July 2011, dozens of wild pigs succumbed on beaches characterized by the same 'green tides'.[3] A climate of suspicion arose as local NGOs believed that the public authorities were withholding information from them and failed to reveal the results of the autopsies on the pigs' death quickly enough.[4] In view of the potential new health hazards linked with macroalgal bloom decomposition on beaches, the French Prime Minister decided to pay a visit to the site. Up until then, the proliferation of

green algae on particular beaches on the Breton coasts had been considered a local problem. However, the phenomenon had been mobilizing riparian and small local environmental associations from the 1980s; these mainly complained about the inconvenience of the unpleasant smells generated by the algae and the aesthetic disfigurement of the beaches. Negative impacts on tourism and the economic development of fisheries in the affected bays also motivated coastal municipalities and local and regional governments to intervene at an early stage. They funded collection campaigns and were involved in research projects and action programs from the 1980s onwards. From 2008 the phenomenon became a concern not only at the regional level, but also for the public authorities at the national level. A national plan to combat coastal eutrophication was launched in 2010 (*Plan de lutte contre les algues vertes*) and the national public authorities commissioned a new scientific report on the origins of the phenomenon. The initiative involving this new evaluation proved to be very contentious. Before that though, green macroalgal bloom phenomenon had been at the center of a low-key scientific dispute beginning from the 1990s but strongly reinvigorated lately in the late 2000s.

2.2. Aligning frames in the scientific arena: The concept of a 'limiting factor (1986- onwards)

Green macroalgal blooms are commonly understood as the result of three series of factors: the presence of nutrients (nitrogen, phosphorous, silicon) in sufficient quantities; the temperature of the water and presence of sufficient illumination (e.g. a long foreshore with a gentle slope); and a topography prone to the containment of biomass and nutrients (e.g. a closed bay).[5] Since diatom algae[6] are the only algae sensitive to silicon, green macroalgal blooms

essentially result from the combination of two physico-chemical factors: nitrogen and phosphorous. This explanation of the mechanisms behind the proliferation of the algae has never been disputed in the case under examination. Instead, the controversy has centred on the identification of suitable levers that could halt the algae blooms. More precisely, the scientific controversy revolves around whether to focus on nitrogen or on phosphorous to combat algal blooms.

Historically, scientists relied on recognized scientific concepts in the production of their expertise on green algal blooms. Indeed, the scientists recycled a concept that had been used in agricultural research since the nineteenth century. This concept, which is called the 'limiting factor', was described in Liebig's work (1844). It applies to plant mineral nutrition. According to this limiting factor theory, also called the 'law of the minimum', irrespective of other elements and their abundance, plant growth depends on the element that is most scarce in relation to the plant's needs. In other words, growth is controlled not by the total amount of resources available, but by the scarcest resource. By transposing this law of the minimum – which aims to explain plant growth – to the objective of preventing plant growth, the limiting factor can be defined as representing the first available element, which, if lacking, will hinder the entire growth of the plant. The concept of the limiting factor is focused, therefore, on action effectiveness. In the case of green macroalgal blooms in Brittany, nitrogen has been identified as the limiting factor since the mid-1980s, based *inter alia* on studies carried out by researchers from the French Research Institute for the Exploitation of the Sea, IFREMER, a public research institute under the supervision of both the Ministry of Ecology and the Ministry of Higher Education and Research.[7] In the next sub-section, I study the links between expert assessment and public agenda-setting.

2.3. The challenges of proposing expert categories that do not fit frames on the political agenda (1986-1995)

The first attempts at designating nitrogen as the element responsible for the risk of green macroalgal blooms were met with considerable reluctance. This did not sit well with the public agenda-setting of the time, which was more concerned with water pollution arising from phosphates in detergent products. Indeed, environmental interest groups had been lobbying for the banning of phosphates in detergent products since the 1980s. More precisely, an environmental NGO called *Association pour la Sauvegarde du Léman* (Association for the Defence of Lake Geneva) was very much involved in fighting Lake Geneva pollution, a lake on the north side of the Alps shared between Switzerland and France. Eutrophication was a major issue which had wiped out most of the fish populations in the lake. The environmental NGO, together with a consumer NGO, la *Fédération Romande des Consommateurs* (French-speaking Consumers Federation), obtained a first victory in 1986 with the banning of phosphates from detergent products in Switzerland. Under pressure, the French government did not pass the same binding regulation but at least, in the early 1990s, signed an agreement with the detergent industry to limit phosphates to a maximum of 20% in their products. NGOs also succeeded in forcing municipal authorities in France to use better water treatment technology before releasing wastewater into watercourses. Thus, the mobilization of political support was focused almost exclusively on the issue of phosphorous and the idea of trying to convince the public authorities to act on nitrogen too was not well received at first,

> When we said 'the limiting factor is nitrogen not phosphorous', the water boards and politicians were not happy. We were introducing complexity. The universally applicable phosphorous thesis would have been a great message, but we were saying that phosphorous is the limiting factor for

> freshwater and nitrogen is the limiting factor for coastal waters. It was far more complicated to convey such a message [politically], so people were not happy with our thesis.[8]

Mobilizing interest in the issue of phosphorous would have been an easier task. At the same time, a researcher from the French National Institute for Agricultural Research (*Institut National de Recherche Agronomique, INRA*) and himself a member of the *Association pour la Sauvegarde du Léman*, was busy demonstrating the impact of phosphate detergents in Alpine lakes and stated that phosphorous was the limiting factor (Barroin 2004). Thus, phosphorous represented an institutionalized factor, which had featured on the political agenda for quite a few years already. And as Bouleau and Deuffic (2016) stress, an expert evaluation attracts more support if it corresponds to issues and categories that are already familiar to power actors.

