Science Advice in Japanese Environmental Policymaking

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Dissertation Abstract

This dissertation is about science advice in Japanese environmental policymaking. It looks into questions what science advice is; how science advice is institutionalized, and administratively regulated; who is giving the advice to whom, and what influence science advisers have in policymaking. General concepts of science advisory structures, and how the relationship between science and policy is theorized are described. The importance of these questions stems from the concept that scientific advice to the government is key for decisionmakers to legitimize their policies. Hence, science is a policy discourse defining factor.

The use of evidence and expert advice is an integral part of policymaking. And nowadays, there is an increasing demand of scientists to participate more in policymaking. In theorizing the role of scientific expertise in policymaking based on aspects of political power of knowledge to influence the policy agenda, influential policy actors are considered to control the flow of information in policymaking networks. The main assumption is that integrated environmental science in environmental policymaking holds influential power and contributes positively to strong environmental policies such as de-carbonization. And in turn their absence from policymaking may explain weaknesses of environmental policymaking.

An explanatory-sequential mixed methods research design was used in which discursive elite interviews of science advisers in environmental policymaking of Japan is informed by the Global Environmental Policy Network (GEPON) Survey conducted in Japan (2012-13). To draw meta-inferences qualitative interviews were integrated in the network analyses based on the survey data. The power potential of actors was calculated from knowledge exchange activities. Social network analysis tools were used to operationalize the main assumption. Networks were plotted to highlight the position and the integration of science advisers in environmental policymaking around the de-carbonization issue. Betweenness centrality measures were used to calculate the “bridging potential” of scientific advisers to facilitate a relation between science and policy actors.

The analyses showed that one key attribute of national research institutes is to manage and supervise ministries’ resources rather than contributing expert advice in policymaking. The main source of expert advice used in policymaking is market-based where corporate research institutes or consulting firms are a service provider to the political customer. Overall science advice is limited and not given much liberty outside ministerial advisory procedures. While such science advisers are theoretically in strategic and potentially powerful positions in policymaking networks a regulatory straitjacket confines the ability of expert advice to reach the government. The integration of findings enriches the scholarly discussions in the field of Japanese environmental policymaking and provide implications for mixed methods research.

要約

本稿は、日本での環境政策における科学的助言について考察するものである。研究課題は以下の通りとなる。まず、科学的助言について概観した上で、科学的助言がいかに制度化されるのかを描写する。続いて、行政上の規定において、誰が誰に対し助言するのか、また、科学的助言は政策立案に際し、いかなる影響を及ぼすのかを明確にする。既述の問いをもとに、一般的にいかなる科学的助言の過程が存在しているのか、並びに、科学と政策の関係性がいかなる様相を呈しているのかを理論的に考察する。それに基づき、日本の環境政策における科学的助言の全体像を捉えることが本研究の目的である。

政府への科学的助言は、意思決定者が環境に関する諸政策を合法化する際の基盤となり得る。故に、科学は政策における決定的要素と言うことができ、エビデンスおよび、専門的なアドバイスは政策立案において、必要不可欠なものなのである。近年では、科学者の政治参加における要求が高まっている。

理論的には、科学的助言を行う者が、政策アジェンダにおいて知的権限を得ることにより、間接的に政治的権力を身に付けると考えられている。中心的な前提として、環境に関する政策立案では、一貫した影響力のある環境科学が、「二酸化炭素排出削減」のような、強固な環境政策へと明確に寄与するとされる。逆に、政策における科学的助言の不在は、環境政策の弱点を説明し得る。

研究方法として、混合研究法(ミックスメソッド)を用いる。具体的には、量的調査として、2012～13年の「地球温暖化への取り組みに関する調査(J-GEPON2)」を用いる。くわえて、質的調査では、専門家を対象とし、日本の環境政策立案での科学的助言に関する多方面にわたるインタビューを実施した。量的調査と筆者が実施した、質的調査の結果を統合し、メタ推論へと導く。また、政治的権力をもち得るアクターを、交換関係行動を用いて測定し、環境政策において、科学的助言者がネットワークの中にどう統合されているかを可視化するため、図式化を試みた。媒介中心性を用いると、科学的助言者は科学と政治との関係性において、架橋的役割を果たしていることが明らかとなった。

分析結果からは、科学的助言の特質として、政策立案に対する専門家の助言としての寄与よりはむしろ、省庁の資源を管理・監督する機能が確認された。本研究の分析結果からは、政策立案における主要な情報提供もととして、科学的助言よりも私的研究機関が多くあがった。換言するなら、両者の関係をサービス提供者(私的研究機関)と、お客様(政府)と捉えることが可能となる。全般的に、科学的助言は限定的であり、かつ、行政上での助言的行為以外では、あまり自由度がない。科学的助言は理論的には、戦力的および潜在的に、政策立案のネットワークにおいて強力な位置づけにある。他方で、科学的助言者が、制限された政策立案過程に対し不満を抱いている現状がインタビューを通し明らかとなった。つまり、科学的助言者と政策立案との関係には実質的な距離があり、両者の関係は強固とは言い難い。

本研究では、日本での環境政策分野においてこれまで行われてこなかった、質的・量的調査を統合し、分析を行った点にオリジナリティがある。研究結果として、実際には科学的助言者の意見が政策立案において、さほど反映されていないことを明かにした。くわえて、政策立案における助言者の役割という新たな課外を提示した点に本研究の意義を見出すことができる。

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Notes on Style

Japanese names are written in the standard way of family name followed by first name (for example Hatoyama Yukio). Japanese terms follow the common Hepburn transcription method. Long vowels are indicated by a macron (for example *gyōsei hōjin*), except common geographical names such as Tokyo.

Besides Japanese terms, other foreign loan terms where appropriate are italicized (for example, *Macht*).

The reference style follows the American Psychology Association (APA) standard. References to previous research are written in brackets in the text. Footnotes are used to provide additional information where required that is not directly connected to the main argument.

Regarding the data used for analyses, there are several mentions of the Global Environmental Policy Network (J-GEPON2) survey instrument in the text. Variables from the survey instrument used for analyses are listed in their original Japanese in the Appendix. The semi-structured interview guide, and the supplement to the interview guide that was used for scientific adviser classification are also listed in the Appendix.

The R script that was used to calculate centrality measures, and to plot network graphs was included in the Appendix in the font style of the programming language R used in R Studio to distinguish it from normal text. The script can be used for any network plotting in R Studio using the package iGraph. For replication of the analyses adaptations in the script might be necessary depending on the data sources used, and the style of data organization.

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Abbreviations

COP	Conference of the Parties
CRDS	Center for Research and Development Strategy
CSC	Center for Science Communication
CSTI	Council for Science, Technology and Innovation
CSTP	Council for Science and Technology Policy
DPJ	Democratic Party of Japan
FFPRI	Forest and Forest Products Research Institute
GEPON	Global Environmental Policy Network Survey
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
JST	Japan Science and Technology Agency
KP CP1	Kyoto Protocol Commitment Period 1
KP CP2	Kyoto Protocol Commitment Period 2
LDP	Liberal Democratic Party of Japan
MAFF	Ministry of Agriculture, Forestry and Fisheries
METI	Ministry of Economy, Trade and Industry
MEXT	Ministry of Education, Culture, Sports, Science and Technology
MHLW	Ministry of Health, Labour and Welfare
MIC	Ministry of Internal Affairs and Communications
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MOE	Ministry of the Environment
NEDO	New Energy and Industrial Technology Development Organization
NGO	Non-governmental Organization
NIES	National Institute for Environmental Studies
NISTEP	National Institute of Science and Technology Policy
NPO	Non-profit Organization

OECD	Organization for Economic Cooperation and Development
PCAST	President's Council of Advisers for Science and Technology
RITE	Research Institute for Innovative Technology for the Earth
TEPCO	Tokyo Electric Power Company
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

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1. Introduction

> "This all points to a problem in Japan that predates Fukushima and seems to afflict every Japanese regime: the absence of a strong and independent scientific voice to advise the government" (*Nature* Editorial, December15, 2011, Vol. 480, p. 291).

1.1 Independent Science Advice in Policymaking: Real or Ideal?

During the immediate phase of disaster control management in 2011, the scope of the problems in the Fukushima Dai'ichi Nuclear Power Plant run by Tokyo Electric Power Company (TEPCO) was still unclear. TEPCO did not provide much important information to the public, nor did they share information with government administrators. Former Member of Parliament Taira Tomoyuki and former Prime Minister Hatoyama Yukio from the Democratic Party of Japan (DPJ) government (2009-2012) criticized the sluggish information-sharing behavior and the exclusion of independent scientists from damage assessments in a comment piece in *Nature* on December 15, 2011 (Taira & Hatoyama, 2011). *Nature's* editorial comment (above) conveyed their conclusion with regards to the authors' discussion.

In the years following Fukushima, science advice to government emerged as a policy theme in Japan, and efforts have been made to change mechanisms and procedures of science advice in policymaking (Sato & Arimoto, 2016). But why was science advice in policymaking not a theme in Japan before? Does this mean science advice is excluded from policymaking in Japan? And if so, what factors explain the weak position of the use of scientific expertise in policymaking, and what does this mean for environmental policymaking in Japan?

The question of whether science advice is excluded from policymaking is the easiest to answer. Scientific advice is not excluded from policymaking in Japan. Scientists are generally appointed in ministerial advisory committees (*iinkai*). But this does not necessarily mean that the advice is either independent or neutral (Yoshikawa, 2016). As for the question of why science advice was not a strong policy theme before Fukushima, literature provides possible explanations, as will be illustrated in this Introduction.

The remaining three questions, what factors explain the position of science advice in Japanese policymaking, what does environmental policymaking add to the discussions, and what this means for policymaking in Japan, however, need more in-depth research to answer. That is the goal of this dissertation.

1.2 Science Advice Before Fukushima

Some explanations may be found in Japanese studies scholarship for why science advice was not a strong policy theme in Japan before the Fukushima disaster. The establishment of socio-political institutions for the environment in the 1960s and 1970s provides a possible explanation. Intense investments in heavy industries to accelerate economic growth in the early post-war era caused a pollution crisis, which resulted in serious health problems – cases of the Itai-Itai and Minamata Diseases are most well-known examples[1]. The harm to the people of Japan during this time worsened partly because the government concealed critical information from the public (Broadbent, 1998). Subsequently, the Environment Agency (est. 1971) and the National Institute for Environmental Studies (NIES) (est. 1974) were established. In fact, NIES was established with the purpose of integrating independent and transparent research on the environment to prevent such disasters from happening again (Kagawa-Fox, 2012; Kameyama, 2017).

The suffering in Japanese society from pollution resulting from the "single-minded determination" by the Japanese government to accelerate economic growth "led to the formation of environmental social movements" (Kagawa-Fox, 2012: 3). Similar experiences during the economic growth phase of the post-war era in Western countries motivated the formation of such social movements globally. The capacity and effect of such environmental movements were stronger in some countries than in others, which led to differences in the institutionalization of not only national civil society organizations, but also of political and administrative institutions for the environment (Schreurs, 2002). In fact, we find the argument in literature that there is a strong connection between environmental science, environmental movements, and administrative institutions for environmental regulations in Western countries (Yearley, 1992). The thesis is that more than any other social activism, the environmentalists' argument was a scientific argument. This is because the environmental movements of the mid-20th century were partly triggered and continuously

[1] "From around the 1890s, in the rich basin of the Jinzugawa River, unusual damage to crops began to occur, such as poor growth of rice. Soon from about 1912, a disease of unknown causes was beginning to occur, one that caused extreme pain throughout the whole body. Local residents feared this disease, which they considered 'the strange disease' that could never be cured once affected…The agricultural and fishery damage … came to be reported by newspapers as to be a result of the mineral poison from Kamioka Mine…The strange disease in the Jinzugawa River basin became known as 'Itai-Itai Disease' from a newspaper report in 1955. This naming was reportedly brought about from the fact that victims were crying out 'itai itai' [(it hurts, it hurts)] because of its intolerable pain" (Toyama Prefectural Itai-Itai Disease Museum, [no publication year indicated]). Cf.: Toyama Prefectural Itai-Itai Disease Museum accessible at http://www.pref.toyama.jp/branches/1291/index.html (Last access: September 13, 2019).
"In 1955, many cases of severe neurological disease were found in the Minamata area of Kyushu, Japan. In 1959 it was demonstrated that the symptoms were due to poisoning by methyl mercury, an effluent from an acetaldehyde plant of the Chisso Corporation. The toxin was transmitted through ingestion of seafood taken in Minamata Bay, hence the term 'Minamata disease' (Study Group of Minamata Disease, Kumamoto University, 1968)" (Harada, 1978: 285).

informed by an ever-increasing body of serious scientific examination of the causes of various medical, environmental, and social problems: "[Unlike] many preceding social movements, the environmental movement claims a scientific basis [because] the green argument is very profoundly a scientific one" (Yearley, 1992: 511). The environmental case against greenhouse gases was born out of scientific knowledge; only through scientific inquiry do we understand today what greenhouse gases are, what causes them, and how they destroy the ozone layer. This is only one example of many environmental issues that illustrate how "the green movement is doubly bound to science, by epistemological affinity and common descent" (Yearley, 1992: 514).

Furthermore, the interconnection of environmental science and environmental policymaking can partly be traced to the existence of Green Parties and by extension to the political institutionalization of environmental movements. Green Parties are not only important policy institutions responsible for carrying a strong environmental policy agenda, they also carry out or motivate important research (Broadbent, 1998). It is the deep roots of the connection between environmental movements and their use of environmental science to strengthen their positions in policymaking that distinguishes science-policy interfaces in environmental policymaking from other issue areas.

In Japan, however, environmental movements were not institutionalized nationally as strongly as in other industrialized countries (Schreurs, 2002) nor was any Green Party involved in the integration of environmental sciences. While it is beyond the scope of this dissertation to discuss the thesis that understanding the potential role of a Green Party may aid the understanding of integration of environmental science in policymaking, because Japan's only official Green Party was established just a few years ago, in 2012, and the connection between science and environmental policymaking in Japan differs from that in other developed countries. Therefore, this may be an explanation for why science advice for the Japanese government was not an important policy theme before 2011.

Previous research in the fields of science, technology and policy studies showed that models and application of science-policy interfaces in environmental policymaking, compared to other political issue areas, lack methodological clarity on how to effectively integrate and apply scientific advice in environmental policymaking (Pullin & Knight, 2012). The complexity of climate change may be a reason for this. To make the connection to the case of Japan, analyses of literature shows that problems of science-policy interfaces for which Japan was criticized can in fact be observed globally. However, connecting the argument about the state of Japan's environmental policymaking with the argument about science-policy interfaces in the policy issue area for the environment may be another possible explanation. Despite institutional differences on the local level, the generalizability of structural and functional issues provides legitimization of the theoretical concept that will be developed in Chapter 4.

Another reason is that socio-political institutions for the environment in Japan might be comparatively weak compared to the aforementioned institutions in other countries. Advanced technologies and the strong economic position of Japan among OECD countries is significant in contrast. Science, technology, and research and development from Japan is internationally well regarded, and often cutting-edge. As Samuels (1994) put it, the pre-war slogan of "rich nation, strong army" was replaced by "rich nation, strong technology" in the early post-war era (Samuels, 1994: 319). The fight against the pollution crisis in the 1960s and the oil shock of the 1970s boosted the development of energy efficient and low-carbon technologies in Japan (Moore & Miller, 1994). Environmental researchers from Japan are important cooperators for the international science collaboration network for climate change, co-authoring the Intergovernmental Panel on Climate Change (IPCC) Assessment Reports since the formation of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. Even more surprisingly is that socio-political institutions in Japan have notably less trust in climate change science than in other countries (Hartwig, 2016; Satoh, Nagel, & Schneider, 2018). As a consequence, less trust in science may be either a cause, an effect, or a correlating factor for weaker integration of science advice in policymaking.

As a result of the strong economic position of advanced technologies, applied research is stronger in Japan than basic research in terms of output and access to resources. Additionally, the dominance of the private sector in education has privatized knowledge (Low, Nakayama, & Yoshioka, 1999). However, this does not explain the trust crisis of science nor why science advice was not a policy theme before 2011, considering the importance that each political administration in Japan (since the end of World War II) has put into the promotion of technology. For example, the expenditure in basic research has increased from 1,978 billion Japanese Yen in 2008 to 2,296 billion Japanese Yen in 2017 from the country's gross domestic product (OECD, 2019). In comparison, the expenditure for applied research sank from 3,767 billion Japanese Yen in 2008 to 3,269 billion Japanese Yen in 2017 from the gross domestic product (OECD, 2019). The Council for Science and Technology Policy (CSTP) (*sōgo kagakugijutsu kaigi*), established in 2001 and renamed to Council for Science, Technology and Innovation (CSTI) (*kagakugijutsu inobeishon kaigi*) in 2014, is similar to the United States President's Council of Advisors on Science and Technology (PCAST). (The institutional framework for science advice in Japanese policymaking will be introduced in Chapter 3.)

Coleman's study (1999) offers some explanations from the organizational perspective arguing that the problem of science in Japan, compared to its Western counterparts, breaks down to organizational and administrative issues. In essence, it is the politics of scientific research institutes, the hierarchical, and rigid organizational structure, and the surprisingly low regard for advanced degree holders that diminishes the societal value of basic research (Coleman, 1999). Even today, holding an advanced degree in a sector for research and development does not affect the position of the researcher nor increase their salary.

The typical labor market structure that favors the seniority system within the hierarchical organizational structure among research groups remains dominant until today. The inner politics of science that favors personal connections for securing funding, selected information sharing, and the exploitation of labor may explain the criticism for the lack of neutrality and independence of science advice to governments in Japan, as well as why scientific evidence is regarded with distrust by the public.

To understand the paradox between advanced R&D yet lack of societal and political value in science and underdeveloped policy discourses on science advice for the government, we have to distinguish between two contrary but related concepts. That is, policy for science and science for policy. Policy for science is the policy that regulates and supports science through institutions such as CSTI through publicly funded research projects, or via private research institutes. In short, policy for science is the overall regulatory framework for scientific institutions (Arimoto et al., 2016). While policy for science in Japan has created a fairly complex institutional framework between public institutions and private research, in science for policy, the conduit through which scientific information could be transmitted to policymaking is in actuality "extremely thin" (*makotoni hosoi*) (Yoshikawa, 2016: 199). The main body of this dissertation delves into the research problem from the other perspective, that is science for policy, because literature lacks a thorough analysis about Japanese environmental policymaking and policymaking in general from this perspective.

Important to note is that the pre-existence of a regulatory framework for science advice contradicts the claim made by Arimoto et al. (2016) that science advice was not a dominant theme up until 2011. Literature that looked into how modern scientific thought in Japan came about discusses the problem of the role of science in socio-political institutions with an argument that considers the influence of cultural norms, that is a sociological institutionalist argument[2]. Literature argues that difficulties in the science community in Japan is that the introduction of the modern scientific thought in Japan, imported from the West during the Meiji Era in the late 19th to early

[2] The sociological institutionalism is a stream in neo-institutionalism, a "methodological approach in the study of political science, economics, organizational behaviour, and sociology … that explores how institutional structures, rules, norms, and cultures constrain the choices and actions of individuals when they are part of a political institution" (Ishiyama & Breuning, 2015). Ishiyama and Breuning (2015) defined sociological institutionalism as follows: "[Sociological institutionalism] has its roots in sociology, organizational theory, anthropology, and cultural studies. [It] stresses the idea of institutional cultures. Scholars of this stream view institutional rules, norms, and structures … as culturally constructed. They tend to look at the role of myth and ceremony in creating institutional cultures, as well as the role of symbol systems, cognitive scripts, and moral templates. At times they take on a normative … approach to the study of political institutions, and they tend to blur the line between institutions and culture. Their work often focuses on questions of social and cultural legitimacy of the organization and its participants" (Article citation from Encyclopaedia Britannica Online).

