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Towards critical ethnographies of resource risks: Regulatory science on shale industry risks in the global North contexts of Brussels and California

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ABSTRACT

By examining two instances of the production of scientific knowledge on the risks of shale rock exploration and extraction in the global North's context of democratic governance and a great concern for transparency, this paper argues for a combination of ethnographic and critical geographic approaches to studying expert knowledge production on risk as different ontological realities with different political consequences. Analytically, the study distinguishes between risks related to the natural environment and human health. While the former were presented as data by the experts, the latter gained a status of local stories. Risks as data and stories co-produced different spaces of extraction risks as abstract and absolute. With this focus, I extend the call recently made in resource anthropology, i.e. by Richardson and Weszkalnys, to ethnographically study how resources become various things for various actors beyond their commodity form and address the questions about the political realities that become co-produced and the possibility to extract and govern them.

1. Introduction

By examining two instances of the production of scientific knowledge on the risks of shale rock exploration and extraction in the global North's context of democratic governance and a great concern for transparency (cf. Barry 2013), this paper argues for a combination of ethnographic and critical geographic approaches to studying expert knowledge production on risk as different ontological realities with different political consequences. Analytically, the study distinguishes between risks related to the natural environment and human health. While the former were presented as data by the experts, the latter gained a status of local stories. Risks as data and stories, I argue, co-produced different spaces of extraction risks as abstract and absolute (Malm 2016). With this focus, I extend the call recently made in resource anthropology, i.e. by Richardson and Weszkalnys (2014), to ethnographically study how resources become different things for various actors beyond their commodity form. I also extend the analytical view of co-production from instances where communities and experts co-produce knowledge and social orders (Perry 2022; Perry and Smit 2022; Durose et al. 2021; Durose and Richardson 2015), to the instances where the work of experts co-produces diverse types of knowledge and socio-political realities.

While there is a vast body of literature discussing extractivist practices and their impacts on rural communities in Latin America (Gudynas 2021, Blaser and de la Cadena 2018, Svampa 2019) – in the global South – extractivist practices in the global North have only recently earned more attention with the onset of shale industry (Ladd 2018, Whitton et al. 2018). Shale industry not only originated in the global North – in the USA – but shale oil and gas reserves were also identified in some European countries – i.e. in France, Poland or the UK (EIA, 2011). This was a real gamechanger for many European and North American communities as they suddenly found themselves in a position of being actual or potential neighbors of extractive industry. Over the last decades, new on-land extraction projects became rare in the global North. Europe closed most of its coal mines in the previous century and outsourced natural gas extraction off-shore. With Europe's ambition to become a global climate action leader, European environmental groups could not agree for new prospects of fossil fuel extraction. Also in the USA, shale industry appeared in some states that did not have a recent extraction experience – like the New York State – or in states with ambitious climate policy targets – like California. The proximity of shale industry triggered new questions – what kinds of environmental, health and community impacts should be expected? How to regulate them? Along a heated and publicly performed controversy over the technology for shale rock extraction – hydraulic fracturing – authoritative knowledge on the impacts of shale industry came in great demand.

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The term extractivism, which originated in the Latin American context as '*extractivismo*' (Gudynas 2021) to signify "a complex ensemble of self-reinforcing practices, mentalities, and power differentials underwriting and rationalizing socio-ecological destructive modes of organizing life through subjugation, violence, depletion, and non-reciprocity" (Chagnon et al. 2022), has recently been proposed as an organizing concept for describing global extractive processes (Chagnon et al. 2022). Speaking of global extractivism connotes some similarities in practices, discourses and power relations irrespective of specific contexts, to be found whether in the South or North of the globe. However, most of the studies examining shale industry, with some notable exemptions (i.e. Szolucha 2019), avoid critical perspectives of political ecology or critical geography, which could provide us with a better understanding of how extractive practices produce destructive modes of organizing life also in the global North.

Shale gas governance, along with the problem of data access (Kinne 2018), complicated property rights (Jacquet et al. 2018), local authorities (Fry and Brannstrom 2018), scientific assessment and public participation (Luke and Evensen 2018; Smith and Haggetry 2018) has been examined for cases from the USA, Canada and Australia – countries where shale gas exploration actually happened. Countries highlighted by the geological services and energy information agencies (i.e. EIA Report 2011) as those of great resource potential, proved to be equally interesting for social scientists, especially, in terms of industry-community relations (Szolucha 2018), and challenges of resource governance (Töller and Böcher 2018). The existing studies attain to the asymmetries between local communities and the industry (Ladd 2018), but avoid a deeper insight into a more general logic of how extractivism works in the global Northern contexts. This constitutes a gap which asks for a perspective attentive to specific contexts but also critically reflecting on the political consequences of extractive projects.

To fill in this gap, two exemplary cases of scientific knowledge production from the global North, organized with a great care for transparency at two different scales in democratic contexts, are examined in this paper. The scalar differences of these two cases provide an opportunity for exploring two different contexts in which the relations between shale industry, regulatory institutions and local communities were established. This allows me to reflect on the differences and similarities of these relations. The first case took place at the supranational level of the European Union and the second case took place at the sub-national level of the State of California in the USA. Both were positioned at the hearts of the political systems, as they carried out their scientific work upon requests of regulatory institutions. The work of the Expert Network for Unconventional Hydrocarbons (UH-Network) was organized by several Directorates General of the European Commission in the EU and the work of the California Council on Science and Technology (CCST) was requested in the California Senate Bill 4.

The examined expert bodies exemplify the work of regulatory science in democratic contexts as a response to societal rather than industrial demands, and can be seen as "boundary organizations" (Guston 2001), which, through different transparency performances (Mathews 2011), strove to draw legitimacy from both scientific and political spheres (Demortain 2017). In the broader context of global shale extraction environments, the two cases come across as attempts to produce authoritative knowledge on extraction risks that could gain a status of legal things in the work of regulatory institutions in the global North. Knowledge practices that are employed by those experts, I hypothesize, could be seen as developed within an epistemic community (Haas 1992) of scientific practice of the global North. With the study of the two cases, I thus extend both the notion of epistemic communities and co-production beyond local scales (cf. Mabon et al. 2019, Chilvers 2008).

As Barry (2013) noted, global oil industry has "long been a knowledge production industry" (p. 4) attentive to the activities of organic substances located in complex material relations and the possibility to disentangle them as commodities. The political life of materials, including oil, gas and other minerals extracted from subsoil, "has become increasingly bound up with the production of information" (Barry 2013, p. 2), including information on the negative impacts of extractive projects. Following Malm (2016), I argue that as much as "commodity production is the production of exchange-value *through nature*, with nature being precisely a substratum, subordinated and subsumed under a purely quantitative logic" (p. 283), so is the production of risks of commodity production dominated by a quantitative logic. This creates constraints on the production of qualitative knowledge claims about potential risks and harms of extractive projects. Extractive industries, being attentive to different materials and actors who may disturb commodification of subsoil minerals (Barry 2013), operate on quantifiable risks which they incorporate into other types of extractive calculations. However, in democratic contexts, in conditions of agonistic struggles (Mouffe 1999), there emerge actors who publicly demand qualitative accounts of risks (cf. Ladd 2018). The political life of shale oil and gas has been seeded with heated controversies erupting around the concept and practice of hydraulic fracturing – technology for shale extraction (Ladd 2018, Bradshaw and Waite 2017, Short and Szolucha 2019), making production of knowledge on the impacts of shale rock extraction in high demand but also highly politicized.