2.4. Enrolling support for the nitrogen thesis (1995-present)

The public authorities in the department[9] of Côtes-d'Armor were gradually convinced by the thesis, which was initially supported by a few IFREMER researchers. This process benefited from the conversion of the Center for Study and Promotion of Algae (*Centre d'Etude et de Valorisation des Algues*, CEVA) to the IFREMER's thesis in the mid-1990s. The CEVA was established in 1982 as a private applied research institute with financial support from the local executive (*Conseil départemental des Côtes-d'Armor*) and industrial companies specializing in the processing of algae.[10] In the 1990s, the CEVA was working on a study commissioned by the local executive which was struggling with persistent eutrophication in several bays of the department of Côtes-d'Armor. Unconvinced by the IFREMER studies on nitrogen as a

limiting factor in coastal waters, the CEVA was focusing its efforts on removing phosphate from wastewater released into the bay of St-Brieuc in the hope that it might reduce the green algal blooms there. The work carried out by the CEVA between 1988 and 1992 was severely criticized by IFREMER researchers at the time. The former's links with and financial dependency on the local executive were perceived by some of the IFREMER researchers as an indication that the CEVA could be subject to the same political pressure as the authorities themselves. In the 1980s and 1990s, this *Conseil départemental* was perceived as being close to the leading agricultural union, which could have been inconvenienced by research studies focusing on nitrogen. Nevertheless, the CEVA soon accepted the IFREMER thesis. First, the experiment on phosphate removal in the bay of St Brieuc was declared inconclusive and abandoned in the mid-1990s. Second, IFREMER, which was facing problems with understaffing, started to outsource most of its studies on green algal blooms to the CEVA. Consequently, the CEVA signed a memorandum of understanding with IFREMER involving the use of the numerical model developed by IFREMER. The CEVA was paid and trained by IFREMER researchers to do this. It is important to note that the IFREMER researchers had relied on this model to prove that nitrogen is the limiting factor for algal blooms in coastal waters. Following the secondment of an IFREMER researcher to the regional water board (*Agence de l'Eau Loire-Bretagn*e) in the 1990s, this organization also began to espouse the nitrogen thesis. It should also be noted that the water board recruited former students trained by IFREMER specialists to work on the green algal blooms.[11] The *Conseil départemental des Côtes-d'Armor* itself changed positions. It had been very much involved in the water quality struggle since the early 1980s, pioneering in France the implementation of a regulation concerning perimeters of protection around catchments for potable water or seconding staff to the Ministry of Agriculture's local office to reinforce its competence on water management. As early as 1984, the local executive had to deal with a conflict opposing two of the main

economic sectors in the region, i.e. mussel farming and agriculture. Mussel producers were accusing farmers of being responsible for a bacteriological contamination affecting mussels and preventing their sale. Staff from the local executive ordered several studies to address the pollution phenomenon, later on tackling eutrophication pollution that had started being problematic in several bays. As the experiment around phosphate removal proved to be non-conclusive, the staff from the local executive started considering IFREMER thesis on nitrogen instead. However no ambitious action targeting eutrophication phenomenon followed. In the mid-1990s, the issue still remained rather low-key, and very localized. It was not featuring on the national agenda yet. Instead the focus was on drinking water pollution.[12] The first public programmes were being implemented at the national level and the local executive was contributing financially to these programmes and supporting farmers to reduce manure surpluses.

3. The socio-political constraints on common categorizations

I contextualize in this section the re-ignition of the scientific controversy in the 2000s when a connection between green algal bloom phenomenon and another very contentious public problem, i.e. intensive farming activities, was established *at the level of public agenda*. I demonstrate that policy implications adverse to influential interest groups can provoke the demise of specific common categorization.

3.1. Expert assessments and policy implications (2000-present)

While the resolution of the dispute with the CEVA, the regional water board and the *Conseil départemental* did not prove to be too difficult for IFREMER, dealing with the controversy that subsequently arose in the late 2000s proved to be far more challenging. The broader socio-political context, in which this controversy unfolded in the 2000s, was more heated and directly involved the leading agricultural union and various professional organizations. On this occasion, the thesis of phosphorous as the limiting factor enjoyed the support of a radicalized fringe of the leading agricultural organizations.[13] Indeed, this controversy in the 2000s was not limited to scientific organizations: it also arose in other arenas, i.e. in the public policy realm and in the media sphere (local, then regional and, finally, national) when green algal blooms began to be related to the issue of the pollution of watercourses by agriculture based on scientific reports. The nitrogen thesis is not politically neutral. The designation of nitrogen as the limiting factor meant that intensive agricultural actors would be required to make new efforts to limit non-point source pollution from their farms. Although the proponents of intensive farming had contested agriculture's responsibility for nitrogen leakage in the 1990s, this was no longer the case in the 2000s [name deleted to preserve the integrity of the reviewing process]. Nowadays, it is commonly admitted that intensive agriculture is responsible for 90 percent of the nitrogen found in watercourses while it is only responsible for 50-60% of phosphorous leakage and shares the responsibility for this with the municipalities, whose wastewater treatment plants were not compliant with the European regulation until recently.[14] Given that agriculture is the main economic activity in the Brittany region, the IFREMER thesis had significant economic and political implications.

