UNIVERSIDADE FEDERAL DE MINAS GERAIS

Instituto de Geociências

Programa de Pós-Graduação em Análise e Modelagem de Sistemas Ambientais

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PARTICIPATION IN THE GOVERNANCE OF THE SAMARCO DISASTER:

An Actor-Network Analysis

Belo Horizonte

2019

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Versão Final

Dissertação apresentada ao Programa de Pós-Graduação em Análise e Modelagem de Sistemas Ambientais da Universidade Federal de Minas Gerais, como requisito parcial à obtenção do título de Mestra em Análise e Modelagem de Sistemas Ambientais.

Orientador: Prof. Dr. Raoni Guerra Rajão

Belo Horizonte

2019

R539p Rickard, Thomas Lloyd.

2020 Participation in the governance of the Samarco disaster [manuscrito] : an actor-network analysis / Thomas Rickard. – 2020.

126 f., enc.: il. (principalmente color.)

Orientador: Raoni Guerra Lucas Rajão.

Dissertação (mestrado) – Universidade Federal de Minas Gerais, Departamento de Cartografia, 2020.

Inclui bibliografia.

1. Modelagem de dados – Aspectos ambientais – Teses. 2. Política ambiental – Teses. 3. Impacto ambiental – Teses. 4. Indústria mineral – Acidentes – Mariana (MG) – Teses. I. Rajão, Raoni Guerra Lucas. II. Universidade Federal de Minas Gerais. Departamento de Cartografia. III. Título.

CDU: 911.2:519.6(815.1)

Ficha catalográfica elaborada por Rosana de Aguiar Vieira – CRB6 2327

FOLHA DE APROVAÇÃO

PARTICIPATION IN THE GOVERNANCE OF THE SAMARCO DISASTER: AN ACTOR-NETWORK ANALYSIS

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Dissertação submetida à Banca Examinadora designada pelo Colegiado do Programa de Pós-Graduação em ANÁLISE E MODELAGEM DE SISTEMAS AMBIENTAIS, como requisito para obtenção do grau de Mestre em ANÁLISE E MODELAGEM DE SISTEMAS AMBIENTAIS, área de concentração ANÁLISE, MODELAGEM E GESTÃO DE SISTEMAS AMBIENTAIS.

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RESUMO

Questões de governança ambiental em países em desenvolvimento, como o Brasil, são particularmente desafiadoras no que diz respeito à participação, ciência e políticas públicas, com impactos sociais e ambientais severos. Um exemplo desse desafio de governança é a recuperação do Rio Doce depois do desastre da barragem de mineração da Samarco em 2015, coordenado pela Fundação Renova com monitoramento do estado em um acordo extra judicial, o TTAC, projetado com o objetivo de rápida resolução de um conflito ambiental. Porém, o TTAC e a Fundação Renova tem sido criticados por várias questões relacionadas à participação. Em 2019, mais um desastre aconteceu no complexo de mineração da Vale em Brumadinho para o qual nenhum modelo participativo de governança tem sido proposto, sugerindo uma falta de aprendizagem. Estudos Sociais da Ciência e Tecnologia (ESCT) e campos relacionados já lidam com tais assuntos há muito tempo e sugerem a necessidade de melhores processos participativos, assim como aponta a literatura crítica ao desastre. Não obstante, uma recente 'Virada Pós Participativa', a partir de perspectivas sistêmicas e emergentes, destaca limitações, incluindo os riscos de se ignorar ciência e expertise e *trade-offs* entre objetivos sociais e pragmáticos. Essa pesquisa explorou a questão da participação na governança formal da recuperação do desastre do Samarco, incluindo a análise do Projeto de Priorização de Reflorestamento que se baseou em modelagem ambiental, para que lições inovadoras possam ser aprendidas em processos de recuperação pós desastre. Definindo participação como comportamento voluntário de sujeitos não profissionais em relação ao estado, esse estudo utiliza a Teoria Ator-Rede (TAR) para investigar as redes dinâmicas e negociadas que tem se formado. O trabalho foca na representação dos atingidos e do meio ambiente, utilizando a análise de conteúdo de políticas públicas e mídia, além de entrevistas semiestruturadas e observações do pesquisador-participante. Os resultados indicam que o TTAC e a Fundação Renova sofrem com problemas clássicos de processos decisórios concentrados e hierárquicos, controle institucional, vulnerabilidade frente a interesses políticos, e um excesso de tecnicalidade. Se observados como um ator-rede, a crise de representação ameaça a estabilidade da rede; a estrutura de governança é desnecessariamente complexa; a manutenção da separação entre o "técnico" e o "político" causa novas vulnerabilidades; os *trade-offs* sociais e pragmáticos não são confrontados ou resolvidos; a influência das companhias de mineração deveria ser limitada mas não eliminada; o processo participativo no projeto de Priorização do Reflorestamento foi altamente limitado desde o começo, mas demonstrou a capacidade dos especialistas para integrar valores sociais na produção científica. Apesar dos problemas vivenciados no Brasil pela Gestão Integrada da Paisagem e pelos Comitês das Bacias, eles oferecem o potencial de melhorar a governança biorregional. A literatura crítica ressalta questões relevantes, como a construção não-participativa do TTAC, abuso aos direitos humanos, práticas excludentes e um padrão tecnocrata mais amplo. Entretanto, a literatura raramente distingue entre Fundação Renova e as empresas mineradoras e, assim, não se aprofunda em possíveis aprendizados. O trabalho aqui apresentado sugere que a recuperação é resultado e oportunidade para se ajustar as redes amplas de governança ambiental na Bacia do Rio Doce e no Brasil. Com ESCT e TAR, a pesquisa oferece uma nova perspectiva sobre governança na recuperação pós desastre. As sugestões se aplicam não só para processos de recuperação, mas também para questões mais amplas de governança ambiental no Brasil e países em desenvolvimento.

Palavras-chave: governança ambiental, participação, Desastre da Samarco, Fundação Renova, representação, Teoria Ator-Rede

ABSTRACT

Environmental governance issues in developing countries, such as Brazil, especially challenge attempts to integrate participation, science and policy, with severe social and environmental impacts. An ongoing example of such governance is the Rio Doce basin recovery after the 2015 Samarco mining-dam disaster, the worst single environmental disaster in Brazilian history, implemented by Renova Foundation with state oversight within an extra-judicial agreement called the TTAC designed to effect rapid environmental-conflict resolution. However, the TTAC and Renova Foundation have been severely criticised for a range of issues related to participation. In 2019, another destructive mining-waste disaster occurred in the Brumadinho Vale mining complex for which no participatory governance model has been put forward, suggesting limited learning. Science and Technology Studies (STS) and related fields have long grappled with such issues and the field has responded with calls for more participatory processes, just as critical literature of the disaster has done. However, a recent `Post Participatory Turn` involving systemic and emergent perspectives has highlighted limitations, including the risk of ignoring science and expertise and trade-offs between social and pragmatic goals. This research explored participation in formal governance of the Samarco Disaster recovery, supplemented by examination of the Reforestation Prioritisation Project that relied on environmental modelling, in order that novel lessons can be learnt for post-disaster recovery. Defining participation as voluntary behaviour undertaken by non-professionals in relation to the state, the study uses Actor-Network Theory (ANT) to investigate the dynamic and contested networks that have been formed. We focus on representation of the Affected and the environment, relying on guided content, policy, media and document analysis, semi-structured interviews and participant observations. The results show that the TTAC and Renova Foundation suffer classic problems of upstream decision-making, institutional control, vulnerability to political interests, and technicality. Understood as an actor-network: a crisis of representation threatens network stability; the governance structure is overly complex; boundary maintenance of the technical and political has created new vulnerabilities; calls to rid the Rio Doce basin of mining may be effective in the short term but do not address long-term change; social and pragmatic trade-offs are not confronted; mining-company influence should be limited but not removed; and the Reforestation Prioritisation Project participatory process was heavily restrained from the outset but demonstrated expert capacities to integrate social values into science-production. Although Brazilian Integrated Landscape Management and River Basin Committees suffer related problems, they offer evidence of the potential to improve bioregional governance. Critical literature highlights important issues, such as non-participatory TTAC construction, human rights issues, exclusionary practices, and broader technocratic patterns, however, it rarely distinguishes Renova Foundation from the mining companies and fails to leverage the range of available learning. This research suggests the recovery is a result of and opportunity to adjust wider environmental governance networks in the Rio Doce basin and Brazil. Using STS and ANT, this study offers a new perspective on the governance of the post-disaster Rio Doce recovery, enhancing present critical literature with reflections on the Brazilian civic epistemology and original recommendations. It brings suggestions for improving not only the recovery but broader concerns around environmental governance in Brazil and developing countries via an example of the utility of ANT and actionable recommendations that can apply to other contexts.

Keywords: environmental governance, participation, Samarco disaster, Renova Foundation, representation, Actor-Network Theory

FIGURES

ABBREVIATIONS

ANT – Actor-Network Theory

CBH – River Basin Committee (*Comité de Bacia Hidrográfica*)

CBH Doce – Rio Doce River Basin Committee (*Comité de Bacia Hidrográfica Rio Doce*)

CBM – Community-Based Monitoring

CBNRM – Community-Based Natural Resource Management

GIS – Geographical Information System

GRO – Grass-Roots Organization

IBAMA - Brazilian Institute for the Environment and Renewable Natural Resources (*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis*)

ICMBio – The Chico Mendes Institute for the Conservation of Biodiversity (*Instituto Chico Mendes de Conservação da Biodiversidade*)

ILM – Integrated Landscape Management

MMA – Brazilian Ministry of Environmment (*Ministério do Meio Ambiente*)

MP – Public Ministry (*Ministério Público*)

MPF – Federal Public Ministry (*Ministério Público Federal)*

NGO – Non-Governmental Organization

OPP – Obligatory Passage Point

SCOT – Social Construction of Technology

STS – Science and Technology Studies

Supram - Regional Superintendence of Environment Regulation (*Superintendência Regional de Regularização Ambiental*)

TAC Gov – Term of Adjustment of Conduct for Governance (*Termo de Ajustamento de Conduta Governança*)

TAP – Preliminary Term of Adjustment (*Termo de Ajustamento Preliminar*)

TAP Aditivo – Additive Preliminary Term of Adjustment (*Termo de Ajustamento Preliminar Aditivo*)

TN – Technical Note (*Nota Técnica*) (attached to the TTAC)

TTAC - Term of Transaction of Adjustment of Conduct (*Termo de Transação de Ajustamento de Conduto*)

UNHRC – United Nations Human Rights Council

UK – The United Kingdom

US – The United States of America

CONTENTS

INTRODUCTION

After a long period of high confidence in experts to govern and produce scientific knowledge, peaking in the years after World War 2, there has been a decline in public trust. Multiple political and technoscientific crises, such as the Cold War and Vietnam War, Thalidomide and BSE health crises, and industrial disasters, such as three-mile island and Chernobyl, have demonstrated the limited capacities of elected officials and technical experts to work in the public interest (BECK, 1992; BUCCHI, 2008). This might be expected, given that today's world is infamously beset by so-called 'wicked' problems (HEAD; ALFORD, 2015)—highly complex problems, such as climate change, natural resource depletion, disease and rapid urbanization—that require 'post-normal' science approaches (FUNTOWICZ; RAVETZ, 1997), including participation. These problems at once offer social, environmental, technical and economic aspects, each intertwined such that interactions and dynamics can never be fully predicted (KURTZ; SNOWDEN, 2003). Abundant technological advances have also had ambiguous social effects in terms of interactions with power, democracy, culture and perhaps even the way we think (FEENBERG, 1999). These issues are compounded in Environmental and Landscape Governance (ARTS et al., 2017; GÖRG, 2007) and developing-country contexts (REED et al., 2017), such as Brazil.

An example of a socio-technical, environmental and political catastrophe, the Samarco Disaster of 2015 in Mariana, Minas Gerais, Brazil, unleashed 60 million cubic meters of mining waste in a wave of mud into the river valley of the Rio Doce, affecting over a million people and severely damaging the environment (FERNANDES et al., 2016). Samarco initially began recovery work, including river recovery and rehousing affected people. Whereas historically such disasters were dealt with via lengthy judicial proceedings resulting in limited reparations, in a nominally participatory extra-judicial agreement, the Term of Transaction of Adjustment of Conduct (*Termo de Transação de Ajustamento de Conduto*) (TTAC), with federal, state and other governmental bodies, in August of 2016, Samarco created Renova Foundation for the reparation of and compensation for the disaster. Renova Foundation has been heavily criticized since inception for issues such as a non-participatory design process and structure, exclusion of the Affected from indemnity, secondary recovery impacts on the basin and population, and technocratic operation (LOSEKANN; MILANEZ, 2018; OLIVEIRA et al., 2017;

TUNCAK, 2017). In negotiation with the Public Ministry (*Ministério Público*) (MP) and others, subsequent agreements have adjusted the governance structure, yet the TTAC and Renova Foundation have thus far failed to operate participatory governance according to multiple actors. In the meantime, another major mining-dam disaster has occurred in Brumadinho in January 2019 caused by Vale, for which the disaster response is again considered inadequate with the mining company operating the recovery in negotiation with the MP and judiciary, prompting questions about what has been learnt.

One of multiple disciplines concerned with participation in science, policy and environmental governance, Science and Technology Studies (STS) have been described as having occurred in three waves: the first, in the 1960s, described what set science apart as authoritative, while the second, from the 1970s and 80s, questioned its authority and broader patterns of enclosed, technical decision-making with social consequences (BECK, 1992; COLLINS; EVANS, 2002). In the 1990s and early 2000s, as a response to second-wave critiques, STS theorists promoted a 'participatory turn', including experimentation with `hybrid forums` and `mini publics` (CALLON; LASCOUMES; BARTHE, 2009; GOODIN, 2006), such as Citizens Juries and Participatory Planning, and experiments in participatory science (CONRAD; HILCHEY, 2011; SALTER; ROBINSON; WIEK, 2010). In these practices and forums, participants and experts interacted ways with social and pragmatic aims of inclusion, social learning, efficiency, legitimacy, salience and credibility in responses to technoscientific and environmental issues (HUITEMA; VAN DE KERKHOF; PESCH, 2007; IRWIN, 2001). Related waves of interest in participation occurred in Deliberative Democracy (ELSTUB; ERCAN; MENDONÇA, 2016), Development Studies (COOKE; KOTHARI, 2001), and Landscape Approaches in developing countries, including Brazil, such as Community-Based Natural Resource Management (CBNRM) and Integrated Conservation and Development (REED et al., 2017). The critiques and developments leading to the latest agreement, the Term of Adjustment of Conduct for Governance (*Termo de Ajustamento de Conduto Governança*) (TAC Gov), largely follow this participatory-turn normative concern for more participation as a solution.

From this broad wave of interest and practice in participation, however, much has been learnt of its often-severe limitations, with case studies in both Western and developing country contexts demonstrating how participatory processes can not only fail normative ideals but positively confound them. Expectations can be frustrated, outcomes controlled,

power-imbalances amplified, and time and money lost to no end. While some responses have been procedural, attempting to correct poor methodology or address contextual limitations, others have taken issue with fundamental assumptions, providing systemic and constructivist accounts. Such contemporary responses include more critical descriptions of participation, knowledge-production and the science-policy interface that maintain its importance and original goals but remove the assumptions that participation is capable of avoiding trade-offs or occurs only in distinct processes. These new approaches include 'participatory ecosystems' (BRAUN; KÖNNINGER, 2018; RASK; MACIUKAITE-ZVINIENE; PETRAUSKIENE, 2012), and constructivist perspectives on participation, questioning how publics emerge, the linear relationship between process and impact, and the multiple ways that participation constitutes science and democracy (BROWN, 2009; CHILVERS; KEARNS, 2016a). One of the research strategies open to such post-participatory turn inquiries is Actor-Network Theory (ANT) (CALLON, 1984), as it attempts to restrict assumptions, such as the normativity and locations of participation, and seeks to better understand how interactions between multiple actors, human and non-human, (fail to) produce participatory governance, including environmental governance (HOLIFIELD, 2009; HOROWITZ, 2012; LOCKIE, 2004).

Questions

- *How has the environmental governance of the Rio Doce recovery developed around the question of participation?*
- *What can be learnt moving forward with both the Samarco and Vale disaster recoveries?*

In this research, ANT is leveraged to understand how multiple actors—including the MP, Academic researchers, social movements, the mining companies, the Federation and state agencies—have attempted to translate the interests of the Affected, the Rio Doce Basin and each other so as to produce an unstable Actor-Network. Claims to represent the Affected and the Rio Doce Basin have been contested. The resulting TAC Gov has resulted in the expansion of an already-complex governance structure, multiplying participatory forums and placing the social norms of participation in conflict with pragmatic concerns. The boundaries between the technical and political are maintained at a significant cost. Meanwhile, alternative governance devices are being developed, as the mining companies lack incentive to engage and seek to delegitimise participation.

The present network operates as a constraint and an opportunity. Recommendations include: render explicit the inherently political nature of both social and environmental representation; clarify of roles and mechanisms that link forums, substantially reducing the present complexity; focus on the wider governance context of municipalities, states, state agencies, and policies, utilizing the experience of the CIF, River Basin Committees, and other Brazilian landscape governance examples; separate the questions of the disaster and basin recovery for the sake of governance proposals; continue to enrol mining companies in recovery operations in a more balanced form; anticipate the closure or substantial alteration of Renova Foundation basin to provide continued and improved governance in the Rio Doce basin; and further research and communication on unfolding governance practices.

After this introduction, the background the disaster is presented, offering the context and demonstrating the need to consider STS and related approaches to participation. The literature on participation, both from STS and for the disaster, is then considered in its historical context, and ANT is shown to be an established and adequate methodological response. ANT is more fully described in the Methods chapter, before the unfolding of participation in recovery governance from the perspective of ANT is analysed. Finally, a Discussion and Conclusion are presented.

BACKGROUND—THE SAMARCO DISASTER, THE TTAC AND RENOVA FOUNDATION

Context

The Rio Doce watershed, 86% of which is in the state of Minas Gerais and 14% in Espírito Santo, covers 86,715 square kilometres and is home to 3.6 million people across 229 municipalities. The area was an environmental and social concern before the disaster, most of which is within the highly biodiverse and threatened Atlantic Forest biome (AGÊNCIA NACIONAL DE ÁGUAS, 2015). Soil in the basin is vulnerable to erosion and many pastures are degraded, leading to sediment offloading and widespread soil degradation. Deforestation for agriculture timber and charcoal has destroyed much native vegetation, with most natural vegetation being secondary regrowth. Periodic droughts have affected the region and the water supply (RAJÃO; PEREIRA, 2018).

Historically, the watershed has been home to a gold mining industry which peaked in the 18th century and continues today. The main industries have shifted to milk and beef production, with some coffee. Iron mining developed in the early 20th century, along with steel mills that used the river and the Vitória-Minas railway. The building of federal highway BR-116 in the 1960s promoted further development supported by energy from 10 hydropower plants (SÁNCHEZ et al., 2018). Sewage discharge is a major problem, with many towns directly discharging into rivers. The socioeconomic status of the region is heterogenous but with a substantial number of municipalities with poor levels of human development and high dependency on public and informal employment and natural resources (AGÊNCIA NACIONAL DE ÁGUAS, 2015; HATJE et al., 2017). There are multiple and often vulnerable Indigenous and Traditional communities. Economically, Brazil entered recession in August of 2015 in part due to commodity prices, including iron ore, which fell from US$177 per ton in 2011 to US$47 in November 2015; politically, the country was going through multiple corruption scandals, including for Petrobras, the Brazilian state oil company, as part of Operation Car Wash (*Lava Jato*).

Brazil has a long relationship with dam building for water control, power generation, landfills and waste retention, as is the case for mining tailings, intensifying from the 1950s to 1980s—a period in which there was little environmental legislation—and leading to population displacements and environmental impacts. Major accidents occurred in the 1960s, such as the Orós dam in the state of Ceará in March of 1960, which ruptured before

inauguration, killing around 50 and destroying the homes of 100,000 people. News was apparently suppressed, including through incarceration for mental illness (FERREIRA; SOBRINHO; MENESES DOS SANTOS, 2012). Safety only became a national concern after disasters in the 1970s, including the Euclides da Cunha and Armando de Salles Olivera dams in São Paulo state in 1977. A regulatory framework was properly established in the National Dam Safety Policy Law nº. 12.334/2010, though previous legislation is relevant, including that for mining, water resources, technical norms and environmental licensing (e.g., the Water Code – Decree No. 24.643/1934 and the old Forest Code – law nº. 4.771/1965) (OLIVEIRA; KERBAUY, 2016).

Brazil previously gained a reputation as a leader for conservation, but this was compromised in the years before the disaster with, for example, the New Forest Code, that gave amnesty to landowners who had deforested and reduced Areas of Permanent Preservation (APPs) (SOARES-FILHO et al., 2014), and attempts at reducing environmental regulation for strategic infrastructure projects. Historically, Samarco has received multiple fines from the state environmental regulator (FEAM-MG) and national environmental regulator (IBAMA), with 19 infractions between 1996 and November, 2015 (MANSUR et al., 2016). These included for water contamination and release of waste materials. The Fundão dam, however, was licensed to operate by the Regional Superintendence of Environment and Sustainable Development (Supram) and guaranteed stability in the audit of July 2015 in compliance with federal and state legislation (SAMARCO, 2016).

The Disaster

On the afternoon of 5th November 2015, the Fundão dam, an iron-ore mine tailings dam in the municipality of Mariana, Minas Gerais, operated by Samarco, in turn owned by Vale and BHP Billiton, collapsed. Depending on sources, this released between 39.2 and 62 million cubic meters of iron-ore tailings slurry into the river Doce (CARMO et al., 2017; GRUPO FORÇA TAREFA, 2016; SÁNCHEZ et al., 2018). These varying estimates may have to do with slower-flushing mud after the initial event. In any case, this represents the largest single environmental disaster in Brazilian history. The wave of mud immediately killed 13 site workers and one mine visitor, entered the Santarém creek valley, and smothered the nearby town of Bento Rodrigues, killing a further 5, before partially submerging other small towns, including Barra Longa (SAMARCO, 2016).

The waste mud then extended through over 600 kilometres of hydrological networks and reached the sea beyond the neighbouring state of Espírito Santo, pulverizing freshwater and riparian ecosystems and disrupting water supplies for humans, animals and agriculture—the mud not only contained some heavy metals but disrupted sediments that contained mercury and other metals used for historic artisanal gold mining. Although much of the mud and coarse grains of quartz and hematite was contained in the first 100 kilometres at the Candonga hydroelectric dam, perhaps 18.9 million cubic tons of fine particles continued down the river, causing further turbidity, and spread out over a coastal area 16 days later. Over 41 cities and hundreds of thousands of people were directly affected (SÁNCHEZ et al., 2018).

Several containment dams were built near the Fundão dam to contain further drainage, along with emergency dykes to protect floodplain freshwater lakes. Displaced people were initially placed in bed and breakfasts or inns, then later moved to homes rented by Samarco. Some affected people were registered with cards entitling them to a monthly income. With operations suspended, Samarco employees were initially placed on paid leave and vacation, before large scale lay-offs began in January 2016 (SAMARCO, 2016).

Impacts

Riparian, marine and freshwater ecosystems were eliminated, with consequent impacts on natural resource dependent livelihoods, tourism, agriculture, fisheries, and fresh water supply. Estimates of damage are difficult to ascertain in part due to a lack of detailed baseline information prior to the disaster (SÁNCHEZ et al., 2018). The immediate wave of tailings deposits was over 1km wide and around 1469 ha of natural vegetation was destroyed in the Atlantic forest biome, a global biodiversity hotspot, along with 90% of the Fundo, North Gualaxo and Carmelo river riparian habitats. This comprised the loss of regenerative capacity, such as through riparian nursery habitats. Including coastal sea spread, the federal environment agency estimated an area of 47,000 square kilometres as affected by the plume over a 15-month period, with a dense plume area of 1,400 square kilometres and a diluted plume of 4,800 square kilometres (IBAMA, 2017).

The river Doce contained a very high species richness of fish, with many species still unknown, and in a region already challenged by human development of dams, extraction, waste, pesticides and exotic species. At the sea, the plume of fine particles smothered

benthic organisms and changing estuarine micro fauna assemblages (GOMES et al., 2017), killing animal and plant life and causing algal blooms due to iron availability (HATJE et al., 2017). Heavy metals, which can remain present at toxic levels for long periods and affect human and ecosystem health, were shown to be present in early reports (BIANCHINI, 2016 & IGAM, 2015, cited in Fernandes et al. (2016)) though this was denied by Samarco.

Clean water, crop production, hydroelectric power, and raw materials were at least partially lost for 41 municipalities, along with tourism and recreational landscapes, ethnic heritage and relational values, indirectly affecting over 1 million people. Several indigenous communities that depend directly on natural resources live within the affected areas of the Krenak, Tupiniquim and Guarani, disrupting basic needs and cultural reproduction. Immediate effects were heterogenous, from the complete destruction of Bento Rodrigues to serious water shortages in large towns, such as Governador Valadares (SÁNCHEZ et al., 2018). An initial estimate of material and environmental costs was set at $20 billion (GRUPO FORÇA TAREFA, 2016) and this was enhanced through lost mining-related jobs and revenues for at least several years, as mining and its related industries formed a substantial source of employment—nearly 2,000 people were laid off in Mariana, where the disaster happened, and in Anchieta on the coast, and there may have been 10,000 indirect job losses. Municipal revenues lost included those from the Candonga hydroelectric plant, which shut down for two years, and further costs of reconstruction and regeneration continue. Job and income loss affected businesses, alongside the loss of tourism business along the Rio Doce. Cultural, aesthetic, and ecological process values are not quantifiable, as well as the extent of the damage reached beyond the river basin. The mitigation works themselves also continue to bring impact risks, such as the disruption of fishing communities (a traditional and culturally significant activity), the offer of indemnification payments bringing in outside populations, the disruption of natural water flow patterns to prevent contamination, and poorly managed community engagement, frustrating already suffering populations, especially with regard to damaged and rural properties (SÁNCHEZ et al., 2018).

Previous environmental conflicts had been resolved through often lengthy and complex expensive judicial processes that could result in no fines being paid either through litigation failure or company bankruptcy. The first major agreement for this recovery, an extra-judicial agreement, the TTAC, was signed in March of 2016 between the MP, states

of Minas Gerais and Espírito Santo, the Federation and the mining companies, Samarco and its stakeholders Vale and BHP Billiton. It created a new governance structure that came to be called Renova Foundation, along with a state-led monitoring body and support, the CIF and its Technical Chambers, 41 socioenvironmental and socioeconomic programs, and a R$20 billion estimated cost. The TTAC and Renova Foundation make a claim to have created a participatory governance structure, but this is disputed by multiple actors. The agreement has since undergone important adaptations and additions, but no fundamental revision of the structure or programs.

Within the recovery, the Reforestation Prioritization Project, a collaboration between the federal universities of Viçosa and Minas Gerais and Renova Foundation, used software modelling to estimate the best locations for different forest regeneration strategies during 2018 for over R$1 billion of regeneration investment. Prioritization focussed not only on environmental factors that could influence regeneration but estimates of where social impact could be enhanced through local investment or support for agroforestry. The process engaged a participatory process that brought together different stakeholders to consider a multidisciplinary and technical procedure within the broader governance structure.