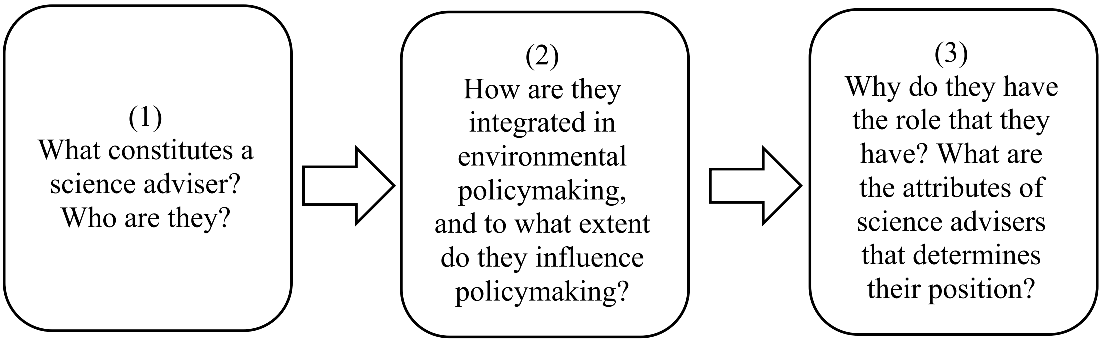
20th century, overlooked that science itself carries "culture and a way of thinking [and] neglected its metaphysical, religious, and philosophical context" (Kanamori, 2016[2011]: 4).

The argument about the interrelation between science advisory processes in governments and environmental policymaking that emerged from environmental movements in the 1960s in North America and European countries puts questions for why Japan did not develop a strong Green Party or environmental policymaking, as its Western counterparts did, in a new perspective. Considering how Japan dealt with its pollution crisis in the 1960s and 1970s to intentionally create a system of environmental science for environmental regulations, distancing itself from government officials as far as possible, may be crucial to understanding why science advice was not an important policy theme until recently, and why the conduit to transmit scientific expertise to the government remains insubstantial. This may be consistent with the argument that the import of the modern scientific thought did not consider science in the cultural sphere.

Applied science is issue-oriented and deals with scientific inquiries and technological developments to serve the immediate social need. In contrast, the purpose of basic research is to investigate natural phenomena from an apolitical perspective unaffected by social and political debates. If applied science dominates, and science advice to the government lacks neutrality as claimed by Yoshikawa (2016), what does this mean for the influence of science in policymaking, and for Japanese policymaking overall? For policymaking, scientific expertise is not the only source of information that is used. And, as we will see in case of Japan, it is de facto not the most important source of information. Nevertheless, because policymakers rely on experts to grasp basic understandings of most important scientific results, which proves to be invaluable in increasing the legitimacy and trust in political decisionmaking processes, the spheres of science and policy are interconnected. It is this interconnectedness that allows us to argue that science is inherently political because it is a "societal institution" and "one part of the scientific 'process' [that is] social and political" (Broks, 2017: 4).

This study wants to solve the puzzle of whether science advice in environmental policymaking in Japan is in fact not independent or maybe even powerless to influence policy agendas if not integrated in policymaking. For this we need to 1) identify who science advisers are considering the complexity of actors in democratic policymaking processes, 2) illustrate how they are integrated in policymaking in regard to what extent environmental policymaking depend on them, and 3) explore features of their role in environmental policymaking. The connection of these questions is illustrated in Figure 1.1. It is empirically difficult to grasp the complex interconnection between the science community and policy community because it is in fact not limited to a connection between just two spheres. It is the actor structure within the spheres that is relevant. Therefore, actor network theories and tools from social network analyses are used to approach these questions empirically (Chapter 4).

Figure 1.1 Research Questions



Source: Author

The reason to approach these questions through actor network theories and social network analyses is because the policy community consists of a large and diverse group of different interest groups among NGOs/NPOs, corporations, and business federations. Moreover, science advisers are not a homogenous group themselves and need to be classified. Besides basic research institutes, nowadays we find an increasing number of consulting firms or private research institutes that are part of the policy process. Depending on the science adviser type their form of participating in policymaking, their position in the policymaking network and their relationships to other policy actors differ. Identifying science advisers is crucial to understanding how science advice is integrated in environmental policymaking. This complexity of policy actors' connections and form of relationships is analyzed through policy actor network methodologies.

The next section in this introductory chapter provides an overview of political theories to explain the connection between the science community and policy community from the basic argument that knowledge is a source of power and is strategically used by policy actors to strengthen their position in policymaking and shape the policy agenda.

1.3 Power of Knowledge in Policy Networks

In *Toward a Political Philosophy of Science,* Joseph Rouse (1987) engaged the question of how power and knowledge relate and, more importantly, what the political effects and therefore significance of scientific practices are (Rouse, 1987: 209). Rouse, however, explicitly detached his argument from the concept of the political influence of scientists as well as the political influence on science.

> "Government and quasi-government organizations undoubtedly have a major impact upon the practice of science. They support it financially and administratively, deploy scientific resources to serve particular ends of their own (e.g. military or medical), and may proscribe or regulate the practice or dissemination of certain kinds of research. These various interactions between science and juridical power are important and interesting, to be sure, but a focus upon them may mask different kinds of power relations that traverse the very practices of science" (Rouse, 1987: 210).

The Power of knowledge is, in his argument, not understood as juridical power. In the case of Japan, however, we may have to consider the juridical power. That is, the juridical power of the social practice that produces knowledge through modern scientific inquiries considering the dominating hierarchically structured (*tatewari*) administrative bureaucracy in policymaking. The argument developed in this dissertation relates itself, in contrast to Rouse, to discussions on the political influence of science.

Rouse (1987) was concerned with the limitations of conceptualizing and investigating the political and social significance of the relation between knowledge and power in traditional forms of inquiry in the political sciences. These conceptualizations were until recently dominated by methodological individualism (Victor, Montgomery, & Lubell, 2018). Policy network approaches aim to overcome these limitations identified by Rouse. By definition, a policy network is a collection of groups of actors involved in policymaking that are drawn together by resource interdependencies (Compston, 2009). Policy outcomes are the results of actors' interactions in such policy networks (Marsh & Smith, 2002), and the formation of groups within policy networks is determined by shared interests and values (Sabatier & Jenkins-Smith, 1993). Technical information, evidence and scientific findings are invaluable sources of information to create effective policies. The questions of how science advice and those who give the advice are integrated in environmental policymaking considers the power distribution among policy actors and asks what effect the integration of science advice has on the power distribution among actors in policymaking.

In a science-policy interface, that is, the integration of scientific knowledge in policymaking (Branscomb, 1991), scientific knowledge is a source of information for all policy actors. Scientific inquiries theoretically do not favor particular interests, and their sole concern is "to explain reality" (Gupta, 1999: 321), in other words, to provide facts about the policy issue area. However, the social constructivist perspective argues strongly against the existence of un-biased science. Scientific facts that are transmitted in the policy network undergo a selection process in a similar manner to other sources of information that are used to formulate policy proposals. This selection process happens at different stages. It begins with selecting the underlying concepts that determines the scope of data collection, analysis and interpretation, and continues until it reaches the stage of selecting information that is to be used and to be presented that eventually goes into policy formulation.

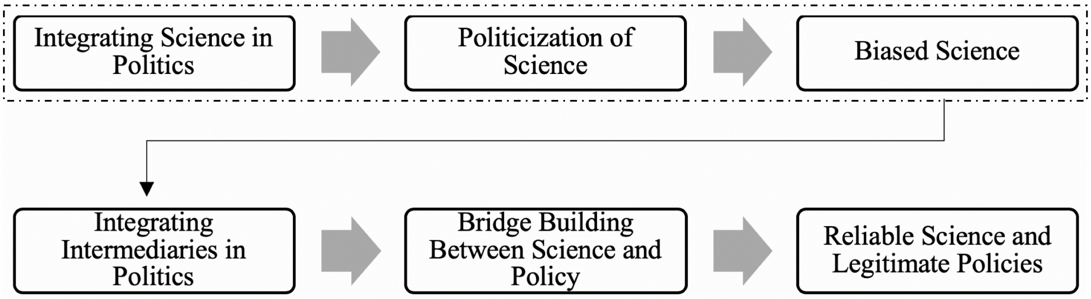
This selection process of available information determines the relationship between actors in the policy network because it is a selection of an issue-group. An issue-group is a sub-set or a cluster of policy actors within a wider policy network, or issue-network (Bulkeley, 2000), that are connected by sharing same or similar values, ideas or opinions about the issue (Sabatier & Jenkins-Smith, 1993). The purpose of selecting groups is to increase the power an actor or the group at large has over the policy agenda (Birkland, 2016). The use of scientific knowledge is understood to affect the power an actor holds over the agenda on a micro-level, and the overall power distribution within a policy network on a macro-level. According to Birkland (2016: 200) the power to influence the policy agenda can be defined as "the process by which problems and alternative solutions gain or lose public and elite attention". This thesis understands the control an issue group has to dominate the discourse in the issue-network as political power. This power creates a bias or a tendency of some issues to reach and eventually dominate the policy agenda because some issue groups are more successful in creating a discourse that is heard by the government and society than others (Birkland, 2016).

Therefore, scientific knowledge is not only a source of information for policy actors to strengthen their position in policymaking (Cortner, 2000). Because it is used to empower actors' positions in policymaking, it is a source of political power (Hajer, 1995). For that reason, unravelling the integration of science advice in policymaking can reveal the power distribution among policy actors if scientific knowledge is considered a resource of power. Consequently, we have to ask whether policy actors who use scientific advice or cooperate with scientists constitute a powerful policy actor group influencing the agenda, or whether science advisers themselves can shape policy outcomes. A brief answer is: it depends on the policy issue (Arimoto et al., 2016).

There are two concerns regarding the means of enhancing the integration of science in environmental policymaking. On the one hand, the demand for direct integration of science into political debates aims to improve solutions concerning climate change. However, this is criticized on the other hand as harmful for independent scientific inquiries and questions of scientific reliability. That is discussed in the literature as "politicization of science," which may be a causal factor for less trust in scientific output as discussed above. It also may de facto increase the distance between science and policy in the long term, if pretended scientific evidence is misused and attached with political ideologies (Cortner, 2000; Pielke, 2006).

The second argument builds on the problem of the first argument, engaging the question by what means this harmful effect could be counteracted or prevented. For this, the main thesis is that science advisers should function as bridge-builders between science and policy. As illustrated in Figure 1.2, advisers that facilitate such a bridge may eventually ensure the reliability of scientific findings and increase legitimacy of public policies (Meyer, Frumhoff, Hamburg, & de la Rosa, 2010).

Figure 1.2 Effects of Intermediary Science Advisers



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The ability of science advisers, who typically operate at low or middle levels of governments to frame and interpret scientific knowledge (Pielke, 2007; Pullin & Knight, 2012) is considered a substantial source of political power because they are "especially influential under the conditions of scientific uncertainty that characterize most environmental problems" (Litfin, 1994: 4). Power of knowledge theories argue that the integration of expert knowledge determines the distribution of power (Hajer, 1995). If science is kept outside of political debates, it is not science that is powerful by itself, but those actors who draw information from science and use it for formulating policy proposals. Considering the question raised above, that is, who it is that influences political decisionmaking, those who use scientific advice may be more powerful in policymaking. The basic argument is developed through the connection of power distribution theories informed by the neo-pluralist perspective. Here, actors are dependent on resources on the one hand and power of knowledge theory on the other (Hajer, 1995). The key resource in this case is knowledge, and policy actors depend on the exchange of knowledge.

To summarize, the basic argument of this dissertation is the following: Science advisers (intermediaries) are theoretically powerful actors in policy networks because they control the selection of scientific knowledge used in policy planning and decision-making. To implement this, social network theories provide definitions of power of individual actors by analyzing networks. It is not only a question concerning the finding that some policy actors are more powerful than others, but a question of why that is. Actors may appear similarly powerful, but they may be powerful for different reasons (Morgan, 2017). Social network analyses operationalize these theories of power distribution in networks based on resource exchange through actor centrality measures. In other words, actors who are centrally located in a network are considered more powerful than actors who are less central (Wasserman & Faust, 1994). In terms of power of knowledge theories, it is the exchange and control of scientific knowledge between actors that determines the power of an actor, as well as the question about the origin of scientific or expert advice in environmental policymaking. In other words, it is a question about who controls the production and dissemination of knowledge among policy planners and decisionmakers in the policy network. To identify such actors, the next section introduces possible science adviser concepts found in literature.

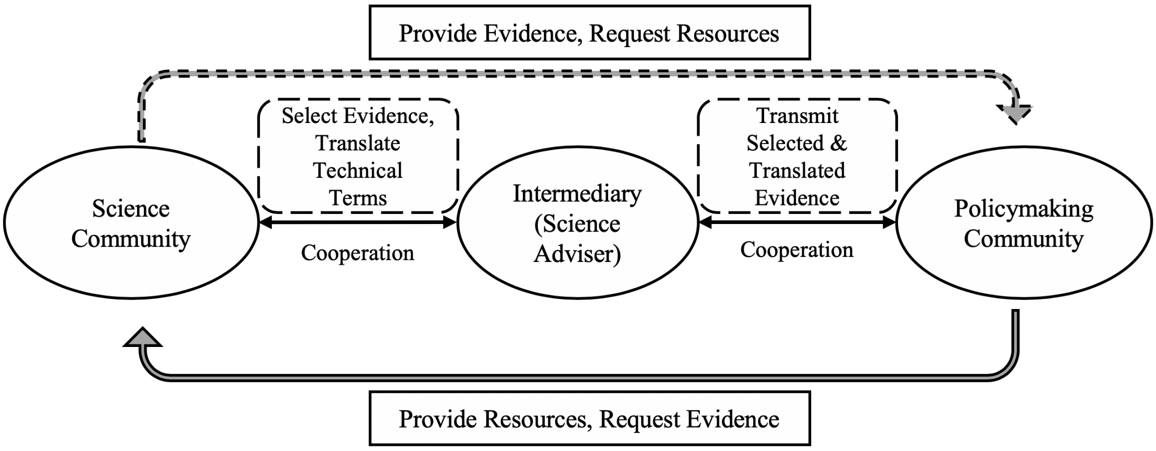
1.4 Science Advisers in a Triangular Science-Intermediary-Policy Interface

The relation between the concept of "intermediaries" and science advisers is informed by Latour's actor-network-theory (2007) to describe the concept of a transmitter or translator of scientific knowledge as someone who acts in the space between science and policy. Such an actor acts as a linkage between policy and science (Litfin, 1994) and is supposed to counteract the tension between political interests and the demand for scientific neutrality in political decisionmaking processes. Figure 1.2 in the previous section illustrates this function.

The demand for integration of science increases the risk that science will be politicized, which may result in a biased selection of scientific inquiries to favor certain policy interests. The integration of an intermediary or science adviser supposedly protects the scientific community from the influence of political ideologies and facilitates a bridge between science and policy to ensure that policymaking integrates scientific knowledge into decisionmaking. Eventually, this process should ensure the reliability of scientific inquiries and the legitimacy of policy outcomes.

Based on this process informed by the theories introduced in Section 1.2, this dissertation developed a triangular model of a science-policy interface that acknowledges the relevance of actors that act in the space between the science community and policy. Figure 1.3 illustrates this triangular model. Generally, science and policy are connected based on the two concepts explained above: policy for science and science for policy. Policy provides the science community with resources, and a regulatory framework and requests evidence on issues for policymaking. Therefore, policy has control over the science community that then acts on the movements in society and policymaking to create such evidence and requests resources from policy to do so. The science adviser, that is connected to the science community on the one side and to policy on the other facilitates a working relationship between science and policy by selecting evidence, translating technical terms to make it understandable for non-experts, and transmitting this to political decisionmakers. This is ideally not a one-way but a cooperative relationship on both sides.

Figure 1.3 Science-Intermediary-Policy Model



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This function describes science advisers as part of the bottom-up structure in policymaking. However, categorical differences among science advisers will show that some types may be part of the "bottom-up" whereas other types that not only channel information but also resources and authority may rather be part of the "top-down" structure.

There are four conceptual types of science advisers offered by Pielke (2007): "Science Arbiter," "Pure Scientist," "Issue Advocate," and what he specifically emphasized as "Honest Broker." These conceptual types are reviewed in detail in Chapter 2. A brief overview of these concepts is provided here. Pure scientists are basic researchers who conduct fundamental research and are generally not interested in politics. Science arbiters are information resource providers to assist decisionmakers in their decisionmaking process. Both, pure scientists and science arbiters are not concerned with a specific decision. In contrast to the proposed un-opiniated position of pure scientists and science arbiters, issue advocates aim to limit the decisionmakers' scope of choice by limiting the amount of information they have access to through an information-selection-process. Issue advocates may be the most dominant type of actors present in multi-layer, multi-stakeholder policymaking processes (Pielke, 2007). While issue advocates follow a selection process of information, the honest broker, as Pielke (2007) termed it, theoretically provides decisionmakers with all available information related to an issue needed to empower the decisionmaker to make the best choice. Both, issue advocates and honest brokers are providers of policy options. Issue advocates however seek "to compel a particular decision, while an Honest Broker of Policy Alternatives [capital letters in the original source] [supposedly] seeks to enable freedom of choice by a decisionmaker" (Pielke, 2007: 3).

As these two sections, Section 1.2 and Section 1.3 demonstrated, the investigation of science advice in environmental policymaking is interdisciplinary. Therefore, a mixed methods research design with which the question of how science advice is integrated in policymaking was developed. The next section briefly introduces the mixed methods approach[3].

1.5 A Mixed Methods Approach

The flow and interconnection of the research questions as was outlined in Figure 1.1 in Section 1.1 argue for the importance of combining quantitative and qualitative forms of inquiry. The research design developed for this dissertation is a mixed methods "Explanatory-Sequential" research design. As the terminology implies, mixed methods employs the mixing of different methods from both quantitative and qualitative forms of inquiry (Creswell, 2014). It is explanatory because quantitative policy network analyses inform qualitative interview data collection[4]. It is sequential because both forms of inquiry happen in sequence, that is they are timewise conducted separately.

It is an interdisciplinary endeavor to identify science advisers, investigate their integration in policymaking and measure their political power. The epistemological basis of science advice to governments comes from the sociology of knowledge. Hence, it requires a combination of different forms of inquiry (see Figure 1.4). Answering the descriptive questions, question group (1) of who science advisers are relies on existing literature and a closed-ended inquiry for actor classification. The second group, question group (2), of descriptive and exploratory questions also follows methods in closed-ended inquiries to answer how science advisers are integrated into environmental policymaking, and their potential to influence policymaking. The third and last group, question group (3), looks into the deeper context to find explanations for science advisers' constitution, integration in policymaking, and how much influence they have in policymaking.

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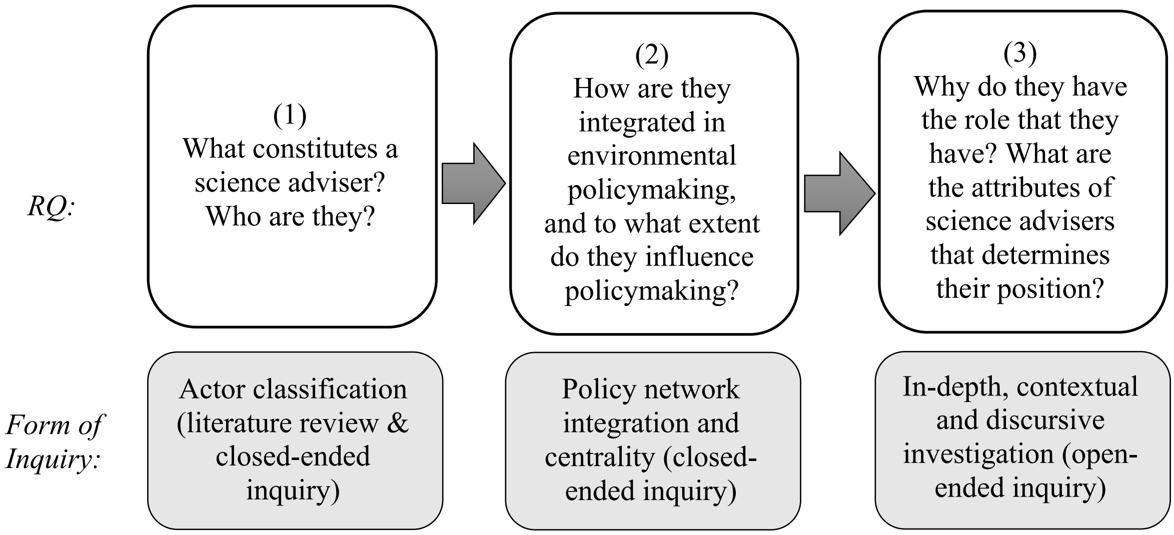
[3] Chapter 5 provides a comprehensive discussion about the research design.

[4] The type of data and data collection is explained in detail in Chapter 5.