2. Beyond the commodity form: Towards critical ethnographies of resources risks

Quite recently, anthropology joined debates developed in human geography and political ecologies (Barry 2013; Bebbington and Bury, 2014; Bridge 2000, 2011, 2014; Kuchler and Höök 2020, Kama 2020) to offer some interesting conceptualizations of how resources come into being in various contexts, beyond their commodity form (Richardson and Weszkalnys 2014; Szolucha 2019, Weszkalnys 2015, Kneas 2020). By shifting attention to ontological questions, anthropologists emphasize how resources can be different things and are conjunctures of the natural and cultural, the socio-political and material, distributed across networks of actors. With their call for an ethnographic approach, anthropology goes beyond the Marxist perspective which sees capital evolving through nature and nature through capital (Moore 2015, Malm 2016) and proposes to study "resource environments" as "the complex arrangements of physical stuff, extractive infrastructures, calculative devices, discourses of the market and development, the nation and the corporation, everyday practices and so on, that allow those substances to exist as resources" (Richardson and Weszkalnys 2014, p. 7). This way, anthropologists avoid the dominant conceptualization of resources as commodities in fossil capitalism (Malm 2016), which allows them to see resource environments as diverse ontological realities, for example as our global or local commons, such as a hydrological systems of a Sacred Mountain (Li 2015).

In this perspective, it is interesting to study the work of regulatory scientists as resource environments and to attain to the materiality and different ontologies of risks produced through their scientific work. While the ethnographic perspective allows me to remain attentive to the context of the experts' work, the critical geography perspective allows me to see the outcomes of their work in a broader picture of the logics of extractive industries. The role of the context was, for example, explored by Rychnovska et al. (2017) with regard to how science produces security expertise. Rychnovska et al. (2017) notice that when producing knowledge on security issues at the boundary between science, bureaucracies and politics, scientists turn their concerns mostly towards securing their authority and making their knowledge credible for other non-scientific publics (see also Edwards 2018). The lens of critical geography, on the other hand, allow me to see the work of experts as co-producing extraction risks ontologically and politically along with spaces for extraction risks – abstract and absolute. This is another instance of co-production, different than what had usually been grasped when co-production between communities and experts was studied (Perry 2022; Perry and Smit 2022; Durose and Richardson 2015). The latter allows us to get a deeper insight into relations between communities' and experts' modes of knowledge production, and the results of the interaction between them. The cases of expert-expert co-production that I examine allow us to analytically approach the diversity of types of expert knowledge and of politics that they co-produce.

Following Malm's definition of abstract and absolute space, after Lefebvre, abstract space emerges "where capital tears material components from their natural beds and heaps them up in places of its own choosing" (2016, p. 301). Absolute spaces, on the other hand, are '"made up of fragments of nature located at sites which were chosen for their intrinsic qualities"' (Malm 2016p. 301 after Lefebrve), with industrial water mills making a good example (Malm 2016, p. 301). The interest in the co-production of knowledge and space by extractive industries has been fruitfully explored by Kneas (2020), who shows how junior mining companies strive to construct and perform similarities and continuities between geographically distinct places of actual and potential extraction in order to attract investors to invest in intact reserves. Through Malm's rereading of Lefebrve's work, one could argue that junior mining companies studied by Kneas (2020) engaged in the production of abstract spaces for the extraction of minerals and their transformation into commodities.

Thus, the combination of ethnographic sensibilities for the context and the critical geography's reading of the relation between nature, capital and space, allows me to argue that the ability of scientists to produce ontologically different risks was embedded in their different material relations with the subsoil, publics, regulatory institutions and the industry, and was contingent upon various asymmetries between actors publicly active in the studied democratic systems. These asymmetries ranged from methodological differences for the collection of knowledge on environmental impacts by different public institutions, asymmetries in data access between regulatory scientists and industries, and also asymmetries between those whose knowledge claims appeared to be politically more effective than of the others (Choy 2011), especially local communities. These material entanglements and asymmetric relations, I argue, allowed for the co-production of risks as data and stories along with abstract or absolute spaces.

Turning the qualities of the subsurface into risks may have far reaching political consequences. As Demotrain (2017) writes "there is an intimate relation between the supposedly scientific activities of measuring, assessing or testing objectified phenomena such as the risks or benefits of a technology, and the legitimacy of deciding on its fate, of structuring a market for it." (p. 148). Risks are not evenly distributed and do not acquire the same ontological statuses through the work of experts, just like nuclearity is not an evenly distributed characteristic across multiple actors' relations with uranium (Hetch 2014). Risks as different things allow different political actions. For example, as Williford (2017) argues, seismicity turned into a risk object was used to construct the modern state of Morocco and to reconstruct the sociopolitical spaces of Morocco's cities. Drawing on data from seismographs, witness accounts, and direct observations of destruction, international teams of experts working in the aftermath of the disaster rewrote Agadir as a seismically vulnerable space. "At the same time, these vulnerabilities resulted less from the complexity of Agadir's post-quake built environment than from the specific ways in which expert strategies for mapping and managing risk intersected with the priorities of an interventionist post-colonial state" (Williford 2017: 1009). This is particularly interesting in the context of democratic political systems of the global North where exists knowledge and institutional capacity for an effective regulation of extractive practices. There is, thus, a need for examining how regulatory science becomes involved in how resources become known as risky and how these risks come to matter politically for the organization of resource governance and its extraction at different scales in democratic contexts of the global North.

3. Methodology and the selection of cases

The selection of two expert groups for the analysis has been guided by the objective of developing a research perspective, rather than by testing a theory (Eisenhardt 1989). As the goal is to propose a context and politically sensitive approach to understand how knowledge on extraction risks is co-produced in various places of the global North and with what politics of extraction risks, I chose cases of regulatory science teams in the context of democratic political systems in the global North. The stories about the UH-Network in Brussels and CCST in California can be told in two ways: starting from their origins or starting from their end products. The first way would reveal that both were established by governance institutions central to the democratic political systems where scientific knowledge on the impacts of shale industry was demanded. The second way would reveal that only in the latter case, the impacts of shale industry on human health was accounted for in experts' final, publicly available reports. These similarities and differences make these cases exciting for a joint analysis with the ethnographic sensibilities for the context (Richardson and Weszkalnys 2014; Rychnovska et al., 2017) and critical lens for power relations and dominant extractive logics of fossil capital (Malm 2016). Why did CCST account for health risks and the UH-Network did not, while this interest was expressed in the mandates of both expert bodies? How were environmental and health risks handled in the work of experts in Brussels and California? These are two guiding questions of this analysis.

Since the work of the two expert bodies is examined as located at the boundary between science and politics, the political context of the two cases needs to be introduced as well. At the onset of the shale gas debate, in 2011, the European Union was divided along the vision of extraction possibilities with Poland and the UK excited about this new opportunity and France fiercely opposing it. Environmental movements organized locally, nationally and across EU member states alarmed about the damaging impacts of hydraulic fracturing – *fracking* – drawing on multiple examples coming from the projects developed in the USA, mainly along the Marcellus Shell. Fear of water contamination and induced seismicity triggered collective imaginary of an environmental disaster and made the pro-shale gas politics highly controversial and unwelcome by various civil society groups. At the EU arena, the European Commission presented an open position with the objective of exploring different options for shale industry – economically and in terms of environmental regulation. However, the traditionally more environmentally concerned European Parliament, created a big coalition against fracking. Shale politics in Europe was highly antagonizing.