As a large scale, sociotechnical and environmental disaster prompting concern for participatory environmental governance, the Samarco disaster demands examination from multiple fields that are concerned with these questions. The Reforestation Prioritization Project offers an example of participation in socioenvironmental and technical concerns in the recovery. In the next section, we consider the contributions that STS has made over the last decades within a historical context that illustrates how the original problems and aims of participation are connected to this disaster and remain controversial. We also examine the critical literature of Renova Foundation and the recovery.

PARTICIPATION: HISTORY & THEORY, PRACTICES & PROVOCATIONS

In this chapter, a range of definitions and models of participation is first reviewed. We then consider the historical and theoretical context for the 'participatory turn'—a wave of largely EU- and US-based concerns about technocracy, epistemology and justice—and how this fed into the normativity of participation and body of practices that emerged. Brazil`s related but distinct history of participation is also noted. Following this, we encounter the range of challenges that the participatory turn has faced—such as assumptions of pre-existing publics, critical views of norms, aims and mechanisms, professionalization, expertise, and reproduced expert-lay boundaries. Empirical evidence for the benefits of participation and in the context of participatory environmental governance in the Tropics is presented and Brazilian examples are reviewed alongside likely normative differences. The critical literature on the Samarco disaster is then described and compared with the participatory-turn literature: there are common concerns for distinct formal processes and the disruption of power imbalances, but the boundaries between the technical and political and the pragmatic role of participation is little considered. A range of responses in a `post-participatory turn` is reviewed, such as a return to realism, traditional categories of science and politics, and the systemic and constructivist perspectives, challenging locations, forms, and meanings. The chapter concludes with examples of ANT as appropriate to understanding environmental governance in the post-participatory turn.

Defining Participation

Multiple fields have arrived at distinct but overlapping notions of participation. Participation has been conceived of in terms of power dynamics, such as Arnstein's ladder of participation, where citizen power is taken to be the most empowering and desirable state and other rungs are means of denying real citizen control (ARNSTEIN, 1969). Arnstein's ladder is show in Figure 1.

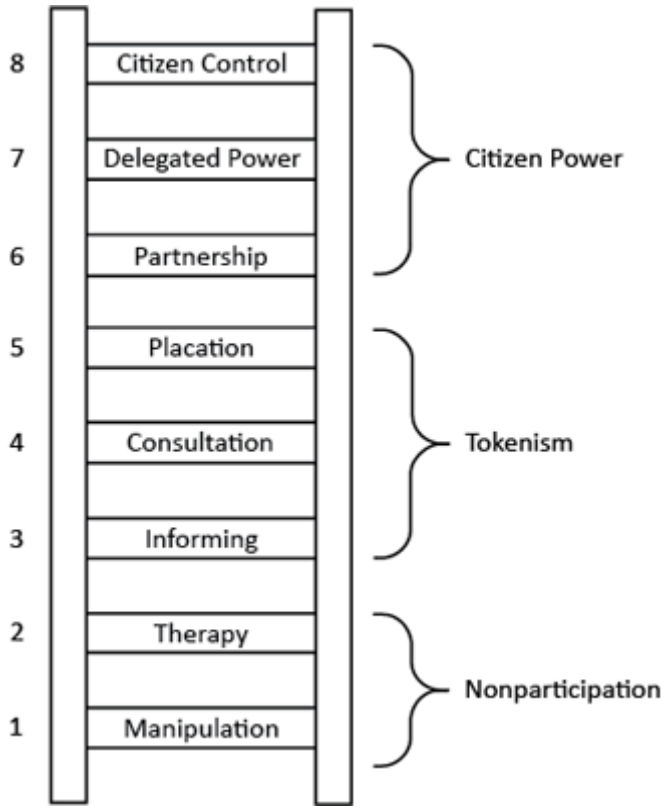

Figure 1. Arnstein's ladder of participation (ARNSTEIN, 1969)

In Development Studies, this ladder concept has been developed by Chambers (2006), among others, who details additional roles, actions and ownership. Apart from the two uppermost rungs in which the dictator and manipulator roles appear, this later model admits of potential benefits and suitability of all other relationships, rather than suggesting that only the more participant-empowered ones are desirable. While offering a more illustrative typology and expanding the relationships that can be considered desirable, it still relies on a spectrum of power relationships between outsiders and local people as its guiding principle. Chamber’s ladder is shown in Figure 2.

A Participation Ladder with Roles and Responsibilities

	Outsiders' objectives include	Roles/Relationships		Actions		Ownership
		Outsider'	Local people's	Outsider'	Local People's	
TOTALITARIAN	State political control	Dictator	Slave	Command	Comply	Outsiders'
NOMINAL	Cosmetic legitimisation	Manipulator	Puppet			
EXTRACTIVE	Obtain local knowledge for better planning	Researcher /planner	Informant			
INDUCED	Gain action Through material incentives	Employer	Worker			
CONSULTATIVE/ INSTRUMENTAL	Improve effectiveness and efficiency	Rational economiser	Collaborator			
PARTNERSHIP	Share responsibility and power	Co-equal partner	Co-equal partner			
TRANSFORMATIVE	Facilitate sustainable development by local people	Facilitator /catalyst	Analyst /Actor /Agent			
SELF-MOBILIZING	Support spontaneous action	Supporter	Owner /controller	Support	Initiate	Local people's

Sources: Draws from several sources, including the versions of Andrea Cornwall (pers comm.) and Pretty (1994, 1995b), and those in Table 4.1

Figure 2. Chambers ladder of participation (CHAMBERS, 2006)

Other typologies include those based on the direction of communication flows, such as Rowe & Frewer (2000), who present three cases: one where a sponsor communicates with the public, one where the public give information to a sponsor, and one in which there is productive exchange or dialogue. Normative ideals, such as empowerment and deliberation, have been contrasted with pragmatic concerns, such as efficiency and outputs, as noted by Musch & von Streit (2020). Pragmatic and social norms have been extended into other frameworks, such as social and cultural determinants and institutional fit (BAKER; CHAPIN III, 2018).

In political science, the focus has historically been on formal democratic processes, such as voting and campaigns, but has expanded to include less restrictive definitions:

> Political participation can be loosely defined as citizens' activities affecting politics. The simple appearance of this definition is deceptive. The list of specimens of political participation is virtually endless and includes such

> divergent phenomena as voting, demonstrating and boycotting – but also guerrilla gardening, volunteering, flash mobs and even suicide protest. (VAN DETH, 2014 p.351)

As will be seen, this research builds on contemporary STS and related research on participation that is less evaluative and more descriptive in its methodological approach, requiring more open and flexible definitions. As a response to the never-ending multiplication of typologies and definitions that are often either out of date or attempt to cover so much as to become meaningless, van Deth (2014) attempted to create a 'minimalist definition' of political participation that can provide an objective means of identifying participation via unambiguous and efficient decision rules. This is based on the assumptions that political participation involves (i) behaviour (ii) undertaken voluntarily (iii) by non-professional citizens and (iv) located within politics, government and the state. Behaviour is chosen over, for example, intentions, and that behaviour is voluntary is assumed in the absence of coercion, such as legal obligations or social extortion. Citizens are defined as those who are not acting as 'politicians, civil servants, office-bearers, public officers, journalists, and professional delegates, advisors, appointees, lobbyists and the like' (p354). Politics, government and state are assumed to be the officially sanctioned institutional architecture. This minimal definition covers traditional notions of participation, such as voting, petitions, and official participatory processes for planning and budgeting. For the wider gamut of more recently recognised modes, such as protest, voluntary work and clicktivism, the definition can be extended to the state as target and not locus of action, or shared and community problems as target and locus of action, such as neighbourhood associations. Further distinctions can be made for intentions, so that, for example, attendance of a protest to find a romantic partner rather than accomplish a political goal can be distinguished. Although each rule that makes up the minimalist definition has been contested, they are sufficiently unambiguous to serve the needs of this research. Figure 3 illustrates the minimalist and targeted definitions, with space for the further refinements mentioned.

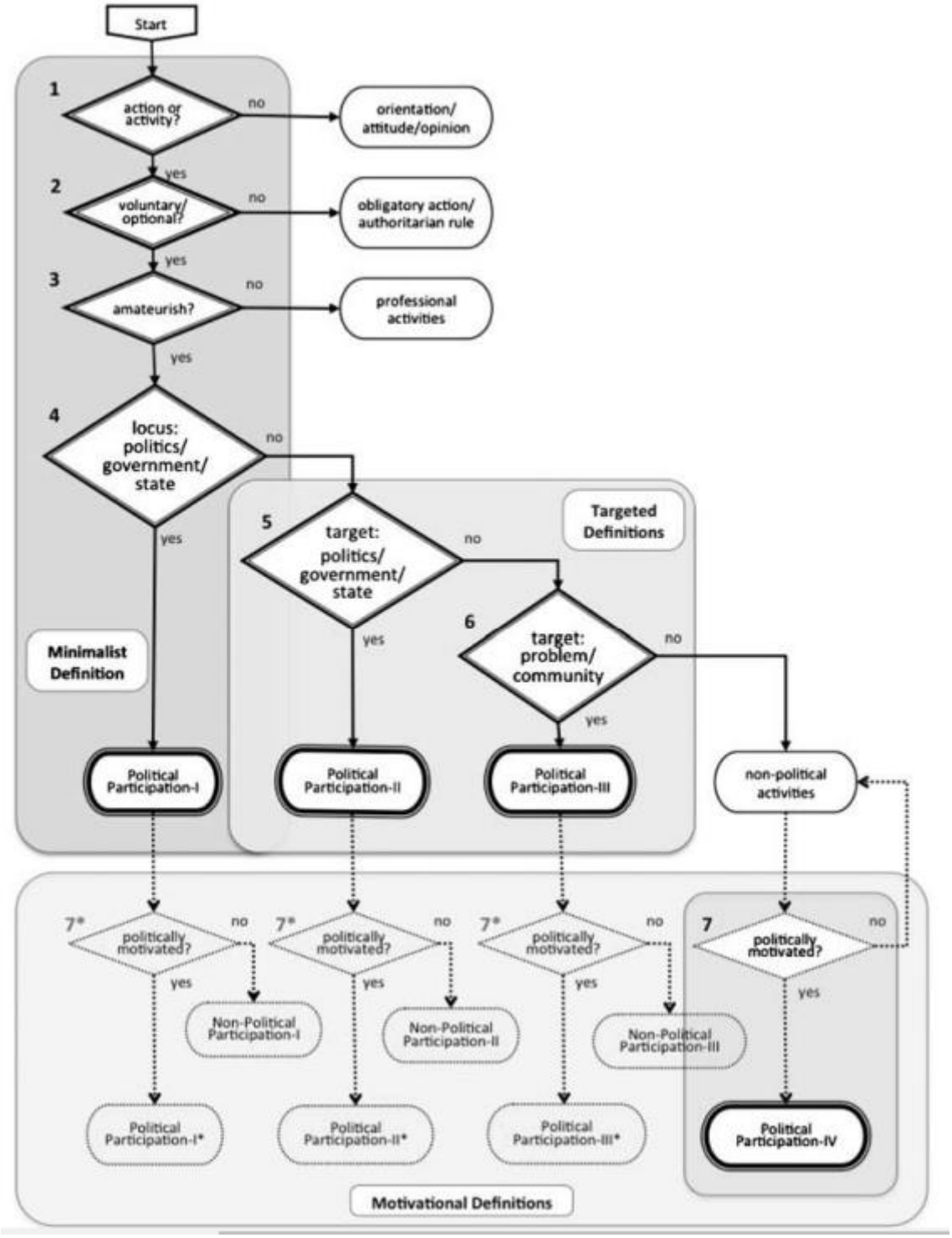

Figure 3. Minimalist, targeted and motivational definitions of political participation (VAN DETH, 2014)

In a review of stakeholder participation in environmental management, Reed (2008) provides a loose definition of participation `as a process where individuals, groups and organisations choose to take an active role in making decisions that affect them`, with the

caveat that stakeholders are `those who are affected by or can affect a decision`(p.2418). This lose definition is applied here to consider the broad range of literature available, as there are many important contributions to the debate that do not fit in a simple framework. Van Deth`s more precise definition will be aligned with this research in the Methodology.

The Participatory Turn—History & Theory

The debates in STS and related fields around participation are connected to social and technological change in the Western world. The historical context presented here also offers a way to contrast and connect to the fields of Development Studies and Deliberative Democracy, and Brazil`s unique past and present. While questions regarding the connections between governance, science and participation stretch back at least to Greek philosophy (MITRE, 2016) and certainly on through European and American Renaissances and Enlightenments (BROWN, 2009), the contemporary period in the US and Europe is marked by a post-World War 2 peak in confidence and investment in political and scientific experts, and a subsequent disillusionment. Victory in World War 2 illustrated the immense and growing power of science and technology and generated unprecedented knowledge, infrastructure and operations. An important milestone, in 1944, President Roosevelt of the US requested advice from Dr. Vannevar Bush, the then director of Office of Scientific Development, regarding how to communicate the science developed during the war, organize medical science to fight disease, aid research, and identify young talented scientists (BUSH, 1945). In the response, Bush linked government-supported science to public health, jobs, national security, housing, agriculture and liberty, and set out to institute scientific independence from government to pursue knowledge for its own sake in an `endless frontier'. A golden age of low-interference public investment was established (MARTIN, 2003).

After the war, a raft of significant social and technological changes occurred with often unanticipated consequences. Hailed as a miracle pest-control substance, DDT was shown to lead to toxin build up in ecosystems (CARSON, 1962). In Europe and elsewhere, Thalomide, a new drug prescribed as a sedative and treatment for morning sickness, caused thousands of cases of birth defects and child deaths. For the US, the Vietnam war, a high-cost and highly technology-driven US intervention that was framed in the broader Cold War, was showing costly failures during the 1960s, along with the eruption of civil rights and feminist movements; and in 1972 the Watergate Scandal further shook trust in politicians. Protests began against apparent abuse of power across a range of social issues,

often within the university system that had been expanded in the post-war consensus. Perpetual images of the nuclear threat as part of the cold war undermined a deterministic association of science with human progress (FELT et al., 2017), as did growing awareness of potential imminent environmental and social collapse due to natural resource abuse, waste generation, and underdevelopment (MEADOWS et al., 1972; UNEP, 1972). There was also a series of high-profile industrial disasters, such as the Ford Pinto Scandal in 1973, the Love Canal toxic landfill development in 1978, the Amoco Cadiz oil spill off of France and the three-mile island nuclear meltdown in 1979; the 1980s saw the nuclear disaster of Chernobyl in Ukraine, affecting Europe and the UK (WYNN, 1996), and the Union Carbide gas leak disaster, killing thousands in Bhopal, India.

This era of societal disillusionment marked a transition point for STS. Building on antecedents, such as Popper (1962) and Kuhn (1962), STS and its origin fields, the philosophy, sociology and history of science, had largely sought to define what set science apart as authoritative during the 1950s and 60s in what Collins & Evans (2002) call the 'first wave' of explanation and justification of science—attempts to demonstrate how scientific knowledge was a privileged way of knowing. Beginning in the 1970s, STS moved into a 'second wave' of critical studies, along with the development of distinct institutionalized research, training, journals and handbooks (Collins & Evans `third wave` is later considered). Second wave critiques centred on why science was the same as other forms of knowledge—for example: attacking the notion of scientific objectivity, the STRONG program (BLOOR, 1976) set itself to deconstructing the psychological, social and cultural factors leading to the success and failure of knowledge claims; investigations took place into day-to-day laboratory life of scientists, examining how they moved between real world observations, abstracted `pure` experiments, and back to universal generalizations (LATOUR; WOOLGAR, 1986); and an influential STS program, the Social Construction of Technology (SCOT) (PINCH; BIJKER, 1987), was developed based on a social constructionist view. This work suggested that, among other things, scientists often operate in relative seclusion, negotiating a variety of limited social demands, cultural conditions, and self-interest in the production of facts.

Both the severity and scale of technoscientific disasters and the emerging critiques from STS and other disciplines began to chip away at cultural norms around the role of expertise. One of the central terms in these critiques was technocracy, the notion of a society run by technical experts. From the early 20th century, this had been offered as a

solution to complex problems (ADAIR, 1970; EDGERTON, 2005), whereas now it was seen as concentrating power in an irresponsible, uncapable and unaccountable elite. Author's, such as Feenberg (1999), Beck (1992) and Fischer (2000) criticize a fetishism of technology and technique that favours top-down control, distances decision makers from effects, and disguises political action in the name of efficiency. For example, Winner (1980) illustrated how certain technologies, far from being neutral tools, in fact embed particular values, social systems and culture, whether intentionally or otherwise; in his examples, nuclear power necessitates a hierarchical control system, the New York transport system isolates poorer populations from wealthy neighbourhoods, and new tomato harvesting technology puts tomato pickers out of jobs. Some of the challenges cited are that the implications of these systems may not be understood by the designers, as they focus on efficiency to the detriment of other values, that experts may frame and understand social issues as technical and ignore contingency and indeterminacy, and that political choices may be positively framed as technical to avoid broader participation. Technocracy can be viewed as a culture, also, bringing technical procedures that favour hierarchical control and narrow methodologies from business and industry contexts into governance and public services, or from developed to developing countries (ROBERTS, 2013).

Narrations of conflictual expert-citizen interactions in STS described common dynamics: people with significant local knowledge were side-lined by arrogant scientists (WYNN, 1996), patients had to fight for the right to participate in their own disease treatment (EPSTEIN, 1998), and politicians and scientists failed to manage public-health crises (JASANOFF, 1997). An alignment emerged among multiple perspectives that the limitations of certified expert knowledge must be recognized and compensated for by greater citizen participation (BECK, 1992; FEENBERG, 1999; FISCHER, 1991). Examples of the new attitude to participation included: 'technical citizenship'—knowledge, power and occasion to speak on social impacts of technical matters in regulations, practices, design and creative appropriation of technologies (FEENBERG, 2011); 'civic science'—the incorporation of diversity and democratic ideals into science and knowledge production and scientific institutions ((BÄCKSTRAND, 2003); going 'upstream'—engaging publics at earlier stages in the research and development process (WILSDON; WILLIS, 2004); and 'opening up' to unexpected responses from the public to science and technology issues and policy (STIRLING, 2008).

Brazil`s history is distinct in several regards, the most obvious of which is the relatively recent democratization process. The 1964-88 military dictatorship can be considered technocratic in that it was operated by a military bureaucracy and engaged in large-scale infrastructure projects while negating public spaces for critical inquiry. Brazilians engaged in voluntary associations, such as sports clubs and neighbourhood groups, and more radical local-scale efforts were under way in the name of popular education. Liberation Theology within the Catholic Church as well as the work of Paulo Freire on 'conscientization' (a kind of political awareness raising) influenced Basic Ecclesiastic Communities (*Comunidades eclesiásticas básicas—CEBs*) and similar projects that formed to educate the poor across a range of topics beside religion (BUTLER; PRINCESWAL, 2010). Democratisation also provided space for NGOs and campaign groups, including for participation in environmental issues as linked to social concerns (JACOBS, 2002). However, while the constitution and subsequent governments institutionalised strong links between civil society and government via thousands of policy councils and the national conferences, there has not been an equivalent crisis of trust in experts, as there was in Western countries. Rather, participation has been framed and enacted within the social norms of justice, inclusion and democracy.

The Participatory Turn—Practice and Policy

In the US and Europe, and carrying a range of normative ideals, such as efficacy, efficiency, ownership, learning and legitimacy, experiments that involved the public in science and policy were developed, from participatory science to 'mini-publics'—small deliberative forums or formal procedures, generally with a cross section of the public gathered to consider a specific issue. Citizens Juries, for example, build on the notion that even complex and specialized criminal cases can be settled by small representative groups; the process gathers a representative group of 12-24 people to deliberate over 4-5 days with the help of expert witnesses that they can interrogate and the Jury then produces a report of decisions and recommendations which may be taken up or responded to by local government or relevant organizations (CROSBY, 1995). A range of such participatory processes for health, environment, local planning, energy and other scientific and technological issues were developed and continue to be applied, including Consensus Conferences (CAMMAROTA et al., 2017; COLOMBO et al., 2016), Joint Fact Finding (SCHENK et al., 2016), and Participatory Planning (FLYNN et al., 2018). Relatedly, the concept and practice of Joint Knowledge Production was developed as a

response to complex issues, offering means of integrating diverse knowledge types—including local, indigenous, non-expert and qualitative—to produce more useful knowledge (HEGGER; DIEPERINK, 2015).

The Participatory Turn was not restricted to STS, with parallel concerns playing out in Democratic Theory and Development Studies. A related `Deliberative Turn` occurred in Deliberative Democracy during the 1990s, where definitions and models of deliberation evolved in a debate around communication, locations, participants and outcomes. STS imported many assumptions of Deliberative Democracy, including standards of communication and assumptions that more participation and deliberation would improve outcomes. We note the recent development of Deliberative Systems Theory later. Development paradigms have arguably moved along a longer trajectory, from 1960s anti-modernization critiques of technology transfers through to local-perspective inclusion in data and planning in the 1970s, collaborative planning in the 80s, and the emergence of participation as an established norm in international development in the 1990s (HICKEY; MOHAN, 2005; REED, 2008). Over the last decades, Integrated Landscape Management (ILM)—`long-term collaboration among different groups of land managers and stakeholders to achieve the multiple objectives required from the landscape`(SCHERR; SCHARMES; FREIDMAN, 2013)—has appeared in a variety of models that try to operationalize participatory environmental governance, such as: Participatory Integrated Assessments, that involve qualitative participant data (SALTER; ROBINSON; WIEK, 2010); Community Based Monitoring (CBM), in which local people can participate in observing their environment so as to better manage it (CONRAD; HILCHEY, 2011); Community-Based Natural Resource Management (CBNRM) (DRESSLER et al., 2010); and Participatory Rural Appraisal, designed to empower poor communities to better collaborate in local resource and culture management (CHAMBERS, 1994; SOLANO LARA; FERNÁNDEZ CRISPÍN; LÓPEZ TÉLLEZ, 2017). The norm of participation as well as defined examples of the strategies above have also been woven into policy in a broad range of influential institutions, including, for example, the UK government (POTTER, 2008), United Nations (SCONFIENZA, 2015) and European Union (SAURUGGER, 2010), who claim it as a founding principle.

In Brazil`s new democracy, both the policy councils and national conferences were expanded during the 90s but became much more significant when the Worker`s Party came to power in 2003. Under Lula`s government, millions of people attended thousands

of meetings, some consultative and non-binding, and many deliberative, with direct impacts on policy. This means of engaging popular input and support accelerated distributive policies, such as Bolsa Família and the national health service, and sector programs, such as for family agriculture. The broader range of participatory spaces has continued to engage people in neighbourhood associations, political parties, trade unions, parent-teacher associations, charities and religious groups. In terms of Brazilian environmental governance, significant global participation took place in the The United Nations Conference on Environment and Development of 1992, or Rio Summit. Locally, a major innovation has been the River Basin Committees: these bodies, often above municipal and below state level, organize around hydrographic basins and sub basins to bring together civil society, government and business to decide on water tariffs, revenue distribution, and coordination on policy. Although often relegated to consultative status, there are examples of active committees that have shifted socio environmental outcomes, even disrupting traditional clientelist politics and mobilizing the state (NEAERA ABERS; KECK, 2009; TADDEI, 2011). Beyond the committees, Conservation Unit law contains differing levels of participatory or consultative rights, depending on whether parks are principally for conservation or sustainable use (HAQUE; DEB; MEDEIROS, 2009). Many examples appear in the literature of participatory environmental governance projects that involve Conservation Units, such as the case of an Oyster Cooperative in São Paulo state (HAQUE; DEB; MEDEIROS, 2009), an indigenous fire brigade (DE MORAES FALLEIRO; SANTANA; BERNI, 2016), and the biome-wide Atlantic Forest Restoration Initiative (PINTO et al., 2014).

In summary, post-WW2 trust in political and scientific experts as well as top-down interventionist development policies gave way to a crisis of legitimacy and efficacy in Europe and the US. Participation came to be seen as a panacea by multiple fields, expected to achieve both pragmatic norms, such as accuracy and efficiency, and social norms, such as justice, learning and inclusion. From these came a range of strategies, from democratic to participatory conservation models, creating bodies of practice, methods, case-studies and policies. Participation has become a `gold standard` (FELT; FOCHLER, 2008 p.489), at least rhetorically, but there are distinct histories for the Western internal social and technological context, interventionist development strategies, and Brazil's democratic evolution.

The Participatory Turn—Issues

Participation was presented as a panacea for many problems, and, though it undoubtedly demonstrated some capacity to bring about desirable goals in certain circumstances, it also brought surprises. Indeed, some STS scholars even reflected that `while our mentors presented us with the idea that public participation was *the solution*, we increasingly feel that we have inherited it as *the problem*` (DELGADO; LEIN KJØLBERG; WICKSON, 2011 p.826 original emphasis). Two lines of criticism can be delineated regarding the participatory turn. The first considers methods and procedures, looking to adapt technique to render participation more effective. In this regard, multiple best practice guidelines and instruction manuals can be found, such as Luyet et al. (2012) and Rowe & Frewer (2000). A second line cuts more deeply—the issues include: limited effects, poor institutional or policy uptake, the expert-lay divide, outcome manipulation, the role of expertise, applicability of models across contexts, and the meanings of participation.

Clearly, drives for different goals, such as efficiency and social learning, or conservation and human development, can come into conflict, but this is not always acknowledged. Bogner (2012) describes `invited` participatory processes or `lab participation`, in which the impetus for organization comes from experts and the execution is often performed as an experiment by social science researchers. These projects do not channel a pre-existing desire for debate but attempt to mobilize one through the motive of being informed, creating highly controlled circumstances with little space for disruptive or unexpected political dialogue. So, this lab participation can bring the normative objectives of organizational success and open, political deliberation that could lead to rationality gains into conflict. In a review of such lab participation, Kurath & Gisler (2009) considered six nanotechnology related participatory processes across the US, UK, Switzerland and the EU to assess `whether a paradigm shift in science and technology communication toward a more democratic engagement of the public had really taken place`. They found that projects generally failed to challenge expertise or an image of unified science and illiterate laypeople, occur upstream from major investments, or go beyond measuring public opinion and consensus formation. Relatedly, Musch & von Streit (2020) observe that many participatory processes for sustainability science incorporate social and deliberative ideals in planning but become functional and competitive as they move to implementation and face resource and time constraints.

The phenomena of conflicting objectives is named by Irwin (2006) in his analysis of participation in science-policy in the UK, where ‘The `new` rhetoric of public engagement and the `old` language of science-led innovation and sound science’ (p.303) often sit somewhat uncomfortably side by side, even in the same policies and documents. In the UK participatory paradigm, transparency is not engaged to make more critical stances possible, but to legitimise state and science. An important device in the process is the notion of the `innocent citizen`—a model citizen that does not have `fixed` opinions but is rational and reasonable enough to accept scientific facts. The implication is that members of activist groups are not legitimate contributors to debate and can be dismissed. Displacing the older public-deficit model of public objection, a trust-deficit model is employed to be negotiated via openness and information, with the boundaries between experts and laypeople, facts and values maintained.