3.2. Water pollution from agriculture on the public agenda for the past 30 years (1990-present)

The issue of agricultural pollution has been a source of major controversies for the past 30 years in France. These controversies relate to the public policies designed to fight the issue and, prior to that, the definition of the public problem in itself [name deleted to preserve the integrity of the reviewing process]. As can be demonstrated with the issue of nitrates and their impacts on human health, scientific controversies also played a role here in the early 2000s. The allegedly detrimental effect of nitrates on human health was the rationale behind the 1975 European Directive setting a maximum nitrate level of 50 mg/l in surface water used to produce drinking water.[15] Regional environmental organizations in Brittany such as *Eau et Rivières de Bretagne* (Water and Rivers of Brittany) made extensive reference to this European legislation in their opposition to intensive agriculture since the 1980s. Together with prominent personalities in the field of medicine, the leading agricultural union organized a symposium in the French Senate in 2002. This symposium involved a researcher who would later feature at the center of the green algal blooms controversy. The publication that followed the symposium provided a sufficiently compelling case to undo the link between nitrates and health issues (Buson and Toubon 2000) and forced regional environmental interest groups to continue the fight against intensive agriculture on other, mainly environmental grounds through the use of another European regulation that prohibits farmers from spreading too much animal waste on their farmland[16] [name deleted to preserve the integrity of the reviewing process].

Hence, for the past twenty-five years, intensive farmers have been struggling with multiple regulations intended to tackle the problem of non-point source pollution from agriculture. These regulations were routinely denounced by the leading farmers union as being far too restrictive. Within this regulatory framework, the objective was to maintain nitrate levels below a 50 mg/l threshold in freshwater. The potential link between the green

algal blooms on Breton beaches and intensive farming activity demonstrated by the nitrogen thesis triggered alarming concern among intensive farmers. Indeed, a study commissioned by the Breton regional government (*Conseil régional de Bretagne*) and the local water board (*Agence de l'eau Loire-Bretagne*) in December 2008 referred to the need to reduce nitrates[17] in inland watercourses by 75 percent before a significant impact on green algal blooms would be noticed.[18] Other IFREMER studies referred to the need to aim for a limit of no more than 10 mg/l of nitrates in freshwater resources. However, after over 30 years of public policy in this area, farmers have hardly managed to reduce levels to below the 50 mg/l limit.

3.3. An expert evaluation report influenced by partisan considerations? Environmental lobbies versus agribusiness lobbies

Against this socio-political background, the acceptance of the latest scientific reports has been even more hampered by the fact that the protagonists of the scientific controversy accused each other of partiality. It would be appropriate at this point to provide a more detailed account of the two main organizations, apart from CEVA, that played a very central role in the renewed controversy in the late 2000s: IFREMER and the *Institut scientifique et technique de l'environnement et de la santé*, ISTES[19] (Scientific and Technical Institute for Health and the Environment). As already mentioned, IFREMER is a national research institute specializing in the exploitation of marine products. It is an applied research institute. Three researchers within this institute were mainly involved in the research and evaluation of green algal blooms. The topic never attracted the interest of more than a handful of the institute's researchers as the phenomenon is exclusively localized in shallow coastal waters and IFREMER's mandate is focused on deep sea waters. For this reason, from the mid-1980s most of the green algal bloom studies which IFREMER was commissioned to carry out were outsourced to the CEVA.[20] As a public research institute under the supervision of both the

Ministry of Ecology and Ministry of Research, IFREMER is the statutory body to which public authorities must direct the studies and reports they commission on maritime issues.[21] In contrast, the ISTES is a self-proclaimed 'scientific' institute essentially composed of one self-employed actor who presents himself as a lecturer from one of the universities of agricultural science in Brittany. However, its critics highlight the fact that this lecturer's academic career was short-lived and dates back to a period spent as a PhD candidate at the French National Institute for Agricultural Research (INRA); the person in question left the institute without graduating. In the past, the ISTES organized scientific symposiums and published books relating to nitrates and health. Some of these books were heavily criticized in the scientific community, for example the one authored by Dr L'Hirondel and L'Hirondel (1996). Others successfully prevented environmental NGOs from continuing to make claims about the harmful impact of nitrates on human health (Buson and Toubon 2000). Regional environmental NGOs denounced the role assumed by the ISTES as a front for big agribusiness companies and the main regional agricultural cooperatives, which are members of the ISTES governing board.