California, known for its environmental progressiveness stayed aside of the shale industry dynamically developing in other parts of the USA for over a decade. By finally allowing shale industry to develop and refusing to ban in, the Governor of California, Jerry Brown, earned fierce criticism from environmentalist groups who accused him of not practicing what he preached. Brown's publicly performed promises to decarbonize California's economy stood in stark contrast with the revival of oil industry through *fracking*. This seriously aggravated the situation of water shortages in the state and fueled political struggles over the protection of water supplies. The political struggles seem similar in both cases, but the scale on which they were played out created different spatial and political distances between local communities and particular projects, on the one hand, and regulatory institutions and scientists on the other. From Brussels' perspective, the fate of local communities seemed more distant and primarily to be taken care of by national regulatory institutions. In California, on the other hand, the fate of local communities experiencing fracking operations was much more closely linked to governmental institutions and politics taking place in Sacramento.

Another important reason for selecting these cases is the different commodity status of unconventional hydrocarbons in Brussels and in California. While in California, shale oil and gas have already become full-fledged commodities, in the European case, the options for shale oil and gas exploitation were only explored. For my study, this presented an interesting opportunity for examining whether the actual and potential commodity status of the resource at hand constituted a different context for the production of knowledge on resource risks around it. While European local communities generally feared the potential extraction of the resource, local communities in California actually experienced it. While the former feared the potential risks, the latter experienced actual harms. This, I hypothesize, put the experts into starkly different relations with local communities, industries, regulatory institutions and the subsoil materials. Moreover, each of the studied expert bodies was formed in the heart of the traditionally opposed contexts – the European context of risk deliberation and risk preemption and in the Californian context of learning risks while doing risky things (Jasanoff 2004).

The case studies explored in this paper are built through a mix of different research methods which helped me to get an in-depth understanding of how the two expert bodies carried out their work. In both cases, I did document analysis as the work of both expert teams was well documented from the beginning till the end – with clearly evidenced regulatory texts calling for the expert bodies to be established, mandates, public documentation of communication with non-expert actors such as NGOs or industries and publicly available final reports. At the same time, different scales and locations of the experts' work – Brussels and California – made it easier for me to become a member of the Brussels-based UH-Network and carry out an ethnographic study there, while I was not able to become part of a closed expert team organized in California. Therefore, while the Brussels study was a classical ethnographic endeavor of "studying up" through a regular membership and participation in the work of the UH-Network, document analysis and expert interviews, the Californian case was reconstructed mainly through expert interviews and document analysis.

4. Data collection

As I was interested in the experts' perspective and their work, expert interviews seemed to be the best strategy of data collection. In both cases, the expert interviews were carried out after the work of the expert groups had been completed. They lasted at least an hour each, however, some turned into recurring conversations on different occasions. I managed to talk to the top level organizers of both groups, to some of them twice. They explained to me the origins of their work, how it developed into a structured scientific task, the challenges they faced in terms of data collection and the relations to other actors – the industry, regulatory institutions and non-experts publics. This way, in both cases, I obtained accounts about the whole process from the knowledge post-creation perspective. However, while in the Brussels case I was also able to participate in the struggles evolving during the UH-Network working meetings, in the Californian case, I arrived in the USA too late to be able to take part in any meetings. This presents an important limitation on the possibility to claim the same kind of understanding of both processes. Having this in mind, in both cases, I limited the analysis presented in this paper to the experts' perspective – I do not reconstruct the perspective of other actors, such as local communities or industries, even though I refer to their statements and opinions in order to obtain a broader picture of the processes. Moreover, I made only two issues the subject of my the analysis – the experts' work on environmental and health issues – because these two themes spontaneously appeared as important in both sets of interviews and in the documentation of the experts' work.

Data for the analysis were collected between 2015 and 2017 when I paid numerous visits to Brussels to participate in the work of the UH-Network as a representative of social sciences and carried out interviews with the UH-Network organizers, and in 2018, when I stayed at the Center for Science, Technology, Medicine & Society (SCTM&S) at UC Berkeley to collect documents and carry out interviews with the CCST organizers. While gathering material for the Brussels case, I talked to about fifteen people involved in the UH-Network's work, its leaders and various experts: engineers, social scientists, NGO representatives, geologists, industry representatives, local community members, ministry officials. The most important interviews that I refer to in this paper were conducted with the two main organizers of the UH-Network from the Joint Research Center (both interviewed twice), the main data analyst at JRC responsible for processing data collected within the UH-Network, a Polish geologist who chaired one of the working groups of the UH-Network (interviewed twice), a local activist from the UK (during a one day visit I paid to Balcombe) who represented communities located near shale gas projects and a high level official from DG Environment. I participated in all four one-day long working group meetings of the UH-Network as an expert in social sciences. However, due to my double role, as an expert and a researcher, I refrained from taking an active part in plenary discussions. Nevertheless, I engaged in conversations with the experts during coffee breaks, listened to their presentations and discussions, and took detailed notes during the meetings. In June 2017, I took part in the final conference in Amsterdam, where JRC experts presented the final outcomes of the UH-Network.

In order to reconstruct the Californian case, I use five in-depth expert interviews – with two lead experts and main organizers of the CSST team, with an NGO representative actively involved in the consultation process, with a local environmental activist and a local sociologist from UC Davis who had carried out a number of studies related to shale oil and gas extraction. I also relied on the written documentation, which had been publicly made available through the project website[1], including an e-mail exchange between project managers and various stakeholders. In order to systematically develop evidence for the argumentation laid out in this paper, I transcribed all interviews and coded them with regard to the two themes of environmental and health risks. I used the same codes to analyze documents.

In the analysis presented below I reconstruct the two processes of knowledge production in respect to environmental and health impacts. This reconstruction is made from the experts' point of view. In the analysis, I am attentive to (1) different contexts of resource extraction and potentiality, (2) the experts' relations to regulatory institutions, societal actors and industry, as well as (3) different asymmetries that underlay the work of the experts. At the end of the paper I provide conclusions where I discuss the consequences of the achieved risk ontologies for the governance of shale industry.

5. UH-Network and CCST as two exemplary regulatory science bodies on producing risks of shale oil and gas extraction

In November 2012, on the wave of high interest in unconventional hydrocarbons in Europe, the European Parliament called for opening an "independent platform" that would gather representatives of industry and science to "provide opinions and establish good practices related to clean shale gas extraction technologies" (Resolution 2012). Roughly at the same time, the Directorate General for the Environment of the EC started drafting a directive to regulate shale gas industry as a separate issue of public concern. All this happened when no commercial extraction of shale gas had taken place in European countries and the conditions under which shale oil and gas could become a commodity were still being negotiated by European institutions and under vast citizens' protests (Szolucha 2018, 2019, Bradshaw and Waite 2017). Only around 20 fracking operations were completed in Poland, a few in the Netherlands and in the UK. This, altogether, summed up to a limited on-the-ground experience with *fracking* from which little data could have been retrieved.

The regulatory situation in Europe stabilized in January 2014 when the EC issued recommendations for the best practices of unconventional hydrocarbon extraction, a soft regulatory solution, which called for

[1] https://ccst.us/reports/an-independent-scientific-assessment-of-well-stimulation-in-california-volume-1/.

establishing a temporary expert body, finally launched in July 2014 as the European Science and Technology Network on Unconventional Hydrocarbon Extraction (UH-Network, Mandate 2014). The network initiated by the EC and managed by the Joint Research Center (JRC) of the European Commission was intended to work for three years (2014–2017). Its aims were to increase "knowledge on unconventional hydrocarbon extraction technologies and practices also in order to further reduce potential health and environmental impacts and risks" and "collect, analyse and review results from exploration projects, as well as to assess the development of technologies used in unconventional gas and oil projects" (COM(2014) 23). It would work to facilitate "open and transparent" information sharing with the public, "bringing together practitioners from industry, research, academia as well as civil society" (COM(2014) 23) and would be regulated by the network's Mandate (Mandate 2014).