These criticisms find echoes in Development Studies, particularly in the landmark volume `Participation: The New Tyranny?` (COOKE; KOTHARI, 2001) at the centre of which is a critique of participation as a depoliticizing technique that often reinforces power relationships and injustice. Notions of citizenship and empowerment can be misused, such as `empowerment as consumer` and citizenship as compliance, and participation has been described as an attempt to disguise the objective of technocratic efficiency with that of empowerment, or at least as a failure to reconcile limited budgets, time and project remits with meaningful engagement (CLEAVER, 1999). This mode of critique is related to critical literature of the disaster, citing a capitalist development paradigm as forming the unquestioned backdrop that restrains meaningful and effective engagement at local scales. The cited constraints include social stratification, state formation, and political economy, and patterns, such as participation fatigue, when the same accessible groups are repeatedly engaged by multiple NGOs and researchers. This justice-based perspective can be contrasted with more openly pragmatic concerns. From a policy stand point, for example, according to Maasen & Weingart (2005), there are distinct trade-offs to engaging more participation with the assumption of greater legitimacy, such as impacts for time sensitive processes, the transfer of local processes to national or supranational policy, and complication of an already-complicated policy-design process that can have downstream effects on transparency, utility and accountability.

Many of the critiques of participatory practices focus in some way or another on the their operation as an afterthought or add-on with little effect. O'Riordan & Haran (2009), in

their examination of the 2006 Human Fertilisation and Embryology Authority (HFEA) consultation on embryonic stem-cell donation in the UK, highlight how the question of *whether* egg donation should take place was elided for *how* it should take place; women's agency was foregrounded as individual empowerment, while the risks of this invasive procedure were described in relation to society or 'people', and the process occurred after licensing for research had already taken place. Discursive and framing issues are also present in the work of Levidow (2007) in his description of state-sponsored European Technology Assessments (TAs) in relation to agricultural biotechnology. Although these sometimes demonstrated multiple roles for the public, many TA structures reproduced problematic boundaries between laypeople and experts, and larger questions—such as innovation trajectories, social values and alternatives—were supplanted by consideration only of how to make the technologies safe or acceptable.

Wynne (2007) relates criticism of top-down meanings of participation to those of science and technology themselves, suggesting that particular, power-laden constructs that restrain the potential for participation are often assumed. This represents a continuation of the public-deficit model, in which objections are assumed to be irrational or caused by a lack of knowledge rather than have validity in themselves. The active constraint of participation can be considered in the design and construction of participatory processes, such as when they deny certain scientific claims are open to debate or are limited to only the 'structured interaction of reasoned arguments and counterarguments'—thus denying such means of expression as passion, solidarity, anecdote and rhetoric, or spontaneous, and not-yet-fully-formed expression. Van Oudheusden (2014), for example, in a critique of Responsible Innovation (RI)—a project to bring about social responsiveness in science and technology—asserts that it has failed to open space for '..politics, understood as the constitution and contestation of power' (p.67). While exhibiting 'an orientation toward anticipation, inclusiveness, responsiveness, and reflexivity', RI has in practice allegedly shown political bias in choosing certain concepts of democracy, legitimacy, expertise, and what constitutes correct values.

The range of issues affecting participatory process outcomes includes cultural differences, and the transportation or translation of participatory models among different contexts. Comparing public consultation case studies in France and the Congo using a performativity lens, Ehrenstein & Laurent (2016) show that practices and meanings of participation, civil society and the state can differ so widely as to almost be

incomparable—where international aid organizations demanded 'civil society' be present, actors presented themselves, despite the lack of community connections that are imagined as motive and legitimation for their inclusion.

Taking a step back, Felt & Fochler (2008) summarize three key issues with participation: substantial unreflective normativity regarding means, ends and the identities of participants, including the notion of the innocent citizen; lack of critical analysis of definition of participation, its methods and aims; and top-down imposed meanings of participation without understanding how citizens comprehend it. These issues are extended in a critique of 'residual realism', fleshed out in a recent volume entitled Remaking Participation (CHILVERS; KEARNS, 2016a), constituting a reaction against the tendency to focus on methods that often present as transparent, accountable and authentic while confirming science`s authority—for example, by pairing deliberative forums with public education programs, forming a kind of public management. Chilvers & Kearns (2016) also take issue with deliberative democracy`s concern with pre-given notions of what constitutes democracy and deliberation, the assumptions of ready citizens and experts, and the absence of adequate consideration of objects and the technical in processes and accounts. The residual realist critique can be summarized as: 1) the assumption that publics exist prior to process; 2) publics as aggregations of individuals; 3) predetermined notions of participatory democracy (that have also been imported to STS); 4) a focus on procedures, techniques and universal solutions; 5) one-off and front-stage events; 6) inclusion based on social science definitions as a measure of success; 7) a linear model of process and impact on decisions; and 8) participation as separate from science, technology and the environments, i.e., preference capture for pre-framed problems, implicit commitments to innovation, and problems of extension and scale. This is accompanied and reinforced by the professionalization of participation via the agencies and consultancies that provide it as a service.

The Participatory Turn—Evidence of Benefits & Brazilian Examples

Participation practices unfortunately suffer a basic deficit of evidence in relation to benefit claims, as projects go unreported, remain in grey literature, use inconsistent evaluation methods, or provide mixed results. An attempt at empirical evaluation, Fritsch & Newig (2012) compared 35 in-depth case studies of deliberative governance for environmental decision-making in North America and Europe against a control group of multi-government agency and/or government-business cases to assess ecologically

valuable outputs, policy implementation and ecological outcomes. They found individual citizen involvement often restricted information gain, as relevant information was of a specialized nature, while collective learning was improved so that win-win solutions were more likely; neither information gain nor collective learning improved environmental decision-making, however—stakeholder interests were far more influential than process format and more participatory processes could lead to less ecological decisions, as private interests could dilute environmental-agency influence. Legitimate spokespersons, representation and fairness—as measures of legitimacy of the process—led to acceptance of results and sometimes improved implementation, especially if acceptance was by non-state actors.

Reviewing largely Western peer-reviewed examples of Transdisciplinary Research (TDR) for sustainable land-use, which often integrates non-scientific actors, Zscheischler & Rogga (2015) found that although communication culture, personal attitudes, project structures, and skills and knowledge were consistently cited as success factors, the benefits of TDR remain unproven. And a review of discursive participation and deliberation in the USA found that, again, good empirical evidence was lacking, and benefits were highly context dependent on participants, connections to authorities, interaction rules, and information and beliefs, with many examples of ineffective or counterproductive processes (CARPINI; COOK; JACOBS, 2004).

Available evidence for tropical environmental management is also mixed, though it suggests participation has potential to improve social and environmental outcomes. Reed et al. (2017) illustrate this with a review of landscape approaches that includes grey and peer-reviewed literature in which some reported success but few provided evidence—this may have been due to the number and scale of projects, the challenges of providing comprehensive empirical evidence, and incentives against reporting failures. Where success was reported, stakeholder engagement, institutional support and effective governance structures were cited as necessary. Estrada-Carmona et al. (2014) analysed the results of 104 case surveys across 21 countries of Integrated Landscape Management in Latin America and the Caribbean. Results suggested increasing application for agriculture, conservation and livelihoods, but 34% cited limitations in stakeholder participation as responsible for the least successful project outcomes. The authors conclude that much more evidence is needed to understand when, how, why and where such initiatives demonstrate success and failure.

No analogous review for Brazilian participatory socio environmental management projects could be found; however, though inconsistently framed and measured, available examples show mixed outcomes. For example, a massive, multi-institutional effort to protect Atlantic forests is ongoing (PINTO et al., 2014) and a successful Joint Knowledge Production project was reported by de Moraes Falleiro et al. (2016), where indigenous knowledge and participation was combined with conservation science and satellite monitoring technology to manage fire in the Cerrado; whereas both Silva (2019) in researching an Amazonian Conservation Unit and Gonçalves et al. (2011) reporting on an urban park in Rio de Janeiro present the state as obstructing local decision-making either through incapacity or lack of incentive to include local people. In line with the above reviews of Integrated Landscape Approaches in the tropics (ESTRADA-CARMONA et al., 2014; REED et al., 2017), some multi-institutional and multi-scale projects have shown better conservation and livelihood outcomes, such as for a Mangrove Oyster Cooperative (HAQUE; DEB; MEDEIROS, 2009), which linked park, municipality and university to create a sustainable business, and a Payment for Ecosystem Services forestation project in São Paulo that integrated an NGO, the national bank and a university (BALL; GOUZERH; BRANCALION, 2014).

As noted, Conservation Unit and River Basin Committees set Brazil apart in terms of policy for participation in environmental governance. In examination of the Jaguaribe Valley in the state of Ceará, Taddei (2011) described the emergence and development of the River Basin Committees in the 1990s. Multiple factors converged, including: severe water conflicts in a drought region, discussions among federal university engineers, World Bank pressure, as participation was adopted as an albeit ambiguously defined requirement for development loans, and a new state governor, Tasso Jereissati, and his associated new state elites; the new participatory structure offered a unique opportunity to undercut traditional clientelist politics. Taddei asserts that, though the new committees gave local populations a more direct link to state level, they also lost the participation of The Landless Movement (*Movimento Sem Terra—MST*) and Pastoral of the Earth (*Pastoral da Terra*)—important grass-roots organizations in Brazil. This was due to Committee preferences for larger-scale and technological development projects over traditional small-scale and family agriculture, which was seen as backwards. The main means of exclusion was the use of technical and specialist language to describe the river

basin and its issues, with committees and local politics influenced by university professors and engineers. This is backed up by survey data on the committees in which…

> …79.3% of all respondents find that the disparate level of technical knowledge among members is the main source of inequality within the committee, above economic and political power disparities. (LEMOS; DILLING, 2007 p.113)

Broader participation in Brazil has had recent challenges. The somewhat predictable issue of public-manager resistance to formal participatory processes has allegedly been exacerbated by a broader development trend towards outsourcing public services, privatization and new regulatory agencies that have distanced the councils and conferences from decision-making (CICONELLO, 2008). The Bolsonaro government elected in 2018 has cut many councils, reduced the number of civil society representatives, and limited transparency (MAZUI, 2019). These evolving national cultural understandings and practices, or `civic epistemologies` (JASANOFF, 2010), then, reveal different expectations and motivations to criticize science, technology and policy, as well as dynamic incentive and opportunity structures. A challenge exists in that public engagement for science, technology and policy might vary substantially in normativity between the US and Europe, where much STS and participatory theory and practice has developed, and Brazil. It may also vary between sectors within the national context, such as for public health and environment.

Regarding national differences, Macnaghten & Guivant (2011) note that the UK has substantial experience with public technology-related controversy and debate, generating a normative notion of participation and a suspicion of expertise; while Brazil, in comparison, has had fewer technological controversies, holds scientists in high regard as neutral arbiters of information, and often associates blame with specific corrupt companies or individuals, rather than with expertise in general. This is partially confirmed by recent survey data on 16-25 year old Brazilians (MASSARANI et al., 2019). Most 16-25-year-olds in the study consider scientists, doctors and teachers as trustworthy sources of information, technoscientific development as positive, and investment as important. They also think that most people can understand and should be heard in big science and technology decisions. However, few could name scientists or scientific institutions, scientific information access appears poor, social media are used as sources, few visit museums or can easily evaluate information, and there are mixed views on vaccinations, climate change and human evolution.

We have seen that evidence is not sufficient to demonstrate that greater participation is necessarily beneficial to either social or pragmatic outcomes, whether in the West or the Tropics and Brazil, whether for science-policy or landscape management. The evidence does suggest that participation can improve outcomes when the right conditions are in place, and work continues to theorise, measure and describe a phenomena that is both coherent enough to drive a research agenda and as idiosyncratic as the range of contexts. Brazil has important experiences with practice and policy rooted in its unique history of democratisation and environmental governance. While experts retain trust, demand for participation is strong including for environmental issues, and scientific literacy is low. And the political environmental is evolving in ways that make it hard to predict longer-term trends. The Samarco Disaster sits across contexts, presenting a complex, bioregional and technoscientific recovery for which participation remains a central issue. We turn now to academic criticism of the disaster to understand the range of established perspectives and issues.

Critical Literature of the Samarco Disaster

Participation has taken centre stage in the Rio Doce basin. While multiple actors claim to provide for and operate participatory governance, a range of critiques question this stance for both the recovery and the broader practice of mining, citing Renova Foundation as an extension of the mining companies. We consider first the broader critiques within which perspectives on the disaster recovery are often framed, before reviewing disaster-specific discussions.

Identifying a regional, contemporary pattern, Svampa (2015) suggests that there has been a shift from the Washington consensus of financial valorisation and privatization with the state as moderator to a Latin American Commodity consensus—`the massive implementation of extractive projects oriented towards exportation, establishing greater flexibility in the state`s role` (p.66). This broader tendency in oil, agribusiness, hydroelectric energy, fishing, forestry and mining is characterized by monocultures and high-capital, technologized low-labour operations with substantial populational and environmental displacement and destruction. And this is accomplished via…

> …a model of appropriation and exploitation of the commons, which advances on populations through a top-down logic, threatening the improvements in the field of participatory democracy and inaugurating

> a new cycle of criminalization and violation of human rights. (SVAMPA, 2015 p.68)

Part of this Latin American Commodity Consensus regards a move to ‘alternative conflict resolution’, a notion that has been applied directly to the TTAC. Whereas previous resolutions involved the justice system and a criminal law orientation that might assign responsibility, more recent resolutions have tended to involve extra-judicial agreements among stakeholders, including government and the affected, that allegedly frame members as equals or even sharing in victimhood (ZHOURI; BOLADOS; CASTRO, 2016). From this perspective, Renova Foundation is a ‘colonial device of governmentality’ that not only resolves disputes but perpetuates and creates ideology, in a historic pattern of suppression and resource extraction that is presented as scientific and neutral while controlling access to justice (DE CARVALHO; ALMEIDA, 2018).

While there is a global pattern of developing-country dam breaks—some of which involve the mining companies responsible for the 2015 disaster, and potentially negating any claim of ignorance as to the risks (CARMO et al., 2017; HUMPHREYS, 2013)—, the Fundão dam rupture has a local historical context. Table 1 below shows recorded mining-dam ruptures and damage for Minas Gerais, Brazil from 1986 to 2019, all of which are for mining waste except that of Cataguases, which was industrial waste.

Location	**Year**	**Name**	**Damage**
Itabirito	1986	Fernandinho Dam	7 deaths, Silva and do Eixo streams polluted
Nova Lima	2001	Macacos Dam	5 deaths, 43 ha and 6.4 km of stream destroyed
Cataguases	2003	Cataguases Dam	1.4 billion litres of bleach released. Contamination of Rio Pomba and Paraíba do Sul, deaths of animals and fish, interruption of water for 600,000 people

Miraí	2007	Rio Pomba Dam	More than 4,000 people homeless or displaced, 1,200 homes affected
Itabirito	2014	Herculano Dam	3 deaths in tunnel collapse, local environmental damage
Mariana	2015	Fundão Dam	19 deaths, 600 homeless or displaced, massive energy, water and transport disruption, 680km of waterway and thousands of hectares destroyed or polluted
Brumadinho	2019	Córrego do Feijão	At least 270 deaths, 12 million cubic tons of waste into the Rio Paraopeba

Table 1. Mining waste dam ruptures and impacts in Brazil 1986-2019

The disaster has been linked to predictable increases in dam ruptures around 2 years after price booms (KOSSOFF et al., 2014), as the Fundão was built rapidly and with a limited licensing procedure so as to take advantage of the 2003-2013 global commodity price bubble. Once the prices dropped, Samarco allegedly stripped back fixed costs, such as Corporate Social Responsibility activities, training and pay (LABONNE, 2016; MANSUR et al., 2016). This was in a context of weak state environmental regulation and a direct conflict of interest as the state bank, the BNDESpar, and major pension funds were involved. At the local level, it is claimed that Samarco evaded resistance to license restrictions by dividing applications, information and affected publics, and framing the development in terms of jobs and income—there was no modelling for a rupture, no alternative technologies were considered as is required, and the dam was rated as safety guaranteed despite local concerns (SANTOS; MILANEZ, 2017; VIANA, 2012).

In line with this, it has been suggested that Samarco and similar companies operate to suppress alternative employment in Mariana and similar towns, ensuring dependence on and support for mining, wage control, an easier licensing process, and less restrictions on indirect activity, such as significant water extraction even during shortages. This is combined with election-campaign funding to capture politicians and reputational control through social and environmental programs (MANSUR et al., 2016). The critique of dependence on or even perpetuation of local poverty has been extended to one of

environmental racism, with the distribution of risk located immediately in the town of Bento Rodrigues, the residents of which were largely (85%) black and mixed race, as for Paracatu de Baixo (80%), Gesteira (70.4%), and Barra Longa (60.3%) (WANDERLEY, 2015).

It is in this context of a broader critique of persistent, technocratic and unjust global and local mining practices that the TTAC and Renova Foundation are often cited. As noted, the TTAC is a Term of Adjustment of Conduct; this is an extra-judicial agreement or contract that exists within Brazilian law and is commonly applied by the MP to cases where business generate illegal social or environmental risks and impacts. The benefit is that it can radically simplify what could be a highly complex or irresolvable juridical process, and they are usually signed off by a judge so that they can be enforced (COSTA, 2014). Tuncak (2017) highlights several points relating to participation in the TTAC. Although the explicit goal of the agreement was 'speed and efficiency', the eight weeks it took to agree may also be taken as evidence of how little participation took place, with scarce time for damage assessment, let alone meaningful involvement of the affected. The Deep Water Horizon disaster negotiation, initiated in 2010, for example, took years to agree and continues to be subject to claims today totalling over US$63.4 billion (REUTERS, 2018; ROBERTSON; KRAUS, 2014). The development of the TTAC was not made public and a lower court agreed it without substantial consultation of those affected. The supreme court suspended the agreement on 1st July 2016 citing a lack of public, scientific, or affected community participation (TUNCAK, 2017), but Renova Foundation was established despite this.

Losekann & Milanez (2018) describe the development of the TTAC from a human rights perspective, citing that Principle 10 of the 1992 Rio Declaration on Environment and Development, re-confirmed in 2012, to which Brazil is a signatory:

> Environmental issues are best handled with participation of all concerned citizens, at the relevant level ... States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided. (UNESCO, 1992)

An urgent appeal was submitted to the United Nations Human Rights Council (UNHRC) by several academic, NGO and activist groups, noting: the effect of the agreement on

other legal processes, a lack of legitimacy and transparency in its development, lack of address of the structural relations between government and the companies that contributed to the disaster, decision-making asymmetry and as to deciding who the affected are, and a lack of defined objectives (AME A VERDADE et al., 2016). This prompted a visit to Samarco by the UNHRC.

For Zhouri et al. (2017), a major concern has been that the TTAC gave Renova Foundation the right to decide who was affected and how. The level of informality in the Rio Doce basin is very high, yet, in the TTAC, for example, for individuals to enter into the Loss Register (*Cadastro dos Impactados*) and gain indemnity, unless in 'extraordinary circumstances', they require public or private documents (or other means of proof) to show: 'personal details, age, gender, composition of family, original location of residence, occupation, level of education, family income before the event, identity and CPF numbers,…basis for categorization as impacted, proof of damages suffered…and other data that come to be shown as necessary` (TTAC cl.21. paragraph 1). The creation of the Loss Register in collaboration with the consultancy Synergia reportedly employed premade lists of affected people and challenging public procedures for disputing misclassification. And classification of impacts was limited to demonstrable economic losses or displacement in accordance with global standards, without consideration of local definitions of loss, such as those of informal and social networks, customary rights, or belonging and identity—definitions that the affected themselves might consider more significant. This register was successfully challenged in Mariana, and yet the results of the new, more collaborative register were not extended to other affected populations. In the years since the disaster, problems have also been cited in the resettlement of the affected towns, with slow environmental licensing procedures, changes in tax regime between rural and urban environments, lack of guarantees to infrastructure and fresh water access, costs of moving, assistance with finding new livelihoods, and families who are still fighting for recognition of the homes they lost (GESTA, 2017).

In the TTAC, according to the MP, 'participation of the affected only occurred via public audiences (Clause 61 of the TTAC), which was absolutely insufficient', as, without 'a certain level of social organization', these audiences are 'merely an instrument of legitimating decisions'—i.e., even when well-run, they 'do not include indispensable means for adequate participation of the affected people'. As a result of concerns for participation, several new agreements were signed that involved the MP: in January 2017,

a new Preliminary Term of Adjustment (*Termo de Ajustamento Preliminar*) (TAP) (MPF et al., 2017a), followed by the Additive Term (*Termo Aditivo*) to the TAP in November 2017 that brought Technical Assistants to the Affected (MPF et al., 2017b), and then the more substantial shift in governance in the TAC Gov in August 2018 (MPF et al., 2018). The TAC Gov introduces local commissions and regional Chambers of the Affected and their Technical Assistants, as well ensuring their presence in other governance forums, such as the Board of Trustees, CIF and Technical Chambers. Yet Roland et al. (2018) highlight that these processes were again without substantial participation of the affected communities, and with several large consultancies tasked with socioeconomic and socioenvironmental monitoring. The MPF itself takes a somewhat apologetic tone in its report on the 'participatory evaluation' that lead to the TAC Gov, citing critical literature directly (such as Milanez & Losekann (2016)) and recognising criticism from civil society and academia that the `seminal failure of the TTAC` was being repeated (MPF; MPMG, 2018 p.5).

Interestingly, from the perspective of STS in relation to framings of neutral expertise, Roland et al. (2018) report that in August 2018, a federal judge on the 12th branch added restrictions to the TAP and TAC Governança: in the name of the 'free choice' of the affected to choose their technical assistants and with 'concern' to protect them from political or financial abuse, Judge Mário de Paula Franco Júnior disallowed that affected communities select persons connected to political parties or with political ideologies or the church (JÚNIOR, 2018). This would exclude several favoured candidates, such as Cáritas, although they were eventually ratified as representatives by the same judge. The state and federal MPs immediately released a statement of rejection of the additional restrictions, as they were not in the original agreements (MPMG, 2018).

After the Samarco disaster, mining legislation was relaxed and another major dam rupture has occurred in Brumadinho nearby, this time operated directly by Vale, releasing 12 million cubic meters of mud and killing at least 270 people. The dam was again considered safe. Since the rupture, multiple towns have been evacuated or placed on alert in the region, a manoeuvre some consider to be a means of reducing the cost of land acquisition and bypassing licensing requirements (LASCHEFSKI, 2019)

As compared to STS and sustainable development literature on participation that is often concerned with pragmatic uptake of local knowledge and direct collaboration in terms of policy and practice, as well as concerns for social norms, the literature on the disaster and

recovery emphasizes a collaboration between state, capital, judiciary and mining companies to suppress human rights and inclusion, including through the TTAC and Renova Foundation. Multiple STS critiques at least partially align with these accounts, such as top-down, 'technical' project implementation that has political and social implications, as in Winner (1980), the call for participation in development (CORNWALL, 2006), and the favouring of `neutral`, `technical` experts over local people and knowledges (WYNN, 1996). However, there is some divergence, in that the academic critiques considered here offer little focus on the potential pragmatic outcomes of greater participation or the production and maintenance of boundaries between the technical and political.

The response provided, as with the broader participatory turn, is to focus on structured forums as means to political empowerment, informed deliberation, and upstream engagement in decision-making, as in the TAC Gov. However, as we have seen, these participatory-turn style responses to issues of technoscientific issues, policy and environmental governance—whether local responses to the disaster, national examples of Brazilian participatory environmental governance, and broader efforts in the US and Europe—have run into consistent problems for diverse reasons. We now consider the range of responses to issues of participation in STS and related fields.

The Post-participatory Turn(s)

The term `Post-Participatory Turn` is used here with reference to the shift from key assumptions that marked out the participatory turn: that participation can simultaneously accomplish multiple social and pragmatic goals, that more is better, and that participation occurs only or mainly in distinct processes or mini-publics. The original normative aims of participation are shared, such as empowerment and policy improvement, but it is recognised that the original assumptions can be limiting in understanding how to reach them. Some responses have turned to further refinement of guidelines or the adaptation of procedures, accepting that participation as it is commonly understood is not always the answer. Some have a more systemic view, asking how means and locations of participation beyond formal or local processes can be considered. And others have attempted to ask in new ways what participation means and how it works in practice. More open, flexible accounts of participation, such as those based on ANT, have become important to taking the debate forward.

In Development Studies, Cleaver (1999) recommends careful analysis of whether participation is appropriate in relation to: the resources people need to participate, how structures both include and exclude people, the related cost-benefit for individuals, and the role of bureaucracies and formalization. In Political Science, Maasen & Weingart (2005) suggest maintaining the distinctions between science and politics, implying that science remains the realm of select experts and politicians deliberate on behalf of constituents as long as science and politics are reconceived as mutually dependent. Explicitly rejecting the notion that legitimacy to participate in technoscientific issues should be extended to any and all citizens, Collins & Evans (2002) attempt to provide a model of expertise to ascertain who should have what input to decision-making, separating scientific and political involvement, specialists and stakeholders, and placing only the `core set`—the deeply involved experts, including uncertified experts—in the technical realm. This renders the wider scientific community as merely other stakeholders and denies the authority of expertise considered irrelevant to the issue, as in Figure 4.

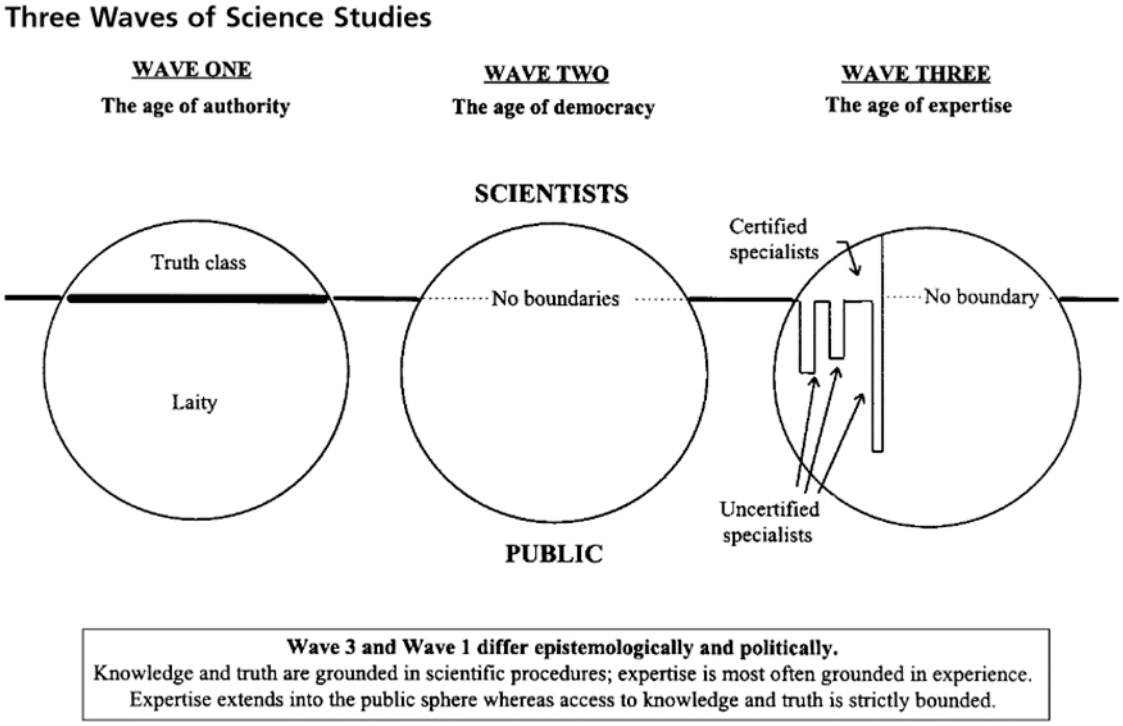

Figure 4. The three waves of science studies (COLLINS; EVANS, 2002)

This model of expertise, constraining both citizens and experts, marks a problem that has since become more relevant: how do we extend legitimacy to participate while

recognising that some people are more expert than others at certain activities? This has been provocative to established STS authors who fear a return to first wave, realist notions of science, ignorant of the contested and power-laden establishment of experts and expertise (JASANOFF, 2003; WYNN, 2003). Today, this links to a 'post-truth' age in which expertise has lost public legitimacy for certain issues and contexts, whether or not it can be attributed to STS deconstructionist accounts (SISMONDO, 2017).