Figure 1.4 Research Questions and Forms of Inquiry



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The identification and classification of science advisers as well as their network integration is investigated and analyzed by applying social network analysis with data from the Global Environmental Policy Network (J-GEPON2) survey that was conducted in Japan in 2012/13[5]. The purpose of the survey was to investigate the relationship of environmental and energy policy actors, and how their network was influenced by Fukushima. In accordance with the conceptual discussions on science adviser categories as described above, the population of the survey informed the procedure, that is, empirically identifying and classifying science advisers in the sampled environmental policy network. Following the science adviser classification and network calculations, the results from the quantitative inquiry informed the scope of the qualitative interviews.

The choice of methods is determined by the research questions and the main argument. The overarching research question on how science advice is integrated in environmental policymaking could be discussed from a purely quantitative standpoint. However, the available data set on the network of environmental policy actors is limited in its explanatory capability in terms of how science advice is integrated or excluded in its current manifestation. In contrast to the survey, a pure qualitative approach provides data to develop an argument on how scientific knowledge is used and to investigate the role of science advisers in policymaking. It cannot, however, provide sufficient information to empirically analyze the distribution of power in relation to the position of science advisers and their relationships to other policy actors in the network. The research design is expected to provide implications for mixed methods research and demonstrates the argumentative capability of integrating the analyses to draw meta-inferences.

[5] The J-GEPON2 survey instrument is explained in more detail in Chapter 5.

1.6 Dissertation Chapter Overview

The argument is that the field of environmental policymaking would benefit from a general conceptual model on the triangular relationship between science, science advisers (intermediaries) and the policy community that would in turn assist in explaining why environmental policies differ between countries, and how we can use the understanding of the triangulation for more efficient policymaking, and effective policies for the environment. Science advisers as a "third party" that facilitate communication between science and policy was proposed to improve the integration of science in policymaking. Scholarship has yet to conceptualize this triangular relationship more concisely, due to the fact that discussions on science advice in the form of knowledge brokerage are mostly case-specific empirical analyses and lack an overarching theoretical model. Existing conceptual frames highlight the science-policy interface in which science is supposedly integrated directly into policymaking. However, a review of the literature shows that the bi-modal perspective can increase the harmful potential and diminish its constructive side.

Chapter 2 begins with a description of how science-policy interfaces and the structures of science advice to governments have been theorized as well as empirically analyzed. The IPCC is a corner stone for both international climate mitigation measures and domestic environmental policymaking. The organization serves as an example to clarify how science advice in environmental policymaking is applied, and highlights the potential influential power of environmental science on political decisionmaking. The discussion about controversies of science advisory processes will extract and reveal harmful and constructive capacities of science-policy interfaces.

Chapter 3 provides background about Japan. The chapter first illustrates the case of Fukushima and why the escalation of the nuclear disaster instigated a global re-evaluation of science-policy interfaces. This is followed by a discussion about what barriers science communication in Japan faces. A review of the state of science in Japan in terms mitigation technology and R&D as well as problems that are observable in the science community is followed by a description of the framework of advisory policymaking processes. Chapter 3 concludes with an overview of research topics on the environment and energy relevant for policymaking in Japan by providing a Japan specific example of an intermediary science advisory organization in policymaking. This is in contrast to the global example in the form of the IPCC.

Building on this analysis, Chapter 4 develops an overall theoretical framework that develops from the interaction of three epistemological fields: sociology of knowledge, institutions, and policy networks. There is a difference between the network perspective and institutional perspective that is that research about networks is interested in what kind of impact an actor's position has, while the institutional perspective is more interested in what impact the actor has who occupies the position, they need to be considered as two sides of the same coin. Both perspectives try to identify generalizable properties of influential actors (Morgan, 2017). The concept of science advisers in environmental policy networks argues that they affect the power distribution based on knowledge power theories. The second part of Chapter 4 develops the framework that political influence depends on the type of science adviser, its location in the policymaking network and its relation to other actors in the network. The main argument is that science advisers are powerful yet overlooked actors in environmental policymaking research.

Chapter 5 is devoted to elaborating on the mixed methods research design. The architecture of a mixed methods research design specific to the research questions ((1) who science advisers are, how they are integrated in environmental policymaking, (2) to what extent they influence policymaking, and (3) what features their network position determine) is a tangential goal of this dissertation. This also has implications for mixed methods research. The type of the data and the collection methods are explained. It commences with the descriptions of the development of the mixed methods research design, and why mixed methods is a core feature for drawing inferences from the results of the investigations. The mixing of quantitative policy actor network inquires with qualitative inquiries on science advisers' relationships within the policy network is crucial for conclusions in the overall argument. Quantitative inquiries provide data for the discussion of who science advisers are and how they fit into the policy network. However, only the integration of a qualitative inquiry provides key pieces for the understanding of their role and what features determine the integration of science advisers in Japanese environmental policymaking. The chapter deconstructs the research design to its core elements and reconstructs it to demonstrate its mechanics. A careful de- and reconstruction makes a case for the reproducibility of the overall study.

Chapters 6 and 7 will unpack the research questions empirically. Chapter 6 focuses on the question of how science advice is integrated in environmental policymaking networks by analyzing the actors' position in knowledge exchange networks in environmental policymaking, and integrate analyses from the interview data. As science advisers are theoretically influential policy actors that are expected to facilitate the connection between science and policy, this "bridging potential" is operationalized through social network analyses' centrality measures. The goal of Chapter 6 is to reassemble the deconstructed environmental policy network to see how science advisers are integrated in environmental policymaking, and how we can explain the findings through the discussion of the qualitative interview data. Chapter 7 focuses on the potential power of science advisers operationalized through the knowledge exchange relationship method by Cook and Yamagishi (1992). The potential power based on knowledge exchange relationships is put in context with actors' political attitude towards de-carbonization, through which science advisers' potential to influence the agenda is discussed.

The Chapter 8 re-examines the preceding empirical analyses, and summarizes the main arguments and their implications in terms of questions on independent science advice to governments in general, relates the findings to the literature, discusses the limitations of the research, problems that occurred during the research and concludes with providing research recommendations.

2. Government Science Advice in Environmental Policymaking

2.1 Chapter Purpose and Structure

This chapter reviews literature about concepts of the relationship between science and policy, introduces international institutions of councils for science and science advisers that aim to improve the role of science in society and policymaking, and describes the political nature of environmental science. The purpose of this chapter is to address the questions of what a science-policy interface is and who science advisers are. The discussions in this chapter look at the questions from a general point of view. Background about Japan is discussed in Chapter 3.

First, conceptual types of science advisers and science-policy interfaces are reviewed. Before going into a review of controversies in the relationship between science and policy and why literature has argued for the political nature of environmental science, institutions for science advice are reviewed. The description of the IPCC connects from the general discussion of the science-policy interface to environmental policymaking. The IPCC serves as an illustration for the interconnection between science and environmental policymaking, particularly climate change because literature argues that environmental science is inherently political (Clapperton, 2016: 12).

The IPCC serves as an example of an influential science advisory system in environmental policymaking because it is the "scientific body" for the UNFCCC that provides its members with detailed information about environmental science findings and climate change to assist in desirable policies towards de-carbonization. The organization will be reviewed to explain why it is an example for the concepts of science-policy interfaces in environmental policymaking, and how it serves as an illustration for the development of the theoretical framework. The IPCC can be seen as the main intermediary connecting science with policy by offering a platform of interaction between different stakeholders, policy actors, and climate scientists.

The need for good practices of science advice in policymaking was repeatedly emphasized by the IPCC on the path towards the Paris Agreement in 2015. Also in 2015, the first chapter in the report of the Sustainable Development Goals discussed the functionalities of and need for improving science-policy interfaces in light of the question of how to operationalize SDGs (UNDESA, 2015).

2.2 Concepts of Science-Policy Interfaces

For the last two decades discussions about the role of scientists and the value of scientific or evidence-based policymaking has intensified. However, discussions about the science-policy interface, that is the integration of scientific expert knowledge in policymaking processes between scientific actors and decisionmakers, are not new (Horton & Brown, 2018). As Lane (2014: 9) phrased it: "We are forever searching for new mechanisms to produce social knowledge – the opinionated blogosphere makes the questions of Plato and Aristotle – whether social knowledge is enough, and how policymaking can take account of scientific expertise – pressing once again". Climate change and the making of public policies that take environmental issues into account are especially challenging in creatin effective mechanisms to produce knowledge that takes scientific expertise into account. The following section describes general mechanisms that connect the science community and policy community. First, conceptual types of science advisers are reviewed and then models of science-policy interfaces described.

2.2.1 Conceptual Types of Science Advisers[6]

During the last three decades, science either indirectly or directly has increasingly taken an increasingly integrative role in policymaking; "What used to be 'private' debates between different scientific viewpoints over areas of uncertainty have now become public disputes that can be exploited by different stakeholders to confirm or deny entrenched positions…[It is] at the centre of many important policy issues and scientists are increasingly visible" (OECD, 2015: 5).

Roles of science advisers in policymaking differ not only between political fields (Arimoto et al., 2016) but their integration differs between policy actors as well. Depending on the issue, science is either used as a tool by policy actors or scientists are part of the process. In other words, science is either outside the process and non-participatory or participating and actively influencing the policy discourse (Montpetit, 2003).

Scientific expertise is not the only source of expert knowledge used in policymaking (Organisation for Economic Co-operation and Develop, 2015; UNDESA, 2015). However, it provides political decisionmakers with a "doubled legitimization" for their actions and decisions – the first legitimization is being elected to government by their voters (Fleischer & Veit, 2010). For effective advisory mechanisms and to ensure legitimization, advisory processes follow basic protocols in one form or another. Protocols for integrating science advice in policymaking can be

[6] Parts of the contents in this section (especially the Figures 2.1, 2.2, and 2.3) have been integrated by the author into an academic Journal article that is at the date of the submission of this dissertation in the peer-review process for publication. Correct references will be indicated in both the Journal article and this Dissertaion when published.

summarized in the following steps: defining the scope of research, defining time period of data collection, analyzing data and reporting findings, and use of results in decisionmaking (Brueckner & Horwitz, 2005).

As a report by the OECD surmised such systems contain four types of actors or institutions: 1) science policy advisory committees or councils, 2) permanent or ad hoc scientific/technical advisory structures, 3) academies such as universities, professional societies and research organizations, and 4) individual scientific advisers and counsellors (Organisation for Economic Co-operation and Develop, 2015). Each set of actors follows internal advisory processes to guide the formulation of policy proposals and recommendations.

Regardless whether science advisers are individuals or organizations, they are positioned between science and policymaking with the purpose of transmitting scientific findings. They can be understood as information and knowledge hubs. Science advisers have special expertise and communication skills as they have more in-depth knowledge about environmental science than other state or non-state actors but not as much as environmental scientists. They have sufficient understanding of the science behind climate change and scientific research in order to translate technical scientific language to policy actors with less expertise in environmental science. This basic function of scientific information translating, and summarizing is in essence an information selection process. Therefore, the function of the science adviser is theoretically informed by the concept of post-normal science[7] arguing that because of the selection process, the values and interests of scientific knowledge transmitters have to be considered when analyzing the form and role of science advice in policymaking. The theoretical concept is explained in more detail in Chapter 4 and revisits the argument about the role of science advisers as knowledge hubs and knowledge transmitters.

Litfin (1994) defined science advisers as intermediaries in environmental policymaking who are transmitters of information and communicators. These intermediaries are located between "original researchers, or producers of knowledge, and policymakers who consume that knowledge

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[7] Post-normal science is a concept in Science and Technology Policy Studies (STS). It states that while major institutional and social changes are necessary to solve the climate crisis, science itself is not immune to these changes. Scientific institutions have to change and adapt to changing political, social and environmental conditions. Hitherto, science and its institutional form cannot in its essence be value-free, neutral, or entirely independent (cf. Funtowicz & Ravetz, 1997; Cortner, 2000). In the context of climate change, that has a global scale and long-term impacts, contemporary environmental issues differ from traditional scientific problems, Funtowicz and Ravetz (1997) surmised that the term post-normal science is used where such new problems occur because "science cannot usually provide well-founded theories, based on experiments, for explanation and prediction. Frequently it can achieve no more than mathematical models and computer simulations, neither capable of being tested by traditional scientific methods. On the basis of such uncertain scientific inputs, policy decisions must be made, under conditions of some urgency. Therefore, policies for solving the environmental problems cannot be determined on the basis of scientific predictions, but only supported by policy forecasts" (Funtowicz & Ravetz, 1997:170).

but lack the time and training necessary to absorb" details about scientific findings (Litfin, 1994: 4). Drawing from the broad conceptualization by Litfin (1994), Pielke (2007) offered more distinct categories. He differentiated science advisers by the advisers' form of institutionalization, their function as well as the advisers' goals in policymaking networks. The review presented here will illustrate that the multi-actor interaction in policymaking including the relationship between the science community and policy highlights an interactive relationship and is consistent with arguments in the literature that a one-way linear relationship between policy and science in policymaking processes does not apply.

The concept of intermediaries is not solely used in studies about science-policy interfaces. For example, Takao (2016) carried the idea of an intermediary into the field of governance in environmental policy processes, an attempt to bridge the gap between local environmental actions and national policymaking. Intermediaries act as agents to connect local environmental actions with national policymaking and increase policy integration of non-state local actors (Takao, 2016). Such intermediaries are sub-governments (Takao, 2016). They also act as linkages between actors, strengthening ties on both the horizontal and the vertical dynamics in policymaking. Local municipalities are considered an important focal point to ensure successful implementation of environmental regulations and communicate the issues such municipalities experience to the national level in order to lobby for their interests. The following explanation about possible forms of science advisers however exclude such intermediaries in the form of governmental bodies Takao (2016) described. However, it does demonstrate the fluid definitions of the term.

Complex policymaking relies on cross-sectoral multi-layer interaction of non-state actors that feed into high-level policymaking processes. Scientific advisers contribute to public policies and problem solving as they are an integrative part of the cross-sectoral multi-layer interaction of non-state actors. This means that science advice could be seen as part of bottom-up structure in policymaking.

Literature argued that policy decisions happens in informal networks (Bulkeley, 2000; Schreurs, 2002). This was conceptualized by Bentley in the early 20th century. Bentley, as quoted in Schwartz (1998: 4) "regarded the various groups operating behind formal institutions as 'the raw material of government'". Government on the other hand is defined as both "formal state institutions and the processes in which [government bodies] operate to maintain social order and provide public goods" (Takao, 2016: 9). This means that integration of science in policymaking shifts from basic to more issue oriented applied science that is more issue oriented because policymaking is a problem-solving mechanism of specific issues.

When scientists are asked to contribute more actively to such processes in policymaking, in itself a problem-solving process, their scope of research is limited to the social or economic issues caused by climate change and moves away from basic research. The understanding of the "political" of science advice in environmental policymaking, and why especially environmental science carries a political weight is discussed in Section 2.4.

As discussed briefly in the introductory chapter, the four main science adviser types proposed by Pielke (2007) are labelled “Pure Scientist,” “Science Arbiter,” “Issue advocate” and what he specifically emphasized as “Honest Broker.” The differentiation is conceptualized as follows and summarized in Figure 2.1. Science arbiters are information resource providers who ideally do not have specific interests or goals. They serve to answer questions about the state of things to assist in decisionmaking processes. Pure scientists, as the term implies, conduct basic research and are generally not interested in politics. Analyses of literature in the case of the relationship between science and environmental policymaking in Section 2.4 illustrates how the theoretical ideal of an apolitical position of basic research is questionable as far as environmental policymaking are concerned. A point of commonality between pure scientists and science arbiters is that they are supposedly unconcerned with a specific decision; they serve mainly as information resources.

While basic researchers (pure scientists) and science arbiters avoid taking sides, issue advocates aim to limit decisionmakers’ choices by assigning relative value to information. The concept of an honest broker theoretically provides decisionmakers with all available information related to an issue to empower decisionmakers to make the best choice. Issue advocates and (honest) knowledge brokers provide alternatives for policy decisions. Issue advocates seek “to compel a particular decision, while [a broker] of [p]olicy [a]lternatives [wants] to enable freedom of choice by decisionmaker” (Pielke, 2007: 3). Literature shows that these general classifications are limited in grasping science-policy interfaces empirically and that it is not always easy to distinguish among types of scientific advisers.

Figure 2.1 Science Adviser Classifications

Science Arbiter	Pure Scientist	Issue Advocate	Honest Broker
•Information resource provider •Serving to answer questions about the state of things to help decision-makers in their decisionmaking process •No side-taking	•Fundamental research •No interest in decisionmaking	•Aims to limit the decisionmakers’ scope of choice by providing values about information and own opinion	•Provides decision-maker with all information related to an issue without leaving out information •Decisionmaker decides what’s best

Source: Pielke (2007)

Boundaries between these categories and distinguishing between science advice from academia and commercial policy expert consultants are a grey area (Fleischer & Veit, 2010). Theoretically, while lobbying is understood as interest advocacy (Fleischer & Veit, 2010), literature on post-normal science argues against the myth of neutrality in science advice (Cortner, 2000; Cairney & Kwiatkowski, 2017; Horton & Brown, 2018). Fleischer and Veit (2010) argue that the difference is that issue advocates or lobbyists try to influence policy outcomes to their own benefit, while science advice is used for problem solving and creating legitimate policies for the greater good (Fleischer & Veit, 2010).

Effective science advice is achieved through skillful communication. Communicating scientific expertise has created new opportunities for participation in policymaking through technical communicators. If we consider science as a social institution, the participation of science advisers in policymaking is a form of public participation in policymaking.

> "[Technical communicators] can help people visualize and understand environmental data so they can make informed decisions. In fact, mitigating an understanding between the problem holders and the technology providers has itself become a growing profession in industry…Technical communicators are needed to manage the information reporting required by private environmental management codes…This market-based economy provides direct opportunities for technical communicators" (Coppola & Karis, 2000: xiii).

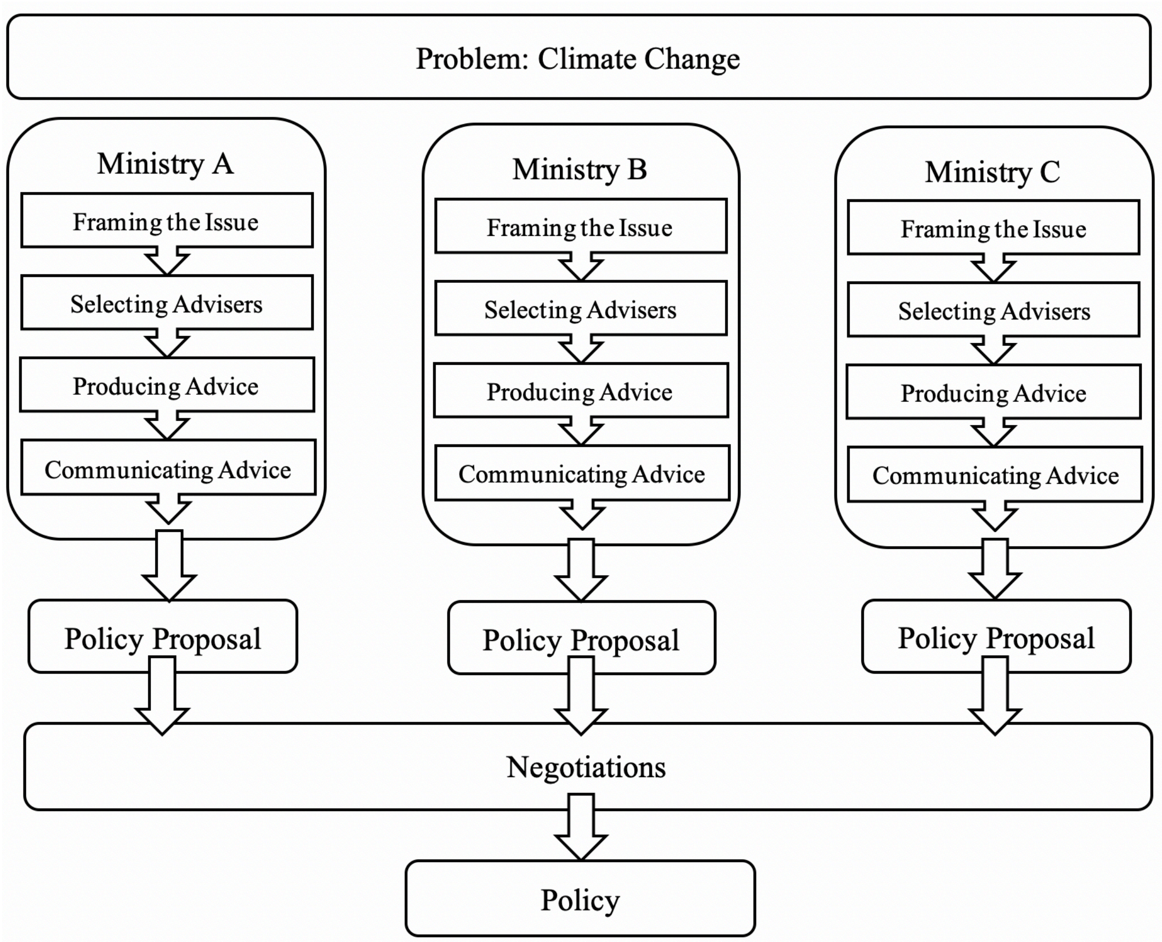
The growing number of actors who may participate in technical communication either as scientific experts or market-based consultants challenges the identification of science advisers as boundaries increasingly blur. It becomes more difficult to distinguish issue advocacy from basic research. The aim of classifying science advisers is to find key differences that do not overlap boundaries. According to Latour (2006) distinguishing between narrative influencing intermediaries and neutral mediators, science arbiters and pure scientists may act as neutral mediators who do not influence the narrative or the policy agenda, while issue advocates may be intermediaries who influence the narrative and therefore the policy agenda. Pielke (2018) concluded that in fact issue advocacy is the default mode of science advisers. Based on the theoretical ideal of neutrality and independence of scientific advisers, a honest broker might be regarded as a mediator, however, from an empirical perspective, as the example of the IPCC demonstrates in Section 2.3.2, an honest broker may be opting more to issue advocacy than these concepts assume.