Roughly at the same time, on the west side of the U.S., in California, the story of unconventional hydrocarbons was developing in a slightly different way. Around 2010, California State authorities would still reject that project, seemingly uninterested in turning shale formations into a commodity within their jurisdiction. However, as soon as some prospects for shale exploration became viable for California, the State administration started to speak of unconventional oil and gas production in the horizon of the next 50 years. Followed by a public outcry, which, among other things, was caused by various mistakes made by high level officials and an increased attention paid to this issue by big media outlets, like the New York Times, a number of lawmakers in Sacramento took interest in unconventional hydrocarbons as a regulatory issue. Oversight hearings were organized and the propositions of new bills were drafted. In 2011, the potentiality of the resource actualized into a full-blown commodity form with shale oil and gas industry fracturing about one hundred and fifty wells per month. The average hydraulic fracturing operation in California used a much smaller amount of water than in many other parts of the country because operators fractured in relatively shallow vertical wells (less than 2,000 ft (600 m) deep). About 95% of the reported hydraulic fracturing operations in California occurred in the San Joaquin Basin, nearly all in four oil fields in Kern County (CCST Report 2015). Los Angeles and Kern County became important places of community-based activism as many well pads and drilling operations were located in close vicinity of residential areas, schools and other institutions.

In 2013, the Senate Bill 4 (SB4 2013) passed in the California Senate to set up a framework for regulating hydraulic fracturing and acid stimulation technologies in the state. SB4 concluded that "insufficient information is available to fully assess the science of the practice of hydraulic fracturing and other well stimulation treatment technologies in California, including environmental, occupational, and public health hazards and risks" (SB4 2013, p. 4) and required the California Natural Resources Agency to conduct an independent scientific study of hydraulic fracturing and acid stimulation technologies in California including "the likelihood that these technologies could enable extensive new petroleum production in the state; impacts of well stimulation technologies (including hydraulic fracturing, acid fracturing and matrix acidizing); gaps in data that preclude evaluation; potential risks associated with current practices; and alternative practices that might limit these risks" (SB4 2013, p. 4). At a later stage, when the team of scientists was put together by the Californian Council on Science & Technology[2] (CCST), another set of negotiations set out around the translation of this one paragraph into the actual scope of the study, which was called "An Independent Scientific Assessment of Well Stimulation in California: An Examination of Hydraulic and Acid Stimulations in the Oil and Gas Industry". The work on the study was commenced at the beginning of 2014 and the first progress report was planned by April 1st 2014 (CCST Report 2015). As the CCST Report (2015) clarifies, "members of the CCST steering committee were appointed based on technical expertise and a balance of technical viewpoints" (p. 6). Thus, a lot of care for transparency was taken. Local community members or NGOs' representatives were not invited but the CCST team organized local meetings.

6. Co-producing environmental risks as data along with the abstract space

The work of the UH-Network in Brussels started in July 2014. However, assembling the mandated knowledge proved to be quite challenging. There was not much data available about the issues of interest. According to the JRC scientists, industries were reluctant to share any information beyond what was publicly known. As one of my interviewees from JRC pointed out, only 5–6 people from the Network supplied some data and most of these data were publicly available in national domains anyway (Interview 5 with JRC high level official 2; Interview 6 with JRC high level official 2). Most of the data came from public institutions but they were often reported in different units of measurement or constructed with the use of different methodologies:

> *It's not a problem of units and so on because we can do all the types of conversions, it's an issue of methodology, because, for example, in Poland we have a certain way of measuring, for example, the air quality with regard to methane pollution. Poland is using certain instruments while in the UK they are using different ones. We don't have a standard methodology for measuring certain parameters.* (Interview 4 with JRC senior expert).

Methodological asymmetries across the European member states' institutions constituted an obstacle for comparing risks in different places of extraction and JRC experts channeled their energies into making different datasets comparable. Moreover, the JRC experts that I spoke to, stressed the fact that geological conditions in various places differed, and thus, neither the efficiency of technologies nor environmental impacts of those technologies could have been meaningfully compared across Europe and beyond it. The problem was that different technologies, including different chemicals, worked well respective of the geological location:

> *Yes, it will be difficult to come up with generalized conclusions about the environmental impacts of fracking. The difference of the geological structures perhaps will accept different solutions and it will be in the end about the economics of it. If everything works fine in one place, why would you change this? So long as something works in one place, people will continue with this.* (Interview 6 with JRC high level official 2).

The experts were concerned about their ability to produce generalized knowledge about risks as data. They hoped that they could come up with datafied descriptions of exploration wells that could be compared along certain environmental and technical parameters. Such comparable wells' descriptions would create abstract spaces of extraction risks – descriptions that tell facts only. The UH-Network experts repeated it like a mantra that their goal was to produce facts and no politics (Interview 4 with JRC senior expert, 5 with JRC high level official 1, 6 with JRC high level official 2), thus disembedding hydraulic fracturing operations from complex local contexts. Driven by this objective, JRC experts channeled their main analytical efforts into the standardization and commensuration of the collected data – to make them comparable across local geologies and institutional methodologies. While carrying out these tasks, JRC scientists had to take a number of decisions, which, at first, could have seemed merely technical. However, following Latour's observation

[2] CCST is a non-profit organization established in 1988 at the request of the California State Government and sponsored by the major public and private postsecondary institutions of California and affiliate federal laboratories in conjunction with leading private-sector firms. Its mission is to improve science and technology policy and application in California by proposing programs, conducting analyses, and recommending public policies and initiatives that, in the official language of the institution, "will maintain California's technological leadership and a vigorous economy" (CCST Report 2015).

that “science is politics by other means” (Latour 1987), these decisions were by no means apolitical. The generalizability, comparability and universality of the produced data on environmental risks and the abstract character of the spaces of shale industry’s operations were the political stakes.

In the case of CCST in California, the science team worked on the technical data that were publicly available and reviewed some relevant literature. Due to time and money constraints, no new data were generated (Interview 2 with Lawrence Berkeley National Laboratory senior expert). The scientists faced similar challenges to the ones experienced by the UH-Network experts. Many data extracted from various public databases, scientific papers and reports were providing a fragmented picture of the industry’s impacts and had to be re-assessed or re-evaluated:

> *Let me give you an example, there are maybe 5, 6, 7 state databases and regulatory agencies, one has measures of depth of wells for injection of produced water, one has geology, another one, but probably written electronically, has the screening of the well where the injection happens and you put all that together and finally realize that these guys may be injecting into water or deep reservoirs that might have good water quality.* (Interview 2 with Lawrence Berkeley National Laboratory senior expert).

Thus, also in the case of the CSST team, the scientists were presented with fragmented realities of resource risks. Different institutions were using different methodologies for knowing the risks, and the work of the CCST team involved putting these different perspectives together in order to obtain a more general view. The relation between particular institutional perspectives and a universal outcome in knowledge terms was also at stake.

For example, many data gaps were discovered about the chemical composition of the fracking fluids: “we all knew we didn’t have a good clue about the chemicals that were injected” (Interview 2 with Lawrence Berkeley National Laboratory senior expert). Companies did not want to disclose precise receipts of their ‘chemical cocktails’. The CCST team disposed of a broad-brushed list of substances but the real problem concerned the fact that the list of chemicals would say nothing about their impacts on environment and living organisms:

> *So one of the things that I remember is that while the chemicals were being listed, there were some discrepancies or some issues with inconsistencies and the second thing was that for all the chemicals, the environmental profile, the questions about what it actually would do in terms of harm to living organisms wasn’t done or hasn’t been done for those chemicals. There was a very large percentage where we didn’t know what these chemical would do to a little mouse that might drink some of the water.* (Interview 2 with Lawrence Berkeley National Laboratory senior expert).