As already stated, IFREMER's interest in green macroalgal blooms was marginal. Among the three researchers regularly involved on the subject, one held a representation mandate from Brittany's leading environmental NGO, *Eau et Rivières de Bretagne*. This NGO has played a decisive role in the mobilization of opinion against intensive farming from the 1970s. Hence, the main actors involved in the scientific controversy routinely suspected each other of representing a particular lobby, i.e. the agribusiness or environmental lobby. Apart from these *ad hominem* accusations, the content of the IFREMER expert report also came under scrutiny. One of the IFREMER researchers was blamed for distorting the meaning of the 'limiting factor' thesis, particularly in the media. He was deemed to have

incorrectly presented it in public speeches as the equivalent of a 'factor responsible for the pollution'.[22] However, as we know, the limiting factor merely designates the factor that should be acted on with a view to improving the problem in the easiest possible way. It is a concept that relates only to the effectiveness of action. The ISTES deplored the fact that it became, incorrectly, a concept used to designate a culprit for public condemnation, in this case intensive farming.

3.4. Are common categorizations always a blessing?

Levain (2014) notes that the first scientific correlations between green macroalgal blooms and intensive agriculture were established, albeit tentatively, in the mid-1980s in *Eau et Rivières de Bretagne*'s journal. The marine ecologist commissioned to write the article linked the phenomenon with urbanization and the shift to intensive farming following the agricultural revolution of the 1960s. Hence, the potential inland origin of the algal bloom phenomenon had already been indicated.[23] Nevertheless, agricultural interests did not mobilize against this claim. The reason for this was that the NGO *Eau et Rivières de Bretagne* itself did not really engage with the phenomenon until the 2000s. 'Green tides' were essentially considered a local issue. Local riparian NGOs such as *Halte aux marées vertes* (Stop the Green Tides) and *Sauvegarde du Trégor* (Save Trégor), to name but two, were at the forefront of the social mobilization around this issue for a long time. Meanwhile *Eau et Rivières de Bretagne* was busy fighting intensive agriculture on other grounds: illegal increases in the size of pig herds, the impact of nitrates on human health, the eutrophication of rivers, etc. Hence, *Eau et Rivières de Bretagne* only joined the 'green tide' opponents in the 2000s when the framing of the issue in terms of green macroalgal blooms became a matter of greater strategic importance for its cause [name deleted to preserve the integrity of the reviewing process]. The increase in the mobilization of environmental interest and the broadening of public concern and media

attention around the effect of 'green tides' on human health in 2008 also coincided with the unprecedented re-ignition of the controversy. More precisely, it seems that IFREMER's expert assessment started raising controversies again at the turn of the 2000s already when the scientific expertise on the green tides collided with the trajectory of the public problem surrounding the agricultural pollution of water resources. In that case, a common categorization around nitrogen[24] did not serve the interests of the IFREMER expert report but undermined its authority instead.

4. Settling the controversy through a new common categorization (2012- onwards)

As already mentioned, the expert opinion on the phenomenon of green macroalgal blooms in Brittany has been the focus of a lengthy scientific controversy for the past 30 years. The controversy was settled episodically over the period and it would appear that another stage involving the temporary closure of the controversy has been reached since 2012. Before reaching such closure though, the IFREMER researchers and the coalition of scientists who supported their thesis have continuously attempted to resort –yet without much success- to a 'boundary work' strategy as defined by Gieryn (1983), to disqualify their opponents. For Gieryn, boundary work consists of scientists trying to demarcate science from other activities.[25] Accordingly, in cases of controversy, researchers prevent lay people from accessing the circle of legitimate discussion and refuse to engage in debate with non-scientists. This strategy was adopted by the IFREMER researchers vis-à-vis the representative of the ISTES.[26] As they saw it, there was no scientific controversy as the Director of the ISTES, who does not hold a PhD, was not entitled to engage in scientific discussion or

comment on IFREMER's research. The ISTES Director was condemned for not conducting any empirical research and not having authored any peer-reviewed academic papers.[27] The coalition of researchers associated with IFREMER often claimed that the aim of the agricultural coalition behind the ISTES was to maintain a state of epistemic tension with a view to cultivating doubt and producing ignorance (Oreskes and Conway 2010). It remains though that the connection with a controversial public issue caused a rather unsolicited publicity, shedding light on some uncertainties or at least on some knowledge areas not yet stabilized and which were quickly exploited by contradictors, hence undermining some aspects of the expert assessment [name deleted to preserve the integrity of the reviewing process]. Notwithstanding, it appears that a 2012 expert assessment report originating from ministerial general inspectorates succeeded in ending the controversy. In this section, I unpack the reasons behind such a success, focusing first on the French expert evaluation culture, then on the introduction of a new expert category, emphasizing the necessity to build categories that can suitably address constraints from both a scientific and political realm.

4.1. Reintroducing the state in the arbitration of the controversy

It is important to emphasize here that between 2003 and 2011, IFREMER researchers multiplied scientific synthesis reports on the phenomenon of green tides, all of which reiterated the exact same conclusions with nitrogen being described as the limiting factor.[28] Over the years, IFREMER researchers' thesis has enjoyed the almost unanimous support of the scientific community.[29] In 2011, IFREMER coalition also received political support from local governments, municipalities or the regional governing council which all published articles at a critical time in the aftermath of the national plan to combat coastal eutrophication.