The existence of different forms of science adviser concepts argue that the type of science adviser matters regarding the selection and transmitting of scientific knowledge, as well as regarding their interactions and relationships with other policy actors. The next section elaborates on modes of interaction in conceptual science-policy interfaces in more detail as discussed in previous literature.

2.2.2 Conceptual Science-Policy Interfaces

A standard advisory process follows four general steps: 1) framing the issue, 2) selecting advisers, 3) producing advice, and 4) communicating the advice (Organisation for Economic Co-operation and Develop, 2015). There exist a number of each type of these institutions within any socio-political system. And each institution usually follows their internal decisionmaking processes that apply these general steps. Taking a look into Figure 2.2 it becomes clear that multi-layered complex decisionmaking processes in policymaking are maintained by these advisory processes. Each policy issue area represented by a ministry in the government has their own advisory processes that differ in terms of their internal agenda. For effective and trustworthy advice-giving, experts are called into the system to strengthen policy planners and decisionmakers' positions.

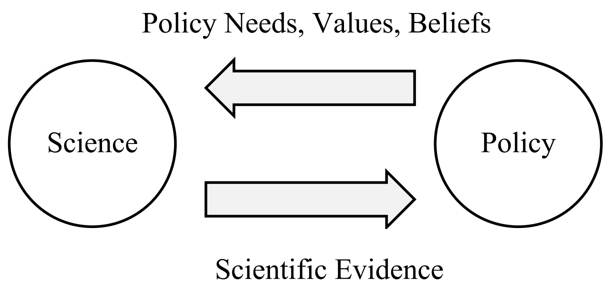
Figure 2.2 Conceptualizing Science Advisory Processes in Environmental Policymaking



Source: Author

Modes of interaction between science and policy manifests itself in different forms. According to the understanding of post-normal science the selection of information and choices for information sources is influenced by the previously existing world views, interests, and values of actors (Cortner, 2000; Gupta, 1999). Therefore, the selection and integration of advisers is guided by the interests, goals, and core belief-systems of stakeholders that rely on scientific input to formulate their strategies or policy proposals. That is, the framing of a problem defines the narrative of the advice in the issue-oriented policy community. In a traditional regulatory model, as illustrated in Figure 2.3, science reacts to social, political or economic demands while creating scientific evidence from an independent and neutral standpoint.

Figure 2.3 Linear Bi-Modal Science-Policy Interface

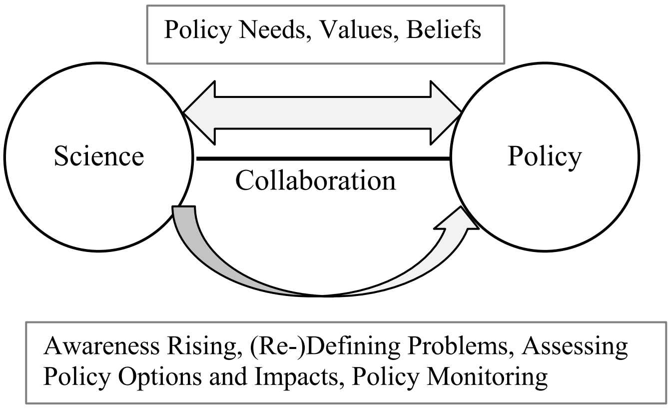


Source: Author (based on Wadell, 2000)

Nowadays, such a linear model is empirically difficult to find and the bi-modal assessment of the relationship between science and policy – or experts and non-experts (Waddell, 2000), as illustrated in Figure 2.3, fails to explain the observation of multi-actor interaction and different types of advisory organizations within policymaking.

Because science is asked to be more active in policymaking, it is an integrative model which creates diverse and multi-layer coalitions between sub-sets of actors who share the same values and beliefs within the policy community (Gupta, 1999). This is illustrated in Figure 2.4. Such an integrative model describes a circular relationship between science and policy (UNDESA, 2015). Through the reciprocal interaction between various stakeholders, scientific expertise is not only used as a tool, but scientific experts become active actors in policymaking themselves.

Figure 2.4 Integrative "Circular" Science-Policy Interface



Source: Author (based on Wadell, 2000)

Waddell (2000) proposes similar models reflecting the science-policy interface based on the core activity that is the communication of technical knowledge in environmental policymaking. The author proposed a mode of interaction similar to the integrative circular science-policy interface described by Gupta (1999). Figure 2.4 illustrates the descriptive explanation of an integrative science-policy interface with Waddell's (2000) illustration of a social constructivist mode of interaction between experts and acknowledges "that the values, beliefs, and emotions of experts also play a role in…environmental-policy [formation]" (Waddell, 2000: 9).

With the increased number of stakeholders and interest groups in policymaking existing advisory systems to governments are in a process of change. Skilled communicators in the framing and problem setting phases in advisory processes set the tone for successful advice giving. The format, language, and timing of the advice are keys to focus attention on the issue and its desired outcome by the policy community (UNDESA, 2015). For this, science advisers become advocates for science. Cairney and Kwiatkowski (2017) called this "evidence advocacy." Therefore, traditional non-linear understanding of policymaking in which a small elite group is in control of policymaking does not apply anymore (Cairney & Kwiatkowski, 2017). Accessibility to evidence advocacy in national advisory systems depends on established socio-political institutions. The form of collaboration is subject to balancing "interests which can affect the framing of questions, the selection of experts or the provision of funding" (Organisation for Economic Co-operation and Develop, 2015).

From the conceptual discussion the next section describes the recognition of the importance of science in policymaking through international institutions that aim to increase science advice capacities and improve the integration of science in policymaking, while at the same time making the connection to the issue area of climate change in environmental policymaking.

2.3 Science Advice to Governments in International Environmental Policymaking

Anthropogenic, that is human-caused climate change has become a grave threat. Societies are at a cross-road, and with the Special Report by the IPCC published in 2018, the call by climate scientists for decarbonization to keep the mean surface temperature increase under 1.5°C received more attention (Intergovernmental Panel on Climate Change, 2019). Additionally, climate change has become the overarching defining issue area for attaining the Sustainable Development Goals (UNDESA, 2015). The understanding of environmental science and scientific advice is crucial to formulate reliable policy proposals. Still, the controversial nature of the climate change debate and costs related to the reduction of CO2 emissions is challenging for policy actors in negotiating long-term goals. Moreover, scientific advice plays different roles in decisionmaking processes between various stakeholders in environmental science. And varying types of scientific advisers take on different positions in the policymaking structure of environmental policymaking.

In September 2015 member states to the United Nations Sustainable Development Solutions Network (UNSDSN) passed the Sustainable Development Goals (World Health Organization, 2015). In December the same year, the 21st Conference of the Parties to the IPCC (COP21) finally agreed on a new international climate change framework, the Paris Agreement. The United Nations Resolution of the Sustainable Development Goals (SDGs) stated only that a multi-stakeholder cooperative framework is supposed to move towards effective decarbonization. Moreover, the resolution emphasizes the need to integrate science and scientific knowledge in policymaking on a road towards decarbonization. Article 17.6 of the resolution (United Nations, 2015: 26/35) states for improving the integration of scientific expertise "enhance[ing]…triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms…" Further, Article 70 grounds the Technology Facilitation Mechanism "on a multi-stakeholder collaboration between Member States, civil society, the private sector, the scientific community, United Nations entities and other stakeholders …" (United Nations, 2015: 30/35). For this, there is a demand for more effective mechanisms in which political decisionmakers and scientist can communicate. The following sub-sections elaborate on the development of international cooperation for government science advice and the IPCC, the main body that connects the science community with the policy community.

2.3.1 International Institutions for Science Advice to Governments

The International Council for Scientific Unions (ICSU) was founded in 1931. After World War II the value of the social sciences was acknowledged with the founding of the International Social Science Council (ISSC) in 1952. To connect these general fields of science, the hard sciences and the social sciences, and to improve the effectiveness of science advice to governments, in 2014 the community of government science advisers proposed to merge the ICSU and ISSC. Through global efforts by more than 220 science advisers from over 40 countries to the International Network on Government Science Advice (INGSA) in 2015 the merger was eventually formalized in 2018 and created the International Science Council (ISC). The movement of these international institutions demonstrates that the topic of integrating science in policymaking transcends systems and is of global concern[8].

The environmental sciences are an important factor in the formation of the international environmental regime. Since the environmental movements of the 1960s international communities of climate scientists have put their effort in improving the understanding of climate change promoting environmental issues in the national governments of most Western countries. The formation of these institutions are explained by Peter Haas' concepts of "epistemic communities" (Haas, 1989). The concept of epistemic communities by Haas (1989) demonstrated how effective control of research by ecologists and environmental scientists influences the decisionmaking process and policy decisions for the environment, and has a positive learning effect on members of the community through global exchange of knowledge (Haas, 1989).

In the next section, the IPCC is introduced as an example of such an epistemic community and demonstrates the importance of the realm where political decisionmaking for the environment draws from the accumulated knowledge of global environmental science.

2.3.2 Connecting Environmental Science and Environmental policymaking: The IPCC

It would take almost two decades, and fruitless implementation of regulations under the Kyoto Protocol to counteract the continuing warming of the earth until members to the convention decided in 2010 to operationalize the goals set by the UNFCCC. Members decided to stabilize the CO2 concentration in the atmosphere and to reduce the mean surface temperature to at least 2ºC, and decided in 2018 a more stringent limit to 1.5ºC. They recognized the need to further promote climate science and its active integration into negotiation processes with these measures.

In 1989 did an advisory council to UNEP had already concluded that an increase of 2ºC in the mean surface temperature should be the "upper limit beyond which the risks of grave damage to ecosystems and of nonlinear responses are expected to increase rapidly" (IPCC, 2007: 99). A second report published by WMO in 1990 recommended to setting the "ultimate objective…to stabilize

[8] https://www.ingsa.org/ (accessed September 14, 2018), http://www.worldsocialscience.org/ (accessed September 14, 2018), https://council.science/ (accessed September 14, 2018), https://www.the-scientist.com/5-prime/icsu-international-council-for-science-51742 (accessed September 14, 2018), http://www.scj.go.jp/ja/int/icsu/ (accessed September 14, 2018), https://www.ingsa.org/about/ (accessed April 23, 2019).

greenhouse [gases] concentration at a level that would prevent dangerous anthropogenic interference with the climate system" (IPCC, 2007: 97).

With the establishment of the IPCC by UNEP and WMO in 1988 environmental science and policymaking for climate change were formally intertwined. It is therefore not only the impact of environmental science on policymaking but conversely the impact of politics on environmental science that has shaped the complex interaction between policy actors for the environment. It is a scientific process because with each assessment report the IPCC publishes it provides new insights, more precise and revised estimates into basic climate change science, future risks and societal adaptability to climate change, economic climate mitigation potential and environmental policymaking (Sachs & Guerin, 2014). It is a political process because the explanation of ineffectiveness of the Kyoto Protocol was that it was a political decision that widely ignored scientific input (Pielke, Jr., 2007). Therefore, the IPCC is an international institution on environmental science, but it is also and foremost a political institution.

The IPCC has a similar purpose as the ISC, described in the previous section, that acts as an authoritative, independent voice for international scientists, and connects international science with policymaking. In other words, such institutions try to provide mechanisms in which political decisionmakers and science can communicate. Through this connection they encourage and promote multi-stakeholder cooperation and provide a secure environment for exchange to foster cooperation. Such activities build capacities for science advice in evidence-based policymaking. The IPCC "[helps] countries address, in a scientifically-informed manner, the problem of global climate change. [It] can carry out its mandate to provide policy relevant assessments of research only if the scientific excellence of its products is sustained" (Carraro, Kolstand, & Stavins, 2015: 1). The phrase "in a scientifically-informed manner" should be noted. The IPCC is "the leading international body for the assessment of climate change." Its main function "is to provide the world with a clear scientific view on the current state of knowledge [about] climate change and its potential environmental and socio-economic impacts"[9]. Therefore, a disregard of environmental science may decrease the likelihood of effective mitigation policies (Haas, 1989).

Put simply, the task of the IPCC is to collect available information on climate change and provide decisionmakers with the information in an understandable manner. How to interpret and how to use such findings is the responsibility of decisionmakers. Pielke (2007) thus classified the IPCC as a "Honest Broker for Policy Options" (Pielke, 2007).

The importance of enhancing the integration of science in policymaking was emphasized by the IPCC during the 15th annual Conference of the Parties (COP15) in 2009, Copenhagen. In the Copenhagen Accord member states agreed to further promote science and strengthen the integration

[9] The quote was taken from the description of the organization that can be accessed here: https://www.ipcc.ch/reports/ipcc-30th-anniversary/ (Last access: October 13, 2019)

of scientific experts in policymaking as it has been emphasized to "[recognize] the scientific view that the increase in global temperature should be below 2 degrees Celsius [in order to] prevent dangerous anthropogenic interference with the climate system" (UNFCCC, 2010: 5). This furthered changes in science-policy interfaces forward.

It is this function of the IPCC to connect environmental science with policymaking and to be the main information hub of climate change science that illustrates an intermediary's role in the science-policy interface and the potential power an intermediary can have in the policy agenda because it controls the flow of knowledge. Beck (2009) provides a thorough overview of the success-model of how the IPCC establishment as a model for advisory policymaking for the environment on a global scale. Experts see the success of the IPCC in its mobilization of scientific expertise and effective integration scientists in advisory policymaking (Beck, 2009: 16). However, in terms of structural functionalities, science-policy interfaces in national policymaking may work differently from the IPCC example because mechanisms to connect scientists with policy planners, decisionmakers and other stakeholders on a global scale is specific to this unique institution. And the need for good practices in local policymaking accompanied with criticisms of dysfunctional science-policy interfaces illustrates that we have to investigate structures of such science-policy interfaces specific to each country.

Local implementation of environmental policies informed by international regulations face difficulties. These difficulties may be rooted in the brokerage of interests of municipalities due to changing environmental conditions that cause latent conflicts between social institutions and the global perspective of climate change and the science behind it. Social institutions carry cultural norms, values, and beliefs through which they mediate the relationship between society and the natural world (Cortner, 2000: 22). Such social institutions differ between countries. According to the structural imbalance in knowledge generation theory, differences in scientific developments between countries cause conflicts in international negotiations for climate mitigation measures because the international trade of scientific knowledge overlooks the fact that scientific inquiries and by extension their results depend not only on the developmental state of science but also on the scientific culture, socio-economic, and socio-ecologic conditions in which research was conducted (Gupta, 1999: 328). The IPCC tries to overcome such potential conflicts, misunderstandings, or even distrust between different stakeholders by providing information about the state of climate change through the collecting of all scientific information that is available, to be summarized by international groups of environmental scientists.

The United Nations Resolution emphasized the need for multi-stakeholder cooperation to achieve climate mitigation and social change by distinguishing such actor categories, where science is an institution that must be considered to be part of the play. The pivotal role of science in major environmental institutions such as the IPCC is, as Litfin (1994) argued, evident for close collaboration between scientists and policymakers. As a consequence, in accordance to Maasen and Weingart (Maasen & Weingart, 2005: 4), the "democratization of scientific advice [made] the expertise of advisers…accessible to contending groups in the democratic process because in contemporary policymaking scientific knowledge is an obligatory "resource of policymaking even though it may be contested and open to interpretation in a specific case."

The planetary scale of the climate change problem and the focus on international organizations for the environment in the literature left local systems overlooked in the main discussion. It is argued that effective science-policy interfaces in environmental policymaking are an independent variable that explain the outcome of domestic policymaking processes and provide a new perspective on explaining why certain countries have weaker socio-political institutions for the environmenant than others. The last section of this chapter will elaborate on the problems associated with science-policy interfaces, and concerns about the effects of a higher integration of science in policymaking for either side, science and policy, if methodological practices for integrating science advice in policymaking are unclear.

2.4 Controversies of Science-Policy Interfaces

"The power of scientific and professional communities to frame the political agenda is both a burden and an opportunity" (Cortner, 2000: 24). Providing scientific evidence to policymakers is a legitimizing factor that increases trust in the outcome and motivates action. But at the same time, it puts pressure on scientists to provide unquestionable facts about climate change and its impact on the environment and society. Moreover, communication about environmental science was "spurred by environmental legislation and, more generally, by the heightened environmental concerns that have inspired such legislation [and environmental communicators] are frequently called upon to facilitate or participate in deliberations about matters of policy" (Waddell, 2000: 3). However, implementing successful science-policy interfaces in environmental policymaking are more challenging because of the contesting nature of environmental issues, scientific uncertainties and interconnections with a broad range of other social and political issues.

Despite the growing input of environmental science in policymaking since the latter half of the 20th century, more recent literature finds that science-policy interfaces in environmental policymaking still lack methodological clarity (Cortner, 2000; Pullin & Knight, 2012). Even though international institutions for science advice in policymaking such as the IPCC provide a success model, a "one size fits all" solution to enhance functionalities of science-policy interfaces is not a solution (Sankovski, 2000). Such an approach overlooks the individuality of local issues and environmental conflicts. The effects may be generalizable nevertheless. Identifying features that are specific to local cases is important for explaining either failing or successful science-policy interfaces in environmental policymaking. The following sub-sections elaborate on the question of why environmental policymaking is a special case for the investigation of science-policy interfaces and describes potential harmful and constructive capacities of science-policy interfaces.

2.4.1 The "Political" about Environmental Science

Environmental experts and science actors were a driving force in the creation of the international environmental regime. The global environment movements of the 1960s are also movements of environmental sciences. For example, the Scientific Committee on Problems of the Environment (SCOPE) was created in 1969 (Keck & Sikkink, 1998) and "[as] a result of public debates over environmental protection in the 1960s, scientists were drawn into the political process. They were instrumentalized as experts whose technical know-how was to support political positions on both sides in vicious controversies over technical issues" (Maasen & Weingart, 2005: 2).

The scientific basis of the environmental movements contributed positively to the institutionalization of environmental policymaking (Yearley, 1992). Since then "the reliance of policymakers on expert advice has increased continuously over recent decades" (Maasen & Weingart, 2005: 4). Yearley (1992) discussed the connection between the environment, environmental science, and the importance of effective discourses in environmental policymaking. That is without climate science we would not know the harm greenhouse gases cause to the ozone layer, and what the increasing warming of the mean earth surface temperature means for all life on the planet. Discourses are created to make the harm of climate change visible and climate science is used to support the argument (Yearley, 1992).

Sociology of knowledge argues that science is not, and never has been, completely value-free nor entirely objective because it is a social institution (Broks, 2017; Cortner, 2000) aimed at solving problems that are socially constructed (Gupta, 1999). In *Ozone Discourses – Science and Politics in Global Environmental Cooperation*, Litfin (1994) concluded that science is more ideologically influenced than expected. The social sciences term this "post-normal science" (Gupta, 1999). Post-normal science, according to Gupta (1999), stems from three input biases in scientific methods that exist because 1) science depends on funding institutions, 2) scientific methods in constructing research designs include pre-defined world views and assumptions that influences the selection of methods and formulation of theories, as well as 3) mistakes in measurement and biased data-selection-interpretation. These three biases would "creep into" policy recommendations (Gupta, 1999: 323).