Thus, the CCST recommended that the industry worked on their environmental profiles and probably “simplify their cocktails” (Interview 2 with Lawrence Berkeley National Laboratory senior expert). At the same time, CCST scientists acknowledged that these cocktails were often locally developed and worked well in particular conditions of local geologies:

> *There are a lot of reasons why these cocktails work or have been working and if you take something away and put something else in, you may suddenly have a clod in you wells and you are in trouble.* (Interview 2 with Lawrence Berkeley National Laboratory senior expert).

Similarly as in the European context, the CCST experts were trying to co-produce the abstract space of extraction risks but they faced difficulties as data generated by different institutions differed, industries did not disclose information about the chemicals and geologies differed from one place to another. In the case of the CCST report, the authors admitted that the validity and usefulness of the report were limited mainly by the characteristic of the examined geological structures:

> *There’s two things. One is that hydraulic fracturing done in California is quite different from what is done anywhere else because of different geology that is currently tackled. So, in terms of the water use, even in terms of chemicals actually, the mixes they use are quite different. So, some of that is difficult to transfer and then, of course if you see our case studies, the impact and the circumstances are somewhat difficult to transfer, and also the politics is difficult to transfer too. So, there are limits to how that can be applied. I think that some of the general lessons surely are good and the regulatory environment is necessary and hasn’t been picked up yet everywhere.* (Interview 2 with Lawrence Berkeley National Laboratory senior expert).

This way, the CCST expert pointed out to two main limitations – the limitations of generalizing geological and political contexts. The two would make it difficult to make more general claims about the discovered risks and impacts. As a result of these obstacles, the objective of the CCST scientists’ work was to standardize the collected data on environmental risks and make them comparable across different contexts. Standardization of extraction risks as environmental data - politics by methodological means – was a way to produce abstract spaces of extraction risks – spaces from which particular risks could be disentangled and quantified for the calculations of shale industry and for the regulatory institutions. Thus, the experts’ concern for the generalization of the produced data on risks can be seen as compatible with the extractive logic of shale industry – its logic of abstraction and quantification – but also with the logic of modern bureaucracies which govern well-quantified realities.

7. Co-producing health risks as local stories and the absolute space

Quite early on in the process, the composition of the UH-Network was challenged by representatives of NGOs based in Brussels. They publicly accused the Commission of having invited an overwhelmingly high number of industry representatives and experts with direct links to shale industry[3], and thus, of channeling industrial interests into the work of the UH-Network. The mandate of the UH-Network did not grant itself with any advisory roles, nor had the Commission ever asked its experts to propose any recommendations (Mandate 2014, Interviews 5 with JRC high level official 1 and 6 with JRC high level official 2). The NGOs’ complaint ended up with a case at Ombudsman who was supposed to decide whether the network was obliged to comply with certain transparency requirements as one of many expert groups that give advice to the European Commission on various technical issues.[4] But, maybe even more importantly, NGOs’ representatives left the UH-Network and refused to grant its work and the outcomes with their approval and authority. A clarification of the situation was made by the UH-Network organizers on their official website that:

> *The number of participants from each category reflects registrations received. While the Commission insists on a fair and balanced exchange of views, it is not within the means or the objectives of the Commission to achieve a balance in terms of matching numbers of participants from each category.*[5]

This quote indicates that from the very beginning it was difficult to construct one coherent public for the work of the UH-Network (author

[3] The Guardian Green groups accuse EU shale gas panel of fracking lobby takeover,15 April 2015 https://www.theguardian.com/environment/2015/apr/15/green-groups-accuse-eushale-gas-panel-of-fracking-lobby-takeover.

[4] Case: 1100/2015/NF ‘Alleged failure of the European 90 Commission to treat the European Science and Technology Network on Unconventional Hydrocarbon Extraction as an expert group and to ensure its balanced composition’ opened on 18 August 2015; available at https://www.ombudsman.europa.eu/cases/caseopened.faces/en/60649/html.bookmark.

[5] https://ec.europa.eu/jrc/en/uh-network.

2018). After the abovementioned statement, NGOs' and local community members who decided to stay in the network and continue to work on shale industry risks, were further estranged from working groups' discussions. One issue was especially controversial for both sides – health risks. While local activists demanded to assign health risks as a number – a parameter or probability – to the usage of particular chemical substances, the experts countered these claims with an argument that it was too difficult to come up with objective measurements of health impacts. Experts claimed that there were no medical experts in the network who would be able to relate chemical substances to health hazards.

Moreover, claims made by non-expert participants in favor of accounting for health risks were countered as imprecise, emotionally loaded, politically minded, wrongly phrased, irrelevant for the discussion, outside of the Network's mandate (UH-Network meetings 2015–2017 and Interviews 5 with JRC high level official 1 and Interview 6 JRC high level official 2). This called into question the sole presence of those people. A local activist from Balcombe, UK – a place where a big anti-fracking protest against the exploration plans of Cuadrilla took place – told me that the issues discussed during the UH-Network meetings were too technical and not relevant for the community's experience with the industry. Their arguments, expressed in non-scientific language, at times through provocative statement such as "we don't want to be Guinea pigs of shale industry" (from the UH-Network meeting notes, 23 February 2016), were perceived as not proper for the scientific forum which the UH-Network aspired to be. This way, the public for the UH-Network expertise became fragmented into experts and non-experts, whereby the capacity of the latter to "publicly speak" about scientific issues of shale industry risks was questioned by the former. Their speech was not "public speaking" (Choy 2011) as it was ineffective in terms of forging relations to the experts present in the UH-Network. This asymmetry between the experts and non-experts resulted in favoring the expert way of knowing environmental risks as data and parameters over the locally embodied health impacts experienced by local communities.

In the end, the health issues were not included in the JRC final report. The involved scientists did not want to relate any human bodies to shale industry risks (from the UH-Network meeting notes, 23 February 2016). The ontological reality of chemical risks remained disembodied. In June 2017, in Amsterdam, JRC experts presented the results of their work: an interactive database of wells with parameters. The parameters did not include health risks but technical data related to environmental impacts only. The database could be expanded in the future and, in this state, presented a good example of an abstract space of extraction risks upon which various calculations could further be made. However, the European Commission clearly stated that no new regulations referring specifically to shale industry would be prepared and that JRC would move on to other topics. The reaction of industries to the interactive map was enthusiastic:

> *We received e-mails from the industry, and from some other groups, some positive things in the sense that sometimes they didn't even know that there were measurements, data. All of them were asking for more. I think that for many people it was a surprise that these types of information could be put together, compiled, etc.* (Interview 5 with JRC high level official 1).

In the end, the asymmetries between experts (from public institutions and industries) and non-experts from local communities structured the relation between environmental and health risks. While the former gained an ontological status of comparable data, the latter remained non-knowledge (Gross 2007), or officially produced ignorance (Mathews 2011). Stories about health impacts remained bounded to the 'emotional and imprecise accounts' of the members of local communities and a few NGOs without gaining visibility through public performances of expert knowledge (Wynne 2005, Mathews 2011). They co-produced absolute spaces of extraction risks, as in the case of many other fractured communities (Ladd 2018).