Yet, the relevant public authorities regulating farming activities and located at the national level reacted differently. Through their representative at the regional level, i.e. the regional prefecture,[30] or through the Ministry of Ecology and the Ministry of Agriculture, public authorities have routinely commissioned new expert reports[31] although the IFREMER coalition kept claiming that there was no scientific dispute and therefore no need for any new report on green macroalgal blooms.

It did not prevent the Ministry of Ecology and the Ministry of Agriculture to jointly commission another expert evaluation in September 2011 during the implementation of the governmental plan to tackle green tides (*Plan Algues Vertes).*[32] Public authorities were acting like they were in control of the authority of experts' statement, more than scientists themselves. The letter confirming the commissioning of the report to IFREMER, CEVA, AgroCampus Ouest and INRA[33] highlights the fact that 'the position [of ISTES] has attracted increasing support within the agricultural organizations'.[34] Indeed, one of the leading farmers' unions in Brittany[35] was refusing to participate any further in the steering committee of the National Plan against Green Algae. It made its future involvement conditional on the drafting of a new expert report by an international team. The objective was to side-line the IFREMER researchers and their allies.

Instead of an internationally accredited team of experts though, the general inspectorate from two ministries was commissioned to carry out the report. The country's political and expert evaluation culture is characterized by a state monopoly on legitimate expertise linked to a centralized republican tradition. Hence, in keeping with typical French tradition, the national public authorities asked the general inspectorate from two ministries to arbitrate the dispute based on 'technocratic expertise' (Lascoumes 1994) and a rational-legal mode of evaluation (Restier-Melleray 1990). This time, the rules of the game changed. This

state-commissioned evaluation was carried out by four representatives of the inspection body of the Ministries of Agriculture and Ecology (Conseil général de l'Alimentation, de l'Agriculture et des Espaces Ruraux and Conseil Général de l'Environnement et du Développement Durable). It meant that engineers were in charge of the new evaluation and would be merely assisted by scientific experts of international renown.[36] The scientists selected for this task were French. They work for the National Museum of Natural History, the CNRS and INRA. In a bid to 'deconfine' the debate, all three scientists were based outside Brittany and the sphere of influence of its local political issues. In addition, they had not been involved in research on green algae prior to this report. It was assumed that this would provide a better guarantee of the experts' independence. The evaluation report was ultimately written by an agricultural engineer and member of the *grand corps* (Chief Inspector for Agriculture -*inspecteur général de l'agriculture*-).[37] He is both a member of the agricultural engineering *grand corps* and a respected scientist.

This last report, which took the form of an academic peer-review process, would prove conclusive. In the end the expert report corroborated IFREMER's thesis about nitrogen being the limiting factor in the proliferation of algal blooms in coastal waters. No further expert evaluations have been commissioned by public authorities since the publication of the last report in 2012. After a particularly virulent interlude between 2008 and 2012, the main protagonist of the controversy, the ISTES, had lost a major part of its audience within the farming sector. The scientific controversy around the 'green tides' no longer features in the public or media debate. Inspired by Jasanoff's concept of "civic epistemology" (Jasanoff 2005), Joly (2009) evokes a French "culture of expertise", arguing that the credibility of scientific knowledge is deeply embedded in national institutions and political systems. Hence, the state general inspectorate appeared to have played an important role in arbitrating the

controversy in the 2010s. However, it emerges that a closer scrutiny of the expert report reveals that more than the proceduralisation of evaluation and assessment, it is, in fact, the framing processes that were used to achieve a shift away from controversial situations.

4.2. Framing new expert categories to settle the controversy: the concept of "control factor" (2012-onwards)

The report was especially cautious in its phrasing. It avoided any reference to responsibility and refers only to the effectiveness of actions. It confirmed the main conclusions from previous expert assessments and stressed that, although phosphorous plays a significant role, 'measures focusing on nitrogen inputs are the most effective and efficient for eradicating green algal bloom in coastal areas'. More importantly though, the report noticeably adopted a new expert category that could also serve to re-frame the public problem and (re-)orient public intervention. This new common categorization revolves around the concept of the 'control factor'. This strategy of shifting the focus of the debate was initiated by the CEVA. Building on the academic literature in limnology and spatial planning, CEVA popularized the concept of the 'control factor' ('*facteur de maîtrise'*, '*facteur de contrôle'*) alongside the concept of the 'limiting factor', which had provoked such an excessively heated debate. This conceptual shift borrows from the recommendations made by Barroin (2004), an expert on the eutrophication of lakes who criticized the concept of the 'limiting factor'. As a concept born out of agricultural research, the limiting factor became more problematic when it was subsequently applied to other fields and, particularly, when it was used as an instrument for fighting eutrophication in surface waters. Barroin advocated the use of the concept of the control factor instead.

Compared to the ‘limiting factor’, a ‘control factor’ is more immediately operational. Rather than evoking the effectiveness of action, the concept of ‘control factor’ focuses more specifically on its efficiency, i.e. it evaluates the relationship between the resources employed and the results achieved. CEVA underlines that when determining the element on which to intervene, the ‘control factor’ takes into consideration, for instance, the costs associated with each proposed course of action. Hence, the ‘control factor’ weights potential ‘candidates’ (ecological indicators) against the technical or economic challenges linked to the prescribed course of action. In other words, this is not only about the potential of one such element to reach the desired objective but about the least difficult or costly way to reach a desired objective.