The IPCC as described in the previous section illustrates the importance of the scientific argument for environmental policymaking. The organization served as a positive example of a science-policy interface on a global scale, the following section describes possible harmful potential for policymaking in dysfunctional science-policy interfaces in contrast to its constructive capacity.

2.4.2 Harmful versus Constructive Capacity of Science-Policy Interfaces

That scientists are asked to participate more in policymaking does not mean that science is to be attached to politics, but to interact with actors in the policy community while keeping a certain distance (Arimoto et al., 2016). Both science and policy have to create a trusting relationship through communication. Scientific advisers have to be guaranteed independence from politics and the government (Arimoto et al., 2016: 22). Even though scientific inquiry alone is incapable of solving socio-economic, socio-ecologic, and political issues (Brueckner & Horwitz, 2005), a discrepancy between knowing scientific results and integrating such results into policymaking has been argued to be a cause for the ineffectiveness of international institutions for the environment in the last decade of the 20th century (Sankovski, 2000).

Without knowing the impact of the given advice, it is rather difficult to improve scientific advice in policymaking. For this, it is important to evaluate the advice and measure its impact (Arimoto et al., 2016). However, measuring the impact of advice is difficult, and in many cases not possible (Organisation for Economic Co-operation and Develop, 2015). In order to somehow measure the impact of the advice, advisory processes need to, for example, include the task for evaluation when a science-policy interface for a policy issue is set up (Arimoto et al., 2016).

The discrepancy between scientific knowledge and policies that may lead to an exclusion of science may be a social institutional issue. This means that, attributes of "scientific culture" (Cortner, 2000: 23) are a cause for the distance between science and policy, as well as between science and society. Such attributes include objectivity, freedom from political values or ideologies, and priorizing advancement of technology and scientific method (Cortner, 2000; Litfin K. T., 1994). Policymaking theories explain the void between science and policy through the "two-cultures theory." Gupta (1999) explained this void as a communication gap between the culture of science and the culture of politics because scientists "are reluctant to formulate policy recommendations for policymakers, which take into account the political, economic and practical problems faced by the policymakers" and policymakers filter complex scientific information for the most important content on which they base their decisions (Gupta, 1999: 326).

If the interconnection between science and types of policy actors has systemic flaws, and if established advisory procedures are faulty, harmful capacities of integrating science in policymaking overlay, and political outcomes may fail or are not even reached which can be a major set-back for the development of environmental regulations. External factors that affect advisory processes negatively are, for example, cases of falsified research results that weaken trust in science. Internal factors are related to the concern of ideological influence through centralization of science advice institutions in policymaking that could have an institutional lock-in effect of scientific actors in the political debate and restricts areas of activities in research through the dependence on funding. Empirical cases of failed science-policy interfaces discussed in the literature points to structural weaknesses. These approaches attempted to directly integrate science in environmental policymaking. However, a direct integration showed to be part of the problem of dysfunctional science-policy interfaces (Cortner, 2000).

Other problems point to a time discrepancy between the slow motor of scientific research compared to the fast motor of policymaking (Müller, 2018). Climate monitoring requires a long-period of data collection, analysis and interpretation. Ad hoc responses in urgent crisis situations requires different methods of evidence collection. This is where interest-based, issue-oriented evidence providers move quicker than science (Müller, 2018).

In Müller's motor engine analogy, an intermediary type of actor acts as a linkage between policy and science similar to the gears in a motor engine (Müller, 2018). Responses to crises require speedy but sound decisions for which expert knowledge and smooth communication is essential. Müller's motor-engine analogy describes how crises cause gears to shift and speed up scientific research output to assist in decisionmaking.

Another discrepancy that can cause the policy engine to slow down is a tension between values and knowledge as cause of a greater expertise bureaucrats have than politicians (Fleischer & Veit, 2010). Political decisionmakers rely on external legitimacy to wit elections. Against the external need for legitimization of policy stands internal legitimization of science through tools such as peer-review publications, citations, and external evaluation of research funding proposals (Fleischer & Veit, 2010). Intermediaries in a decisionmaking process where policy draws on scientific expertise is supposed to counteract the tension between political interests and values to expert knowledge (refer to Chapter 1).

The discrepancy between science and policy is not only one of speed but also one of understanding of the status of situations. Expert knowledge is technical, speaks in jargon, and goes deep into the matter. Such in-depth studies and research take time and communicating complicated topics to the public is challenging. Decisionmakers choose advisers whom they trust and translates the most relevant and selective information in terms that are easy to understand, because not all available information can be processed. Trust however, according to Müller's motor-engine analogy, is not replaceable. If trust between experts and decisionmakers is harmed, it leaks out slowly and gradually, and cannot be refilled. One of the most common tools for transmitting such selected and translated information is the "summary for decisionmakers" that for example the IPCC or the OECD provides in the front of lengthy reports. However, such reports are also criticized because their political use causes controversial debates which effects trust in scientific information negatively (Beck, 2009).

Procedures for selecting advisers and available information can be powerful, but also harmful if mechanisms are administered poorly, or if procedures lack transparency (Brueckner & Horwitz, 2005). Political decisions gain less public trust and acceptance or loose trust and acceptance entirely if it is unclear how decisions were reached (Brueckner & Horwitz, 2005). That means that, if the public and interest groups do not know what kind of information and evidence were considered from what kind of sources policies can fail because they have no support to be executed (Brueckner & Horwitz, 2005). Knowing how decisions were reached, who gave advice to whom, and what source of information was used ensures trust (Brueckner & Horwitz, 2005). If we do not know how and by whom the space between science and policy is filled, and how the actors in this space interact with each other it increases the risk that political decisions favor certain interests over others, and that scientific evidence is ill-used or ignored entirely.

Communicating scientific findings and their implications for society has shown to be a difficult task for science. And because of the opacity of who uses what kind of evidence from what sources that may even not have come from scientific inquiries, there are cases in which information sources had wrongly assigned the scientific label (Cairney & Kwiatkowski, 2017; Cortner, 2000; Horton & Brown, 2018; Pullin & Knight, 2012). Communicating scientific findings effectively requires specialized skills. It is difficult for scientists to compete with well-equipped communicators of interest groups who are accustome to reach out to the public or decisionmakers to make themselves heard and secure support for their cause. To alleviate the burden and make use of opportunities a communicator between the science community and the policy community a third bridge-building type of actor that is the science adviser or the intermediary has been supported by the international society for government science advisers as a proposed solution.

2.5 Chapter Summary and Conclusions

In conclusion, this chapter provided an overview of conceptual types of science advisers and models of science-policy interfaces. The four main categories of science advisers (pure scientist, science arbiter, issue advocate, honest broker) demonstrated that the complexity of multi-actor policymaking has more layers than research on advisory policymaking discussed thus far. Because, science advice is not one homogenous group but a complex set of varying actors that differ in terms of their functions, goals, values, and interests. Features that may affect their potential influential power in policymaking. However, common concepts about science-policy interfaces overlook the different layers of actors between science and policy. Even though literature developed the understanding of a more integrative model where non-state actors have a more pro-active role in policymaking as Figures 2.3 in Section 2.2.2 illustrated, these models still neglect to recognize the importance of dynamics that happen in between science and policy as basic research is typically kept outside political debates. And in order to integrate the scientific voice a transmitter or communicator between both realms is an important yet hidden influential policy actor. As Takao phrased it: “One party needs the assistance and cooperation of the other in order to achieve policy outcomes” (Takao, 2016: 12).

The interconnection between environmental science and policymaking was illustrated through the example of the IPCC that also illustrated the importance of intermediaries that facilitate a connection between science and policy. The IPCC collects and analyses available scientific findings on the environment and climate change from the international science community and translates the science of climate change into understandable terms for non-experts. Therefore, the IPCC acts in the realm between science and policy. Furthermore, post-normal science scholarship argued not only against the ideal of value-free and independent science, the interconnection between environmental science and socio-political institutions demonstrated the political nature of environmental science.

Science-policy interfaces improve legitimacy and trustworthiness in policymaking, yet, contesting issues such as climate change pose substantial risk for dysfunctional methods of how to integrate science in policymaking. Science advisers or intermediaries have been conceptualized to improve the functionality and effectiveness of such science-policy interfaces. The ability of intermediaries, "who typically operate at low or middle levels of governments or international organizations, to frame and interpret scientific knowledge is a substantial source of political power. Intermediaries are especially influential under the conditions of scientific uncertainty that characterize most environmental problems" (Litfin, 1994: 4).

By combining the conceptual discussions found in previous literature and propose a concept that emphasizes the realm between science and policy this dissertation proposed the triangular model of a science-intermediary-policy interface (illustrated in Figure 1.3). From these conceptual discussions the next chapter provides background about Japan.

3. Possibilities and Limitations for Advisory Processes in Japanese Policymaking

3.1 Chapter Purpose and Structure

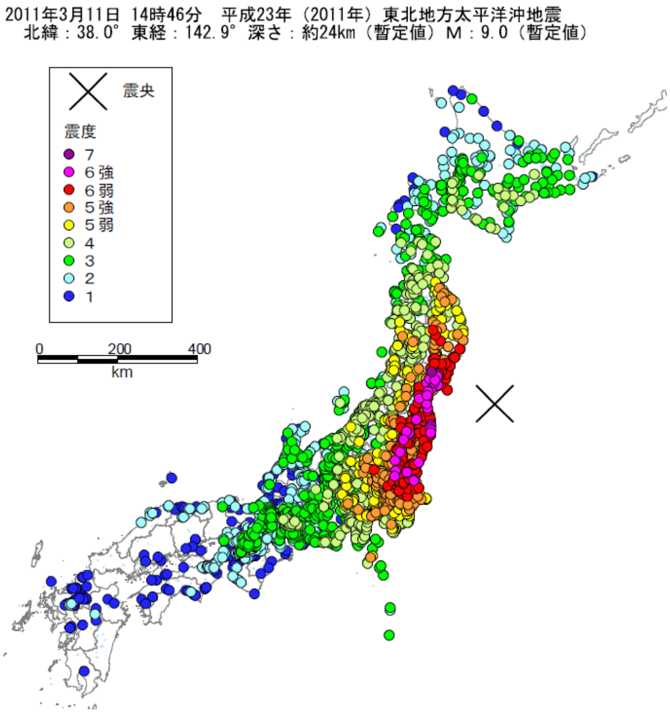
While the previous chapter described the conceptual framework of science-policy interfaces proposed by European and American scholarship and provided a general example (the IPCC) for what an intermediary science adviser is, and why it is important for analyzing the relationship between science and policy in environmental policymaking, the purpose of this chapter is to provide a thorough background about Japan. The chapter starts with describing the case of the Fukushima disaster and related criticism of the relationship between science and decisionmakers instigated by the disaster and barriers against science communication in Japan. A description of the state of science and problems the science community of Japan faces is followed by a discussion of the science advisory process in Japanese policymaking including a general review of advisory policymaking. The last section relates the discussion of advisory policymaking to a review of the current state of environmental research for policymaking and provides an example for an intermediary science adviser in the case of Japan; the Center for Research and Development Strategy (CRDS).

3.2 Questions for Japan's Science-Policy Interface after Fukushima

3.2.1 The Case of Fukushima

In the wake of the triple disaster of Fukushima on March 11, 2011 science-policy communication was criticized as having escalated the nuclear catastrophe in the Fukushima Dai'ichi nuclear power plant to an unnecessary extent (Takao, 2016). Due to its proximity to the ocean (Figure 3.1) the power plant was hit by a Tsunami with a historical height up to 40 meters, caused by a magnitude of 9.0 earthquake (Richter scale) on the east coast of Japan. This caused a total shut down of the power plant's cooling system led to the nuclear meltdown (Omoto, 2013). Takao (2016), Thatcher and colleagues (2015), and Arimoto and colleagues (2016) argued that the nuclear disaster escalated due to preventable human failure. More specifically, a divide between decisionmakers and scientific experts, the former ignoring the latter, and the exclusion of outside experts and scientists to assist in assessing the situation was argued to be the root cause (Arimoto et al. 2016; Omoto, 2013; Thatcher et al., 2015). Also, the Center for Science Communication (2016) argued that critical information needed for decisionmaking in crisis situation was not disseminated to the public. The following paragraphs provide first an overview of the disaster from the political and administrative perspective and then examines the impact Fukushima had on the issue about science communication.

Figure 3.1 Epicenter and Magnitude of the Great East Japan Earthquake, March 11, 2011, 14:46



(March 11, 2011, 14:46, Heisei 23 (2011), Tohoku Pacific Coast Earthquake, North Latitude: 38.0º, East Longitude: 142.9º, Depth: Appr. 24km (Provisional Value) M: 9.0 (Provisional Value))

Figure source: https://www.jishin.go.jp/main/oshirase/20110311_sanriku-oki.htm (last access: September 19, 2018)

Omoto (2013) argued that disaster management by government officials and TEPCO lacked preparedness and was criticized as showing poor judgement in decisionmaking. Upon the publication of a disaster projection report published in 2002 by the government's Earthquake Research Headquarters regarding the "prevention of radiological impact on humans and the environment" TEPCO neglected to act on proposed measures to prepare for an earthquake and tsunami that would exceed a magnitude of 8.3 and a height of 10m because the probability such events would occur were unlikely according to TEPCO's judgement of the available data and projections (Omoto, 2013; Thatcher et al., 2015). Regardless of the probability of an earthquake with a magnitude higher than 8.3 so close to the nuclear power plant, the outdated state of the cooling system was that of the 1990s standards. Therefore, the technical system of the cooling system was insufficiently equipped to deal with a scenario where the cooling system would fail completely as so happened in the Fukushima Dai'ichi Power Plant (Omoto, 2013). Thatcher and colleagues (2015) identified issue categories in how failed information behavior caused the escalation. Such issue categories in information behavior were, for example, cultural attitudes, risk management and preparation (Thatcher, Vasconcelos, & Ellis, 2015). The authors showed that efforts to keep an image of nuclear safety ignored technological maintenance.

Besides the lack of technical preparedness, the interrupted flow of information during the Fukushima disaster management was on the agenda in the public discourse. Some criticized the government for not sharing or even hiding critical information relevant for decisionmaking during the crisis. Relating to these critiques other issue categories identified by Thatcher and colleagues (2015) were information avoidance and information filtering. Insufficient sharing of information and poor communication by TEPCO and government representatives to the public increased fears and caused misunderstandings (Omoto, 2013; Thatcher et al., 2015). Information that would question the image of "nuclear safety" was filtered, meaning decisionmakers would have avoided communicating critical information that would contradict the cultural image of safety and control. As it turned out, those in charge did not have sufficient information to make good decisions (Thatcher et al., 2015). Eventually, both the government and TEPCO underwent a series of investigations because of these claims.

The picture below shows lawyers for the plaintiffs suing TEPCO and the central Government holding up banners saying "central government found liable," and "partial victory" in front of the Fukushima district courthouse on March 17, 2017 published in an article in *NIKKEI Shimbun* (NIKKEI, 2018).

Figure 3.2 Image by NIKKEI, March 18, 2018

Source: *NIKKEI* "Court Ruling found TEPCO and the Central Government of Japan liable for the Escalation of the Fukushima Nuclear Catastrophe" (NIKKEI, 2018)

While the central government was found partly liable, former TEPCO executives however were found not guilty as the Tokyo district court ruled on September 19, 2019. The ruling received global media attention. The photo in Figure 3.3 illustrates a featured article in The New York Times Online, for example (Dooley, Yamamitsu, & Inoue, 2019). The picture shows protestors in front of the Court House in Tokyo holding up signs saying “all not guilty” and “unreasonable judgement.”

Figure 3.3 Image by The New York Times, September 19, 2019


The New York Times

Fukushima Nuclear Disaster Trial Ends With Acquittals of 3 Executives

A rally in front of Tokyo District Court on Thursday protesting the acquittals of former executives from the company that ran the Fukushima Daiichi nuclear plant. They had been charged with criminal negligence in connection with the plant’s meltdown in 2011.
Kazuhiro Nogi/Agence France-Presse — Getty Images

By Ben Dooley, Eimi Yamamitsu and Makiko Inoue

Sept. 19, 2019

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TOKYO — A Japanese court on Thursday acquitted three former Tokyo Electric Power Company executives who had been accused of criminal negligence for their roles in the meltdown of the

Source: The New York Times “Fukushima Nuclear Disaster Trial Ends With Acquittals of 3 Executives” (Dooley, Yamamitsu, & Inoue, 2019)

Government leaders themselves were in many cases not included in the information sharing network between TEPCO, experts and bureaucrats (Takao, 2016). Information was not disseminated through official channels. Informal networks of personal acquaintances disturbed the decisionmaking chains (Thatcher et al., 2015; Arimoto et al., 2016). An explanation for the inefficient and interrupted communication by the national government could be found in systemic problems within the former DPJ; and also within their party but also within governmental institutions: "The unexperienced new government under the DPJ was put under test for crisis management for the greatest disaster since the Second World War and a nuclear accident, without precedence in Japan's history" (Zakowski, 2015: 140).

At the beginning of the party's legislating period the DPJ's main goal was to reform the LDP dominated and bureaucratic centered policymaking that ruled Japan for over half a century to a politician-led government (Zakowski, 2015). Kan Naoto was Prime Minister when the catastrophe happened, and he "insisted on dealing with the crisis under the banner of a politician-led government, but he seemed unable to fully grasp control over bureaucratic institutions. Many interministerial coordination problems appeared, which forced the Kan administration to accelerate the process of returning to some of the old decision-making patterns. At the same time, however, the ineptitude of bureaucratic structures further breached the prime minister's trust with civil servants and made him rely more on private-sector specialists" (Zakowski, 2015: 140). The case of DPJ's crisis management, dysfunctional information flow, and inconclusive integration of independent science advice in decisionmaking chains instigated re-evaluation of the overall science-policy relationship in Japanese policymaking (Arimoto et al., 2016).

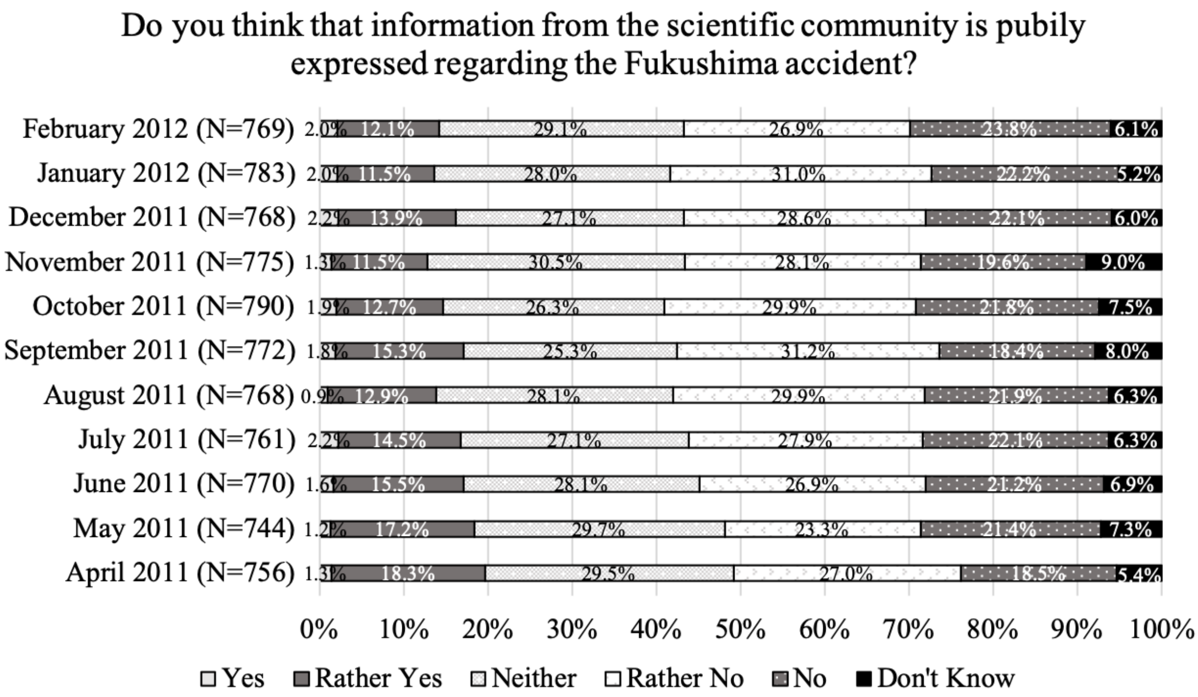
3.2.2. Barriers against Science Communication

Science communication, that is communicating science to non-scientists, directed towards policymaking can be understood as science advice in policymaking, while science communication directed towards society aims to increase the public understanding of science. Either form eventually aims to close the gap between science and society. Addressing issues of communicating science to the public and to policymaking is fundamental for improving the integration of science advice to governments because giving science advice is a communicative act ("speech-act") and its language, timing, and audience are key features for its impact in policymaking (UNDESA, 2015).