In the Californian case, placing impacts and risks in relation to local communities seemed to be a more straightforward thing because those communities actually experienced shale oil extraction in their vicinity. In order to account for these relations – between local industrial projects and local communities – the experts came up with an idea to write several case studies that would be placed "somewhere specifically" in the final report, and "would deal with a series of particular issues more deeply" (Interview 1 with CCST high level official). The case studies included: San Joaquin Case Study, Los Angeles Basin and San Joaquin Basin Case Studies, Monterey Formation Case Study and Offshore Case Study (Interview 1 with CCST high level official; Interview 2 with Lawrence Berkeley National Laboratory senior expert, CCST Report 2015), and, according to my interviewee, they largely grew out of questions that the team of researchers got involved with:

> *The second part of the Los Angeles Basin Case Study compensates for the lack of data documenting adverse health outcomes by investigating information that suggests, but does not confirm with certainty, the risks to human health. The precepts of the field of public health include an emphasis on the anticipation of potential problems even though specific problems have not been observed or proven to create risk. In this way, the public health chapter of Volume II and the public health analysis for the Los Angeles Basin Case Study differ from other parts of this report. A major goal of public health research is to anticipate and avoid harm rather than to observe and allocate cause for harm* (CCST Report 2015).

In other words, health impacts gained relevance in the CCST work through the ontological status of local case studies - stories. The team held various stakeholder meetings during which local community members could ask questions and share their experience:

> *there were certain questions that we always got, that we thought were to be clearly addressed. Everybody always asked about the chemicals and that was going to be addressed in the Monterey chapter, but there were other things that sort of fell through the crack, there were things like the whole off-shore drilling issue, and off-shore hydraulic fracturing, there was a lot of hustle about the Monterey Rock, you know, that there would be a lot of fracking in the next 10 years, so it was clear that there is going to be a chapter that would address it.* (Interview 1 with CCST high level official).

The final report referred to health hazards and gave the recommendation that public health studies should explore the issues further in order to ascertain if any mitigation policies are needed:

> *pollutants can be concentrated near production wells and present health hazards to nearby communities. California public health studies could determine the magnitude of this issue and the need for any mitigating policies. Studies done outside of California found workers in hydraulic fracturing operations were exposed to respirable silica and volatile organic compounds (VOCs), especially benzene, above recommended occupational levels, but confirmation of this issue awaits specific evaluation in California.* (CCST Report 2015).

The reception of the CCST report was fairly positive, and some NGO groups were able to look beyond some of its limitations (Interview 1 with CCST high level official; Interview 3 with Clean Water Action expert). The most important environmental NGOs involved in oil issues in California, such as The Environmental Defense Fund, National Resources Defense Council (NRDC) and Clean Water Action were particularly interested in the issue of irrigation: "irrigation won big news. There's been a pretty big struggle for the irrigation which was that thing that people were really aware of" (Interview 1 with CCST high level official). After the work of the expert team had closed, new regulations on water use were introduced for the whole oil industry in California. The final report raised concerns about the regulation of conventional branches of the Californian oil industry. As political debates on the shrinking shale industry in California gradually faded away, debates on oil and gas industry on water resources remained. A representative of the Clean Water Action who at the time of the interview worked in Washington D.C. made a favorable comment on the report:

> *I think that the study starts to point to some of those gaps that are outside of the scope of the study, and then we had been able to say, you know, "your work has identified some issues" and there's health impacts for people working on oil and gas wells. The important part of that is that the study was very helpful in getting more attention to that aspects, I would say on the waste water side, the information about waste disposal in open pits helped really bring attention to that issue for us and also disposal of waste water for irrigation, that part of the study was very helpful for exposing that.* (Interview 3 with Clean Water Action expert).

However, even if the approach to communities was different among the CCST scientists than among the UH-Network experts, the community experience was not inserted as data into the main body of the final report. Communities' experience was separately told outside of the main body text, inserted into neat frames of local stories. The purification of knowledge claims from local contexts seemed more difficult than from public institutions' databases and methodologies. While the latter required some tiding up and standardization of measurements and methodologies, the former required disentangling risks from people's accounts, their imprecise language, emotions, multi-actor local assemblages and political values. The experts' accounts of health risks seemed to have co-produced absolute spaces of the fractured communities, spaces which had to be presented in its complexity and with its multi-relational entanglements.

8. Fragmented risks, publics and different spaces of extraction: Towards critical ethnographies of resource risks

As shale industry re-inserted extractive projects into many local places in Europe and the USA, it also re-introduced fossil fuel extraction as a political problem for democratic societies and as a regulatory issue for public administration. With shale industry, the global North seemed to have joined global extractivism (Chagnon et al. 2022) with its practices of turning subsoil materials into commodities, discourses of quantification and the uneven power relations between the almighty fossil capital and the others. The study presented in this paper was devised as a magnifying glass which allowed me to peer into two specific locations where the Northern extractivism could be observed – two instances of regulatory science production at two different scales. The examination of these two cases cannot provide us with a full picture of what shale extractivism is like and how it works in the global North. However, through these two cases one obtains a better understanding of how regulatory science of the North works in relation to fossil capital. And though each context produced slightly different results with regard to the status of environmental and health impacts of shale industry, structurally the results of scientific work were similar. Environmental impacts became known as datafied risks, while health impacts got a status of local stories. The main objective of both expert groups was to provide generalizable knowledge in form of standardized data that would co-produce abstract spaces of extraction risks upon which regulatory institutions could act. However, these abstract spaces are also what fossil capital seeks to produce when working through the nature to commodify it (Malm 2016).

Thus, the work of regulatory scientists seems to be compatible both with the logic of modern bureaucracies as well as with the logic of fossil capital. Regulatory science of the global North, through the examined cases, appears to be a coherent epistemic community striving to produce neatly bounded facts that could circulate across spaces, disentangled from local politics (Latour 1987). Just like fossil capital quantifies nature and turns it into exchange value (cf. Malm 2016) - producing people-less commodity spaces along the way (Bridge 2000) - regulatory science quantifies environmental risks and erases human health impacts from spaces of extraction risks. Thus, the embodied experience of resource risks gained little representation in the final reports, even if certainly much more in the Californian case where shale industry existed and the resource had already actualized as a commodity.

The analysis has also revealed a number of asymmetries between experts, industries and non-experts in democratic systems. As knowledge intensive industry (Barry 2013), shale industry had more knowledge about the subsoil than any public institution. The process of making nature through capital and capital through nature (Moore 2015) was accompanied with intensive knowledge production. However, most of the produced knowledge was owned by the fossil capital and only a portion of it was publicly shared with institutions and society. This asymmetry in access to knowledge about the subsoil was constitutive to the outcomes of the work of both expert groups. The other asymmetry was more technical and referred to incompatible methodologies for collecting and generating data about the resource making environment. Scientists working in both groups devoted most of their energies to solving different methodological approaches used in different public institutions. And despite their efforts, some data remain incompatible – difficult to compare across various contexts.

The third asymmetry concerned the relation between experts, industries and local communities. Typically, for the industry, local communities appear as potential obstacles for their extraction projects (Barry 2013). It eagerly moves people to other places to clear extraction spaces off any humans and off their politics (Bridge 2000). In densely populated spaces, like the ones in California and throughout Europe, human populations become part of extractive assemblages – they cannot easily be relocated elsewhere. In the context of democratic political systems, with the ability to represent their interests and voice their claims, local communities do not remain silent against extractive industries (Ladd 2018, Szolucha 2019, Bradshaw and Waite 2017). Moreover, as they can legally turn to regulatory institutions for protection or restoration of the caused damage, they constitute a potential cost for the industry. However, despite these rights, local communities often become silenced or sidelined when confronted both with industries and regulatory science experts. The scientists tend to make a distinction between expert and non-expert knowledge claims (Wynne 1991, 2001) and silence the latter (Wynne 2005, Mathews 2011). As a result experts tend to assign community accounts' a different ontological status – the one of local stories which cannot be quantified, because of their context specificity, complexity and politicization. As stories, local impacts, especially those on human health, are difficult to be administratively governed.