Pushing legitimacy and expertise back in the other direction and taking Jasanoff's (2004) coproduction idiom as a cue for empirical analysis, Nelson & Vucetic (2009) reviewed literature on scientists as advocates for social and environmental positions. Their conclusion was that—despite fears for credibility, rigor, objectivity and compromise as policy advisors—it is inevitable that scientists are citizens with values and politics. Their call for objectivity as transparency rather than neutrality demands greater examination of how and when experts engage values in nominally technical procedures and knowledge production. In this regard, Monteiro & Rajão (2017) illustrated that technicians working on GIS satellite imagery of deforestation in the Amazon were sensitive to social narratives, political and policy implications, future challenges to their integrity, and the risks of interpretation without ground-truthing and shared experiential knowledge. As such, knowledge of ethical and political values and implications was a motive to uphold rigor and transparency.

Building on substantial prior work, Latour (2004) proposes to do away with a conception of politics that restrains it to the deliberation of values and a conception of nature that renders it inert and capable of objective representation, arguing that they produce a contradictory singularity of nature and plurality of cultures. While offering historical context, Latour asks not that `people who speak of nature as if it were an already constituted unity` (p.222) desist from exercising their power, but that they treat it as a power by demonstrating proofs of their legitimacy, means of election, motivations and the institutions that facilitated the representation. In his proposed model, associations of humans and non-humans—such as forests, rivers, animals and plants, but even bridges and other material objects—alike are represented by spokespeople, whom must always be questioned, in two Chambers: the first `takes into account` new entities and the second `puts them in order` in the progressively constituted common world. For example, the first Chamber, including veterinarians, scientists, farmers, and the public, might consider the existence of prions (proteins that cause mad-cow disease), their presence, importance

and function; the second Chamber could then evaluate them and how they might be accounted for in the ordering of, for example, meat production chains and consumption habits. As the distinction between facts and values is not maintained, there cannot be an apolitical or objective representation of nature, even as the sciences do the work of making propositions that the Chambers may consider. Social or human sciences are to work not by explaining society through massive yet invisible powers, such as class or race, but by providing `multiple and *rapidly revised* versions that allow us to understand the collective experience` (p.225 original emphasis).

Several frameworks try to broaden out from formal participatory processes to account for and operationalise the variety of ways in which science and expertise might manifest in a democratic context that demands the multiple goals of participation. Brown (2009) recognizes Latour's (2004) notion of involving assemblages of human and non-human actors within his framework for a representative, rather than liberal, democracy, involving `authorization, accountability, participation, deliberation, and resemblance`: authorization can occur primarily through voting, the decisive if temporary closure of deliberative process, and representatives may be authorized to represent moral constituents, such as ecosystems and future generations; accountability follows authorization in the traditional view, yet this can also be rendered as having to `give an account`, to justify, and to be held to account, an activity that lay people can engage in in relation to specialists; participation can occur through deliberation but also through voting, demonstrations, public media, consumer choice, passion, solidarity and other means; deliberation refers to the deliberative qualities of a system (see also below), and should be informed by expertise (`on tap, but not on top` (SPRAIN; CARCASSON; MEROLLA, 2014)) to give space for the development for mutual understanding between laypeople and experts; and, finally, resemblance refers not to statistical or likeness measures, nor even position, but shared perspective that can adapt to dialogue.

Other frameworks consider how science and policy can interact at a system-level conceptualization, rendering deliberative forums as one aspect of participatory ecosystems—diverse structures, such as the myriad ways in which governmental agencies communicate, links to civil society organizations, institutional conventions and mass-mediated deliberations, rather than single instances or mini publics (BRAUN; KÖNNINGER, 2018; ELSTUB; ERCAN; MENDONÇA, 2016). The deliberative capacity of the scientific and governmental ecosystem can be assessed, including:

resources, such as regulations, infrastructures, links to education, funding and improved participation skills; demand conditions, such as a culture of debate, the institutional development stage, technoscientific controversy, social capital, public education level, and saturation of a participatory market; related factors, such as NGO activity, networking among actors, and success case availability; and governmental strategies, such as strategies for participatory ecosystems, a history of deliberative processes, international pressure and competing national priorities (RASK; MACIUKAITE-ZVINIENE; PETRAUSKIENE, 2012). This can be applied at the institutional level, designing more reflexive institutions and supporting independent bodies to establish public debate and multi actor dialogues (HAJER, 1995), including the Chambers of Discourse concept—that discursive representation can be achieved in large institutions due to the limited number of social narratives around an issue. Constitutional change can provide a response, such as the allocation of public rights to knowledge and the allocation of responsibilities to government and organizations for social implications of their operations (ECKERSLEY, 2004). And, recalling Monteiro & Rajão (2017), scientific institutions themselves can also exhibit deliberative qualities in the way that projects are framed, designed and applied, with a focus on how this in turn contributes to a wider deliberative system (BERG; LIDSKOG, 2018).

Aiming squarely at fundamental assumptions behind contemporary participation literature, Chilvers & Kearns (2016) offer specific constructive (in both senses of the word) responses to their critique of residual realism: 1) publics are mediated and emergent, not methodologically mobilized; 2) publics are part of sociomaterial collectives that know and act in the world; 3) participation is experimental practice in the making, constructed, contingent, negotiated and emergent; 4) participatory collectives are coproduced, material and diverse, shaped by and shaping technoscientific and social orders, opening new meanings and configurations of engagement, including `material, embodied, visceral, private, everyday and mundane forms'; 5) the notion of relational ecologies, 'multiple, diverse, entangled and interrelating collectives of public involvement within particular political constitutions, systems or issue spaces', is pertinent; 6) reflexivity and humility are key qualities of successful participation, including reflections on openings, closing, frames and knowledge-commitments; 7) participation is non-linear and multiply productive, indivisible from distributed agencies

that constitute the sociomaterial order; and 8) participation is and always has been central to science and democratic politics, it is constitutive of science and democracy (p.50).

Across the critical accounts and responses in STS, environmental governance, democracy and development studies is a call for more investigation into how participation is happening. Given that different modes, meanings and contexts are dynamic and variable, the new generation of post-participatory turn approaches—both those that look at systems and manifestations and those that consider how participation and expertise are constructed and maintained—look to describe instances with an approach that is less restrained by previous researcher conceptions and more attuned to how actors and assemblages (re)constitute participation. Ethnographic descriptions alongside awareness of notions such as coproduction and boundary work, as in Chilvers & Kearns (2016a), can provide unique insights into how actors understand and negotiate their contexts. And, as mentioned in relation to Brown (2009) above, citing Latour (2004), attention to not only people but animals, objects and other non-humans can liberate researchers to engage in innovative empirical descriptions that include the material without resorting to explanations via predefined categories. ANT has been defined as:

> a disparate family of material-semiotic tools, sensibilities, and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located. (LAW, 2009 p.141)

And it has emerged as an important research paradigm for such investigations. The approach offers means to show how participation is produced in particular contexts without assuming it is restricted to certain processes, locations, languages, or actors, or that participation necessarily (fails to) attain any normative goals. As noted by Irwin (2006), `it is important to explore science-public relations in an open, empirical and symmetrical way`—i.e., whether successful or not in terms of expectations, examples of participatory processes are a phenomena to be studied in their own right. The following examples illustrate the range of ANT uses, providing suggestions and background to the later Methods section for this research in which it is presented in more detail.

Lockie (2004), in examining the Australian Landcare Movement, inquires into the way that agribusiness associate themselves and their products with sustainability but also normalize chemical use through `action at a distance` by providing information, interpretative frameworks, sponsorship and awards. These actions set expectations and

assumptions for participatory forums for farmers and conservation groups. As the Landcare Movement has been powerful in setting a more pro sustainability agenda, conservation groups have enrolled as participants and supporters; however, this has also limited conservation groups` ability to question the assumption of chemical use in farming. This description of a social movement illustrates costs and benefits to both membership and non-membership of organizations that promise to mediate the interests of people and nature. Competing translations of landscape as economic resource or visual value is taken up by Kitchen (2000) in describing landscape policy implementation in the Blackdown Hills in the United Kingdom. Different groups tried to `speak for` the landscape: generally, farmers who were concerned for use rights, described a living and working landscape, whereas local residents and tourists wanted to preserve a public good and visual resource. The Environmentally Sensitive Area designation at least temporarily enrolled both groups, tying payments to farmers for conservation farming practices. Networks of participants formed, then, around different roles, relationships and constructions of nature, illustrating its importance in social dynamics.

In ANT, networks are continuously evolving, stabilizing and collapsing, and the stability of a network depends on the negotiation and collaboration of human and non-human actors alike. Whereas the last example emphasises human actors, Callon (1984) examined the participation of scallops and fishermen in St. Brieuc bay in Northwest France. In his example, scientific researchers attempt to represent scallop fishermen as concerned for their environment and sustainability of their catch, scallops as interested in controlled reproduction, and themselves as in service of science and able to meet the objectives of all actors through a research program. While some scallops collaborate for a time by latching to new nursery structures, and the fishermen agree to delay catch in some areas, the network is undone as they both eventually negate their ascribed roles. Callon uses this to discuss the roles and risks of representation of people and nature alike: the scientific researchers take certain fishermen and scallops as representatives of their communities and act as representatives of them to their own scientific community in turn by representing the Scallops, Fishermen and scientists roles, interests and identities in conference presentations and papers.

Addressing non-humans as a participants in a social movement, Sepúlveda-Luque (2018) describes the unusual case of Valdivia in Chile, where swan deaths in a previously ignored wetland area provoked the largest political movement the city had witnessed.

‘Associations of swans and citizens’ challenged the installation of a cellulose plant that was suspected of illegally dumping waste into the wetlands, prompting a halving of the 6,000-swan population. Previous studies and data on the swans, as well as images, videos and media coverage multiplied. Eventually, the technocratic government`s approach to environmental licensing was itself challenged, prompting a change in national environmental policy. Sepúlveda-Luque (2018) uses the case to show that animals can have political agency beyond that ascribed to them by any particular movement or group, offering not only a shift in policy but a competing ontology in which environment, landscape and animals are recognized not as inert material but beings and actors in their own right.

Relating such an approach to mining disasters, Lockie (2007) considers that ANT can be used descriptively and normatively for participatory environmental licensing by enhancing social impact assessments of large dams. This is accomplished through examination of how categories are built and the ways that webs of humans and non-humans are mobilized in the process. Lockie suggests going beyond a push for more human participation to recognizing how the environment, impacted communities, institutions, and data are translated and accorded legitimacy differently in processes and forums—with attention to who speaks on behalf of ‘animals, plants, microbes and ecosystems that are, ultimately, just as critical to sustainable resource management as the people with whom they interact’ (p797).

The process of translation—of negotiation for common meanings and definitions—is described in relation to NGO and grassroots activist organizations around conservation, mining and indigenous peoples in New Caledonia by Horowitz (2012). Aiming to enhance the understanding of capitalist infrastructure, Horowitz recounts how local grass-roots organizations (GROs) presented themselves as spokespeople for victimized indigenous peoples and a precious natural environment in opposition to aggressive mining expansion. To do this, the GROs tried to render themselves necessary to all parties for access information, negotiation, and the formation of an indigenous representative body, Rhéébu Nuu. The indigenous group, however, enacted a different network of people, environment and mining, locating themselves as spokespeople of all indigenous communities—with the GROs in a supporting role—and in search not of ecosystem preservation at all costs but recognition and compensation for impacts. The mining company in turn attempted to sever the role of Rhéébu Nuu as spokesperson for all

indigenous people by bringing the group closer to formal forums and situate itself as provider of economic benefits and protector of the environment. In this way, Rhéébu Nuu became the most powerful player not only by enrolling, convincing and speaking for others but through strategic alliances. These alliances were made possible by actors adjusting their identity and interests sufficiently to garner support, yet these adjustments also risked the power of the original network to fight for environmental concerns.

Conclusion

While democracy and participation in environmental science and policy have become established as necessary to legitimacy, the original concerns for participation not only continue to present but have become more complex to deal with. The participatory turn cannot be considered a failure, given the shift in policy and practice it has provoked, yet it is also hardly a success given the weight of problems, and this is reflected in the Samarco Disaster recovery, where struggles over participation have born limited fruit to date. As all agree that participation is both necessary and facing fundamental challenges, new ways forward must be found. While returns to realist frameworks, although providing important questions, push the debate back to reasserting the legitimacy of expertise, other approaches look to understand how expertise, citizenship, technocracy and participation are continually reproduced across surprising locations and forms. As multiple examples of research based on ANT demonstrate, by loosening some of the original assumptions and frames behind the call for participation—by opening up to surprising dynamics, evolving coalitions of humans and non-humans including the environment—a greater foothold can be found and a new path seen. In the next Methods section, we consider how to approach the governance of the Samarco disaster recovery from the perspective of Actor Network Theory.

METHODOLOGY

Introduction

To recall, the central questions of this research are: 1) How has the environmental governance of the Rio Doce recovery developed around the question of participation? and 2) What can be learnt moving forward with both the Samarco and Vale disaster recoveries? The participatory turn has been largely effective in making the case for greater participation in science-policy and environmental issues. In Brazil also, partly as a response to Western demands but also to a unique internal context, participation has become embedded in discourse and policy. However, STS research on participation in the US and Europe has questioned that it can simultaneously meet multiple normative goals, occurs only in distinct formal processes, or can be easily defined across contexts. As noted by Irwin (2006) for the UK, more recently by Braun & Konninger (2018) for STS more broadly, and by Ehrenstein & Laurent (2016) for developing countries, empirical accounts that examine how participation is unfolding in practice are necessary: goals can conflict, participation can occur in a systemic way, and it can mean surprising things to different organizations and locations. Research methodology that is open, flexible and revealing is needed and Actor-Network Theory can provide this.

Actor-Network Theory was developed in the late 1970's and early 80s by Bruno Latour, Michael Callon, John Law, Medeleine Akrich, Annemarie Mol and others as a response to broader questions of how to render older philosophical questions open to empirical and historical inquiry. It has been defined as…

> …a disparate family of material-semiotic tools, sensibilities, and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located. (LAW, 2009 p.141)

ANT built on the work of the STRONG program (BLOOR, 1976), from which it adopted a central principle of symmetry: that, rather than explaining failed knowledge claims as a result of bias and successful claims as a result of the discovery of facts or truth, sociology should approach both successful and failed knowledge claims as caused by social factors—the resultant methodology avoided assuming a hierarchy of sciences, knowledge claims or actors. One of the first areas ANT was developed for was scientific-knowledge production in laboratories, employing an ethnomethodological approach to examine how scientists, devices, ideas, and writing rendered the natural world from samples into data,

new scientific facts and published papers (LATOUR; WOOLGAR, 1986). Their argument was that `the social, the economic, the political, the technical, the natural, and the scientific` should be approached in the same terms, rather than switching register or ontology or using social forces as explanations (LAW, 1987). Instead, it is assumed that there are only interactions between heterogenous elements that are more or less stable and that produce effects such as `power, fame, size, scope or organisation` (LAW, 1992).

Any element or actor (sometimes referred to as actant) is themselves a network of others. This is often hidden behind what appears as a unified author of action, such as an organization or computer, but that, when it fails or is closely examined, reveals a further web of elements. Instability, rather than stability, is assumed, and the problem of the researcher is to uncover the continuous work that goes into maintaining networks via the enrolment of actors into a particular translation of their identities, interests and roles. Attributes, whether to humans, animals or objects, are not assumed from the outset, requiring that the researcher show how actors circulate and distribute and adopt or discard properties, whether or not we would normally think of them as human or not. Objects can have traditionally human attributes and vice versa, a car may be compassionate and a human mechanical—`the stability and form of artefacts should be seen as a function of the interaction of heterogeneous elements as these are shaped and assimilated into a network` (LATOUR, 1996; LAW, 1987).

Because ANT provides only a minimal `infralanguage` or analytical stance with which to follow and describe phenomena, it is agnostic as to locations, forms, and meanings of participation and therefore an adequate approach to the demands of new research on participation. More than this, ANT is particularly adept at inquiring into ongoing, conflictual, bounded and public controversies (VENTURINI, 2010). As noted, examples include analysis of: power dynamics in social movements for conservation (HOROWITZ, 2012), the representation and participation of nature and humans (CALLON, 1984), animals as participants in local development and environmental policy (SEPÚLVEDA-LUQUE, 2018), and mining licencing processes as deliberative actor-networks of human and environmental concerns (LOCKIE, 2007).

Methodology

There are many variants of ANT; here we apply the model put forward by Callon (1984) in his description of scallops, fishermen and scientists in St. Brieuc bay as it offers the

useful notion of an `Obligatory Passage Point`, described below. In the example, the scientists attempted actor-network moves through stages that can overlap:

- `Problematization` produces questions or frames that imply particular entities with a common goal. In this case, the apparently simple and scientific question ‘do the scallops anchor?’ implies scallops and fishermen that have a common concern with better scallop reproduction and scientists able to advance knowledge by pursuing the research question. In their problematization, the scientists render themselves an Obligatory Passage Point, a point in the network that all actors must pass through to achieve their goals. An illustration of the OPP from Callon’s paper in shown in Figure 5.

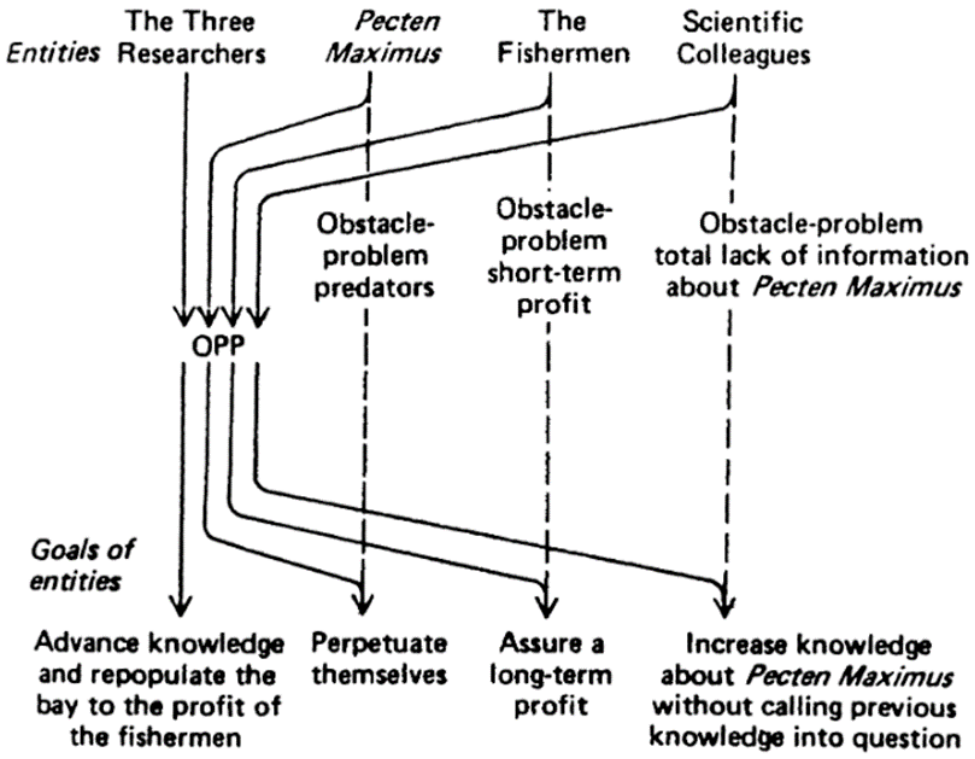

Figure 5. Problematization by the scientists in St. Brieuc bay, rendering them an Obligatory Passage Point (CALLON, 1984)

- A second stage, `interessement`, tests the proposed relationships: the actors can submit, negotiate, or reject the actor-network by defining themselves differently. Importantly, roles and identities are ‘translated’ at this stage in a compromise, and

actors participate via necessarily losing connections to other entities in an ongoing negotiation, as aligning with one identity implies negating another. The term translation means a 'mechanism by which the social and natural worlds progressively take form' (p.75), that is, how actors are defined and associated by a 'spokesperson'—someone who claims to represent other actors—and remain faithful to their alliances (or not). Representatives rather than entire communities may be involved in translations, and there are often several competing centres of translation, creating instability. In Callon`s example, *interessement* is the stage where the scallop collection devices test the scallop's ability to anchor and the fishermen's willingness to suspend catch for some time in the area.

- `Enrolment` refers to the success of the *interessement*, the various actors perform their roles, when the scallops anchor to new devices and the fishermen suspend catch, although this is always fragile and subject to change, requiring constant work to maintain.
- Finally, `mobilization` occurs, the network is transported to and displaced in different locations, with actors substituted by representations. In the example, the scientists act as representatives of all actors in the network in scientific conferences via graphics and numbers that displace them. This brings at least temporary closure to the network in which the 'fact' that scallops anchor is produced (though this is later disputed in the account).

Further useful terminology is available. A `Black box` refers to a system, object or device where its inner workings are disguised, such as the internet, where only inputs and outputs are known. In the above example of Lockie (2004), chemical agriculture was intentionally back boxed, rendering its mechanics hidden and its appearance natural. An `intermediary` transports the force or meaning of another actor without altering it, simply passing it from one actor to another, e.g., a certificate or administrator as they approve a decision made elsewhere. Scientists can claim to be an intermediary for the environment, for example. A `mediator`, in contrast, translates, distorts or changes the meaning or elements they transmit. It may not be easily known if an actor is an intermediary or mediator. If an actor is a means of enrolment in a network, this is an `inscription`—the network is embodied in a durable material, such as a policy or technology. A table of terminology is provided below in Table 2.

TERM	DESCRIPTION
Actor/actant	Human, animal or object in the network
Problematization	Problem or frame that implies actors with a common goal
Interessement	Testing and negotiation of the actor's roles and identities
Enrolment	Actors perform their roles and identities
Mobilization	The transportation or displacement of the network to other arenas, as in through a presentation
Translation	The definition and association of actors
Spokesperson	A representative of a given community of actors or network
Black Box	Actor whose operation is hidden or frozen and often difficult to alter
Intermediary	Passes unchanged meaning between actors
Mediary	Distorts or translates what is transmitted
Inscription	Actor that embodies an actor-network, including documents and materials

Table 2. Key Terms in Actor-Network Theory (CALLON, 1984; LATOUR, 2005; LAW, 1987)

Methods and Analysis

Although the ontology of ANT states that networks are infinite, within a research method, some decision must be made to make a limited account feasible; this is called `cutting the network`, meaning that the number of actors and connections is limited while acknowledging that there are further levels that might be explored. This research involved a restricted topic and network. As mentioned, various definitions of participation are available. As the most open analytical stance is desired, the minimal operational definition of van Deth (2014) is employed where participation is: (i) action or activity that

is (ii) voluntary or optional and (iii) undertaken by non-professionals (iv) within the locus of politics, government or state.

The chosen limits of the network respect this definition in that the locus of politics, government or state is taken to be the formal governance structures in the major policy agreement, the TTAC, and the subsequent Renova Foundation, both of which were partially formulated and executed by the Brazilian Federation and the states of Minas Gerais and Espírito Santo, with the involvement of multiple municipalities and state agencies. The relevant non-professionals undertaking voluntary activities in relation to this governance structure are referred to as the Affected (*os Atingidos*) or Impacted (*os Impactados*). These came to be defined in the TTAC as 'physical or juridical people, and their respective communities, that have been directly affected by the event' through loss of, for example, significant friends, family and others, property, productive capacity, possibility to fish, income, natural resource access and management, physical or mental health, or mode of life (TTAC, 2016 cl.II.2). The success of the TTAC & Renova network implies alignment of human and non-human actors, such that the mining companies, state, MP, Affected, participatory processes, the Rio Doce basin, rivers, forests, etc., perform the roles ascribed in their translation in enrolment and mobilisation. This research describes the work that goes into the attempt.

As well as evolution of the TTAC and Renova Foundation, this researcher took part in the Reforestation Prioritization Modelling Project in the Rio Doce Basin. The project was a collaboration between the Federal University of Minas Gerais (UFMG), the Federal University of Viçosa (UFV), and Renova Foundation that applied software modelling to prioritize reforestation in the Rio Doce Basin based on a range of secondary social and environmental data during 2018. The collaboration involved the Rio Doce River Basin Committee (CBH-Doce) and the Technical Chamber for Forest Restoration and Water Production (*Câmara Técnica de Restauração Florestal e Produção de Água*) (CT-Flor). This researcher was a grant-receiving project assistant during 2018, taking part in data-processing, meetings, and one of five participatory workshops in the Rio Doce to present results and take feedback. Participant observation, interviews, and policy visual material analysis for the Reforestation Prioritization Project provide insight into an example of the participatory processes occurring within the wider governance context. The project, again restrained to formal process as mandated in the TTAC, executed by Renova, and in

relation to the Affected, is treated as its own attempt at translation of the identities and needs of scientists, institutions, the Affected, the environment and participation.

The methods and analysis for ANT often appear much like an interpretative case-study or ethnography, with heterogenous sources and analysis types adapted to context to produce narrative accounts (LATOUR, 1987; YIN, 2018). Table 3 provided below shows data sources, analysis and rationale.

DATA SOURCE/COLLECTION	**ANALYSIS**	**RATIONALE**
Policies: TTAC, TAP, TAP Aditivo and TAC Gov. The policies are publicly available.	A guided content analysis (HSIEH; SHANNON, 2005) was undertaken via software coding in Atlas.ti Cloud.	The software provided means to look for connecting themes across multiple policies and provided foundations for interview questions.
Media and Documents: Organisational webpages (e.g., Rio Doce River Basin Committee, Renova Foundation, Samarco), company reports, national and local news coverage.	Guided content analysis in relation to policies	The TTAC and Renova Foundation form the centre of the network, so media and documents were considered in as much as they were linked to and revealed this network.
Notes taken during Participant Observation of Reforestation Prioritization Project.	Notes were summarised and reviewed. Queries were checked with team members.	The participant observations are an important inside look at decision-making, materials, and practices. Note taking and query confirmation provide

		some assurance of fidelity.
Recording of Reforestation Prioritization Workshop presentation August 2018 made on TASCAM DR-40. Notes on conversations with participants.	Notes at the time and then using the recording.	The workshop provided direct insight into local participatory practice. Recordings and notes at the time assured fidelity.
Reforestation Prioritization Project workshop materials: PDFs, PowerPoints, posters	Visual content analysis	ANT approaches materials as important actors in the network
Open-question, semi-structured interviews with 1) a high-level Renova Foundation manager, 2) the lead Public Prosecutor for the MP taskforce for Mariana and Brumadinho, 3) the director of the Rio Doce River Basin Committee, and 4) a scientist and 5) the Renova Foundation lead from the Reforestation Prioritization Project. Recorded on a TASCAM DR-40. Some follow up questions were communicated by email.	Interviews were noted at the time, then using the recordings in Word, and reviewed.	The research is topic focussed, requiring some structure, but ideally the actors should speak for themselves to reveal the network. Selections were made on the basis of relevance, availability, willingness, and diversity (as diverging accounts can be more revealing in ANT).