It is critical to note that, depending on the context, nitrogen, phosphorous, or even other elements, can be a control factor in green macroalgal blooms. The expert report does not exclude new research around this control factor providing that such new research remains localized and applied: ‘It must accompany the action plan in place and not constitute a pre-requisite’. [38] Such a conceptual shift from the concept of “limiting factor” to the concept of “control factor” allowed for a reorientation of the research on green algal blooms and opened up the possibility of finding new avenues for action which the leading agricultural coalition would find more acceptable because such new proposed category might more often target phosphorous than nitrogen, and hence leave intensive agriculture out of the spotlight. As a result, since 2012, expert evaluation reports on the topic of green tides have taken a back seat in agricultural circles and the media and debate has been focused on the action plan instead.

5. Framing as a two-way process

5.1. Framing from both a scientific and political perspectives:

The critical role played by issue framing in settling the scientific dispute echoes Bouleau and Deuffic's (2016) conceptual framework. These authors stress that common categorization between public problem-framing and ecological expert assessment offers important resources for the success of both socio-political mobilization around an issue and expert assessment. In their view, the concurrence of the processes of the production of an expert report and construction of a public problem creates an opportunity for the emergence of a common cause between two distinct spaces (Bouleau and Deuffic, 2016) and the joint allocation of responsibility.[39] This not only facilitates socio-political mobilization but also the imposition of a particular evaluation. In contrast, a lack of correspondence between the public-problem framing and a designated scientific factor hampers the adoption of a specific ecological evaluation. Accordingly, as already described, IFREMER initially encountered difficulties in asserting its evaluation because it did not benefit from a favourable political and media context, which was more attuned to a framing based on phosphorous at the time. The IFREMER researchers eventually overcame this difficulty. However, they later faced an even greater challenge in the 2000s when their scientific expertise on the green tides collided with the trajectory of the public problem surrounding the agricultural pollution of water resources. Indeed, the relationship between intensive agriculture and green tides evoked at the very onset of the IFREMER evaluation in 1986 triggered hardly any reaction from leading agricultural interests. At that time, agricultural pollution was not yet high on the political agenda and the main regional environmental NGOs had yet to mobilize around the issue of green tides. However, when this changed almost 20 years later, it provoked an unprecedented controversy around the IFREMER evaluation, the proportions of which reflected the importance of the socio-economic interests at stake in the agricultural sector. In that case, a common

categorization[40] did not serve the interests of the IFREMER expert report but undermined them instead. This corroborates Le Bourhis's conclusions in his study on the genesis of ecological indicators and their use within public policies: public authorities have a capacity for neutralizing indicators that are perceived as problematic for various reasons (Le Bourhis 2016). Yet, this does not imply in our case, like in Gusfield's account (Gusfield 1981) for instance, that policy makers are always at liberty to just select, ignore or leave aside elements that do not fit their pre-formulated policy orientations. Framing, in our understanding, means a more proactive capacity to construct common categories that can respond to constraints emanating from both the policy and the scientific arenas. This is understandable because as a two-way process, "expert assessment as a framing exercise" has to be in a position of displaying a minimum of scientific authority to convincingly frame the policy debate as well. I delve into that aspect in the next section.

5.2. Solving the paradox of scientific authority: Resorting to expert reports to reframe the political debate

The ambition of this paper was to delve into the "paradox of scientific authority", i.e. the fact that despite science's credibility and authority being challenged when scientists get involved in public disputes, "the appeal to scientific expertise is growing as never before" (Limoges 1993, 417). It is out of necessity, some argue (Lascoumes 1994), that experts are still convoked by policymakers to guide them in their decisions, because of the inflation of technical questions in our globalized world. I wanted to highlight another dimension and demonstrate that one of the crucial roles of expert assessment and evaluation is to establish a more compelling definition of the problem to be dealt with by policy-makers. Using science

as a cognitive resource to bring legitimacy to political actions, public authorities could thus avoid the political costs associated with organizing a more open debate and with regulating certain controversial issues. In our case, I demonstrate that the expert report was used to relocate the public debate over the pollution of water by agriculture around an orientation of public policy perceived to be more suitable to powerful socio-economic interests struggling with multiple regulations of the agricultural sector for the past thirty years. It also eventually silenced some high-profile environmental NGOs since the new "control factor" category is no longer able to ensure the link between intensive farming and "green tides": depending on the ecological context, the nitrogen factor might be or might not be the control factor. More precisely, a re-direction of the debate following the introduction of this new "control factor" category could be observed at three different levels.

Firstly, it would appear that the kind of expertise required evolved and no longer involved the mere identification of the mechanisms resulting in the proliferation of green algae. Indeed, the new framing of the expert report around the control factor led to new research questions and programmes that are potentially more consensual, for example the Acassya project which aims to gain a 'better knowledge of the nitrogen cycle within various landscapes and territories'.[41] Moreover, the relocation of the focus of the evaluation required to low nitrate-leaking systems and the in-field nitrogen cycle involved denying IFREMER the opportunity to have a legitimate say in the evaluation. Indeed, IFREMER researchers are aquatic biologists and not specialists in soil or agricultural science.