Thus, the proposed critical ethnographic approach allowed me to see different politics, differently established relations between various actors and struggles among them depending on the context of the inquiry. It also allowed me to see how scientific discourse and practice of turning impacts into quantified, comparable risks cuts across these contexts and speaks both to the logic of regulatory institutions in democratic systems as well as to the logic of extractive industries. The vision of where politics and where science lies seems to be shared by regulatory science, regulatory institutions and the industry in the global North. While the ethnographic sensibilities allowed me to examine the work of experts in particular contexts, the critical geography perspective provides space for asking more general questions about the political consequences of the experts' work.

A distinction between abstract and absolute spaces gives us an opportunity to critically reflect on what the results of experts' work could do for extractive industries and regulatory institutions. Datafication of environmental impacts, I argue, co-produces abstract spaces and local stories co-produce absolute spaces. I propose to attain to the ambiguity of this result. Abstract spaces are conducive to the operation of fossil capital, which tears material components out from their natural beds and moves it across market spaces for the sake of producing more exchange value (Malm 2016). Co-production of abstract spaces of extraction risks allows fossil capital to evaluate and quantify risks of their projects and avoid places where the cost of risks is too high. Abstract spaces also allow regulatory institutions to put constraints upon the value extractive practices of fossil capital through general regulations and bureaucratic rules of environmental protection. Datafied risks, I also argue, can more easily become legal things than risks told as local stories. Stories co-produce absolute spaces – case studies that need to be presented with their environmental, social and political complexity. Stories make places into unique, incomparable assemblages that are difficult to generalize and abstract. It is thus more difficult for regulatory institutions to act upon risks identified through local stories. At the same time, however, a local story embeds materials extracted by fossil capital and puts constraints on the possibility to turn particular places into "a matrix of nodes and arteries that evolve not through their revealed biophysical attributes, but through the circuits of capital itself" (Malm 2016, p. 301). Stories make spaces into places.

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Data availability

Data will be made available on request.

References

Barry, A., 2013. Material Politics: Disputes Along the Pipeline. Wiley Blackwell.
Bebbington, A., Bury, J., 2014. Political Ecologies and the Subsoil. In: Bebbington, A. and Bury, J. (Eds.), Subterranean Struggles: new dynamics of mining, oil and gas in Latin America. pp. 1-27.
Blaser, Mario, and Marisol de la Cadena. 2018. "Introduction. PLURIVERSE." In A World of Many Worlds, edited by Marisol de la Cadena, and Mario Blaser, 1–22. Durham, NC: Duke University Press.
Bradshaw, M., Waite, C., 2017. Learning from Lancashire: Exploring the Contours of the Shale Gas Conflict in England. Global Environ. Change 47, 28–36.
Bridge, G., 2000. The social regulation of resource access and environmental impact: production, nature and contradiction in the US copper industry. Geoforum 31 (2), 237–256. https://doi.org/10.1016/S0016-7185(99)00046-9.
Bridge, G., 2011. Resource geographies 1: Making carbon economies, old and new. Prog. Hum. Geogr. 35 (6), 820–834. https://doi.org/10.1177/0309132510385524.
Bridge, G., 2014. Resource geographies II: The resource-state nexus. Prog. Hum. Geogr. 38 (1), 118–130. https://doi.org/10.1177/0309132513493379.
Chagnon, et al., 2022. From extractivism to global extractivism: the evolution of an organizing concept. J. Peasant Stud. 49 (4), 760–792.
Chilvers, J., 2008. Environmental risk, uncertainty, and participation: mapping an emergent epistemic community. Environ. Plan. A 40 (12), 2990–3008.
Choy, T., 2011. Ecologies of comparison: An Ethnography of Endangerment in Hong Kong. Duke University Press, Durham and London.
Demortain, D., 2017. Expertise, Regulatory Science and the Evaluation of Technology and Risk: Introduction to the Special Issue. Minerva 55: 139-159. DOI 10.1007/s11024-017-9325-1.
Durose, C., Perry, B., Richardson, L., Dean, R., 2021. Leadership and the hidden politics of co-produced research: a Q-methodology study. Int. J. Soc. Res. Methodol. 1–21. https://doi.org/10.1080/13645579.2021.1960738.
Durose, C., Richardson, L., 2015. Designing public policy for co-production: Theory, practice and change. Policy Press, Bristol.
Edwards, M.L., 2018. "Just report the science": How scientists frame engagement in contested debates over fracking in the Barnett Shale. Energy Res. Soc. Sci. 45 (2018), 67–74.
Eisenhardt, K.M., 1989. Building Theories from Case Study Research. Acad. Manage. Rev. 14 (4), 532–550. https://doi.org/10.2307/258557.
Fry, M., Brannstrom, C.h., 2018. Experimental regulatory approaches for unconventional gas: the case of urban drilling and local government authority in Texas. In: Whitton, J., Cotton, M., Charnley-Parry, I.M., Brasier, K. (Eds.), Governing Shale Gas: Development, Citizen Participation and Decision Making in the US, Canada, Australia and Europe. Routledge Studies in Energy Policy. Taylor & Francis Group:, London and New York, pp. 83–97.
Gross, M., 2007. The Unknown in Process: Dynamic Connections of Ignorance, Non-Knowledge and Related Concepts. Curr. Sociol. 55(5), 742-759. doi:10.1177/0011392107079928.
Gudynas, E., 2021. Extractivisms: Politics, Economy and Ecology. Fernwood Publishing, Nova Scotia, Canada.
Guston, D.H., 2001. Boundary Organizations in Environmental Policy and Science: An Introduction. Sci. Technol. Hum. Values 26, 399–408.
Haas, P.M., 1992. Introduction: epistemic communities and international policy coordination. Int. Organiz. 46, 1–35.
Hetch, G., 2014. Being Nuclear: Africans and the Global Uranium Trade. The MIT Press, Cambridge, Massachusetts, London, England.
Jacquet, J.B., Witt, K., Rifkin, W., Haggerty, J.H., 2018. A complex adaptive system or just a tangled mess?: Property right and shale gas governance in Austraria and the US. In: Whitton, J., Cotton, M., Charnley-Parry, I.M., Brasier, K. (Eds.), *Governing Shale Gas: Development, Citizen Participation and Decision Making in the US, Canada, Australia and Europe.* Routledge Studies in Energy Policy. Taylor & Francis Group:, London and New York, pp. 37–50.
Jasanoff, S. (Ed.), 2004. States of Knowledge: The Co-Production of Science and Social Order. Routledge, London, New York.
Kama, K., 2020. Resource-making controversies: knowledge, anticipatory politics and economization of unconventional fossil fuels. Prog. Hum. Geogr. 44 (2), 333–356. https://doi.org/10.1177/0309132519829223.
Kinne, B., 2018. Regulating unconventional shale development in the United States: diverging priorities, overlapping jurisdictions, and asymmetrical data access. In: Whitton, J., Cotton, M., Charnley-Parry, I.M., Brasier, K. (Eds.), *Governing Shale Gas: Development, Citizen Participation and Decision Making in the US, Canada, Australia and Europe.* Routledge Studies in Energy Policy. Taylor & Francis Group:, London and New York, pp. 23–36.
Kneas, D. 2020. Placing Resources: Junior Mining Companies and the Locus of Mineral Potential. Geoforum (2020), doi: 10.1016/j.geoforum.2020.05.007.
Kuchler, M., & Höök, M. 2020. Fractured visions: Anticipating (un)conventional natural gas in Poland. Resources Policy, 68, 1-9. DOI: 10.1016/j.resourpol.2020.101760.
Ladd, A. E. 2018. Fractured Communities: Risk, Impacts, and Protest Against Hydraulic Fracking in U.S. Shale Regions. Rutgers University Press. Doi: 10.2307/j.ctt1sq5vhr.
Latour, B., 1987. Science in Action: How to Follow Scientists and Engineers through Society. Harvard University Press, Cambridge, MA.
Li, F., 2015. Corporate Mining, Activism, and Expertise in Peru. Duke University Press, Durham and London.
Luke, H., Evensen, D., 2018. Community representations of unconventional gas development in Australia, Canada and the United States, and their effect on social licence. In: Whitton, J., Cotton, M., Charnley-Parry, I.M., Brasier, K. (Eds.), Governing Shale Gas: Development, Citizen Participation and Decision Making in the US, Canada, Australia and Europe. Routledge Studies in Energy Policy. Taylor & Francis Group:, London and New York, pp. 130–148.
Mabon, et al., 2019. What is the role of epistemic communities in shaping local environmental policy? Managing environmental change through planning and greenspace in Fukuoka City, Japan. Geoforum 104 (2019), 158–169. https://doi.org/10.1016/j.geoforum.2019.04.024.
Mathews, A.S., 2011. Instituting Nature: Authority, Expertise, and Power in Mexican Forests. The MIT Press, Cambridge, Massachusetts, London, England.
Malm, A., 2016. Fossil Capital. The Rise of Steam Power and the Roots of Global Warming. Verso, London, New York.
Moore, J.W., 2015. Capitalism in the Web of Life: Ecology and the Accumulation of Capital. Verso, London, UK.
Mouffe, C., 1999. Deliberative Democracy or Agonistic Pluralism? Social Research 66(3), PROSPECTS FOR DEMOCRACY (FALL 1999), pp. 745-758.
Perry, B., 2022. Co-production as praxis: Critique and engagement from within the university. Methodol. Innovations 15 (3), 341–352. https://doi.org/10.1177/20597991221129773.
Perry, B., Smit, W., 2022. Co-producing city-regional intelligence: strategies of intermediation, tactics of unsettling. Reg. Stud. https://doi.org/10.1080/00343404.2022.2044464.
Richardson, T., Weszkalnys, G., 2014. Introduction: Resource Materialities. Anthropol. Q. 87 (1), 5–30.
Rychnovská, D., Pasgaard, M., Berling, T.V., 2017. Science and security expertise: Authority, knowledge, subjectivity. Geoforum 84 (2017), 327–331. https://doi.org/10.1016/j.geoforum.2017.06.010.
Short, D., Szolucha, A., 2019. Fracking Lancashire: the planning process, social harm and collective trauma. Geoforum 98, 264–276.
Smith, K.K., Haggetry, J.H., 2018. Devolved governance and alternative dispute resolution programs: an examples from the Bakken. In: Whitton, J., Cotton, M., Charnley-Parry, I.M., Brasier, K. (Eds.), Governing Shale Gas: Development, Citizen Participation and Decision Making in the US, Canada, Australia and Europe. Routledge Studies in Energy Policy. Taylor & Francis Group:, London and New York, pp. 184–197.
Svampa, M., 2019. Neo-Extractivism in Latin America Socio- Environmental Conflicts, the Territorial Turn, and New Political Narratives, 1st ed. Cambridge University Press, Cambridge, UK.
Szolucha, A., 2018. Community understanding of risk from fracking in the UK and Poland: how democracy-based and justice-based concerns amplify risk perceptions. In: Whitton, J., Cotton, M., Charnley-Parry, I.M., Brasier, K. (Eds.), Governing Shale Gas: Development, Citizen Participation and Decision Making in the US, Canada, Australia and Europe. Routledge Studies in Energy Policy. Taylor & Francis Group:, London and New York, pp. 242–255.