Table 3. Data, Sources, Analyses, and Rationale

The initial categories for the guided content analysis were: social (accountability, justice, inclusion, social learning) and pragmatic (accuracy, efficiency, implementation) norms for participation from the literature; discourses regarding participation and expertise; environmental actors, such as the Rio Doce Basin; institutional actors, such as state or private institutions; other actors, such as traditional peoples and the affected; Renova

Foundation elements, such as CT-Flor and the CIF; and the brief for the Reforestation Prioritization Project. During analysis, categories were extended to further impacts (e.g., Water System Impacts), Participation Mechanisms, Exclusion Practices, other social norms (local Engagement, dialogue, and accessibility), Legal Process, and discourse on Technoscience.

Interviews were undertaken using an interview protocol that included a data usage permission form, subject details, and initial guiding questions about their view of themselves and their relationship to the TTAC and Renova Foundation and how they saw the evolution and status of the network using natural language (rather than ANT terminology). All data were securely stored on a password protected Windows 10 PC with password protected OneDrive backup in a dedicated folder structure.

Observations and Limitations

Typical limitations include limited researcher time and capacity in a highly complex context. Added to this, the researchers native language is English and not Portuguese, although he is fluent and has lived for several years in Brazil; in order to assure understand, the recordings were carefully reviewed, interviewees were available for clarifications, and the supervisor, whose original language is Portuguese, was also fluent in English and accessed for support.

As the interviewees have a stake a still-unfolding controversy, it was quite possible they intentionally or unintentionally misled the research with the understanding that the research itself may serve as an inscription or disruption to reinforce or undermine evolving networks. Yet, this is not viewed as a particular problem when interviews are considered as, as with other actors, attempts to problematize, enrol, translate and mobilise actor-networks; in fact, that an interviewee considers the interview an opportunity is a motive for them to reveal more of their own translation of and relationship to the network (DANKERT, 2011).

Participant observation as a collaborator in the Reforestation Prioritization Project brings both benefits and risks. Participant observational notes and experience enhance the study through close-up participant-observer examination of the process and the position provides otherwise unavailable access to people, information and understanding; the risks include bias, conscious or unconscious, towards subject framings of the case, subject self-editing in meetings due to knowledge of the researchers dual position, and conflict

between the researcher and participant demands (YIN, 2018 p.167-169). Due to limited time and resources for this research that restrict the possibility of a focus group or other external form of validation that might counter the risk of epistemological or other biases, the only forms available are multiple sources and triangulation between them, self-reflection on possible blind spots, and rigorous linking of analysis with evidence and reasoning.

In regard to acknowledging conflicting interests or demands, the researcher can state that direct involvement in the project in question is complete as of 2018, which, though potentially reduces recall, greatly reduces risk of immediate conflict. Relevant also is that the project team-leader is also the research supervisor, and so care has been taken to interview a variety of sources with divergent views and lay out reasoning in a transparent way.

A more fundamental criticism of this 'entrepreneurial' style of ANT is that, in comparison to more ecological variants, it centres on attempts by often-powerful individuals or small groups of people to enrol networks in a competitive scenario. As attention is paid to the central players and their respective networks, marginal voices that are not considered to have impacted the network are therefore potentially left voiceless in the account (GHERARDI; NICOLINI, 2005). Indeed, this research, while highlighting issues of participation of those considered to be Affected, as defined in the TTAC, did not interview anyone that might be considered Affected. The actor-network was restricted to that relating to the formal governance of the disaster, and this act of exclusion certainly leaves multiple important networks out of focus. However, that is not to say that issues of power are not engaged with—rather, the limitations of the Affected's control in comparison with their ascribed roles are explored as an important part of the account. This will be further considered in the discussion.

ENVIRONMENTAL GOVERNANCE IN THE POST-DISASTER RIO DOCE BASIN

We consider here the TTAC and Renova Foundation as an attempted Obligatory Passage Point as part of a network created through the negotiation of multiple interests in the post-disaster context. The mining companies' incentive to recover image and limit costs, the government interest in transferring responsibility, and the state agencies that likely fragmentated the recovery will be highlighted. An example of a socioenvironmental project and participatory process, the Reforestation Prioritisation Project will be presented and analysed, suggesting an important relationship to the TTAC & Renova network. We then consider the TTAC & Renova network in the light of a crisis of representation that has led to new agreements, experts and participatory forums. The analysis provides for conclusions regarding boundaries between the technical and political, risks to future stability, the role of expertise, and the connections to the Brazilian civic epistemology.

The TTAC and Renova Foundation as an Obligatory Passage Point

To understand the story, we must return to the start and sketch out the options on the table immediately after the disaster, with some speculation as to the interests and possibilities in play—though, there is no point in making comparisons to extremely unlikely counterfactuals (FERGUSON, 2011). As recalled by Zhouri et al. (2016), there has been a broader pattern of moving from judicial and criminal procedures to extra-judicial agreements in environmental disaster scenarios. This has taken place in part as the urgency of the situation renders lengthy and disputed legal procedures a threat to social and environmental recovery, ironically offering those responsible some leverage to offer reduced, up-front payments, and demonstrating the weakness of the policy environment. The companies' interests lay in both avoiding long-term and high-impact financial claims, as in the Deep Water Horizon disaster (REUTERS, 2018), and the chance to redeem their public reputation. Before the disaster, and despite the then existing critiques, Samarco had a relatively good reputation for working conditions and the environment (RUFINO; SILVA; LUCENA, 2019); as such, the possibility was present that this reputation could be regained, the disaster considered a one-off event, and the companies at fault considered responsible for mitigating and compensating the damage. As confirmed by the Renova

Foundation manager, the state, in the form of the Ministry of the Environment (MMA) led by Izabella Teixeira, at a moment of broader political crisis with the impeachment of the then president Dilma Rousseff, faced an unprecedented situation and some choices: (i) enter into lengthy and perhaps futile litigation, risking massive state costs for recovery and/or loss of reputation; (ii) fine the mining companies an amount adequate for the disaster but so high for the companies (the MP initially sued for R$155 billion) it would risk bankruptcy that would make funding of the recovery impossible as in other disasters; (iii) the mining companies pay a fixed immediate fine, lower than that might be achieved in long-term litigation, and pass responsibility to the state, perhaps through a Foundation; (iv) the mining companies take charge of the recovery directly, as Samarco had begun to do, risking substantial public trust issues and further damage, as well as outcry from civil society; or, as was the case, (v) some hybrid entity of state and mining company would be created. This last choice had the potential to: maintain recovery investments by holding open the possibility that the mining companies restart operations, offload state responsibility while engaging state supervision, and offer the mining companies the chance to recover their public image. Of course, we can consider another possibility, that the mining companies paid and continued to pay whatever was deemed necessary by the state to complete the recovery without any oversight or involvement, but we can assume that Samarco, BHP Billiton and Vale would prefer to enter litigation with a view to paying less or fold, as they rejected the MP suit.

As evidenced by multiple media and company reports (e.g., Mascaro & Mascaro (2016) Samarco (2016), Grupo Força Tarefa (2016)), in the post-disaster context, multiple actors had incentive to align with the state and mining companies' mutual problematization of the situation as requiring immediate and coordinated investment and action via a new hybrid agency. The Affected had lost friends and loved ones, homes, land, services, jobs, and ways of life; they needed not only immediate and ongoing socioeconomic support, but justice and reparation. The rivers, forests, vegetation, and species had suffered partial destruction and needed immediate and long-term work to continue, clearing mud from waterways, restoring vegetation, saving and protecting species. The long-term condition of the basin as abused, degraded, and ignored by successive governance arrangements was only exacerbated. For both Minas Gerais and Espírito Santo, affected municipalities, and multiple federal and state level environmental and social agencies—entities already limited in capacity and resources—multiple pressing demands were coming from a range

of sources, confounding information access and coordination. The Federal government, also poorly funded, had to attempt to ensure the recovery, or at least maintain a national and international image of responsive governance under fire for shared responsibility for the disaster (e.g., UNHCR (2015)). Civil society groups clamoured to become involved and campaign for and organize specific actions. And the MP sought to protect human rights in the recovery, as it had done in various other mining-related activities. Given the range of pressing needs, historic, immediate and long-term, pressure was in place to organize around them. An illustration of the major actors, their problems and goals is displayed in Figure 6.

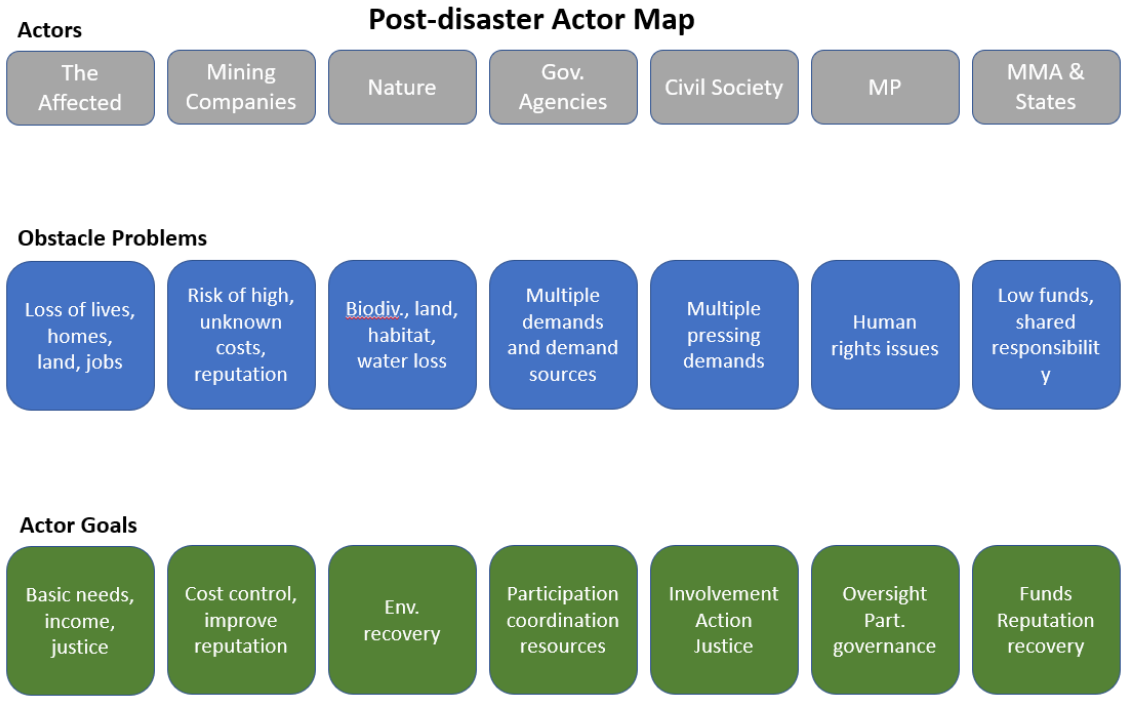

Figure 6. Post-disaster map of major actors, problems and goals

At this point, a pre-existing characteristic of the network came into play: within Brazilian law, the mining companies and state had the capacity to enter into an extra-judicial agreement in respect of the disaster that did not require the signature of other actors, merely the approval of a judge. Taking advantage of this, as well as the range of pressing interests, the problematization produced by the Federation, states of MG and ES, and the mining companies translated everyone`s interests as favourable to the formation of a new network with a new agency as an OPP that rendered government and mining companies as essential. Many of these actors, while distant from the Affected, both in terms of

geography and network proximity, located themselves as spokespeople for them and necessary to their assistance. In the act of (attempted) translation into a network, however, actors' identities and interests are inevitably adjusted and compromised. This can be through coercion, an act of the powerful to decide and engage others on certain terms, through acquiescence, perhaps due to low risks or costs, or through negotiation, in which multiple actors compromise or adapt their original interests to enter in a new arrangement. Although the legal possibility of creating an extra-judicial agreement was open, work was still required to assure the collaboration of the actors and relationships inscribed within it. With the necessity of a new Foundation established, the phase of *interessement* began, the development and adaptation of devices by the mining companies and the MMA that could enrol the multiple actors necessary to success.

The Federation and states, with shared responsibilities for the disaster and the reparation, as well as limited funds and parallel crises, encountered the possibility of having their identities as guarantors of democracy and protectors of the people be adhered to, while offloading direct responsibility, protagonism, and funding for the reparation. This appears as a likely motive to render the mining companies ultimately responsible, giving them 6 out 7 Board of Director positions, whilst generating a web of devices nominally proposed to hold them to account to the state. Here, the vulnerability and urgency of the environment and the Affected were reinforced as motivations of the state and mining companies to avoid judicial process. With the legitimacy of the agreement at stake, participation was emphasised as a fundamental motivation along with 'innumerable' governance devices that would supposedly assure it, as in the TTAC Technical Note:

> this model of governance…proposed by the public authority…appears to represent the best way to combine speed in execution (a Private Foundation), guarantee of fulfilment of the [mining] businesses` responsibilities…, preservation of the public interest…and transparency and social participation (due to innumerable devices present in the Agreement, such as the Advisory Board, participation of the affected in the Interfederative Committee, disclosure of information about execution, guarantee of negotiation with the affected, among others). (TN.6)

The primary means of accountability was and is the Interfederative Committee (Commité Interfederativo) (CIF), proposed as external to and independent from Renova Foundation and 'formed exclusively of representatives of public authorities', without replacing any

of the competencies or responsibilities of the organs represented, such as those of environmental licencing. The official role of the CIF is that of 'permanent interlocution with the Foundation, accompanying, monitoring and supervising its results', including working with the relevant environmental bodies, and it is bound both by the TTAC and its own statute, approved by its members (TTAC cl.242). If there is any persistent divergence between the Foundation and the CIF, the TTAC provides that this is taken to the Specialist Advisory Panel (see also below), and then, if it continues, to the judiciary. Should Renova Foundation or Samarco and its shareholders fail to meet their obligations in the TTAC, the CIF is to `formally communicate` this with them so that they are aware and can respond or justify the failure (TTAC cl.247). If the failure is persistent, the CIF has the power to impose fines on Samarco by way of an absolute majority, subject to adjustment by the judiciary (TTAC cl.249). It is also the CIF that attests to the completion of the programs, thereby authorizing the eventual closure of the Foundation (though we consider the substantial role of experts in this later) (TTAC cl.6.XXVI).

The CIF was originally made up of: 1-2 representatives of the MMA, 2 other representatives of the Federal Government, 2 representatives for each affected state, Minas Gerais and Espírito Santo, two representatives of the affected municipalities of Minas Gerais, one representative of the affected municipalities of Espírito Santo, and one representative of the Rio Doce River Basin Committee (*Comité da Bacia do Rio Doce*) (CBH-Doce), a distinct actor-network in itself involving multiple representatives of social and natural entities across the basin. State and municipal representatives are chosen by the states, the MMA selects its own representative from its executive arm, the Brazilian Institute for the Environmental Renewable Natural Resources (*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis)* (IBAMA), and the Federal Government representative is selected by the chief minister of the Chamber of the Presidency of the Republic. The member for the MMA acts as president, submitting the statute for approval, and the body acts via a simple majority with a quorum of two thirds of the members and the president with a deciding vote. The TTAC provides that the CIF create 'Thematic Chambers' (*Câmeras Temáticas*) that were later instantiated as 'Technical Chambers' (*Câmeras Técnicas*) (CTs), made up again of public entities in respect to their competencies as necessary in order to provide 'technical' support for decision-making (TTAC cl.244). Thus, the identity and roles of the MMA and all three levels of government were enrolled into the CIF, an essential body capable of representing

society, the Affected, and the environment in the supervision of a recovery to be executed by the mining companies.

Beyond the states and Federation, and at risk of creating substantial resistance rather than collaboration, a long list of state agencies appear to have been enrolled via the chance to contribute to program construction, take part via the Technical Chambers, and receive resources (TN.9). For this, they are cast as 'representatives of society' and enhance the TTAC's legitimacy via their involvement as such. The 41 programs clearly communicate the interests of a range very different social and environmental concerns. A few examples are provided here to illustrate the diversity of stipulated activities, on the socioeconomic side: historical, cultural and artistic memory registration and recovery, including archaeological projects (TTAC cl.8.III.b); assistance to animals (TTAC cl.8.I.g); research into `socioeconomic technologies`(TTAC cl.8.V.a); the reintegration of schools (TTAC cl.8.III.a); and a mental and physical health program (TTAC cl.8.IV.a). On the socioenvironmental side: the recovery of 5,000 springs (TTAC cl.15.II.c); biodiversity conservation (TTAC cl.15.III); consolidation of Conservation Units and strengthening of the Rural Registry (CAR) and Environmental Recovery Plans (PRAs) on properties (TTAC cl.15.VII); and waste and water supply management improvements (TTAC cl.15.IV).

With government and state agencies granted roles and access to resource governance, the Affected—the central legitimation of the new OPP—had to be enrolled too, albeit by making some assumptions about how they might prefer their involvement to take place or identity established. It is for the Affected more than any other actor that participation, in various forms, is discursively proposed as the means of ensuring their consent and the claim to represent them. The Affected (sometimes `the Affected`, *os atingidos,* sometimes `the Impacted`, *os impactados*) are defined by the TTAC as 'physical or juridical persons, and respective communities, that have been directly affected by the event' due to loss of partners, spouse or family up to the second degree, cohabitees or relationships of economic dependence, proven loss of property, loss of productive capacity, fishing capacity, income work or self-subsistence, loss of natural and fishing resource management including on public land and for subsistence, physical or mental health impacts, and 'destruction or interference with communal modes of life or the reproductive conditions of sociocultural and cosmological riverine, estuarine, traditional and indigenous peoples' (TTAC cl.1.II). A cut is then made, where the 'indirectly affected'

are those that reside in the affected area, also predefined in a list of municipalities, and ‘suffer limitation in the exercise of their fundamental rights’ due to the disaster’s ‘environmental or economic consequences’, for whom access to information, ‘participation in community discussions’, and ‘access to public equipment resulting from the programs’ is granted (TTAC cl.1.III).

The TTAC claims as central…

> …the possibility of the affected to effectively participate, be heard and influence at every stage and phase arising from the present agreement, in the planning phase as much as in the effective execution of programs and actions referred to in this agreement, to be assured in a collective way, following methodologies that permit individual expression and participation, in the terms of this agreement. (TTAC cl.11)

The frequency with which it is mentioned (37 times) is at least matched by an emphasis on its albeit underspecified intended roles in both planning and implementation, as the TTAC itself becomes an inscription that claims to represent the will of the Affected to participate. For example, it is taken that an `organizing element` of the agreement is `Effective participation of the affected such that they are given opportunities to be heard and influence planning and execution of programs` (TN.12g); and the Technical Note ‘highlights the participation of the affected population in the planning and execution of recovery measures foreseen of the public authority in the validation of Foundation decisions and in the monitoring and supervision of results’ (TN.20). However, and as confirmed in interviews regarding the discussion leading up to the TTAC, the goals of participation, whether social or pragmatic, or simply that of legitimisation, were not discussed or assigned. The resulting ambiguity was destined to contribute to substantial conflict.

Claimed intentions with underspecified means continue, as the preamble defines the range of actors that can be considered as Affected and marks the `need to secure for the impacted, including physical and juridical persons, communities and organized social movements, social participation in the discussion and accompaniment of the actions laid forth in the Agreement` (p.5). Yet space for those in the river basin to make claims to be or represent the Affected is severely limited. The target of a major critique, specific references in the TTAC in relation to participation included the Coordinated Negotiation Program, set within the Program for Reimbursement and Indemnity of the Impacted in

Subsection 1.2. and expected to be `just, rapid, simple and transparent` (TTAC cl.10.; TN.12.f). This was to occur via voluntary (TTAC cl.34) negotiation where reparation was not possible (TTAC cl.31). Who counted as Affected and what counted as impact was left to the Foundation to define and submit to the CIF (TTAC cl.34) with negotiation to be carried out in locations that 'facilitate access and participation of the impacted'(TTAC cl.35).

If considered to be of the Affected, the major formal means of participation is partial presence via an Advisory Board (*Conselho Consultivo*) capable of offering non-binding opinions and solutions on plans, programs and projects, hearing legitimate associations for the defence of the rights of the impacted, as well as establishing channels of participation with civil society (TTAC cl.217). It is made up of 17 members: 5 of the Rio Doce River Basin Committee, 2 for the Interministerial Commission for Sea Resources (CIRM), 5 representatives of teaching or research institutions with notable knowledge (indicated by the MPF, Public Ministry for Minas Gerais (MPMG), MPES, Board of Trustees and CIF), and 5 representatives of impacted communities (3 for MG and 2 for ES) selected by the CIF (TTAC cl.219). We can observe here the first divergence between rhetorical commitment to `influence at every stage` and mechanisms through which this might occur: the Affected—defined by the TTAC and new Foundation and their representatives approved by the CIF—can 'discuss' and 'accompany' the actions laid out, with the major forum in which they participate capable of 'non-binding' opinions.

Also inscribed in the network by the TTAC as a distinct entity was 'society' or the 'public interest' that is served by transparency and information access, thereby rendering Renova Foundation accountable. This ranges from the more active case of an environmental education program in the area around the dam (TTAC cl.172) to broader aspirations, such as `transparency and engagement with communities' (TTAC cl.7b), a guarantee to access information (TTAC cl.9.III), such as rights and programs (TTAC cl.26), and 'ample, transparent, complete and public information, in accessible language, adequate and comprehensible to all interested, as a necessary condition to enlightened social participation` (TTAC cl.60). The modes of disclosure include periodic thematic panels (TTAC cl.63), an interactive platform (TTAC cl.65), a question-and-answer manual and press releases (TTAC cl.67), annual events regarding accounting and actions in all regional bases (TTAC cl.63), and public consultation for all programs to be provided online (TTAC cl.69).

Many of these items are within sub section 1.6 Program for Communication, Participation, Dialogue and Social Oversight, which also mentions involvement and dialogue as aspirations. For example, the elaboration and execution of programs and projects should, `as a general rule`, consider `transparency in actions and involvement of communities in discussions of measures` (TTAC cl.5.XIV.a) and `dialogue between the Foundation, the CIF, and the impacted` (TTAC cl.5.XIV.f). There are to be `permanent channels of communication and interaction with society in fixed or itinerant spaces`, including a `permanent dialogue and negotiation table`, and `dialogue spaces with the communities` (TTAC cl.64) , though dialogue is not defined in distinction to, for example, simply presenting information. The above noted divergence between rhetoric and mechanisms is maintained here: while information about the recovery will be available and the Affected listened to, that this could result in the Affected influencing the recovery is implied but not guaranteed. These, then, are the translations of the roles and interests of Society and the Affected by government, state agencies and the mining companies. Their interests served by communication and forums without mechanisms of control. Their role is to provide a legitimacy-giving witness—essential justification for the new OPP and a possible threat to its future stability if not involved—but incapable of defining themselves or making decisions about the recovery. Society and the Affected's interests will be faithfully intermediated by the wealth of public agencies offering oversight on their behalf whilst rendering those agencies indisputably essential to the recovery.

Among those known as the Affected, an important group with its own state agency, Indigenous People, have their identities set out as…

> …culturally differentiated groups that recognise themselves as such, that have their own forms of social organization, occupy territories and natural resources as a condition of their cultural, social, religious, ancestral and economic reproduction, using knowledge, innovations and practices generated and transmitted by tradition (TTAC cl.51)

Sub section 1.3 describes the Program for Protection and Recovery of Indigenous Peoples Quality of Life, which is linked in the Technical Note to Convention no.169 of International Labour Organization (ILO) of Indigenous and Tribal Peoples (ILO, 2003 ;TN.21), legislation that itself guarantees a broad range of rights including participation, self-management, and natural resource management. Specific indigenous peoples are mentioned in the TTAC, such as the Tupiniquim and Guarani (TTAC cl.44), within the

Krenak territory, and the indigenous lands of the Camboios, Tupiniquim and Caieras Velhas II (TTAC cl.39). The program is to be `constructed` with the indigenous, and `consultation and participation` of the indigenous people is to take place via `mechanisms` in all phases of this program (TTAC cl.39). The National Fund of the Indian (FUNAI) is given a role in negotiation and validation (TTAC cl.41), as is the Special Secretary for Indigenous Health of the Ministry for Health (SESAI), in respect to their competencies (TTAC cl.42). This is complemented in sub section 1.4, the Program for the Protection and Recovery of Other Peoples and Traditional Communities Quality of Life. While the definition of Indigenous People is provided by the TTAC, program co construction and mechanisms of participation are certainly desirable and commendable, yet they remain under-defined—if there is a conflict, who decides and how? More fundamentally, if Indigenous Peoples are indeed as connected to the territory and natural resources, if they have knowledge, innovations and practices based on this relationship, it is far from clear that these have contributed to the landscape inscribed in the TTAC.

On the other side of the major divide in the TTAC between the `socioeconomic` and the 'socioenvironmental' programs, the natural environment is characterized in number of ways, primarily in anthropocentric terms and only in relation to the pre disaster scenario in which mining already damaged and limited access to it. The Affected have the `right to enjoy an ecologically balanced environment…within public policy standards…with regard to the previous situation` (TTAC cl.14). Again, likely as testament to the involvement of state agencies, this implies recovery and mitigation for abstract and scientific entities, including for human use, such as ichthyofauna along 680km of rivers, water quality, water supply (especially for agricultural production), vegetation, areas of ichthyofauna reproduction, trophic cascade impacts, gene flow between water bodies, species of specific habitat, structure and function of ecosystems, and fish stocks for dependent river populations (TTAC preamble p.4). The resulting programs for hydric and environmental security, biodiversity conservation, forest restoration (see also below) and water production reinforce the environments identity and role as human property and resource, economic production and services, and subject to rational measurement and management. The suggestion that the Affected and Traditional Peoples` environmental ontologies may be various, differ from, or have alternative implications for recovery to this primarily reductionist-scientific one is not encountered, illustrating the power of the TTAC to inscribe some meanings of participation and render other forms both disguised

and restrained. The actors that ensure the legitimacy of the TTAC cannot define themselves, nor can they stand as spokespeople for the environment on which they depend.