Secondly, not only is it about framing relevant scientific knowledge through new expert categories but this new category also framed the policy-making process. In other words, the expert report also helped re-orient public action and re-define problems on the public agenda. For over 15 years, public policies dealing with pollution from agriculture

strived to tackle the problem of the pollution of water resources by reducing nitrogen production and aiming for balanced fertilization [name deleted to preserve the integrity of the reviewing process]. By considering the new need to understand nitrogen cycles within the landscape,[42] the public authorities are now focusing on a different policy target: not in merely reducing nitrogen production, hence intensive agriculture activities *per se* but more in the pedo-climatic conditions of particular sites which are vulnerable to the pollution of water resources instead. Consequently, on the occasion of an evaluation study for a Green Tides Plan, senior state engineers recently claimed that, nowadays, the issue of the drainage ('*lame drainante'*) was the main concern in the search for the cause of green tides. Re-focusing on 'reducing nitrogen leakage' as opposed to reducing nitrogen *production* (or herds' size) was also presented as the way forward in the governmental plan to tackle green tides in one of the priority river basins in Brittany.[43]

Finally, the influence of framing activities can also be observed in the attempts by the leading agricultural coalition to mobilize around the common solution of methanation.[44] Although methanation was never presented as a panacea for resolving the problem of green tides or water pollution from agriculture, some confusion was generated around the promises of such a technological solution using a frame alignment strategy (Benford and Snow 2000).[45] Indeed, in a bid to support the methanation solution and change the status of green tides from a pollutant to a desirable product for the renewal energies sector, the debate around renewable energies has been tentatively advanced and equivocally assimilated into the fight against green tides.

6. Conclusion

This paper contributes to unraveling the "paradox of scientific authority" in controversial contexts, i.e. the fact that expert advice is still being solicited despite the objectivity and reliability of various expert reports being questioned because of the controversy. I argue that one of the crucial roles of expert assessment and evaluation is to establish a more compelling and manageable definition of the problem to be dealt with by policy-makers. Yet one can legitimately question how disputed expert advice can really guarantee the efficacy of scientific knowledge in legitimating policy aspirations (Shackley and Wynne, 1995, 221)? Taking the long-lasting scientific controversy surrounding the expert assessment on the proliferation of green algal bloom on Brittany (France) beaches as a case in point, I show that the answer to that question points at the necessity of conceiving expert assessment as a framing exercise. Here, framing refers to a process of bridging and aligning categories and frames between the scientific and the policy arenas. In that perspective, I discuss Bouleau and Deuffic's concept of common categorization (2016). The authors highlight the importance of forging common categories between the public policy and the scientific spheres in a bid to assert a particular expert assessment. However, in the particular case of green macroalgal blooms studied here, it was also observed that not all common categorizations were equally successful in settling the controversy. I emphasize that the legitimation of a particular framing common to both the expert assessment and the public problem relates to the distribution of power more generally in society. In that respect, this study corroborates Boehmer-Christiansen's statement (Boehmer-Christiansen 1995), when she posits that the direction that the mutual construction of science and policy might follow does not appear completely contingent or open-ended. [46] In our case, the concept of the 'limiting factor' was replaced by the concept of the 'control factor' because this new category has enabled the emergence of more consensual research projects and to relocate the public debate around the issue of

'reducing nitrogen leakage', allowing for a re-orientation of public policies perceived to be more acceptable for powerful socio-economic interests.

Yet, recognizing the influence of socio-political forces on knowledge selection and issue framing does not imply that these are the only constraints that common categorization efforts have to adapt to. Framing in our understanding is not an account of pure manipulation of science or imposition of the most powerful interests. For public authorities to be able to use the advisory reports to reshape the problem more convincingly, I argue that "framing" has to be conceived as a two-way process: it is about coming up with common categories that can satisfy constraints from both the policy and the scientific arenas. These findings need to be further investigated though, in a bid to determine more precisely under which circumstances framing (as a two-way process) plays such a crucial role as compared, for instance, to the critical role of state expertise. In that respect, a comparative work across sectors or between countries where the influence of "grand corps" is less prevalent would be welcomed in a bid to assess whether these results can be generalized to other national configurations.

Notes

[1] STS literature suggests that scientific controversies rarely experience closure; at best they are settled temporarily.

[2] *Ulva armoricana* species

[3] Pejorative expression used by the NGOs actively involved in the opposition to the phenomenon of green algal blooms.

[4] The results were eventually published in September 2011 by the INERIS (National competence centre for Industrial Safety and Environmental Protection) and confirmed the link between the animals' deaths and the inhalation of hydrogen sulphide gas from decomposing green algae.

[5] See the conclusions of the *Plan de lutte contre les algues vertes* (Plan for Combatting Green Macroalgal Blooms), 5 February 2010.

[6] A microscopic alga

[7] The research mentioned here refers specifically to work carried out by the IFREMER (*Institut français de recherche pour l'exploitation de la mer*) Laboratory of Coastal Ecology in Brest (Brittany). See in particular : PIRIOU J-Y (1986) *Les marées vertes sur le littoral breton. Bilan 1985*. Direction de l'Environnement et des Recherches Océaniques, IFREMER.