Szolucha, A., 2019. A social take on unconventional resources: Materiality, alienation and the making of shale gas in Poland and the United Kingdom. Energy Res. Soc. Sci. 57 (2019), 101254.
Töller, A.E., Böcher, M., 2018. Governing shale gas in Germany. In: Whitton, J., Cotton, M., Charnley-Parry, I.M., Brasier, K. (Eds.), Governing Shale Gas: Development, Citizen Participation and Decision Making in the US, Canada, Australia and Europe. Routledge Studies in Energy Policy. Taylor & Francis Group:, London and New York, pp. 66–82.
Weszkalnys, G., 2015. Geology, potentiality, speculation: on the indeterminacy of First Oil. Cult. Anthropol. 30 (4), 611–639.
Whitton, J., Cotton, M., Charnley-Parry, I. M. and Brasier, K. (Eds) Governing Shale Gas: Development, Citizen Participation and Decision Making in the US, Canada, Australia and Europe. Routledge Studies in Energy Policy. Taylor & Francis Group: London and New York.
Williford, D., 2017. Seismic Politics: Risk and Reconstruction after the 1960 Earthquake in Agadir, Morocco. Technol. Cult. 58 (4), 982–1016.
Wynne, B., 2005. Reflexing complexity: post-genomic knowledge and reductionist returns in public science. Theory Cult. Soc. 22 (5), 67–94.
Wynne, B., 2001. Creating Public Alienation: Expert Cultures of Risk and Ethics on GMOs. Sci. Cult. 10 (4), 445–481. https://doi.org/10.1080/09505430120093586.
Wynne, B., 1991. Knowledges in Context. Science, Technology, & Human Values. Vol. 16, No. 1 (Winter, 1991), pp. 111-121.

Documents

CCST Report (2015) An Independent Scientific Assessment of Well Stimulation in California Summary Report: An Examination of Hydraulic Fracturing and Acid Stimulations in the Oil and Gas Industry. California Council on Science & Technology, Lawrence Berkeley National Laboratory (July 2015) https://www.waterboards.ca.gov/centralvalley/board_decisions/tentative_orders/1906/17_mckittrick/17_mckittrick_cbd3_ex2.pdf.
Energy Information Administration. (2011). World shale gas resources: An initial assessment of 14 regions outside the United States. Retrieved January 2014, from http://www.eia.gov/analysis/studies/worldshalegas/archive/2011/pdf/fullreport.pdf.
Mandate, 2014. Ares(2014)4022184 - 02/12/2014 https://ec.europa.eu/jrc/sites/jrcsh/files/Mandate_and_ROP_attached_to_note_to_JS.PDF.
Senate Bill No. 4 (2013) https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB4.
Resolution of 21 November 2012 on industrial, energy, and other aspects of shale gas and oil http://www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=P7-TA-2012-0444&language=EN.

Interviews:

Interview 1: CCST high level official, Berkeley, October 20th, 2018, phone.
Interview 2: Lawrence Berkeley National Laboratory senior expert, Berkeley, November 5th, 2018.
Interview 3: Clean Water Action expert, November 7th, 2018, phone.
Interview 4: JRC senior expert, Brussels, July 5th, 2017, phone.
Interview 5: JRC high level official 1, Brussels, July 3rd, 2017, phone.
Interview 6: JRC high level official 2, Amsterdam, July 10th, 2017.