Recalling the major actors at the table and the broad range of distinct interests that have moulded the TTAC and future Renova Foundation, the effort to engage the Affected and Society on vague and hopeful terms can be contrasted with a substantial consensus on the need for distinct mechanisms by which 'experts' will be involved. They are presented as intermediaries, i.e., actors that can faithfully transmit the identities and needs of other actors, including the environment, and defined as

> …physical or juridical persons, or groups thereof, legally established and contracted by the Foundation for management, evaluation, elaboration and/or implantation of programs and/or projects, total or partial. (TTAC cl.I.XXI)

There is a later caveat that they should have `notable experience` in any areas they work in (TTAC cl.185), and, beyond experts, non-profit teaching and research organizations with `recognised competency` are eligible to be contracted (TTAC cl.5.XI). Although the names, descriptions and some directives of the 41 programs are defined in the TTAC, their eventual definition, as a point of operational principle, is intended to be based on impact assessments undertaken by experts (TTAC cl.6), with the condition that the Foundation and experts consider `available technology, current methodology and public policy standards` (TTAC cl.5.XII). This is so that they have a `scientific basis` where possible for the sake of `proportionality` and `efficiency` (TTAC cl.6.II) via studies, diagnostics, and identification of measures for program execution (TTAC cl.4.X). This is repeated for: the `definition of compensatory measures` by `expert studies`, to be approved by the CIF in collaboration with environmental and river basin bodies (TTAC cl.149); annual plans to be based on expert studies (TTAC cl.188); `technical studies` to define the people, businesses, families and communities that may enter the Loss Register (TTAC cl.22); and the limitation of the preservation of that with historic, archaeological or artistic value to those items inventoried or protected by the responsible government organs and classified as affected by the event (TTAC cl.95).

Within the Technical Chambers, experts are expected to be present, as within the CIF itself, and the Advisory Board (five representatives chosen by CBH-Doce—a somewhat participatory environmental-management body—and five `representatives of teaching

and research institutions or specialists with notable knowledge`) (TTAC cl.219). The ultimate internal point of conflict resolution between the CIF and the Foundation was to be the Specialist Advisory Panel of 3 experts (TTAC cl.188) (though according to interviews, this has failed to function). This panel would be available at any time to produce a `technical report` about the divergences and to provide questions regarding good practice in applicable Brazilian legislation (TTAC cl.246). Accountability, while often mentioned in the literature as an objective of participation, or in the case of the Foundation occurring primarily via the CIF, is often explicitly linked in the TTAC to `independent auditors`, with the largest four operating in Brazil suggested. Samarco and its shareholders have the right to audit the Foundation `at any moment` (TTAC cl.223), while the MP will also regulate the Foundation (TTAC cl.224). The definition of responsibility on the part of the Foundation does include `any action or omission by the Foundation, employees, the companies and experts` (TTAC cl.248) at least. Yet, when it comes to deciding new measures and actions beyond the agreement, these should be `technically justified`, and whether a program or programs may be considered complete is to be based on independent audit and CIF validation with `the relevant competent organ or entity` based on `objective demonstration supported by technical indicators and data, where applicable`(TTAC cl.195).

The narrativization of negotiations to build the Foundation and programs is coherent with the TTAC`s mixture of rhetoric and mechanisms, being described as collaborative, participatory, and expert led. Beyond the presentation of number and variety of contributions and contributors, there was `dialogue` with public and private institutions, NGOs and `international organizations`, `specialist contributions` were made, and `many meetings` involving the listed bodies took place. The initial contribution of Minas Gerais that laid the ground for the TTAC `contemplates` the `listening process` with the affected population by way of a `State Table of Dialogue and Negotiation` with meetings undertaken in Mariana, Barra Longa, Governador Valadares and Resplendor (TN.10).

For the mining companies themselves, their original interests in avoidance of criminal responsibility, restarting operations, and limiting costs are explicit: `the signing and assumption of obligations here laid out does not imply the recognition of guilt or responsibility…for the event` (TTAC cl.256); `the importance of reinitiating the operations of Samarco` (p.6); the resolution of civil action no.0069758-61.2015.4.01.3400, supersedence or extinction of `other actions contained within or

connected to that action` or that `come to be proposed` (Preamble p.5); the inclusion of fines in the Preliminary Agreement in the figures to be paid (MPF; MPT; MPES, 2015 ; TTAC cl.227), and a portion of payments laid out in the TTAC as counting towards other potential future legal processes against the mining companies in relation to the disaster (TTAC cl.223). In comparison to the alternative scenarios available immediately after the disaster, however, the mining companies had their interests moulded somewhat. They became responsible for both payment for and execution of the recovery via a complex governance arrangement involving the state—something unprecedented not only in Brazil but perhaps around the world. If it effectively limited the participation of the Affected, and nominally avoided guilt, the arrangement still implied responsibility for the accident in a way that simply moving to a legal defence would not.

With the TTAC and Renova Foundation as an OPP within a negotiation of the government, state agencies and the mining companies, the Affected are certainly translated as a crucial, legitimating actor with urgent needs, but not as one that has an actual interest or need to represent themselves or the environment. Certainly, the notion that they might be involved in defining programs themselves is undermined. While the mining companies interests in cost control and reputation recovery are undoubtedly present, the TTAC attempts to inscribe them as interested in speedy and efficient recovery and the consolidation of litigation, while accepting at least some responsibility for the disaster. The Federation appears as responsive, reasonable and responsible. The environment, as with the Affected, remains represented by experts, and it exists in terms of scientific terms and human security concerns (although clearly it has no equivalent rights to information or transparency). Government agencies are legitimating participants with monitoring capacities but divergent influence over programs. Experts and expert studies, auditors and audits appear as apolitical, dependable spokespeople, or intermediaries, offering the basis on which to engage in the recovery. The MP, however, was not successfully enrolled, did not engage in the design of the TTAC and did not sign it, though, as part of a failed *interessement*, they were present within the Foundation structure as a form of oversight, along with the major auditing companies. The attempt to enrol the MP may well have not been without reason, as the MP has been one of the most challenging actors for mining operations historically and it became the most challenging in terms of renegotiating the network, a point to be considered below. Their historical experience with mining companies and human rights conflict in the region as well as their

constitutionally protected role likely prepared them to take a defiant stance. Finally, the judiciary had to be engaged, ratifying the TTAC and pressuring actors to enrol via a legally binding agreement. An illustration of this attempted actor-network with the TTAC and Renova Foundation as an OPP is presented in Figure 7.

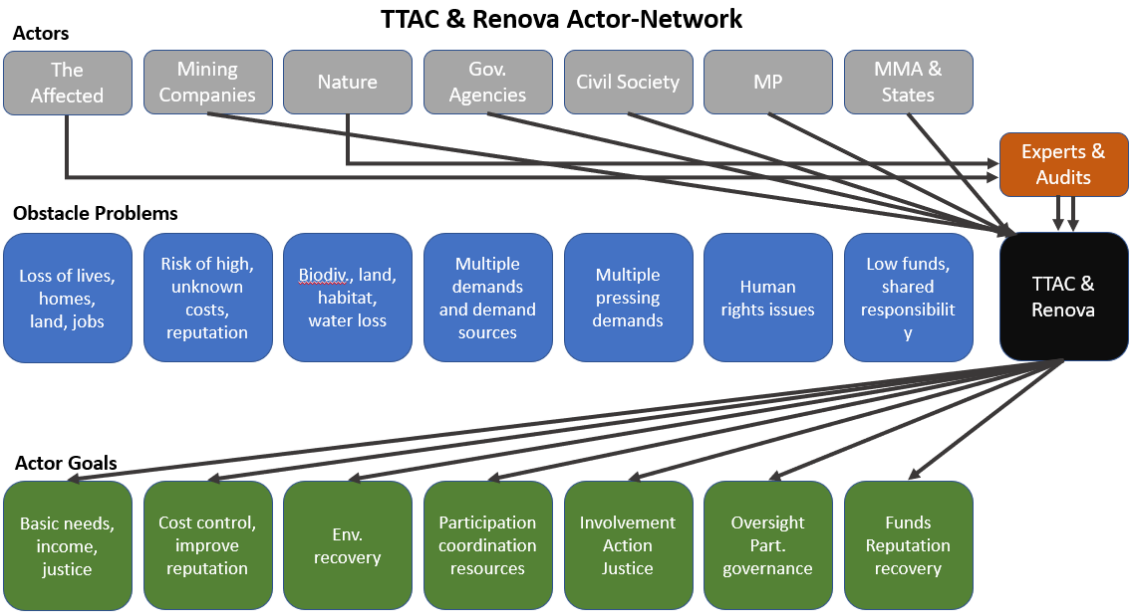

Figure 7. TTAC & Renova Foundation attempted actor-network

Although the TTAC and Renova Foundation may appear as a radical reorganization of the actor-network in the Rio Doce Basin, it maintains a substantial analogy. Prior to the disaster (as well as presently) the state was tasked with oversight of a mining-company-executed project within a policy framework designed to protect citizens and the environment. Policies included licencing, itself a nominally participatory process in which affected communities are heard but cannot substantially influence decisions, and transparency in safety assessments and annual reports. Certainly, Renova Foundation presented an innovation in the structure and range of governance, but it also replicated the relationships that could be said to have contributed to the creation of the disaster—state oversight of mining execution with rhetorical commitment to participation and a preference for technoscientific framing of operation and risk.

The Reforestation Prioritization Project

We first consider the relationship between the TTAC and this project, and then the project is described using the same terminology and sequence as above, with its own problematisation, OPP, *interessement*, enrolment and mobilisation. As noted, the TTAC represents the environment in abstract terms and from an anthropocentric perspective. In the first moment of translation, above, the state and mining companies along with state agencies spoke for the nature and needs of the river basin, both nature and society, problematizing the actors and needs such that a new Foundation was required, as inscribed the in the TTAC. Inherent in such a comprehensive structure and program were multiple, significant constraints, as the TTAC attempted to inscribe and black-box many decisions without notable justification, whether social or technical, and thus render them immune from questioning or negotiation. This included the needs of the Rio Doce Basin: within Clause 161 the Program, 'Recovery of APPs, and recharge areas of the Rover Doce basin with control of erosive processes', it was stipulated that 40,000 ha (86,711 km^2) of degraded Areas of Permanent Preservation (APPs) (areas of protected vegetation on public and private land as relate to distance from water sources, hill-tops and inclines) be restored within ten years as a compensatory measure (TTAC cl.161.II.2); 10,000 hectares were to be plantation and 30,000 hectares assisted natural regeneration.

Despite the TTAC`s subsequent suspension in the courts, it continued to function as an inscription of the new actor-network, acting to generate functioning governance structures in the CIF, Renova Foundation, and Technical Chambers that would support monitoring and implementation of the programs. One of these Technical Chambers, CT-Flor, was constituted with a technical and governmental membership, presided over by the national environmental executive, IBAMA, alongside CBH-Doce, the State Institute for Forests (*Instituto Estadual de Florestas—IEF*), the Chico Mendes Institute for the Conservation of Biodiversity (*Instituto Chico Mendes de Conservação da Biodiversidade*) (ICMBio) the National Water Agency (*Agência Nacional de Águas—ANA*), State Secretaries for Environment, and other federal and state agencies. Negotiation of roles was ongoing—one interviewee remarked that, at first CT-Flor considered itself an environmental monitoring body, in line with the historic role of the involved institutions, but that, as time went on, they discovered Renova Foundation was 'here to help' and that they could collaborate in the design of (and therefore potentially responsibility for) recovery activities.

CT-Flor and Renova Foundation located technical analysis of the landscape as the local OPP in their problematization of Clause 161 in their Terms of Reference (ToR)—Definition of Prioritization of Areas Criteria for Environmental Recovery in the Rio Doce Basin (CT-FLOR, 2016). Product 1 was a register of institutions that work with reforestation, Product 2 was mapping of alternative water sources in capture areas. More substantial were Product 3, prioritizing areas of the basin for recovery according to parameters that indicate suitability for regeneration, and Product 4, the scheduling of areas to be regenerated (cl.4 b-e). Naturally, the problematization, in line with the TTAC, maintained that the state institutional membership of CT-Flor were responsible actors capable of speaking for society and environment in their decision-making. It also required that modelling specialists be employed that would satisfy a demand for scientific intermediaries for society and environment in terms of: 'social and geopolitical demands' (cl.3), 'mapping' in order to identify areas of greater environmental and social vulnerability (cl.4), and 'modelling of risks, vulnerabilities and opportunities' (cl.1).

CT-Flor's translation of the TTAC's requirement for participation in their ToR, as approved by the CIF, was that priority areas be defined 'after listening to regional actors' via 'workshops with an intersectoral and interinstitutional network of technical specialists, for discussion about models and methods, with the proposed environmental and socioeconomic criteria, parameters and weights' (CT-FLOR, 2016 cl.4.d). Analogous to the TTAC's emphasis on accountability via transparency and information, other related requirements included one scientific seminar for 'the appreciation of the proposed prioritization of the model and methodology by the academic and research community' (cl.4.d.vi) and 3 seminars for the 'presentation' of the prioritization maps to involved actors in the low, mid and high Rio Doce (cl.4.d.x). Validation of Product 3, however, remained with CT-Flor and ultimately the CIF (cl.4.d.xi & 5.b). Continuous (non-public) meetings were stipulated, and there were 12 meetings with Renova Foundation, the CIF and CT-Flor from May to December 2018, when all products were validated.

Products 1 and 2, initial mapping of water catchment and institutions was completed by the consultancy BioAtlantic Institute (IBIO) which had experience supporting River Basin Committees but dropped out. Thus, *interessement* for products 3 and 4 of Clause 161 began with the search for experts capable of delivering a technical landscape-scale analysis. Renova Foundation and CT-Flor contacted federal university teams of modelling and landscape specialists who organized around a proposal. The modelling

process constitutes a third level in the network, as the university teams problematized the modelling such that multiple secondary sources of quantifiable landscape data, negotiated and manipulated by the modellers in *interessement*, acted as spokespeople for environmental and Affected characteristics. In turn, they could claim that the they and the model were themselves intermediaries for the environment and Affected in relation to Clause 161. Though in fact more complex, a short summary is given in the following text box to illustrate the nature of the project.

Reforestation Prioritization Modelling Procedure Summary

For the prioritization (Product 3), the team used the modelling software DINAMICA EGO (SOARES-FILHO; RODRIGUES; COSTA, 2009) to compile multiple variables into 5 indices. The variables included, for example: socioeconomic factors, such as income and infrastructure, that suggest greater potential social impact of investment in regeneration; environmental measures, such as soil type, rainfall, and forest fragmentation, that are associated with regeneration success; and institutional factors that could affect availability of seeds and seedlings or agroforestry development. They also estimated the amount of degraded APP, again using modelling, as there wasn`t reliable data for this.

The indices were then combined and weighted in different ways to produce prioritization maps of the municipalities of the Rio Doce basin according to three regeneration strategies: plantation, natural regeneration, and agroforestry. One of these maps, the prioritization map for natural regeneration, as provided in Figure 8, was a result of the indices: vocation for natural regeneration (45% weighted), environmental vulnerability (45% weighted), and social vulnerability (10% weighted). Importantly, these weights reflect an interpretation as to what is most important for the different regeneration strategies, for example, that vocation for natural regeneration should be balanced with environmental vulnerability (45%; 45%) (too-degraded land would not regenerate and too high a vocation needs little assistance), and that, as this regeneration type is low investment, social impact (10%) is of limited consequence.

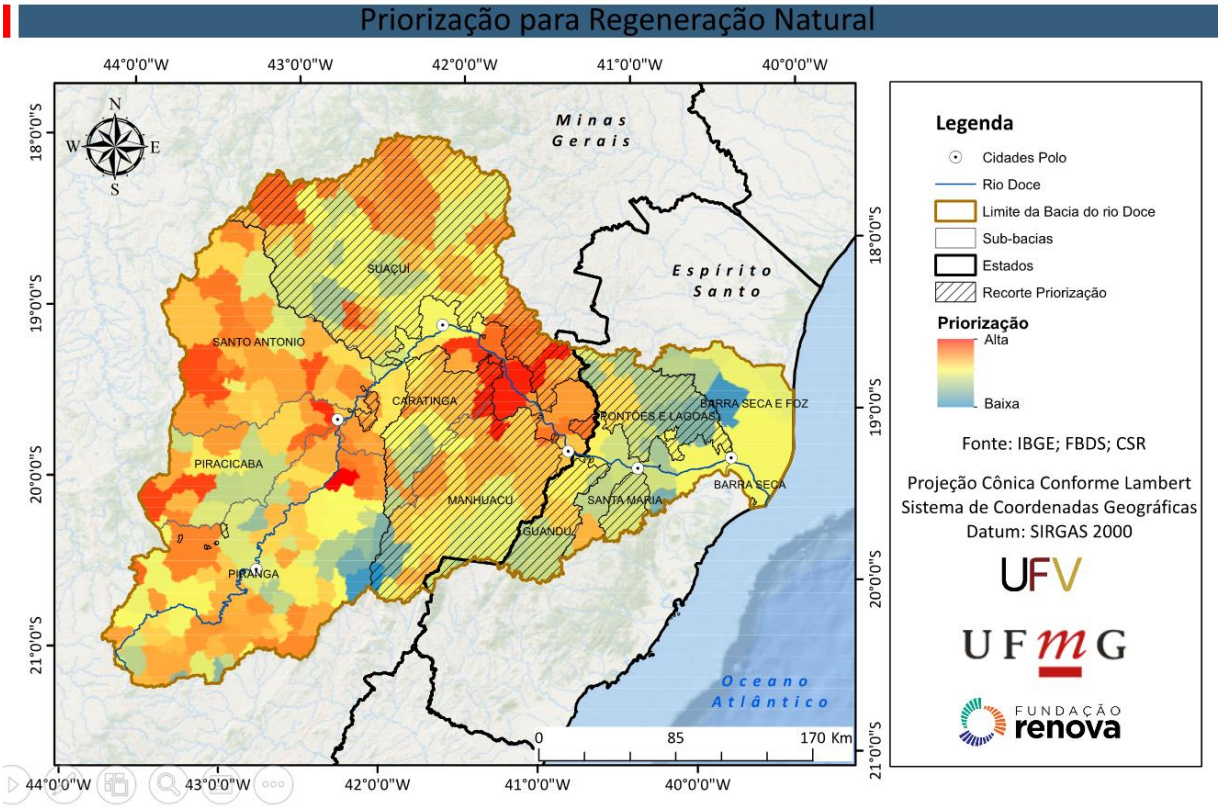

Figure 8. Prioritization for Natural Regeneration map (red is a higher priority and blue is lower)

According to participant observations and the interviewees for CBH-Doce, Renova Foundation and the UFMG university team, there were some key differences in the goals of the project and the identities and needs of the environment and Affected. IBAMA, ANA, and ICMBio, on the one hand, spoke for the landscape and recovery in terms of water and biodiversity conservation, though biodiversity was not named in Clause 161; while, on the other, CBH-Doce and the university teams spoke for a multi-use landscape that focused more on potential social impacts. There were two distinct 'camps' for environment and society, each negotiating from institutional centres of translation of the landscape that appear to reflect the broader division of labour in Brazilian state institutions as well as the division of programs in the TTAC.

The identity and role of the university teams risked paradox at times, as they attempted to negotiate not only as scientists, capable of the rational and objective intermediation of the landscape that rendered them necessary to the network, but as citizen-spokespeople for social issues. The first resolution of this was to generate and integrate further social vulnerability indices in the model by stating that the `strategy` was a value decision they could contribute to but not make, while the `procedure` of inclusion was technical and therefore their domain. The second manoeuvre was to resolve the two social and environmental camps demands by creating a third prioritization map beyond assisted natural regeneration and plantation for conservation by assisting in the interpretation of agroforestry as a second form of plantation for conservation. Agroforestry, seen as a more sustainable form of agriculture accessible to poorer and small-scale farmers, was enrolled as `plantation with economic purpose`, a solution to sustainable means of income generation that left biodiversity served by plantation `without economic purpose`. Here we also see an attempt to leverage the recovery as more than simply compensation for the disaster, a means of shifting economic structures for the long-term. A third intervention by the university teams in their hybrid roles was to suggest initial prioritization of Indigenous and settlement lands within Product 4 on the basis that they provide a means of working on larger areas via fewer people on locations that met project conditions and could therefore speed up implementation. Though this somewhat undermined the modellers quantitative and software-driven scheduling procedure, it placed people and environment the team considered more vulnerable ahead of other potential recipients of investment whilst remaining in service of pragmatic concerns.

An interesting difference arose between CT-Flor, CBH-Doce and the university team as to who would weight the different indices, especially for social vulnerability, demonstrating negotiation of the boundary between the technical and political. From the perspective of CT-Flor and CBH-Doce, they were 'not a technician' and 'didn't want to adjust the weights, so as not to introduce distortions'. On the university side, they recall the resistance to accepting responsibility for allocating weights, and the team's push back, which was described as 'giving them the tools'. While the modelling team understood the choice of weights as based in values and interpretation, and therefore the remit of the assigned decision-making bodies, CT-Flor and the CIF, some members of CT-Flor initially hoped to offload political responsibility. Whether by their own understanding or others, the possibility to claim the results were objective and apolitical rather than value-driven was open to them at least in part as modelling presents a black box—most actors understand model inputs as ready data, bereft of the means of its production, and model outputs as generated by similarly hidden processes.

If the university team engaged in negotiation of their roles as citizens and spokespeople for society, they could not risk their enrolment as intermediaries of an environment of largely abstract and quantifiable entities and factors. They were spokespeople for the science of modelling, of its promise to offer landscape-scale analysis and control via its own series of reductions and assumptions. The roles were enacted not only in the choices of Renova Foundation and CT-Flor to enrol them as modelling experts and in the immediate context of meetings and conversations—where their respective authorities were actively and asymmetrically distributed across domains of politics and science, of values and facts—but also pre inscribed in the TTAC and ToR.

As we have seen, there were differences between experts as to how to best serve the CIF, ToR, and TTAC and represent the environment and Affected as the intended beneficiaries of the recovery. Negotiation also revolved around the formal participatory process. Seen as a process of *interessement*, participants, participation, CT-Flor, and the model and team as spokespeople for society and environment with respect to Clause 161 had to be performed such that all were successfully enrolled via their respective tests. As such, the participatory process had to be (i) sufficient, i.e., visible, attended, and effortful, such that it would reinforce and legitimise the network, and (ii) limited, i.e., without dispute of CT-Flor, the approach and model, let alone the TTAC and broader network, such that it would not threaten or delegitimise the network. Beyond the ToR caveat that it be attended by a

network of technical experts, three further moments restrained the workshops as the central means of participation: their location toward the end of the project, their design, and their reduction in number from ten to five. According to the university team interviewee and participant observations, initial ideas centred on using workshops to validate indices and weights, providing early validation on model inputs and local knowledge via small focus groups. However, the workshops were increasingly pushed towards the end of the project, after important decisions such as the conceptual framework and data choices were made, and in the end Renova Foundation organized groups of 100 or so in large spaces for a sequence of technical presentations. In regard to number, the reduction being reasoned as for the sake of time, CT-Flor's meeting notes reveal an understanding of the workshops that implies no expectation of influence on the project: 'CT-Flor approves the reduction of the workshops predicted in the Terms of Reference, to give greater speed to the process, *without affecting the final result*' (CT-FLOR, 2018 p.5 emphasis added). A conceptual map from a project presentation placing the workshops later in the project is presented below in Figure 9.

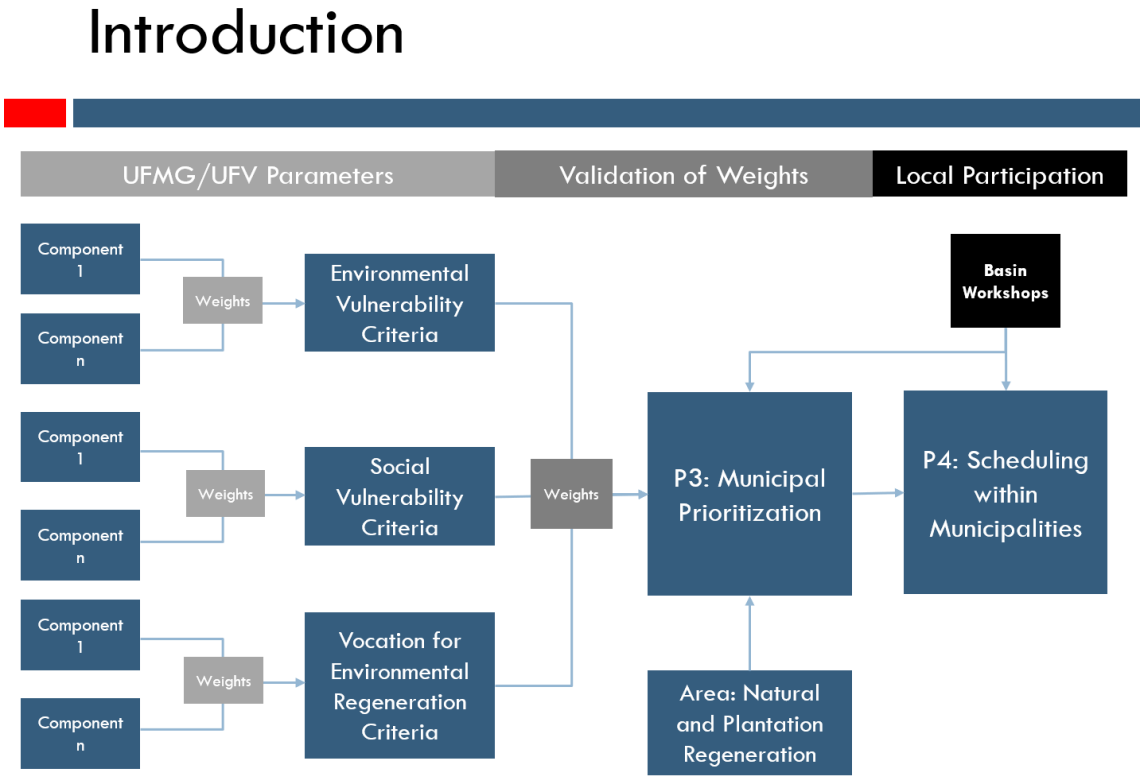

Figure 9. Project conceptual map with workshops (taken from project presentation, authors translation)

I attended one of the workshops, in August of 2018 in Mariana, Minas Gerais. The walls were covered in computer generated maps and technical diagrams of the project, materially reinforcing the complexity of the procedure, along with an extensive PowerPoint presentation. The requisite coffee and cheese-bread of local events were laid out on tables. The participants were arranged as an audience in a seating plan that placed the experts in a stage position. As intended, various government, NGO and other institutional actors, numbering around 100 were present; I met no small-scale producer of the sort that might constitute either the Affected or private landowners whose collaboration would be required to implement recovery. The university teams were accompanied by both Renova Foundation representatives and an outsourced facilitation team, which had been the topic of some discussion for the university teams, as they anticipated a more general pattern of Renova Foundation workshops: that conflictual issues related to the broader disaster and recovery would come up. Indeed, questions beyond the scope of the project representatives did appear, such as the reasons 40,000 hectares had been chosen, waste management, how the TTAC had been created, or how long-term basin recovery might be approached. Facilitators reminded participants of the limited scope of the workshops and no overt conflict was witnessed. Presentations of another related project, the recovery of alternative water sources in the basin, took place before that of the Reforestation Prioritization Project.