Communicating science comes with fallacies, however, and poses a challenge for scientific advisers to establish an effective role in policy networks other stakeholders or interest groups are not concerned about, since science advice is supposed to be un-biased and neutral when providing evidence about a complex issue. Are those who give science advice to be held responsible and liable for their advice? In case of the L'Aquila earthquake of 2009 in Italy, the prosecution of a group of scientists answered this question with "yes." And the escalation of the 2011 nuclear catastrophe in Fukushima, Japan, has been argued to be the cause of a failed communication between experts, decisionmakers, and energy industry (Thatcher et al., 2015; Takao, 2016).

The catastrophe in Fukushima revealed systemic issues in Japan's administration and the issue of information sharing appeared comparable to the early post-war environmental pollution crisis introduced in Chapter 1. It also revealed that science was not only apart from political decisionmaking it was apart from society in Japan as well (Center for Science Communication, 2016). In a social survey to measure the public's scientific literacy conducted monthly by the Center for Science Communication (CSC) via the Internet between April 2011 and February 2012 less than a fifth replied to think the opinion of the scientific community regarding the Fukushima accident was expressed publicly (Figure 3.4). Taken the answers "rather no" and "no" together (Figure 3.2), the majority did not see information by the scientific community provided to the public throughout each time the survey was conducted. The data showed an upward tendency towards the opinion of people that the voice by the scientific community was not expressed in the public. Moreover, scientists of the natural and life sciences that includes environmental science, expressed that they do not engage in conversations or discussions about their field with society (CSC, 2016: 24).

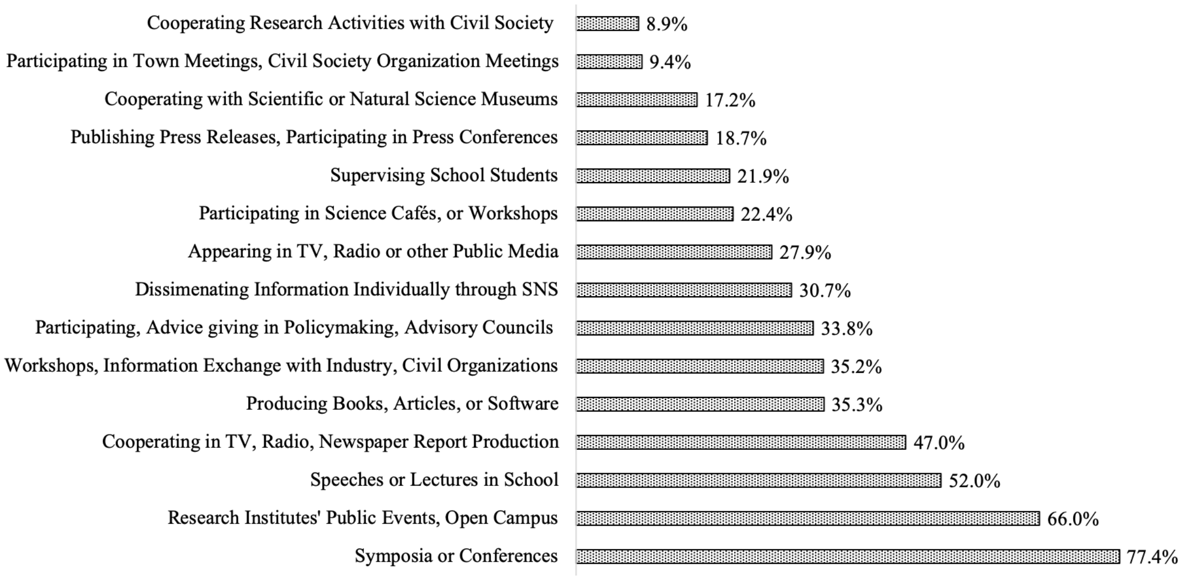
Figure 3.4 Scientific Literacy Survey Data by the Center for Science Communication



Source: CSC (2016: 9)

In terms of varying forms of science communication, science advice to governments is one example of possible activities by scientists communicating about their field outside the scientific community. Figure 3.5 below lists possible forms of science communication defined by the Japan Science and Technology Agency (JST). Participating in advisory councils or giving advice to policymaking accounts for one third and is the seventh most relevant form of science communication.

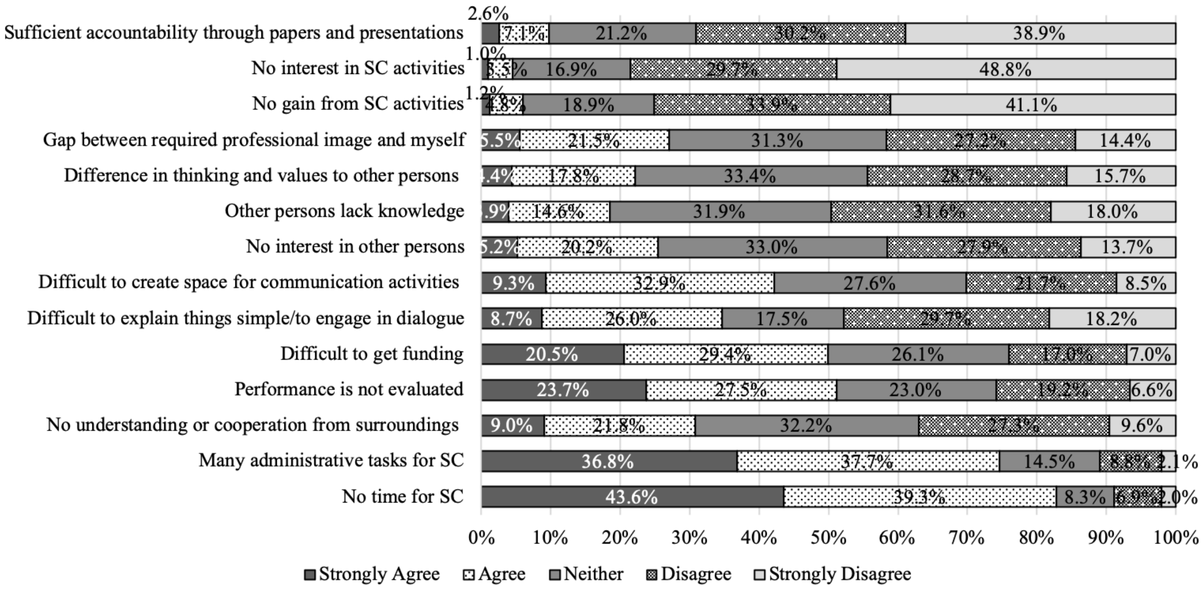
Figure 3.5 Science Communication Activities among Japanese Scientists (N=5,362)



Source: JST (2013)

In the same survey, the greatest barriers for effective science communication activities scientists face to effectively communicate with the public and advice giving in policymaking can be summarized due to lack of time and demanding research schedules that make it difficult to organize or engage in outreach activities as well as a substantial amount of clerical work related to engage in such activities (Kagakugijutsushinkōkikō, 2013). 43.6% strongly agreed, and 39.3% agreed on the issue of having not enough time. 36.8% strongly agreed, and 37.7% agreed that a substantial amount of clerical and administrative work necessary to engage in science communication activities is a significant barrier.

Figure 3.6 Barriers for Science Communication Activities (N=5,362)



Source: JST (2013)

The attention about science communication related issues such as the need for publicly available scientific, technical and expert information soon increased in the public and on the policy agenda after Fukushima. The changes in public and policy discourses were not limited to Japan and similar discussions intensified in many countries as the international community of scientists and science advice as discussed in Chapter 2 (Section 2.3.1) illustrated and has gained increasingly public attention sinc then.

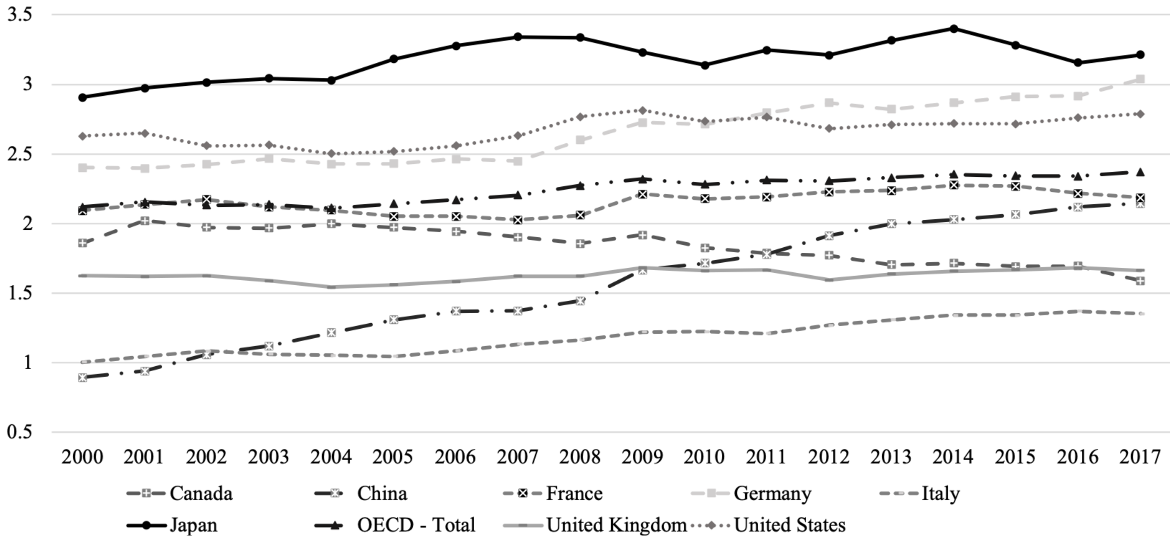
This section described how Fukushima instigated public, political and scholarly attention on the issue of science communication to the public and to policymaking. The review of literature about the disaster revealed how the science-policy interface of Japan did not function appropriately and, moreover, that its dysfunction caused the escalation of the nuclear disaster. Building on this discussion, the following section discusses the state of science in Japan and problems the science community faces.

3.3 State of Science in Japan

3.3.1 Japan as Research Forerunner

An analysis of the main OECD science and technology indicators illustrates Japan's leading position in research and development (R&D). For instance, Figure 3.7 demonstrates a comparison of the R&D investment of the GDP in per cent between the years 2000 to 2017 among the G7 countries and China. Since 2004, Japan's R&D spending was between 3.0% to 3.4% of the GDP. That is roughly one per cent point over the OECD average. In fact, Japan, Germany, and the United States (in descending order of their R&D spending of the respective country's GDP as of 2017) were the three biggest investors in domestic R&D. Even during the financial crisis of 2008, the decline in R&D investment in Japan did not last long as it increased again from a low in 2010 and remained in its top position throughout.

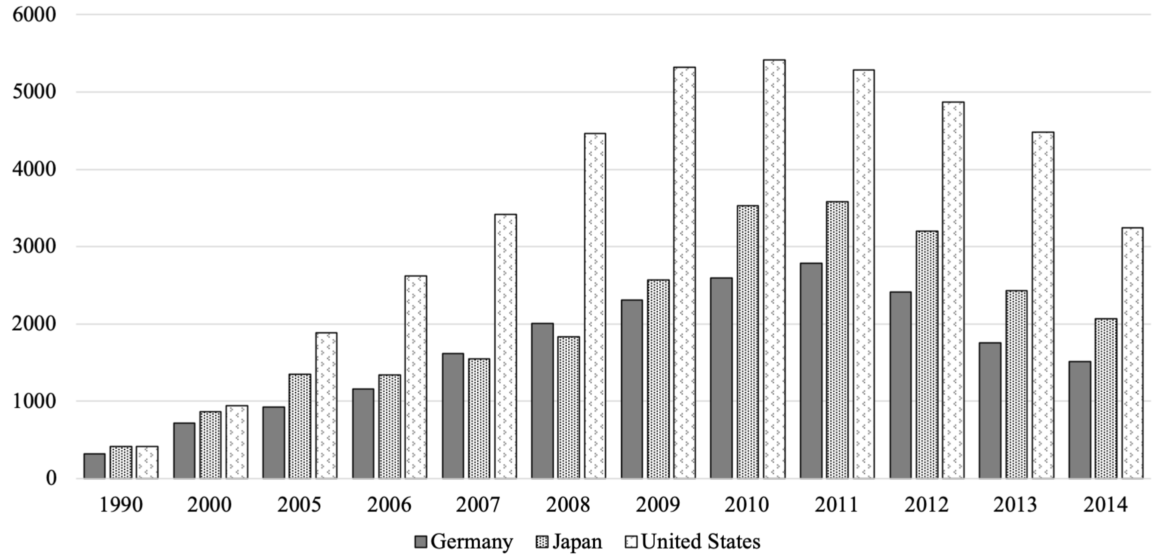
Figure 3.7 Gross Domestic Spending on R&D, Total, % of GDP, 2000 – 2017



Source: OECD Science, Technology and R&D Statistics: Main Science and Technology Indicators

In *Green Gold, Japan, Germany, the United States, and the Race for Environmental Technology*, Moore and Miller (1994) investigated how these three countries became the world leaders for energy efficient, and low-carbon technologies and illustrated that the promotion of developing such technologies for the environment rooted in economic policy rather than environmental policy, yet, the environmental label was used to foster economic growth through new technologies. We observe the countries' influence in the development of technologies with mitigation potential by looking at the OECD Environmental Policy Indicators in Figure 3.8 where the number of patents for climate mitigation technologies related to energy generation, transmission, or distribution (including renewable energies, nuclear energy, combustion technologies, and other technologies with mitigation potential) among these countries dominated the world market.

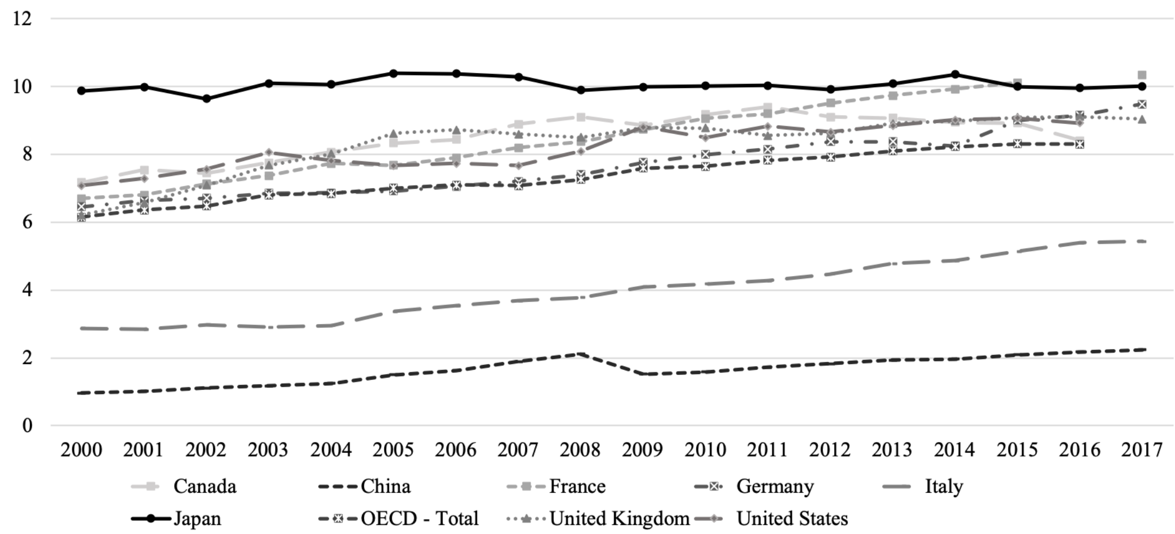
Figure 3.8 Climate Change Mitigation Technologies 1990 to 2014 (Number of Patents)



Source: OECD, Environmental Policy Indicators, Patents on Environment Technologies

Changing the perspective from the technology market to the labor market in comparing again the G7 countries and China, the highest number of total researchers per 1,000 employed as Figure 3.9 illustrates. Countries with the highest number of researchers on the labor market are France, Japan, Germany and the United Kingdom (in descending order of the number of researchers total per 1,000 employed).

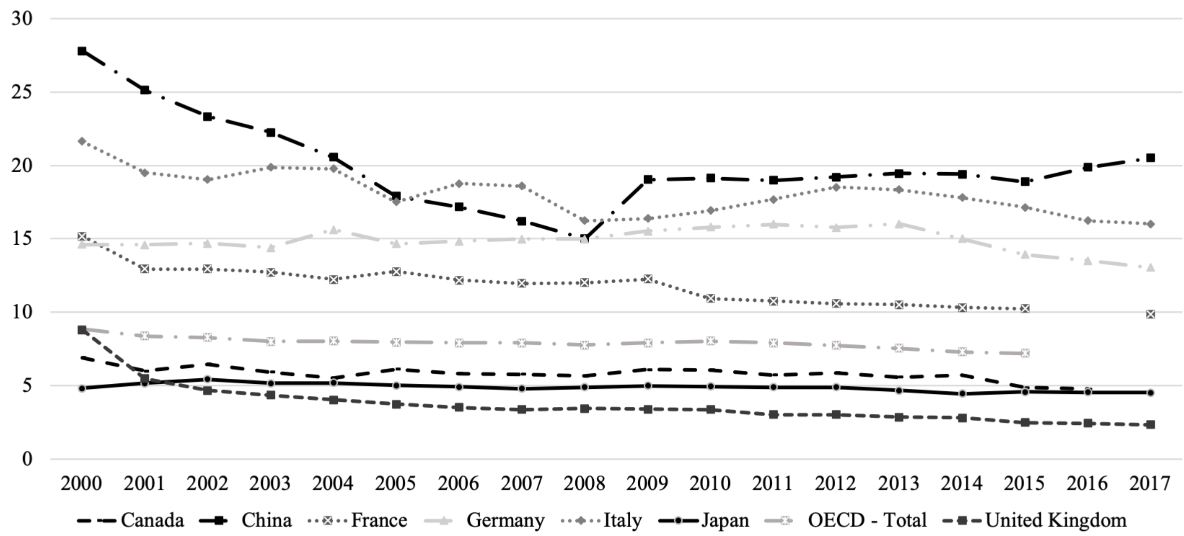
Figure 3.9 Researchers Total, Per 1,000 employed, 2000-2017



Source: OECD Science, Technology and R&D Statistics: Main Science and Technology Indicators

In contrast to the number of researchers per every 1,000 employed, Figure 3.10 shows that the number of government researchers in relation to the total number of researchers in Japan is among the lowest of the G7 countries. 4.5% of the total of researchers were government employed researchers in Japan in 2017 in comparison to Germany at 13.0% or Italy at 16.0% and below the OECD average of about 7% (last data point for the OECD average was 2015). Low et al. (1999) described how the dominance of private research companies in Japan appeared in the 1950s and has been increasing ever since compared to its counterparts such as Germany or the United States. The private sector offers more attractive work environment than public research institutes as for example "large companies were prepared to pay twice the wages of the public sector to lure capable researchers and technicians from national research laboratories and universities" and academic degrees are regarded less value on the labor-market in Japan than in other industrialized countries (Low et al., 1999: 18). A trend that has not changed until today.

Figure 3.10 Government Researchers Total, % of National Total, 2000-2017



Source: OECD Science, Technology and R&D Statistics: Main Science and Technology Indicators

R&D spending and the overall number of researchers on the labor market in Japan demonstrates the importance of research, science and technology for the country's wealth. The attention on the progressive picture of the international comparison however gets dim when investigating the domestic state of science in more detail. For example, Japan experienced a number of scandals about falsified research, plagiarism, a decrease of scientific output, and its recognition in the international scientific community in general. To analyze these symptoms an example from the public discourse provides some insights.