[8] Interview with IFREMER researcher, Brest, July 2013

[9] A *département* is an administrative and political region in France.

[10] The CEVA's mission is to ensure the transfer of scientific knowledge to economic actors in the algae value chain.

[11] Interview with IFREMER researcher, Brest, July 2013.

[12] We develop that aspect in the next section.

[13] It should be noted, however, that not all branches of these leading agricultural organizations supported the thesis of phosphorous as the limiting factor. In 2011, for example, the chamber of agriculture in the department of Côtes-d'Armor (*Chambre d'Agriculture des Côtes-d'Armor*) publicly distanced itself from the members of the leading agricultural organizations who were willing to continue entertaining the controversial view rather than mobilize farmers to modify their practices: see *France 3 Bretagne* TV broadcasting news, 24 March 2011.

[14] Council Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment. The contribution of agriculture has tended to increase, however, as the punctual municipal supply continued to decrease over time.

[15] Council Directive 75/440/EEC of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States. The European regulators adopted a recommendation from the World Health Organization for the limitation of nitrates to 50 mg/l in potable water.
[16] Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources.

[17] A derivative of nitrogen in freshwater.

[18] Dussauze M and Menesguen A (2008) *Simulation de l'effet de 3 scénarios de réduction des teneurs en nitrate et en phosphate de chaque bassin versant breton et de la Loire sur l'eutrophisation côtière bretonne*. Report RST.DYNECO/EB/n°08-06, December.

[19] http://www.institut-environnement.fr/. Not to be confused with the former IFEN (*Institut français de l'environnement*).

[20] Interview with IFREMER researcher, Brest, December 2008.

[21] In that respect, IFREMER researchers have contributed to all the reports and studies commissioned by public authorities on green macroalgal blooms since the 1980s, either as single authors or as contributing authors.

[22] See, for example, *Le Monde* newspaper, 20 August 2009, '*Algues vertes: plus personne ne nie la responsabilité des nitrates'*.

[23] Journal of the *Association pour le Protection et la Promotion des Salmonidés de Bretagne* (formerly *Eau et Rivières de Bretagne*), 'La mer malade de l'homme', n°46, 1986.

[24] Nitrogen being both the limiting factor for IFREMER and the source of watercourse pollution denounced by environmental NGOs over the past 30 years.

[25] Other boundary-defining strategies (temporal, geographical, etc.) were attempted by opposing parties in the controversy, although none of them proved successful. Each time what was at stake was the ability to establish a connection, through scientific expertise, between the setting of a particular boundary and intensive agriculture (See [name deleted to preserve the integrity of the reviewing process]).

[26] the IFREMER researchers had always refused to engage in dialogue with the Director of the ISTES.

[27] Interview with CNRS researcher, Paris, July 2013.

[28] See for instance : Menesguen A (2003) *Bilan des connaissances scientifiques sur les causes de prolifération de macro algues vertes* IFREMER; Menesguen A (2003) *Les 'Marées vertes' en Bretagne, la responsabilité du nitrate* IFREMER.

[29] See for instance the press release in 2009 of the regional *Conseil Scientifique de l'Environnement de Bretagne* (Scientific Council on the Environment in Brittany).

[30] In France the *préfecture* is led by the *préfet*, the representative of the national government in the departments and regions.

[31] For instance, a report was commissioned in November 2009 and delivered in December 2010; another one was released in June 2011: Menesguen A et al. (2011) *A propos des marées vertes: allégations et réponses scientifiques*, 24 June 2011. The report was authored by several researchers from IFREMER, INRA and AgroCampus Ouest.

[32] A mere few months after the precedent one dating June 2011.

[33] All of which are under both ministries' direct supervision.

[34] Lettre de mission, 5 September 2011.

[35] Namely the FDSEA Finistère (*Fédération départementale des syndicats d'exploitants agricoles du Finistère*)

[36] Lettre de mission, 5 September 2011.

[37] See Chevassus-au-Louis et al. 2012

[38] Interview with a Chief Inspector for Agriculture (*inspecteur général de l'agriculture*), Paris, July 2013.

[39] See the concept of blaming (Felstiner et al., 1980)

[40] Nitrogen being both the limiting factor for IFREMER and the source of watercourse pollution denounced by environmental NGOs over the past 30 years.

[41] The research project Escapade-Acassya ('*Accompagner l'évolution agro-écologique des systèmes d'élevage dans les bassins versants côtiers*') is funded by the French National Research Agency (ANR) and has been coordinated by INRA since 2009.

[42] Interview with a senior official, Ministry of Agriculture's Regional Office, Rennes, July 2015.

[43] Interview with the project manager in charge of one of the priority Green Tides local Plans, Bay of St Brieuc's water utility, St Brieuc, Sept. 2015.

[44] Methanation is the biological process used to generate biogas from organic matter such as manure and slurry or food and green waste.

[45] Snow et al. (1986) identify four frame alignment processes: frame bridging, frame amplification, frame extension, and frame transformation.

[46] See also Frickel and Moore (2006) and their "new political sociology of science" (Frickel and Moore 2006) which insists on resources and power asymmetries in the production and dissemination of science.

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