In the presentations, the identities and needs of the landscape and society, as well as those of CT-Flor, the CIF and Renova Foundation were mobilized via presentation and a range of visual materials. The presentations were in several parts of around 20 minutes each, with breaks for participants to discuss in small groups and write down key questions to submit on paper. These were collected and summarized into points that the team could later respond to. Questions included: adjusting the social vulnerability index to include riverside communities, the exclusion of areas of environmental protection with poor enforcement, data sources and suggested further variables, such as migration, and the weighting of social vulnerability in the maps. Some stated that they were happy to see investment in technical capacity for a study that could have further application and approved of the presentation style. And local knowledge was supplied on seedling production capacity and highly vulnerable areas that did not appear in the maps. Although no detailed regeneration implementation plan was presented, as the workshop was nominally restricted to the model, suggestions for implementation emerged, such as

institutional partnerships, concern that Indigenous Peoples did not appear well integrated, and disbelief that farmers would engage with little trust of state or Renova Foundation and many unofficial properties.

However, as both the Renova Foundation lead and project scientist confirmed, every prior decision was explained and no new decisions were taken. While we can speculate on the expectation of public questioning as a mechanism for rigor through the anticipation of objections, no interviewee or observation could confirm any change to the model as a result of the workshops. There may have been important input into the implementation strategy, though that would require further research. The Renova Foundation lead and CBH-Doce representative expressed that, although admittedly limited, participation occurred 'as much as possible' at this initial modelling stage and that it would become more participatory at implementation where private land-owner cooperation was required.

If it was indeed as participatory as possible, a sequence of translations of the environment and Affected and the TTAC and Renova Foundation had ensured that this was so: (i) without participatory process, the TTAC inscribes a scientific landscape, including Clause 161 for environmental regeneration, and defines the Affected. It rhetorically stipulates participation of the Affected but includes mechanisms of expert control; (ii) the CIF and CT-Flor governance forums are generated with expert and state representation of said environment and Affected, as mandated in the TTAC; (iii) the ToR inscribes a problematisation of Clause 161 such that experts are enrolled to speak as intermediaries for environmental and society via modelling; and (iv) the workshops, populated by an audience of 'technical specialists', are placed at the end, reduced in number, and managed to restrain questions to model development. This is not a statement as to the impact of the project, whether the results might serve society or the environment, which would require quite different research. Rather, it is a description of the TTAC & Renova performing as an OPP for the actors involved in this recovery activity via the inscription of their roles and interests. While the Affected must `influence every stage` of the recovery—at every stage of the Reforestation Prioritisation Project, from TTAC to participatory process, experts have handed other experts the right to speak for an inert environment and rendered participation a safe, orderly, and limited presentation. While participation served its role as legitimation, it brought about no change in the model, let alone for any concern of social value or political consequence.

After the TTAC

For a network to endure, the actors must both be enrolled and maintain their allocated identities and interests, whether by coercion or choice. It may not be surprising then—given that the lynchpin of the network with Renova Foundation and the TTAC as an OPP, the Affected and their need to participate, was not involved in the creation of the TTAC nor given substantial means of participation—that there was significant instability. Into this vulnerability, multiple spokespeople stepped forward with a claim to represent the Affected, including diverse voices within Renova Foundation, many of whom could not themselves be classified as Affected.

As mentioned in the literature review and above, the MP immediately condemned the TTAC as having been reached without participation of the affected and continued a lawsuit for R$155 billion, far more than the initial R$20 billion agreed for the TTAC. The TTAC was suspended by a high court but Renova Foundation was founded despite this. A group of academics and civil society also prompted a UNHCR visit based on the same criticism. According to the Renova Foundation manager, however, in the year after initiation, internal dynamics were underway that began to provide a range of spokespeople for the Affected inside Renova Foundation that would conflict with mining-company preferences. Up until this point, the mining-company managers had largely presided over the recovery, but they lacked the backgrounds and skills for the range of programs. While Renova Foundation was not yet recognised as the lead actor in the recovery, there were two conflictual internal positions: one `pro mining-management`, where the mining companies retained their presence, and another, `pro-independence`, led by the new CEO Roberto Waack, intent on shutting down commissions with mining-company employees and bringing in third-sector, ex-government and other non-mining staff. The new intake fought to expand recovery activities and efforts were made at participatory processes outside the bounds of the TTAC.

During this period, efforts to change the network were underway in the form of legal inscriptions to adjust, rather than fundamentally alter, the TTAC. In the TAP of January 2017, the MP, always unsatisfied at the TTAC, established their own suite of experts, paid for by the mining companies, in the form of established consultancies: Lactec for socioenvironmental diagnostics, Integratio for socioeconomic diagnostics and assistance to the Affected, Ramboll for program monitoring, and the World Bank for coordination of experts (MPF et al., 2017a cl.2). The work of these consultancies was expected to

contribute to the final agreement by undertaking `public audiences` with the Affected, traditional and indigenous people and by evaluating program progress and completion. Participation of the Affected is mentioned in relation to revision of the Loss Register (cl.1.2.2.1), public audiences for Traditional Peoples (cl.2.2.1), and in one of the guiding principles for the development of the final agreement—'Adequate legitimacy through the participation of affected communities, including in the definition and development of programs' (cl.4.1.3). In this way, the MP attempted to establish itself and its experts as obligatory to the recovery as well, simultaneously reinforcing the role of experts as spokespeople for environment and the Affected. Some of the chosen experts were immediately attacked by social and Affected movements for having links to Samarco and Vale (LOSEKANN; MILANEZ, 2018). As Renova Foundation was gaining a reputation for being present and slow in the basin, if at least active, toward the end of its second year of operation, the MP—this time in collaboration with some public university researchers and social movements in further claims to representation of the Affected and the basin—established the TAP Aditivo in November 2017. It suspended the R$155 billion civil action, adjusted the chosen experts, and brought the new players in as essential spokespeople. Consultancies and experts were restricted to those who have no technical or financial ties to the mining companies, are capable of forming multidisciplinary teams, and non-profits (MPF et al., 2017b cl.3.9) who will use 'methodological approaches to obtain technically free and objective and scientifically founded analyses as demanded by an international level of excellence' in the socioeconomic diagnostics (cl.3.13.2). As such, Integratio was exchanged for *Fundo Brasil de Diretos Humanos* (The Brazilian Fund for Human Rights) (hereon, Fundo Brasil) and *Fundação Getulio Vargus* (Getúlio Vargus Foundation) (FGV), for which payments must be approved by the MP. The major departure of the TAP Aditivo is in making Technical Assistance available to the Affected, i.e., direct professional support, that would be `performed by suitable, capable technical entities with recognised practical expertise in their field, with independent action based in the confidence of their attended community` (preamble); the Technical Assistants are coordinated by Fundo Brasil with the caveat that they do not have 'ideological or religious reasons` (cl.7.3.h).

With the TAP Aditivo, there is at last some explicit reference to normative goals of participation, with emphasis on effective participation for justice and the guarantee of rights, transparency and accessible language, and respect for collective logics of

belonging and self-organization with a preference for collective negotiation (MPF et al., 2017b cl.1). The selection of Technical Assistance is to be based on `free choice` of the Affected (cl.1.1.10) (MPF et al., 2017b cl.1) and the generation of concepts and categories of the socioeconomic diagnostic is to take place in a participatory manner, offering the first moment in which those considered to be the Affected might be involved in defining the disaster impacts. As well as Technical Assistance and the change of experts—and in addition to the TTAC's external auditors, Specialist Panel, and Consultative Council made up of Affected, CBH Doce, NGOs, academics and others—an Observer Forum was setup, formalizing the involvement of academia and representatives of civil society (chosen by the MP), the Affected, and impacted communities (cl.4). And, a series of public audiences organized by the MP and run by Fundo Brasil was designed to facilitate effective participation in a range of territories (cl.6). These new motives and means of participation continue to sit uneasily alongside respect for the technical and independent capacity of experts, who are understood to undertake work `without outside influence` so as to arrive at `solid results, conclusions and recommendations based on the best scientific knowledge` (cl.1.1.9.1).

As Renova Foundation moved through a period of relative independence from the mining companies during early 2018, having established itself as an operational, multi-billion-real organization—and even as it was under fire for secondary impacts of recovery actions—, the TAC Gov was being negotiated by the states, mining companies, MP, the already existing coalition of academia and social movements, and the Public Defence (*Defensoria Pública*) (DP). While technically another addition to the TTAC, it represents the most fundamental shift in (or addition to) the governance structure thus far in creating regional Chambers made up of local commissions of the Affected. The new (and voluntary) local commissions will decide their own composition and functioning with their Technical Assistance (cl.8.2), and have the ability to: access all documents and communication between the CIF, Renova Foundation, and Technical Chambers; 'propose adjustments via technical notes' to their activities and in relation to projects and programs; and liaise with other commissions and the regional Chamber (cl.10). Renova Foundation and the local commission can enter into an agreement for local program delivery as long as this doesn't conflict with program scope or the CIF (cl.11). Where suggestions exceed the TTAC, they are taken to the regional Chambers and CIF for consideration in the eventual revision of programs (cl.12-13). The commissions in turn are obliged to inform

the Affected of the elaboration of programs, inform the other aspects of governance of problems detected, defend the Affected, meet periodically to deliberate, and produce reports (cl.IV.15). Quilombo, Indigenous and Traditional communities can form their own local commissions. And training is to be made available to support the Affected to participate (cl.IV.5). The local commissions connect to six (also voluntary) regional Chambers who can similarly enter into agreements with Renova Foundation for adjustments to programs and projects and make suggestions for the eventual revision of programs (cl.29-35). This reemphasises the Affected as involved and now on grounds of justice and human rights, and certainly improves their chances of influencing the recovery, albeit as yet untested on the scale promised; however, much depends on their Technical Assistance and the structure and functioning of forums that have little mechanism of power at present other than accessing information, highlighting problems, and requesting to enter an agreement with Renova Foundation. Influence may increase substantially upon the predicted revision of programs.

The Affected enter the CIF, Technical Chambers and Board of Directors (2 Affected, 1 CIF member, and 6 mining company seats) via representatives. The MP and DP also enter the CIF and Technical Chambers. The role of social movements and academia selected by the MP is adjusted as the Observer Forum can dialogue with the local commissions to evaluate programs and the experts contracted by the MP. These changes in themselves do not break the presence of the TTAC and Renova Foundation as an OPP in the network, it is still the central actor and OPP, but it does render a shift in the locations and forums of the Affected while extending the reach of experts, including those directed by the MP. A major goal is to establish means of effective participation in a final agreement that would describe all impacts to be repaired or mitigated in order to terminate Renova Foundation.

In this new network, the mining companies' intention to recover the basin quickly and sufficiently to regain their reputation is undermined, as they are cast as attempting obstruction and delay of the recovery, thus requiring the new agreement and further oversight. The MP seeks to create multiple new participatory structures and affirms and extends its own body of experts to act as intermediaries of the Affected via `diagnostics` and `public audiences`, including in the Observer Forum of selected academics, social movement members and representatives of the Affected. The Affected are given Technical Assistance in local commissions and regional Chambers that may prove to increase influence but suffer vulnerabilities. The MP's influence becomes greater than

before, which depends in turn on their claim to speak for the Affected. The new attempted network is shown in Figure 10.

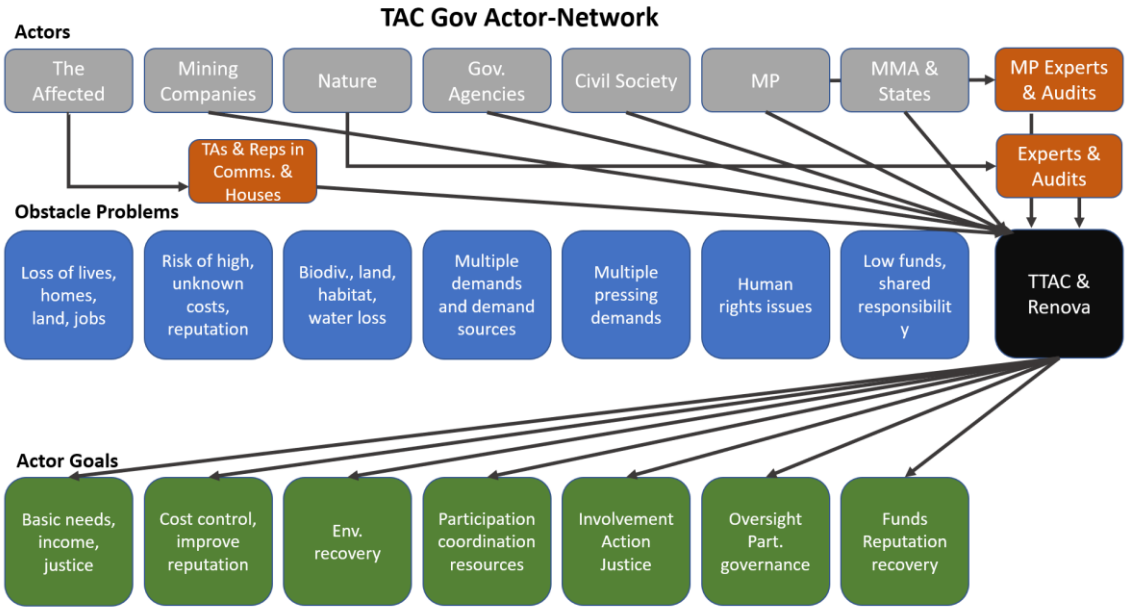

Figure 10. The TAC Gov Actor-Network

The development of the TAC Gov, as described in an MP report, illustrates a revealing tension. The TTAC is described as aspiring to participation and transparency but failing to achieve these in its construction and the subsequent structuring of the Foundation. This was especially by…

> ...reflecting an understanding that the recovery…was a question to be treated and decided by technicians, that is, pubic administrators and specialists in the environment and socioeconomic aspects (MPF; MPMG, 2018 p.7)

with the effect that the affected were to be passive recipients of the process. The TAC Gov, on the other hand, is contrasted with the TTAC as means of approaching `good governance` that includes…

> …participation, orientation towards consensus, accountability, transparency, responsiveness, efficiency, effectivity, rule of law, equity and inclusion. (BRASIL, cited in MPF et al. (2018 p.6))

This notion of governance is presented as shared by academia, the state, and social movements, and includes `government in networks`. However, how the complexification of the governance structure is to achieve the pragmatic concerns of responsiveness, efficiency, and effectivity is not addressed. Further, the MP admit the policy-construction process was expert-driven like the TTAC. The framing of the MP-led construction of the TAC Gov, taken from the explanation on the MPF website (MPF, [n.d.]) and confirmed in interview with the MP, is that judicial time limits that could have resulted in the ratification of the TTAC limited the process and the MP has restricted resources to dedicate. Expanding this in the evaluative report of the process for the construction of the TAC Gov (MPF; MPMG, 2018), 'anthropologists and sociologists of the MPF and MPMG undertook, in the diverse territories along the Rio Doce, a participatory evaluation project'. They state that the participatory evaluation was not a consultation with the affected, 'because there were not methodological conditions for this work, in such a short period of time'. That the construction of the TAC Gov was undertaken in a comparable fashion to the TTAC is explicitly addressed, with the reasoning that there was `little available time to adequately inform [the affected]…for effective social participation` and that it was `impossible to cover the whole universe of the affected`, resulting in a `participatory evaluation`—a process described as a `technical work via which it was possible to capture critical observations…of certain segments of the affected, civil society organizations and the academic community` (p.9). For this, they chose an ethnographic method, which is characterized by an approach that appreciates reality `from the perspective of the subjects themselves` (p10). Yet, apparently, this was `not very productive` due to the document already having been produced in…

> …a different social and cultural environment, in which the affected had not participated, even indirectly—via representatives—, and whose technique, language and vision of the world does not correspond to their experience of life. (MPF; MPMG, 2018 p.10)

Where there was room to discuss the document more directly, where technical assistance was already available, the form and perspective of the conversation was determined by `local dynamics and the type of relationship maintained with the diverse institutions involved in the reparation` (p.10). The approach mixed meetings with the affected, mostly `local leaders`, and semi-structured interviews, though they note the difficulty of selecting a representative sample of a highly differentiated and distributed population. In all, they

accomplished meetings and interviews across 9 of the 229 municipalities in the basin. In the end, while public audiences in the TTAC fail without a `certain level of social organization` and are `merely an instrument of legitimating decisions`, the MP process can only offer `participatory evaluation` due to time and resource constraints.

Can the MP and its coalition of academia and social movements, then, legitimately claim to represent the Affected, and in the creation of this new governance structure? Although they enrolled some representatives of academic research and social movements in the Observer Forum and the extensions to participatory structures in general, their own claim to represent the Affected is tested by more than their own report. Academics—who have contributed to the broader critique of the TTAC as having been accomplished without participation, naming the people who count as the Affected for the sake of the participatory processes, or rendering them the protagonists—take the same issues with the new TAC Gov (LOSEKANN; MILANEZ, 2018). And social movements criticise that it continues to place the Affected at the mercy of the mining companies, drops the R$155 billion suit, and offers minimal effective participation to date (MOVIMENTO DOS ATINGIDOS POR BARRAGENS, 2018).

Present dynamics demonstrate that Renova Foundation and others can resist their enrolment as leading effective participation in multiple forms, so that processes nominally set in motion to render the effective participation of the Affected more feasible may provoke alternative strategies. The Renova Foundation manager described a scenario in which the CIF often deliberated without consulting Renova Foundation; if Renova Foundation trustees deem the deliberations illogical or unwanted, they are then either paid fines for until resolved or taken to a judge, as the adjudicating Specialist Panel has never operated. The weight of the multiple auditors has led to `80% of Renova Foundation employee time [being] spent on compliance`, and the MP admits that bureaucracy is a `serious issue`. In another challenge—while the MP tries to render itself, its experts, academia and the Affected via new spokespeople more significant gatekeepers to what constitutes legitimate action—according to the Renova Foundation manager, Renova Foundation has now entered its third and most recent phase: the mining companies are shifting to restrict Renova Foundation actions to only those formally agreed and drain the influence of the CIF via new external councils involving the states and not the state agencies. Challenges from the courts have appeared too, such as an `interpretative caveat` by Judge Mário de Paula Franco restricting the choice of Technical Assistance to those

without religious, party-political or local NGO and social movement connections, implying that many of those chosen by the Affected, such as Cáritas, would be excluded (JÚNIOR, 2018). The judge has thus rendered himself an OPP, necessary to the approval of Technical Assistants who are in turn crucial for the Affected to participate—a manoeuvre that depends on the wider power of legal agreements as enrolling inscriptions.

These challenges relate to two other campaigns by the MP and some social movements and media sources (e.g., MOVIMENTO DOS ATINGIDOS POR BARRAGENS, 2019): one is a consistent campaign to undermine Renova Foundation and the mining companies claims to interest and success in the recovery, including participation. While this campaign may result in short-term success in the form of the TAP, TAP Aditivo and TAC Gov (that is, if one considers the substantial complexification of governance and expert involvement success), the incentive for the mining companies to engage Renova Foundation to completion to serve their interest in repairing their reputations is diminishing. A second campaign is to extend indemnity and emergency payments without well-defined or achievable termination conditions. Payments, while crucial for the Affected in the present, may render an `unsustainable policy` (Renova Foundation Manager Interview) the centre ground of energy and action, rather than issues around long-term socioeconomic structure in the basin—the same structure that provided conditions for both Samarco and Vale dam disasters to occur. The MP are no doubt serving their role as protectors of human rights in seeking adequate compensation for what they claim is a limited number of cases, but with the risk of spiralling costs without benefit of reputational gain—and even less now that the Vale disaster in Brumadinho has happened—the logical choice for the mining companies is to use their influence to restrain expenditure where possible and manoeuvre in legally inconsequential or low-risk ways to limit participatory spaces that could increase the bill.

In summary, the post-disaster context was problematized by the MMA and mining companies with a view to forming a new agency to engage the recovery. In the negotiation or *interessement*, the new Foundation and recovery began to take form as a complex governance and program structure that reflected the broad range of actors who were enrolled via the inclusion of their interests. The TTAC inscribed a predefined Affected that performs as legitimating the agreement but whom cannot dispute it, and a scientific conception of the environment that elides the possibility of alternative ontologies, such as those of Traditional and Indigenous Peoples. Both the Affected and the environment

are represented via expert spokespeople and the agreement largely replicated the prior relationship between a regulating state and mining-company project that lead to the disaster.

One of the environmental recovery projects, the Reforestation Prioritization Project, was coordinated by the new expert-led Technical Chamber CT-Flor and Renova Foundation in partnership with local public universities. At each moment of translation, from TTAC to ToR and the participatory process, experts handed experts decision-making, centring the project on quantitative and specialised modelling of the river basin to produce a representation of society and environment. This participatory process was limited, late, and of limited consequence for the model, but it was significant in terms of legitimating and reinforcing a network that claimed to: intermediate the interests of the Affected while excluding them, and intermediate the interests of the environment in abstract, anthropomorphic concepts.

Multiple claims and counter claims as to the Affected have prevented the TTAC & Renova Foundation network from fully stabilising, i.e., identities, roles and interests of multiple actors are in dispute. The evolving shifts and additions to the structure, particularly in the TAC Gov, have complicated and already-complex governance structure and reinforced the boundary between technical and political representation without resolving either. The mining companies, without the incentive of recovering their reputation—with the pressure of a speed and efficiency and their interests in cost and conflict limitation threatened by the new structure—are maintaining instability by creating new alternative decision-making spaces with the states.

We turn now to discussion of the evolution of the TTAC & Renova network, including the Reforestation Prioritisation Project, in the context of the STS and related literature considered previously.

DISCUSSION

According to multiple actors, the TTAC and Renova Foundation have failed to produce participatory governance. It has failed in the first place by the TTAC`s own definition of effective involvement of the Affected from design to implementation of all programs. It has failed according to the MP, though they signed the most recent agreement ensuring its continuity, if moderate evolution. It has failed according to social movements who continue to resort to occupation and protest to extend indemnity to families thus far excluded, among other actions (G1 MINAS, 2019). And it has failed according to multiple academic critiques that locate Renova Foundation as an extension of the mining companies and a broader system of oppressive global capital (MILANEZ; LOSEKANN, 2016; OLIVEIRA et al., 2017). That is not to say that `nothing has been done`, as some researchers and campaigners are prone to stating. With a reported R$5,7 billion spent, over 500 employees and 8,000 people contracted indirectly, clearly substantial action is underway in the basin across a range of programs, even as this may not satisfy the standards of all of those it is directed too, the practitioners in the field, or observers. It is also not to say whether it is the best entity to carry out the recovery at this moment or in the future, if on the terms of the recently departed ex Executive Director, Roberto Waack (PIZARRO; ARIADNE, 2019), the MP (ANTONIO DIAS NETTO JUNIOR, 2019), or some new arrangement. What may be concluded is that, in terms of an Actor-Network, of an attempt at establishing relationships between aligned actors and goals around, it has never fully stabilised to accomplish complete enrolment or uncontested mobilisation. This is for a crisis of representation, of spokespeople whose subjects did not perform as they said they would, despite strength of the TTAC as an inscribing device. In the end, it appears that no actor can testify to their satisfaction in reference to identities and aims of the original Actor-Network.

In response the Brumadinho disaster, it is the mining company Vale, in negotiation with the courts and MPMG that remains in charge of the recovery. The MP, who did not have the means to undertake a participatory process in the Rio Doce basin, albeit this time concerning far fewer communities, appears as the protagonist in reparations—seeking measures for water security, indenisation and emergency payments, food baskets, a R$50 billion lawsuit for Vale, and criminal charges for Vale and Tuv Sud who signed off on dam safety (MPF, 2020; MPMG, 2019). They moved to install Technical Assistance for affected communities, but not in the context of a participatory governance structure or

new foundation, which was resolutely rejected (INÁCIO, 2019). Vale is implementing a range of programs for the Affected and the environment, but there is no mention of a participatory process (VALE, 2019). Though the scales and reach of the disasters are quite different—the Samarco disaster having impacted hundreds of kilometres of river and multiple sectors across two states and the Vale disaster far more local though deadly with at least 270 dead—the apparent absence of substantial attention to participation in recovery is conspicuous given its previous status as central and legitimating. If Renova Foundation has been, at least until now, a failure, though, rejection of the entire project would surely be quite foolhardy. As the MP admits, the question remains open as to how best to learn from events thus far to contribute both to the Samarco disaster recovery and the Vale disaster in Brumadinho, for which improved responses are much needed.

The analysis presented here does not directly challenge the critiques either of the mining and political system in Brazil that led to pre disaster impacts, risky infrastructure and the ultimate collapse of the dam, nor the challenges to Renova Foundation`s handling of the loss register and indemnity and continued treatment of many affected people. The range of classic critiques of technocracy apply—top-down decision-making, an exclusive process framed as `technical` rather than political, a lack of accountability, and impacts on those excluded from participation (BECK, 1999), and technocracies extension to developing countries via international involvement (ROBERTS, 2013). The scenario is easily aligned with multiple STS critiques. Winner`s (1980) description of architectural expression of elitist cultural and economic values can be applied to the dam`s construction above vulnerable communities for the profit of multinationals. For the immediate crisis, its complexity and urgency confounded a coherent response from state and mining company, with a substantial communication-action mismatch and neglect of responsibilities, as in other historic technoscientific disasters (JASANOFF, 1997). In the construction of the TTAC and Renova Foundation, comparisons can be made to assumptions of expert authority that led to many narrativizations of ineffectual, obstructive and immoral interactions between scientists and non-scientists (EPSTEIN, 1998; WYNN, 1996). This analysis may well depart somewhat, however, in considering failure as a property of the network and not necessarily a consistent, binary opposition of oppressor and oppressed, even as distinct and important power differences are present.

A challenge comes from adding to rather than overhauling the governance structure, the result of what appears as a somewhat ad-hoc inclusion of all who made significant claims

to know the needs of and represent the Affected; this includes the MP, who reinforces its position as defender of the Affected and the major force for changing governance. The new Observer Forum—academics, civil society, and Affected people—though described as external to governance and selected now by the MP, overlaps with the original Advisory Board—CBH Doce, NGOs for social and environmental issues, academics, and the Affected. Both add voices and neither issue binding opinions.

Regarding the commissions and Chambers, as noted by Milanez & Losekann (2016 p.35), the generation of a participatory governance structure before allocating who it is that shall participate has often led to conflicts over inclusion later on. The TAC Gov multiplies forums and locations of the Affected without dictating strong mechanisms by which they might have some effect on the recovery, though influence appears potentially stronger and may well increase in the revision of programs. The new 'participatory' capacities are largely directed towards access to information, rights to speak, and therefore the function of witnessing and thereby legitimating the operation, in a similar way to the public audiences undertaken by the MP for the TAC Gov 'participatory evaluation', those in the TTAC, and those employed more generally in environmental conflicts in Brazil (PINHEIRO; TRIGUEIRO, 2014).

The flexibility for commissions to decide themselves on structure and functioning is a gamble—on the one hand, this may be the necessary condition for local meanings of participation to emerge and be enacted, on the other, which depends a great deal on local capacity and Technical Assistance, participatory spaces may become at once more numerous, conflictual and ineffectual. As noted in the literature, if underconstructed, these modes of participation replicate and reinforce existing power relationships between the actors that enter them (COOKE; KOTHARI, 2001), while failing to approximate an effective deliberative system (ELSTUB; ERCAN; MENDONÇA, 2016). In ANT terms, like the Reforestation Prioritisation Project participatory process, they could result not only a black box but a sandbox: the expected operation is known, the mechanics are not, and whatever the output, it is not designed to impact the wider system. The hope is that the Affected and their Technical Assistance will know how to operate it, but in an historic context of corrupt, depoliticized and patronage politics, there is a significant risk of malfunction. Neither does geography guarantee proximity in the structure of voluntary local commissions: the old questions of who has time, energy, competence and interest will inevitably arise. Then again, none of these concerns alone invalidate the proposal in

terms of its aims, merely highlighting risks—understanding the development of the new structures would constitute important research.