3.3.2 Difficulties in the Science Community

A featured series during September and October 2018 in the *Asahi Shimbun*, one of the major daily newspaper companies, discussed the topic of Japan's science capacity (*nihon no kagaku ryoku*). The author of the first part of the series gave the following three reasons for explaining the causes of the symptoms about the problems to which the Japanese science community has come: the number of researchers, time for conducting research and research budget (Kabata, 2018a). The author argued that the number of permanent positions for researchers has been decreasing and replaced by an increase in the number of employments with limited contracts. Hence, the labor market for researchers became more irregular. Time for conducting research consequently decreased as well. Besides the decreased time frame for research projects, the time to conduct research within the employment has decreased from 47% to 35% as administrative tasks increased. In two subsequent articles in the same series of the *Asahi Shimbun*, Kabata (2018b; 2018c) elaborated on the financial issue and how the limited budget for basic research constrains scientific capability.

In addition to issues on the labor-market and the work environment the observed less societal trust in scientific output (Chapter 1) (Hartwig, 2016; Satoh, Nagel, & Schneider, 2018) can be explained with fraudulent scientific behavior observable in the scientific community. Japan was labeled as the "Great Nation of Research Fraud" especially after the 2014 STAP research fraud scandal at the Waseda University, Tokyo[10] (Kabata, 2018d). The increased pressure and competition among young researchers in the precarious work environment provides an explanation for the increasing problems of science in Japan that results in increased fraudulent research (Kabata, 2018d).

Part six of the article series engaged the question whether political leadership defines important research topics. Komiyama (2018) discussed that the government decides research topics through the top-down framework of the CSTI that creates conflicts within competition policymaking. The framework will be discussed in more detail in the next section (Section 3.4) of this Chapter. Furthermore, the top-down framework raises questions concerning responsibilities of the research output (Komiyama, 2018). An issue that will be revisited in the discussion of questions for Japan's science-policy interface after Fukushima in Section 3.5.

From the example of the public discourse about the state of science, a panel survey conducted by the National Institute of Science and Technology Policy (NISTEP) (2019) between the years 2016 and 2018 provides a comprehensive set of data to add to the critical discussion of the science

[10] The case of Obokata Haruko and the STAP cell scandal in 2014 became one of the "world's best known scientific frauds" and earned the Japanese researcher Obokata entries in Wikipedia in Japanese, English, Korean, Uyghur, and Chinese (link: https://ja.wikipedia.org/wiki/小保方晴子, last access: September 23, 2019). Obokata conducted research fraud claiming to have found a way to reproduce stem-cells (STAP). An investigation was launched based on found irregularities in the images she produced and eventually revealed misconduct. As the research of STAP cells is of international impact in the research community the scandal had lasting effects and received global media attention.

in Japan. The purpose of the panel survey was to evaluate the impact of the Fifth Science and Technology Basic Plan that was enacted in 2016. The Basic Plan is renewed every five years and the surveys' objective was to evaluate whether the current Basic Plan improved the state of research in Japan. According to these data the state of research did not improve which is consistent with the newspaper article series. The following paragraphs highlight some of the key aspects the data provides to understand the precarious situation the science community in Japan faces and how that reflects in issues related to science advice to the government.

The top 10 of the most problematic issues Japan's science community faced as summarized in Figure 3.11 are consistent with the discussions in the public discourse. The first column of the table describes the contents of the questions NISTEP investigated in the research community of Japan between 2016 and 2018. The second column illustrates the percentage of the respondents who changed their assessment of the issue between the first phase of questioning in 2016 to the second phase in 2018. The following two columns show the proportion of the respondents who changed their assessment either more negative (assessment value decreased) or more positively (assessment value increased) compared to their first answer. The last column highlights the proportion difference between the changed assessments.

Figure 3.11 Assessments about the State of Science 2016 to 2018 (N=2,502)

Question contents	Changed assessments by respondends (%)	Assessment value decreased (%)	Assessment value increased (%)	Proportion difference
Output of basic research from Japan stands out internationally.	44%	36%	8%	-29%
Diversity of basic research is ensured as source for innovation.	36%	29%	7%	-22%
Output of R&D from Japan is sufficiently connected with innovation.	37%	28%	9%	-20%
Resource distributing organizations (JST, AMED, NEDO, etc.) function according to their role.	38%	28%	10%	-18%
State of support of government research funding for the state of development for excellent research.	33%	25%	8%	-18%
State of government budget for science and technology.	29%	23%	6%	-16%
Environment for cultivating creative, advanced R&D, and human resources.	36%	26%	10%	-16%
Framework for ensuring time for research.	35%	25%	10%	-14%
Technological development meets modern demands (competitive, comprehensive, integrated, international).	34%	24%	10%	-14%
State of intellectual foundation, and research information infrastructure in Japan.	33%	23%	10%	-14%

Source: NISTEP (2019)

Output from basic research in Japan does not stand out internationally, and reasons for the decreased assessment were that "all areas and levels of basic research of Japan continue declining rapidly" or "in times where the immediate acquisition of research funding is the utmost goal, future oriented research results do not come out" or "the presence of Japanese researchers in international conferences is decreasing" (NISTEP, 2019: 5). Reasons for a decrease in assessing situation for why basic research is not as much a source for innovations were for example that "research is continiously biasing towards short-term research and output that serves immediate social needs" (NISTEP, 2019: 5). The negative response about whether R&D output is sufficiently connected with innovation was explained with the situation in which the "the bridge [that is human and financial resources] to turn research results into a product is insufficient," the research gap between basic research and the market is big" or "a lot of research activities aim to keep up with Europe or the US" (NISTEP, 2019: 5). In terms of funding and support by the government the time constraint, and pressure to produce output quicker with less resources is a re-occuring issue.

The work environment for national research institutes in terms of budget, time for research, and human resources has decreased from 2016 to 2018. Internal budgets or time for research, and the provision of research assistants were "extremely insufficient" (*hageshiku fujūbun*); government provided budget is decreasing year by year (NISTEP, 2019: 11) which eventually pushes research closer to the market as researchers have to find other sources to be able to conduct research at all.

Overall, problems of basic research and funding management are gradually worsening despite the adaptation of the new Science and Technology Policy Basic Plan. Time constrains, lack of human and financial resources, insufficient administrative managers in public research institutes and universities are critical issues in the science community. Pressure from two sides, the administrative side and the pressure to be competitive with private research organizations on the market have created a precarious situation in which science advice to governments that is understood to be emanating from national research institutes and universities is expected to be weak in Japanese policymaking.

Already in 2016, the state of the framework and the function of science advice to governments was assessed as insufficient and decreased further until 2018. Reasons raised by the science community for the framework's inadequacy were for example that "the influence of the CSTI has been decreasing" or "science has not only responsibility to address politics but the society as well" or "even though advice was raised in politics the advice was considered" (NISTEP, 2019: 112). Nevertheless, the understanding of the importance of the SDGs in policymaking had a slight positive effect for some science advice pracitioners in the science community. Overall, budget for the science community to create science advice has been assessed insufficient and the demand to produce advice more quickly intensified (NISTEP, 2019: 112). As the science advisory process of Japan has been widely criticized because of this, the following section reviews the Japanese science-policy interface in terms of its institutional framework in more detail.

3.4 Science Advisory Processes in Japanese Policymaking

3.4.1 Regulation of Advisory Processes for Policymaking

Before explaining the science advisory process in Japanese policymaking, a few words have to be said about the general advisory process that exist in Japan. As noted in Chapter 2, science advisers are one type of actors in the multi-stakeholder governance process in policymaking. In *Advice and consent. The politics of consultation in Japan*, Schwartz (1998) provided a thorough analysis of the advisory policymaking in Japanese policymaking. Generally, we have to distinguish between the two main forms in the advisory policymaking process: *shingikai* and *iinkai*. *Shingikai* "are purely administrative committees that do not include participants from outside the government (*iinkai*)," yet, consent by a shingikai on a policy proposal has more weight for a policy proposal to pass legislation (Schwartz, 1998: 48).

First of all, policymaking without expert advice is hardly possible in Japanese policymaking as the establishment of advisory boards is required by law (Schwartz, 1998). More precisely, Article 8 of the National Government Organization Act (*kokka gyōsei soshiki hō*) defines the scope and establishment of a *shingikai* (internal advisory council to the government) under the jurisdiction of the Act. The purpose of such a council is to "study and [deliberate] important matters, administrative appeals or other affairs that are considered appropriate to be processed through consultation among persons with the relevant knowledge and experience" (MOJ, 2009). Within the scope of the council it "establish[es] test and research laboratories" to collect and produce new knowledge to inform policymaking (MOJ, 2009).

Table 3.1 Article 8 of the National Government Organization Act on "Councils"

National Government Organization Act   **Act No. 120 of July 10, 1948**
"(Councils, etc.)"
"Article 8 An Administrative Organ of the State as set forth in Article 3 may, within the scope of the affairs under jurisdiction as prescribed by the Act, establish an organ having a council system for taking charge of the study and deliberation of important matters, administrative appeals or other affairs that are considered appropriate to be processed through consultation among persons with the relevant knowledge and experience, pursuant to the provisions of an Act or a Cabinet Order."
"(Organs such as Facilities)"
"Article 8-2 An Administrative Organ of the State as set forth in Article 3 may, within the scope of the affairs under jurisdiction as prescribed by an Act, establish test and research laboratories, inspection and certification institutes, educational and training facilities (including organs and facilities similar thereto), medical and rehabilitation facilities, reformatory and internment facilities, and work facilities, pursuant to the provisions of an Act or a Cabinet Order."
"(Extraordinary Organs)"
"Article 8-3 An Administrative Organ of the State as set forth in Article 3 may, when particularly necessary, establish extraordinary organs in addition to those organs that are prescribed in the preceding two Articles, within the scope of the affairs under jurisdiction as prescribed by an Act, pursuant to the provisions of an Act."

Source: MOJ (2009)

The right to establish a research group as stated in Article 8-2, highlights how the state attempted to integrated scientific advice from the inside of state organs. A governmental body is required to establish a council to gather information and expert knowledge for the formulation of a law or policy. And in addition to that, governmental bodies have the right to set-up their own research groups to conduct further research on relevant issues. The top-down policymaking created *tatewari* (vertically divided) advisory process in policymaking that is a hierarchically structured system in which ministries have their own advisory councils consisting of interest-group representations that includes academia, NGOs/NPOs, private or publicly funded research or business corporations that "influence the government's policymaking process from within, but broad peak associations do not dominate the articulation of private interests or engage in wide-ranging negotiations with one another" (Schwartz, 1998: 1). In other words, in the vertically divided advisory policymaking that was described in Chapter 2 in Figure 2.2 cross-sectoral interaction between varying interest groups is rare.

In neopluralist understanding of Japan's advisory policymaking the concentration of specific policy issues is dealt with by a sub-set of actors who form a (temporary) coalition based on interests and goals. In Japan, such a coalition was called the "Iron Triangle" , "Subgovernments" (Schwartz, 1998), "Ruling Triad", or "Triple Control Machine" (Broadbent, 1998) in which "[b]ureaucrats play a central role in the framing and implementation of policy" (Schwartz, 1998: 1). The formation of state institutions in 1948 set the basis for the relationship between science and policy, and how non-state actors, stakeholders, interest groups, and experts are being integrated in the work of the government, however, ministries and their advisory boards are "increasingly constrained by markets, their clienteles, and elected politicians" (Schwartz, 1998: 1).

The analyses in Chapters 6 and 7 demonstrate the closeness of science advice to the market, and the closedness of the vertically structured advisory policymaking. From the general regulatory framework of advisory policymaking discussed in this section, the following section describes the structure of the CSTI that was introduced in Chapter 1 in more detail highlighting the formal institutional framework for science advice to the government.

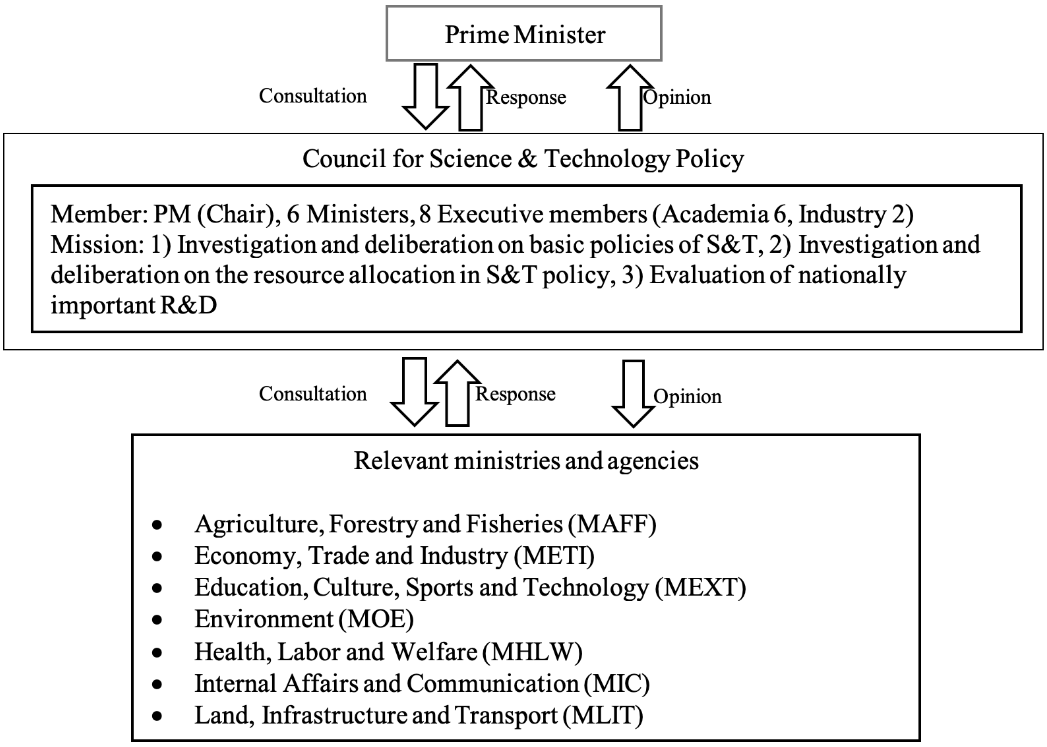
3.4.2 Structure of the Council for Science, Technology and Innovation

According to Arimoto et al. (2016) science advice to the government in Japan manifest itself in a dual dynamic of science advice between a "Risk Evaluation Base," and a "Benefit Evaluation Base" (25). In this dual system, the authors described the control mechanism of science advice as "Regulatory Science," that is science that provides all political fields such as health, environment, food safety, or labor market with a scientific basis to formulate and execute sound policies (25). Regulatory science materializes within the controlled internal research procedures in the *shingikai* system.

In Japan, scientific advice to the government is institutionalized in the Cabinet Office, similar the Parliamentary Council for Science Advice (PCAST) in the United States. In 1995, the government of Japan passed the Science and Technology Basic Law to strengthen the position of science in policymaking and society as it is a pillar of Japan's growth. Its objective was to "achieve a higher standard of science and technology…to contribute to the development of the economy and society in Japan…as well as to contribute to the progress of [Science and Technology] in the world and the sustainable development of human society…" (Kantei, Cabinet Office, 1995). Six years later, in 2001, the Cabinet Office established the Council for Science and Technology Policy (CSTP) "as one of the Councils on Important Policies" (Kantei, 1999). In 2014, it was reformed to the Council for Science, Technology and Innovation (CSTI) as "the body that determines Science and Technology Policy [by which] Science and Technology Promotion Policies are promoted to be a tool that solves all major problems in Japan. From problems in the welfare of society coming from declining birthrates and population aging, to problems in the energy sector" (Kantei, 2015).

Compared to countries like Argentina where no formal mechanisms for science advise exist (Abeledo, 2018) or other countries like Germany where formal mechanisms are decentralized, Japan's advisory mechanisms in national policymaking are highly formalized and centralized. The structure of the Council is illustrated in Figure 3.12. It was established under the Cabinet Offices Law that locates the Council in the Cabinet Office in which the prime minister is the head and holds main administrative authority. The Council consists of six ministers one from each of the main ministries that are MAFF, METI, MEXT, MOE, MHLW, MIC and MLIT, and eight executive members (six from academia and two from industry). The inner workings of the Council are revisited in the analyses in Chapter 7.

Figure 3.12 Structure of Council for Science, Technology and Innovation Japan



Source: Tanaka, Regional Update: Japan's R&D Strategy of Nanotechnology (2012)

The purpose of the CSTI is to promote and regulate science and technology. Therefore it creates a policy for science, integrates the importance of scientific inquiry in policymaking, and it defines the business model of the government. From the perspective of science and technology studies, the outset of the framework allowed the expectation of a substantial integration of science advice in policymaking because it is recognized as a pillar for society. From the institutional framework of policies for science, the following section describes how the interaction between science and policy is defined within codes of conduct for both sides, science and policy.

3.4.3 Codes of Conduct in the Japanese Science-Policy Interface

Upon the discussion of the issue on responsibility between the government and scientists after Fukushima, the JST and its affiliated Center for Research and Development Strategies (CRDS)[11] published a strategic proposal in March 2012 entitled *Toward the Establishment of Principles Regarding the Roles and Responsibilities of Science and Government in Policy Making*[12]. Building on this strategic proposal and the discussions about failings in the crisis management after Fukushima, the Science Council of Japan published a statement on their "Code of Conduct for Scientists" in January 2013 that was first published in October 2006. The Code provides guidelines for expert advice to the government (Arimoto et al., 2016).

Articles 12 and 13 specify science advice activities and science advice to the government in more detail[13]. Article 12 on "Scientific Advice" of the guideline states as follows:

> "Scientists shall conduct research activities with the objective of contributing to public welfare, and offer fair advice based on objective and scientific evidence. At that time, they shall be aware of the gravity of the impact and their responsibility that their statements may make on public opinion building and policymaking and shall not abuse their authority. As well, scientists shall make maximum efforts to ensure quality in their scientific advice, and at the same time clearly explain the uncertainty associated with scientific knowledge as well as the diversity of opinions" (Nihongakujutsukaigi, 2013).

Article 13 on "Scientific Advice to Policy Planners and Decision Makers" states

> "[w]hen scientists offer scientific advice to persons who plan or decide on policy, they shall recognize that while scientific knowledge is something to be duly respected in the process of creating policy, it is not the only basis on which policy decisions are made. In the event that a policy decision is made that diverges from the advice of the scientific

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[11] CRDS was established in 2003 and is affiliated to JST. A co-founder of the Center explained that the motivation to establish the center was to create an independent institution that investigates science, technology and innovation, and provide strategic policy proposals.

[12] Original title in Japanese: *Seisakukeisei ni okeru kagaku to seifu no yakuwari oyobi sekinin ni kakawaru gensoku no kakuritsu ni mukete*, CRDS-FY2011-SP-09. Accessible here: https://www.jst.go.jp/crds/pdf/2011/SP/CRDS-FY2011-SP-09.pdf (Last access: June 17, 2019).

[13] English translation of the "Code of Conduct" was provided by the Science Council of Japan. The Japanese version is accessible here: http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-22-s168-1.pdf (Accessed: June 17, 2019). The English translation is accessible here: http://www.scj.go.jp/ja/scj/kihan/kihan.pamflet_en.pdf (Accessed: June 17, 2019).

community, scientists shall request, as necessary, accountability to society from the policy planner and/or decision maker" (Nihongakujutsukaigi, 2013)[14].

The question of responsibility and accountability may exert pressure on the science community and raise concerns among science advisers that added another barrier against science communication to society and policymaking that was not measured in the surveys described in Section 3.2. The guidelines by the Science Council of Japan focus on the relationship between science and policy from the standpoint of scientists. A Code of Conduct for decisionmakers on how to use and integrate information and advice from the scientific community was published by the Cabinet Office in 2016. These guidelines on the integration of science advice in policymaking from the perspective of policy planners and decisionmakers came belated in the 5th Science and Technology Policy Basic Plan by the Cabinet Office's Science, Technology, and Innovation Council.

Chapter 6 of the Basic Plan covers the issue of how to improve actor relationship and science communication. More specifically, Article 3 about "Science Advice to the Government" states "[i]n responding to natural disasters and climate change…the role of science and technology in government has increased significantly. For this, in the effort to ensure the value of science advice, scientists shall clearly explain the limits of scientific knowledge, that is the existence of uncertainty or differing scientific opinions to the various social stakeholders. On the one hand, to expect understanding of all different stakeholders, scientists shall give scientific statements from an independent standpoint without influencing policy planning. Moreover, even though scientific advice has to be respected in policymaking, it is important for all stakeholders to understand that political decisions are not based on one single judgement. Further, regarding the state of scientific advice in Japan, based on recent international developments, it is necessary to evaluate this mechanism and enhancements of the system" (Kantei, 2016)[15].