There are further risks, however, that are more unique to this network: Renova Foundation`s subsequent manoeuvre to engage alternative spaces outside of the CIF and other participatory forums might appear unsurprising in the light of the mining companies' interests. With the possibility of reputational gain absent and an indemnity program expanding without foreseeable end, the logical step is a manoeuvre to pull back on the one remaining gain for the mining companies: restrained spending. There is a strong incentive, then, for the mining companies to restrain participation via Renova Foundation as much as possible, making the new network as fragile as the previous one. As Renova Foundation was challenged as a failure to represent the Affected, so participation itself will be challenged as a means to the recovery. This could be attributed to lack of specific goals, practices and positions of participation.

We also encounter here, however, a mostly unspoken tension that runs through the evolution of the debate on participation and offers further incentive to resist participation in its current manifestation: the challenge of meeting both social and pragmatic demands. The major criticisms of Renova Foundation include that it is too slow to act, especially with, for example, the resettlement of Bento Rodrigues (A SIRENE, 2019), or that it is inefficient (ASSEMBLEIA DE MINAS, 2019). Where the social norms of justice and inclusion are often associated with the arguments for participation, speed and efficiency almost never are (there is an exception on the Renova Foundation website, where transparency and dialogue are the `only way to construct durable solutions` (FUNDAÇÃO RENOVA, [n.d.])). This leaves an interesting challenge that, in the face of concerns for speed and efficiency, the MP has increased expert oversight and deliberative forums without explicitly naming how this can lead to pragmatic aims or be compensated for, despite its own definition of good governance. If participation is envisaged in terms of social aims alone, perhaps leading to social learning, inclusion, or even political awareness raising, then the risks of participation fatigue and frustration are high in the new arrangement.

This emphasis on justice and not efficiency via participation is complemented by the persistent boundary maintenance between the technical and political. If the Reforestation Prioritisation Project suggests anything, it is that Technical Assistance can only engage with questions of values in as much as this does not compromise their role as `suitable,

capable technical entities` (MPF et al., 2017b preamble) that can `obtain technically free and objective and scientifically founded analyses` (cl.3.13.2) without 'ideological or religious reasons` (cl.7.3.h). Where the MP proclaims to find the decision to limit *who* can be Technical Assistants, rather than the *position* of the Technical Assistant troubling, the MP—along with the diverse state agencies and government—has also helped translate itself and its expert assistants as capable of providing an apolitical service. The role of the Technical Assistants presents as a confusing hybrid, rather than a healthy one: the Affected need them to participate, which we presume is a form of political action, but the Technical Assistants should not be political representatives according to almost any actor. Their power as spokespeople of the Affected and the environment means that Renova Foundation, the mining companies and the judiciary seek to avoid Technical Assistance alignment with social movements against mining, while the MP is wary of the risks of technocratic and mining company alignment—there is an uncomfortable insistence, then, that they have significant potential political power but must not use it.

Perhaps the Technical Assistants will not be so constrained as the scientists as they are given the task of supporting the Affected in the defence of their rights and in the new participatory local commissions and regional Chambers, yet, the possibility that they might be independent, or purely technical, much STS work calls into question as part of the original call for participation (e.g., JASANOFF, 2004; WYNN, 1996). To reiterate, it is quite possible, if not inevitable, for support to be at once technical and political. Maintaining that it is apolitical may only incentivise continuing work to claim the absence of a role for values in assistance, rather than lead to public and accountable deliberation of their integration. This may be implicitly understood in practice, as, for example, the Catholic consultancy Cáritas was ratified as Technical Assistance by Judge Mário; yet this leads to the question of why it is not addressed head on, with the caveat that there may be some value in the famously informal and often contradictory Brazilian relationship to administration (CALDAS; WOOD JR, 1997). Given the new commissions and Chambers are neither state, municipality, nor mining company, it remains to be seen how far it can interact with, inherit or remould the broader Rio Doce basin networks dominated by mining companies, submissive municipalities, and dependent residents with the environment as a resource to be made 'secure' for mining, as it is for the recovery.

The Reforestation Prioritisation Project is our example of the kind of expert-led project and participatory-process design and implementation that the legal agreements inscribe, at least for issues delineated as socioenvironmental. Its evolution demonstrates the capacity for experts to negotiate and contest the production of science and the roles of experts, as the university team, Renova Foundation, and CT-Flor and its members made decisions to reinforce measures to represent the Affected and society in the river basin, as well as environmental characteristics. Though specialists operating within public universities laboratories, they explicitly navigated the integration of social values, such as equality in wealth, infrastructure and education, into the model and implementation strategy. It is no coincidence that one of the public university leads for the project had researched and written on scientists awareness of social narratives and values in their work (MONTEIRO; RAJÃO, 2017). For the sake of transparency, it is highlighted here that he was also the supervisor of this research. However, even as diversity among specialists appeared and contributed to model and implementation changes that may have had important impacts for those they claimed to represent, the project also highlights the persistent constraints on those involved: while a variety of data types could be selected and combined for social vulnerability and agroforestry plantation, these would always be secondary, quantitative and scientifically derived model inputs; as the university team could suggest prioritising indigenous and settlement lands, it was on pragmatic grounds that this could be accepted; even if their values as citizens were included in conversations on strategy for the participatory process, their role as scientists as intermediaries of the Affected and the environment could not be compromised. This fits in with specific cases of upstream decision-making and participation as add-on without effect (O'RIORDAN; HARAN, 2009; WILSDON; WILLIS, 2004).

Again, this is not an evaluation as to whether the project demonstrated the best strategy given the context. It is not to say whether the university teams would seek to reconfigure the network in other circumstances, and such consideration of social values and impacts by experts is surely an aspect of several models of science-democracy relations (BERG; LIDSKOG, 2018; BROWN, 2009). Nor, on the other hand, does not deny that the enrolment of the public universities may well have served in part to bolster Renova Foundation's own legitimacy. It highlights, rather—and just as Horowitz (2012) and Lockie (2004) describe in relation to conservation groups—that in order to maintain a position of any power and influence in the network, the scientists had to accept certain

boundaries of their role, even as they negotiated them. This, in turn, implies and agrees with said contemporary approaches that emphasise complex systems over distinct processes, as the deliberation of experts can only serve effectively within a broader framework. Without a responsive system, the participatory process was, again, a sandbox in relation to the model if not the implementation strategy: the decisions were taken elsewhere.

The notion of expert, apolitical intermediaries is reinforced with regards to the entities that remain least questioned in terms of their politics: those considered to be the natural environment. Indeed, the MP, in interview, hesitated to speak for participation in Technical Chambers for socioenvironmental issues and suggested these were not of significant concern. Alongside the evolution of the legal agreements described, this implies that the major divide between programs is not socioenvironmental and socioeconomic, but environmental, and therefore technical, and social, and therefore (potentially) political. From the first inscription in the TTAC to the Reforestation Prioritisation Project, alternative ontologies of the natural environmental have been excluded for the preferred representations of the state agencies and scientists, so that the possibility of the Affected, Indigenous and Traditional Peoples to speak for the environment or define impacts has been dismissed (although this possibility is mentioned at least in the TAP Aditivo). The devices employed to stand with the modellers as an intermediary of the river basin, from original landscape-scale data with their own means of production to software manipulation, map production and presentations are born and of and reinforce an abstract, reductionist landscape in the same way the TTAC does. Perhaps in implementing regeneration on Indigenous and settlement land there will be room for engagement with other relationships to the environment, but that would require further research. But while it is easier to imagine those who depend most closely on environmental resources as suffering for a loss of ability to say what the environment is and wants, as Sepúlveda-Luque (2018) demonstrated, natural entities can impact environmental politics for those less directly affected as well. We can ask, then, about the broader cost of the dominant frame of nature inscribed in the agreement by the state agencies. What if someone were to speak of the basin and its non-human inhabitants as if they had desires and needs? How would this impact not only the recovery, but the essentially unaltered network that translates the basin as populated by inert people and resources to be measured and managed?

There is no intention here to denigrate the science of modelling in itself or its important capacities, and there are examples of modelling and modelling experts in collaboration with Indigenous and Traditional Peoples (DE MORAES FALLEIRO; SANTANA; BERNI, 2016; FLYNN et al., 2018; RÖCKMANN et al., 2012), even as there are substantial risks (BARBER; JACKSON, 2015). However, Latour (2004) insists that this power to speak for nature is exercised *as a power*, i.e., not performed by black-box devices presented with their operatives as intermediaries; Brown (2009) extends this into a normative framework that suggests politically accountable and authorised representatives of humans and non-humans deliberate within in a participatory system. Evaluating the Reforestation Prioritisation Project and its participatory process as political in any sense would reveal severe deficiencies. More interesting is describing the parallels between the way the Affected and the environmental are subject to intermediation by experts that must reinforce their capacities as objective and technical in order to be admitted, which may also be compared to the negotiation the Affected must encounter in order to enter the Loss Register and other bureaucratic structures (ZHOURI et al., 2017), albeit with a substantial difference in power relationships. The network to date has not encountered the possibility of explicitly political representation of the environment.

Recalling evidence of a Brazilian civic epistemology— Macnaghten & Guivant (2011) suggestion that Brazil does not treat broad participation as normative in technoscientific issues and Massarani et al. (2019) survey of young Brazilians suggesting demand for participation along with limited scientific literacy and trust in expertise—the examples of the legal agreements, the MP opinion, and the Reforestation Prioritisation Project, reinforce the notion that the two unresolved voices that Irwin (2006) identified in UK discourse are alive and well in Brazil. One calls for greater engagement of citizens, stakeholders, or the Affected, the other demands rigorous, scientific and expert-led, decision-making. And the resolution of the legitimacy gap via transparency, a public deficit of trust rather than information, is comparable to the extent that the innocent citizen is here also employed: activists and those with religious or ideological ‘bias’ are illegitimate participants. Substantially different from the UK or US contexts, however, is the historic presence and role of the state, private companies, residents dependent on the mining economy and/or natural resources, and continuing historic environmental degradation.

The local context of long-term challenges prompts another question—also suggested via the inclusion of agroforestry as plantation type in the model—that may divide critics of Renova Foundation: is Renova Foundation meant to repair and compensate the disaster (as defined in the TTAC) or the Rio Doce basin as a whole? Or do we define the disaster as having begun decades or centuries before and continuing through to today? Although Roberto Waack claimed that the aim of Renova Foundation is to arrive a better situation than before the disaster, the mining companies interests clearly lie in another direction. There is a distinct conflict of interests here that link to social movements. If the aim is to rid the basin of mining, assuming this is in fact the deeper interest of the Affected, then it may make more sense to disrupt the recovery by whatever means so that Renova Foundation fails; success would risk empowering mining companies and their failure can be used as evidence that they are incapable of operating without impact. Yet, if the goal is broader changes in the web of relationships between mining companies, the wider economy, politics and government, then neither the present complexity nor a forever-unstable network can accomplish this. Mining companies are deeply embedded, economically and culturally, leading to the 16,000 petition for the return of Samarco's operation in Mariana—a petition of the Affected. If it is the entire Rio Doce river basin that is to be recovered in the context of many years prior to 2015, this implies that this is at least partially beyond the responsibilities of Samarco and its shareholders. If they are to be held to account, it must clear what they are accounting for, and where the responsibility becomes shared with government and other private sector. Already for those in the basin, the line between Renova Foundation and the state is blurred, according the Renova Foundation manager. Perhaps this is unsurprising given the role of the state in creating and operating the Foundation. In terms of criticism and learning, though, in the creation of new aims, strategy, and accountability, the argument requires careful consideration.

Finally, those who can successfully claim to speak for the Affected clearly have significant power, given that they are that which the legitimacy of the recovery rest upon. That which determines who, when, where and how they may (not) be spoken for is the subject of this research. So, where is the voice of the Affected in this research? Are they co responsible for the network that renders them incapable of defining themselves and excluded from the centres of translation? As noted, this form of ANT can have the effect of following and thereby reinforcing the powerful actors. As the actors in *this* network

were followed—albeit also limited by the time and resources of a single researcher—those who might be considered the Affected were not found to have had impact beyond their competing translations by others. But it is not suggested that those who have been affected by the disaster are inactive or without influence (see, for example, *Jornal a Sirene*). Instead, it is hoped that by highlighting the means by which the network at the centre of which sits the TTAC & Renova has been produced, negotiated and maintained to ensure the Affected have few real means of disputing their position as both incapable and legitimating in relation to formal governance that learning can take place. There are certainly many other networks and forums in which the Affected and those they choose to represent them are politically active (the new structures certainly need research), and at least some in which the identity and needs of the environment are politically represented or at least considered in different ontologies—these offer important practices, experiments and innovations that may well already create impact at a distance and could guide a formal governance structure that properly encounters environment and Affected.

Relatedly, well it may also be asked: what should be done next? This we approach in the following Conclusion chapter.

CONCLUSION

Critiques, such as the Latin American Commodity Consensus (SVAMPA, 2015), a recovery operation that produces further suffering (ZHOURI et al., 2017), and the abuse of human rights (TUNCAK, 2017) highlight wrong-doing and the abuse of power. The analogies and connections between the TTAC & Renova network and the wider network in the basin, of state, mining-company, economies and environment that produced and is partially replicated and reinforced by it, are important. This research takes a related but different perspective, that of the Post-Participatory Turn, i.e., participation is always emergent, experimental, and in the making (CHILVERS; KEARNS, 2016b), and that of ANT, i.e., networks of humans and non-humans are continually enrolling, negotiating, and coercing each other to produce the social (CALLON, 1984; LAW, 1992). Even if the Renova Foundation is merely a front for the mining companies continued abuse of power, and though many may deem the TTAC & Renova Foundation a failure, this neither precludes the possibility of important innovations taking place nor diminishes the responsibility of researchers to examine them with an open mind.

Assuming that one model of governance or participatory process should be appropriate over others would be to engage in precisely the mode of operation that is being criticised. Certainly, there is motive for the MP to hesitate in prescribing the means by which the local commissions and regional Chambers might function. On the other hand, observations can be provided that might guide those that are considering both the 2015 Samarco Disaster in Mariana and the 2019 Vale Disaster in Brumadinho, while respecting their substantial differences. These observations connect to environmental governance in the basin and Brazil beyond the disasters. We consider conclusions in terms of: principles to guide future efforts in light of STS literature and the boundary maintenance between the Technical and the Political, and Nature and Society; systemic perspectives, understanding the governance structure and participatory processes within a broader network; recommendations for addressing the remit of Renova Foundation and the involvement of the mining companies; and a brief evaluation of the use of ANT as a method and contemporary perspectives on participation.

In general terms, we can recall Felt & Fochler (2008) criticisms of participation, which are written here as recommendations: reflect on norms, means, and aims (they lack

coherence to the point of conflict); disregard the idea of an innocent citizen (new forums can replicate power imbalances); and discover participant meanings of participation (follow the Affected in how they imagine participation). More specific to the TTAC & Renova network, STS has long grappled with the boundaries of the Technical and the Political (GUSTON, 1999; JASANOFF, 1995), and this boundary appears in: the division between socioeconomic (social) and socioenvironmental (environmental and technical) programs; an abstract and scientific translation of the environment; the presence of experts and consultancies as intermediators of nature and to some degree the Affected with distinct mechanisms of control; the descriptions of Technical Assistance as objective and neutral; and in the Reforestation Prioritisation Project ToR, development, and restraint of the participatory process. This appears to reflect patterns elsewhere, such as the UK (IRWIN, 2006), but also a Brazilian civic epistemology that retains trust in expertise (MACNAGHTEN; GUIVANT, 2011; MASSARANI et al., 2019): participation is considered in terms of social norms over pragmatic ones, as linked to a distinct history of democratisation rather than a Western crisis of trust in expertise (CICONELLO, 2008). In practice, this division may be implicitly understood to be false (CALDAS; WOOD JR, 1997), yet, as witnessed in the Reforestation Prioritisation Project negotiation over the roles of technical procedures and experts capable of intermediation of society and the environment, the boundary provides a vulnerability. The university teams negotiated their roles with a view to explicit deliberation of the integration of social values in strategy and the production of science, but without a network that can remain stable while enrolling experts and science as actors with social values, this potential mitigation will fail.

For those that are considering strategies for today and the future, it is recommended not that experts and scientists are excluded in favour of participants, but that the inevitable production of values in nominally technical representations is openly addressed. This is approached by Roland et al. (2018) when they state that, far from compromising the Technical Assistants, connections to religion, NGOs, politics and social movements would in fact make them *better able* to represent them (p.19). But this is not extended to the values or ideology of those who represent the environment, nor does it deal with the broader boundary between expertise and politics that has been built. Unless Technical Assistance in particular is recognised as involving value-based decision-making, unpalatable decisions will be derided as failing to be objective, rather than based on alternative priorities. For the revision of programs, Indigenous, Traditional and Affected

ontologies of the environmental and impacts should be considered to achieve inclusivity and legitimacy, if not improved pragmatic outcomes (COSCIEME et al., 2020). Even if the division between socioeconomic and socioenvironmental programs is maintained, the assumptions and values behind environmental analysis, program design and implementation should be addressed head on. This does not necessitate full-fledged adoption of a framework for science in democracy (BERG; LIDSKOG, 2018; BROWN, 2009), though guiding models, such as Callon et al. (2009) Hybrid Forums of diverse experts and citizens may be of use. Rather, an orientation toward representation of nature as a power that requires accountability (LATOUR, 2004) along with principles of reflexivity and humility are required (CHILVERS; KEARNS, 2016b). ANT has itself been suggested as means to improved environmental licencing procedures in a similar fashion (LOCKIE, 2007). In the Reforestation Prioritisation Project—as in the example of Monteiro & Rajão (2017) and some of the original Participatory Turn frameworks, such as Bäckstrand (2003)—scientists consider democratic values and demonstrate that this does not inhibit their practice as experts but complements it. And, restricted as it was to specialist procedures and quantifiable secondary data, the Reforestation Prioritisation Project still contained key opportunities for the Affected to provide earlier input in terms of local knowledge, alternative data sources, and social validation of the weights applied to produce the indices. Open consideration of how values are selected and reproduced in science should not place expert enrolment at risk.

Beyond the boundaries between the Technical and Political and the representation of nature, social and pragmatic goals of participation are not fully reasoned out. The common pattern in the broader literature is that trade-offs are not fully appreciated, with intentions for social outcomes often suffering for pragmatic concerns, or vice versa (FRITSCH; NEWIG, 2012; MUSCH; VON STREIT, 2020), including in the Tropics (ESTRADA-CARMONA et al., 2014; REED et al., 2017). If the intention is to include diverse actors and perspectives and to offer an opportunity for the Affected to develop deliberative capacities and learn, this will hardly provide quick and concise responses to urgent demands for recovery actions. Where rapid decision-making and implementation takes place, this may well suffer for democratic ideals. Appreciating the Post Participatory Turn loosening of the assumption that more participation is better implies that there are situations in which the costs would outweigh the benefits; however, this does not support the present restriction of participation to questions demarcated as social—the boundaries

between that which is left to a restricted group of experts and who counts as expert can be openly and collectively considered in principle to guide protocols for urgent situations that preclude deliberative decision-making. The need to address trade-offs is only enhanced by the analysis of the TTAC & Renova network that suggests the mining companies' incentives have been reduced to cost control, as participation itself is likely to be the target of a delegitimization campaign—this can be accomplished via accusations of inefficiency.

Moving on to understanding the implications of the broader network in light of a systemic perspective, the CIF, Technical Chambers and the operations Renova Foundation provide unprecedented contact between levels of government and state agencies within a bioregional framework. The historic divergences between institutional perspectives, as illustrated both in the development of 41 programs but also in the institutional negotiation for the Reforestation Prioritisation Project, may well have produced and be at least partially reproduced in the recovery, yet the Reforestation Prioritisation Project also demonstrated a limited but important example of adaptation to the new remit and decision-making forum: the representatives of different agencies adjusted their role from oversight to project design, and accommodated multiple translations of the river basin that included a multi-purpose-landscape intervention strategy in agroforestry. If such adaptations are being replicated in other Technical Chambers and forums, such as the CIF, this would imply that important new partnerships and experiences are being generated that could contribute to improved inter-institutional collaboration.

Much as Hybrid forums, ANT as licencing practice, and accountable representation of nature stand as references, the significant local pre-existing bioregional governance structure, the River Basin Committees, likely also provides nearby spaces for innovations. Prior research has investigated the limitations and potential of this important Brazilian policy: Neaera Abers & Keck (2009) comment on their capacity to provide collaboration between non-state actors and mid-level government to effect decision-making and mobilise state implementation of policies; and Taddei (2011) describes their potential to disrupt traditional clientelist politics and link local populations to state politicians. This is not to suggest they are presently an ideal institution, as they can suffer power imbalances, overly technical deliberations that reflect our analysis of the Rio Doce, and lack stakeholder diversity (BARBOSA; MUSHTAQ; ALAM, 2017; LIBANIO, 2018), nor to imply that, like the new local commissions and regional Chambers, that they have

sufficient mechanisms of power, but to respect the principle that complex, systemic change relies at least partially on local experiments and innovations and not top-down imposition (GEELS, 2011; KURTZ; SNOWDEN, 2003). In a similar vein, we can look to the examples of participatory Brazilian Integrated Landscape Management as modes of collaborative translations of landscape, such as Protected Area management planning (BOCKSTAEL et al., 2016), Indigenous fire brigades in the Cerrado (DE MORAES FALLEIRO; SANTANA; BERNI, 2016), and cooperative oyster management in São Paulo state (HAQUE; DEB; MEDEIROS, 2009). As with other research on ILMs, the conditions for success were projects lead by institutions concerned with social and environmental values and involving both state and private sector (REED et al., 2016).

There is evidence, then, that interinstitutional and participatory environmental governance projects can be successful, and that Brazil is no stranger to such experiments. ANT provides that power is a property of relationships and the Post-Participatory Turn brings a systemic and emergent perspective that renders relationships as both constraints and opportunities: Brazil's relationship to participation, environmental governance and expertise is ever evolving; a shift to improving the range of outcomes depends on both demand conditions, policy and institutional frameworks, and experiences (RASK; MACIUKAITE-ZVINIENE; PETRAUSKIENE, 2012). Assuming that effective practices that may be subject to amplification or transfer are occurring in the Rio Doce basin and in Brazil, this calls for more research and communication—not only in academic forums, but between institutional and participatory spaces with accessible narratives of multi-actor interactions, both successes and challenges, such that new translations are available for actors to negotiate and enrol.

Obvious immediate recommendations include: the simplification of the governance structure with clearer aims, membership and relationships, as well as the reduction of auditing with improvement of bureaucratic systems; consideration of the power for local commissions and regional Chambers to force Renova Foundation to accept agreements within the remit of the TTAC or the final agreement, providing a real power mechanism; and reduction of mining company influence. Allocating decisions on indemnity payments might well be more suited to a public body, if one were prepared to take it on with its inevitable conflicts. The judicial route and licencing procedures have thus far proved mostly ineffective in changing operations and require strengthening and simplification: it must enough not to risk such disasters, but not so much as to render the source of the fines

extinct. However, less obvious, and likely more provocative, is that, taken as an implication of ANT, mining companies should not be removed from governance of either the Samarco or Vale disasters, nor even other forums of governance in the Rio Doce basin. If mining is one day to depart the basin, it will not be soon. Without the opportunity to recover public image, there is no incentive for the companies to invest in and collaborate with the recovery; without multi-actor forums, there will be little contact between mining companies and the people subject to their impacts such that they might ever be encountered and mitigated or prevented.. The present Renova Foundation structure, with the mining companies as a majority of trustees is clearly imbalanced and has likely contributed to an institutional mindset inherited from Samarco (VIEIRA, 2017), but it is rebalancing and not exclusion that is more sustainable.

Careful delineation of responsibilities is recommended also: just as academic critiques set Renova Foundation within the context of historic relationships of power and environmental degradation, so expectations that it might recover the disaster overlap with the possibility of longer-term recovery via its actions. We must be concerned with environmental degradation and poverty in the basin, with the relationships between mining companies and the state, and with the recovery operated by Renova Foundation, they are related. But they also branch out into different lines of cause, consequence and responsibility should governance of the river basin be considered. That Renova Foundation would continue to engage in Rio Doce basin regeneration beyond the remit of the disaster of November 5th 2015 is possible, so too is that the mining companies would contribute to such an endeavour (though presently there is no incentive), but it does not make sense to hold Samarco or Vale and its shareholders accountable for decades and centuries of neglect spanning the entire basin. This is surely the remit of all levels of state, private business, NGOs, farmers, Indigenous and Traditional Peoples, and all other actors who depend upon each other and the land. As above, collective responsibility implies collective governance, including and balancing the mining companies in respect of their contributions.

The existence of Renova Foundation, its likely closure whether sooner or later, connects to the above-mentioned concern to learn from present experiments in order to generate resilience. The Rio Doce basin and its inhabitants will still be in need of good governance. Thus, it makes sense to anticipate how the CIF, Technical Chambers, local commissions, and regional Chambers might reconfigure at the closure of Renova Foundation. This

might suggest some program of reinforcement of CBH-Doce, given that it is the established bioregional forum, or uptake into municipal and state level agencies. In either case, the potential stands, if considered in advance, to leverage the investment in networks, skills, partnerships and information thus far produced in this unprecedented experiment to continue to work to change the wider network of relationships for better social and environmental outcomes.

This use of ANT to understand Rio Doce recovery governance has opened up new insights and offered recommendations. By considering actors in the translation of identities, roles and interests, unexpected dynamics have been described that show not only an unstable and contested actor-network, but the significance of claims to representation of the Affected by multiple actors. Issues of representation of the environment emerge as important in a related way. In comparison to a return to realism and the displacement of the debate (COLLINS; EVANS, 2002), recommendations point in the other direction: of openly deliberating the meaning and roles of expertise and participation. The absence of the voices of the Affected is notable, yet this results from and highlights the production of constraints on their inclusion.

There is partial overlap with existing critiques of bloated structures, the absence of a defined Affected that might co construct participation, and an excess of mining-company influence. Examination of fundamental norms, goals, and mechanisms may seem obvious, though actors have failed to coordinate this. As an innovation, however, this research has suggested leveraging the existing structures and experience of Renova Foundation, the CIF and River Basin Committees to engage in new experiments in bioregional governance based on collaborative translations of the human and non-human world—experiments that could feed back into the participatory ecosystem that helped produce the present disaster response. The recommendation to continue enrolling mining companies cuts against most critical literature and would likely find resistance. With the failure of one disaster response, however, and in the midst of yet another, all actors must look hard at what has worked, what doesn’t, and where new pathways lie. Research that understands participation in the basin from Post-Participatory Turn has proved innovative and valuable, and further examination of ongoing innovations, both from this perspectives and others, is critical for the future of the Rio Doce Basin.

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