The system that is referred to at the end of Article 3 is the system of science advice to the government. It is therefore recognized that current ways of integrating science advice in policymaking and how the relationship between the science community and policy community is facilitated requires review and evaluation. The apparent less optimal and partly worsening state of science communication described in Section 3.2.2 raises attention to the statement to evaluate the system that was written into the regulations. The following section briefly describes forms of science advisers specific to Japan in relation to the concept described in Chapter 2.

[14] The document cited here has no page numbers.

[15] Translation by the author. The Science and Technology Basic Plan is accessible here: https://www8.cao.go.jp/cstp/kihonkeikaku/index5.html (Accessed: June 17, 2019).

3.4.4 Science Adviser Types Specific to Japan

According to studies by NISTEP discussed in Section 3.2, three types of scientific institutions that are part of the advice-giving structure in Japanese policymaking could be identified: "Universities," "National Research Institutes," and broadly all private, corporate research and development institutions labeled as "Innovation Centers." Relating the identification of types of science advisers in the Japanese system to the four concepts of science advisers discussed in Chapter 2, the following can be said about the three types of science advisers in Japan.

Basic research is located in universities. Therefore, the pure scientist (refer to Chapter 2) are University academics. It was expected that national research institutes are carriers of basic research as well. However, national research institutes are more a form of science arbiter. Innovation center are a form of issue advocate. The fourth conceptual type introduced in Chapter 2, the knowledge broker, was empirically difficult to identify because the concept proposed by Pielke (2007) is too ambiguous as to make a clear identification of such actors in domestic policymaking possible. The two dominant science adviser types in Japanese policymaking were science arbiter (national research institutes) and issue advocates (innovation center). The next paragraph describes how they could be drawn inductively.

As part of the interview survey conducted for this research (the data type and collection method are explained in Chapter 5) the identification of types of science advisers in Japanese environmental policymaking was possible by including questions that were asked the informants to assist in the science adviser classification. Informants were asked to classify the actors in a prepared list between the four conceptual science adviser categories: pure scientist, science arbiter, issue advocate and knowledge broker (the list can be found in the Appendix). Because functions and activities of organizations are diverse it was expected that drawing clear boundaries between the categories would be difficult. Therefore, informants could give two answers per organization. It was in fact not always clear what category to assign to organizations. As a result, the two main categories of science advisers that issue advocate (innovation center) and science arbiter (national research institutes) could be empirically identified[16]. The last section of this chapter provides an overview of what topics in environmental research are relevant for policymaking in Japan and how important the field of environmental research is in comparison to other areas.

[16] The analyses in Chapter 6 and 7 use the differentiated classifications of possible science advisers in Japanese policymaking to investigate how science advice is integrated in environmental policymaking.

3.5 Relevant Research Topics in Advisory Policymaking for the Environment

The CRDS is a form of think tank of the JST established in July 2003. The Center's aim is to lead "the advancement of science and technology as well as the creation of innovation for the purpose of the sustainable development of Japan and human society. [It] extracts issues to be tackled, proposes R&D development strategies aiming to be utilized on policies and works with stakeholders to accomplish them [by] follow[ing], overview[ing] and analys[ing] the trend of society, [science and technology innovations] and their relevant policies in Japan and abroad" (JST/CRDS, 2017: 3). As it operates between the fields of STI/R&D and policymaking CRDS is an example for an intermediary science adviser to the government in case of Japan.

For conducting this research, the Senior Deputy Director-General and co-founder of the Center of the CRDS was interviewed. The purpose of this interview was to get a better understanding of the Center's structure, purpose and tasks in context of science advisory boards to the government. This interview conducted in the early stages of the research project differs from the interview survey that is explained in Chapter 5. Because of the Center's aim to overview generally all relevant fields of science and technology, research and development, it was not part of the J-GEPON2 target population (refer to Chapter 5).

The motivation to establish the Center was to provide policymaking with an objective overview of relevant issues in science and technology, and research and development. Before its establishment government bureaucrats of MEXT were cooperating with many researchers, however, the science community was not as forthcoming to government officials. Therefore, there was a need for an institution that works closely with the science community and can provide policymaking with all relevant information. By following closely developments in the science community in Japan and abroad, extracting relevant issues for policymaking and evaluating the potential and social impact of emerging topics, the Center provides decisionmakers with suggestions and strategic proposals for policymaking. Generally, the Center produces such proposals or reports every two years. To raise awareness in the policy community in the early stages, and ensuring attention for the proposed measures of relevant issues and movements in science and technology, and research and development the selection of topics and strategic proposals are produced in close cooperation with relevant ministries and governmental bodies.

Among the greenhouse gases, CO2 is the main cause for anthropogenic climate change, therefore, to achieve zero-net emissions the energy sector has to be de-carbonized. The research area for energy in Japan's science community, as identified by the CRDS, included 31 research topics. Among the following five general areas, research on the environment was the least important. These five general areas are: energy, environment, system and information technology, nanotechnology and material science, and life science and clinical medicine. The most important field of research are the life sciences and clinical medicine. As of 2017 a total of 49 R&D topics related to this field were being researched. In contrast, the area for the environment was the smallest in terms of number of research topics: environment included 15 R&D topics Table 3.2 summarizes the number of R&D topics by sections and research area.

Table 3.2 Number of R&D Topics by Field (2017)

Research Area	Number of Sections	Number of R&D Topics
Energy	3	31
Environment	4	15
System and Information Technology	6	36
Nanotechnology and Material Science	7	37
Life Science and Clinical Medicine	5	49
Total	25	168

Source: CRDS (2017)

Table 3.3 R&D Topics by Section for the Environment (2017)

Section	R&D Topic
Climate Change	Climate Change Predictions
	Climate Change Impact Predictions and Evaluation
Environmental Pollution and Health	Air Pollution
	Water Pollution
	Soil/Ground Water Pollution
	State of Material Cycle/Environmental Dynamic
	Health/Environmental Impact
	Chemical Risk Management
Life's Diversity and Ecological System	Concept and Prediction of Life‘s Diversity and Ecological System
	Ecological System Service Evaluation and Management
Recycle-based Society	Water Cycle
	Environmental Research of Agriculture, Forestry and Fisheries
	Recycle and Waste Disposal
	Resources, Production, Consumption Management
	Urban Environment

Source: CRDS (2017)

Table 3.4 R&D Topics by Section for Energy (2017)

Section	R&D Topic
Energy Network/Usage	Decentral Cooperative Energy Management System
	Direct Current/Superconductive Energy Transmission
	Power Electronics
	Electric Storage Devices
	Heat Technology
	Transactivation Magnet Material
Energy Supply	Energy Resource Technology Development
	Thermal Power
	Advanced Nuclear Energy Reactor
	Fusion Reactor
	Nuclear Energy Safety
	Decommissioning of Radioactive Waste and Used Fuel
	Wind Power
	Geothermal Power
Energy Supply/Network/Usage	Energy System Evaluation
	Energy Carrier
	Fuel Cell
Energy Supply/Usage	CCUS (Carbon Capture Utilization and Storage)
	Photovoltaic
	Biomass
	Catalyst
	(General) Combustion
	Tribology
	Heat-resistant Material
Energy Usage	Smart Building/House
	Heat Insulation/Thermal Barrier/Modulated Light
	Illumination/Display (Organic EL, Quantum Dot LED)
	Heat Recycling Technology
	Separation Technology
	(Car) Engine Combustion
	High-intensity Light Material

Source: CRDS (2017)

3.6 Chapter Summary and Conclusions

Severe pollution problems due to rapid post-war economic growth in the 1950s and 1960s caused toxic air pollution in highly populated urban areas in Japan that was comparable to some regions of contemporary China (Avenell, 2017). As a result, top-down implementation of environmental regulations through administrative guidance in cooperation with big business in the 1960s and 1970s lead to intense investments in low-carbon energy efficient technologies that turned the country to a forerunner for such technologies it is today.

Even though, social and political institutions for the environment are weak compared to other countries that have strong Green Parties in either opposition or government coalitions (e.g. Germany, and Scandinavian countries), or strong national environmental NGOs/NPOs that take part in policymaking, Japan did develop stringent environmental regulations in the 1970s (Broadbent 1998; Schreurs, 2002; Kameyama, 2014). Whereas pollution problems were quickly resolved by Japanese steel industry as a whole that managed to cut their emissions between 30% to 80% between 1970 and 1980 (Moore & Miller, 1994), almost four decades later, the country remains a major CO2 emitter. Germany, the United States, and Japan are research and technology superpowers. Yet, even though they are forerunners in the development of technologies with mitigation potential, their environmental and energy policy framework differs significantly. Considering the significant output from Japan's research and development, as well as the given legal framework discussed in Sections 3.3 and 3.4 the criticism about Japan's weak science-policy interface was first unexpected.

Despite systemic issues of Japan's science-policy interface and problems in the science community as discussed in Sections 3.2 and 3.3 these problems are neither specific nor unique to Japan. Cases about environmental policymaking in Australia, for example, illustrated how the limitation and control of scientific knowledge by bureaucrats and the exclusion of scientific expertise for making sense of scientific evidence lead to failures in environmental conflict resolution between local authorities and national politics (Brueckner & Horwitz, 2005).

For developing a theoretical framework to explain the role of science and its integration in environmental policymaking, some would argue from a sociological institutionalism perspective, however, because cultural norms seem to be irrelevant in explaining why in such cases vertical boundaries exclude scientific expertise from political decisionmaking, and because political power is centered among bureaucrats, the cultural argument in the sociological institutionalism is limited to make a case for these observations. Access to, and control over knowledge is considered a substantial source of political power. The intended distance between science and policy, and an indirect approach through multi-layer advisory systems may provide insights for the conceptualizing of science-policy interfaces, and for the methodological development of the science-policy interface in environmental policymaking particularly.

4. Power of Knowledge Networks

4.1 Chapter Purpose and Structure

The purpose of this chapter is to describe the theoretical framework to investigate the integration of science advice in environmental policymaking in Japan. The main thesis is that the exchange of scientific knowledge is an independent variable for the power distribution among actors in environmental policymaking. This is developed through combining key arguments from those three fields: sociology of knowledge, institutions, and networks. The interrelation between these three fields is as follows. Attributes of actor interaction and actor relationships based on communication and knowledge exchange explain actors' integration in a network in which skilled communicators shape the policy agenda and are hence powerful players in policymaking (Birkland, 2016). The basic assumption is that knowledge is a resource of political power (Rouse, 1987). But for science on the environment and climate change to be a resource of power in environmental policymaking it needs to be accessible for policy actors. Relationships provide actors with this access to resources (Wasserman & Faust, 1994). Therefore, the exchange of knowledge is a form of interaction that is regulated through networks where shared interests guide the interaction of actors, and the exchange of or access to resources (Sabatier & Jenkins-Smith, 1993).

As discussions about science-policy interfaces have shown, it is the relationship between different stakeholders and how they share – or not share – intellectual resources, and whether independent scientists are included in decisionmaking that determines political outcomes (Chapter 3). Therefore, the theoretical framework in this dissertation integrates power of knowledge theories with social network theories to conceptualize and operationalize potential influential power. The motive for the integration of these theories is derived from the main thesis that science advice is a resource of power in policymaking networks. The purpose of integrating social network theories in the power of knowledge theories was to find ways to empirically measure power in policymaking networks, that Straßheim (2010) equated as knowledge networks.

Because knowledge is considered a resource of power, it is therefore assumed that it is not shared boundlessly. The knowledge exchange relationship depends on actors' values, interests, and preferences (Sabatier & Jenkins-Smith, 1993). Preferences for discourses; Whether to support more stringent environmental policymaking. Preferences for information sources to support the actor's standpoint. Preferences for relationships; the formation of coalitions or networks depend on actors' choices for a potential powerful group of actors to make use of the resources, and to increase chances that the preferred discourse wins over others through an influential coalition. The selection process for information puts value on the type of available evidence, and it puts value on the connection between actors. Therefore, the main thesis argues that (s)he who has control over scientific evidence and control over the selection process of scientific evidence has significant power to influence the policy agenda.

The integration of, and access to expert advice is a key element for decisionmaking in policymaking. Therefore, it is expected that power of knowledge theories apply in Japanese neo-pluralist (Schwartz, 1998) consensus based (Renn, Webler, & Wiedemann, 1995) advisory policymaking. We may find features that are specific to Japan in terms of how and by whom scientific knowledge is distributed in the policy network. In Japan, the distribution may be more limited or controlled in policymaking networks than in other countries because of high boundaries and limited access to policymaking networks within the *tatewari* advisory structure in Japanese policymaking (Chapter 3).

The review of theories starts with defining networks in terms of "knowledge politics," continues with a brief discussion about network exclusions, and how the limitations on policymaking networks were conceptualized. Then, a discussion about the connection between discourses and influential power in policymaking networks is followed by conceptualizing the power of scientific knowledge transmitters.

4.2 Science-Policy Interface as Policy Network

Analyzing networks in policy research has become more prominent because "social relationships are a fundamental component of political systems" (Victor , Montgomery, & Lubell, 2018: 3). And we find many sources to define policy networks. The vast literature has defined policy networks broadly in these or similar terms: a policy network is a set of political actors that have some form of relationship and are drawn together by resource inter-dependencies that creates a governed interdependence and is capable of developing successful policy strategies because it constrains participation (Compston, 2009; Rhodes, 2017; Victor , Montgomery, & Lubell, 2018). However, Victor et al. (2018) have argued that while network theories and methods in various academic fields are fairly robust, methodologies to analyze networks in policymaking are still in early stages and have much potential to develop (Victor et al., 2018).

Fleischer and Veit (2010) argued that the dynamic of the relationship between science and policy is driven by actor relationships, and the increased involvement of diverse actors such as advisory councils, think tanks, or commercial consultants has changed democratic processes. In other words, policymaking is not exclusively the realm of governments. It happens in institutional cooperation among different stakeholders, including state and non-state actors (Montpetit, 2003). Literature identified this as "governance."

Theories of policy networks focus on the relational aspect of policymaking (Victor et al., 2018). Policy networks "play a key role in policy formulation and implementation" because they are "structures that regulate the interactions [of actors] in the governance process" (Montpetit, 2003: 4). As Schneider and Ingram put it (1997: 4): multi-actor interaction gives democratic systems the capacity to produce public policies that meets social expectations for which all actors rely on expert advice to formulate policy proposals. Therefore, to understand the dynamics behind these concepts we need to look at them through the policy actor network lens because networked politics are always knowledge politics (*Wissenspolitik*) (Straßheim, 2010).

Straßheim (2010) argued that networked politics become theoretically and empirically comprehensible through the conceptualization of networked governance based on the social distribution of knowledge if we consider actors' preferences and positions as network forming and network coordinating features. Science-policy interfaces are processes of knowledge exchange. The conceptual models of science-policy interfaces call for theories about networks because at the core science-policy interfaces lays actor interaction that are a driving force of policymaking (Victor et al., 2018). Networks regulate interaction, they consequently limit participation of actors. Therefore, conceptualizing boundaries and constraints of networks need to be part of the theorizing process. Networks' regulating function of social interaction includes defining roles of actors as well as excluding issues from the policy agenda.

Limiting participation in policymaking to a selection of key players of different state and non-state actors is supposedly rendering policymaking easier (Montpetit, 2003). The policy theory of conflict of interest explains influential power of policy actors in terms of group size and closedness; policy actors are influential if the group size is minimal in "the sense that they contain no more members than is necessary" to win (De Swaan, 1973:75) and closed in the sense that they contain only members that are adjacent on a one-dimensional policy scale (Axelrod, 1970: 169). The limitation of network integration might make policymaking easier if an elitist linear top-down system of policymaking applies. However, in pluralistic democratic societies such policy decisions may lack sufficient social support and trust. Montpetit's (2003) main thesis was concerned with issues of distrust in policy networks arguing that distrust among actors is in fact the default mode of policy networks (Montpetit, 2003).

The other side of network integration discussed that dynamics in policy networks deal inherently with distrust across actors that causes conflicts and dysfunctionalities in politics (Straßheim, 2010; Montpetit, 2003). It was argued that the integration of science advice increases trust and legitimacy in policy decisions (Chapter 1). The search for good practices of integrating science in policymaking seems to be an eternal search for how we can increase trust among actors and trust in scientific output. Therefore, the thesis about network integration cannot be fully understood without discussing network exclusion.

The following section discusses the connection between policy networks and environmental discourses in more detail. This connection is consistent with the post-normal science of the sociology of knowledge that attitudes, values and interests are an integral attribute of scientific inquiries and have to be considered when discussing the question of how science advice is integrated in policymaking.

4.3 Discursive Power of Influential Policymaking Networks

Limited integration of science advice in environmental policymaking requires effective framing of most important scientific results on climate change. The connection between discourses and policy networks developed into a sub-field of policy network research with its own theories and methodologies. Studies by, for example, Young (1992), Hajer (1995), Bulkeley (2000), or Humphreys (2009) illustrated how the dominance of discourses that are favored by certain actors influences the power distribution in environmental policy actor networks. The thesis according to the literature is that policy actors form networks based on their shared interests and these networks influence the perception of issues because of the way they frame it. This argument leads to another layer of limiting the network, not only from the argument of group size to make policymaking efficient, but also from the social institutional argument that actors prefer to build a coalition or enter an existing one that is similar to their own values and interests (Sabatier & Jenkins-Smith, 1993; Van Deemen, 1997). In turn, existing coalitions or groups may exclude actors who do not share the group's opinions and perceptions of certain issues to secure the dominance of an established discourse.

An established discourse favors certain policy options. In environmental policy negotiations Humphreys (2009) labeled the process of determining favored discourses as "discursive struggle". In the discursive struggle, the credibility and accountability of, and trust invested in, the storyline by the actors become significant. An established discourse holds discursive power that manifests itself in the degree to which its implicit future scenarios permeate through society that leads to re-conceptualizing of interests and recognizing new opportunities (Hajer, 1995). In Hajer's (1995) argumentative approach, a struggle for discursive hegemony in which actors try to secure support for their definitions of reality, discourse coalitions are formed based on interests, beliefs, and understandings of specific policy problems. Keck & Sikkink (1998) argued that actors in environmental advocacy networks may invoke professional norms of interests as well as values. In turn, a powerful discourse coalition may invoke norms, interests and values created by the interaction of actors.

An organization in the environmental policymaking process seeks out to form connections with other organizations that share same or similar policy goals and attitudes. The purpose to form a connection is to share resources. In a formalized network, as opposed to an informal network, the material and financial resources such as funding, for example, create dependence relationships between actors who depend on public or private funding. In an informal network, it is less material resources but rather intellectual resources that binds the actors together. In relationships where policy actors depend on scientific expert advice, influential science adviser may form the core of the network that accumulates many relations to diverse policy actors.

Van Deemen (1997) explained the formation of social coalitions (not political party coalitions) as a choice process in which a preference is used for making a selection from a set of possible coalitions. Thus, preferences become explanatory variables. In other words, preferences become relevant in situations in which a choice has to be made from a set of alternatives (Van Deemen, 1997: 2-15). In an ideal situation, preferences with whom to build a valuable coalition or which existing coalition to enter weighs more than either "value" or "availability." If there are enough alternative groups for the actors to choose from, and if entering the group is easy, preference as to an organization or a set of organizations within the dominant group is known in terms of what political interests and goals they have (Van Deemen, 1997).

The discursive struggle among policy actors in policymaking networks affects the distribution of power as well as the distribution of and access to resources. In other words, interaction between power as discourse, and power as the control and deployment of resources emphasize the means of effective discourses. Discourses with influential power help shaping common understandings of environmental problems across a broad range of actors. In Foucauldian terms of discourse as power, the attribute exercised by states that control significant material resources, such as finance, technology or industrial infrastructure determines the strength of support a discourse can receive (Brown, 2006). From the social integration argument discourses are created by actors, and the "power of an actor depends on whether that actor can produce, shape and propagate discourses that other actors accept as legitimate" (Humphreys, 2009: 324).

Political legitimacy and expertise are sources that contributes to influence and power (Takao, 2016). Scientific expertise is used to create or make existing discourses more influential. In his argument for the political significance of scientific knowledge, Rouse (1987) argued that the interpretation of scientific practices, and the knowledge they produce, works in both ways. It defines the political influence on science, and it defines the political influence of science (Rouse, 1987). Therefore, knowledge emanating from scientific expert advice need to be addressed as an aspect of power (Winkel, 2012).

The overall arguments can be summarized in Hajer's knowledge-based theory that says that the existence of scientific consensus is just as invaluable among other factors such as public awareness of the issue, active NGOs, and the existence of media coverage as independent variables that explain the formation of environmental policy networks (Hajer, 1995). Consistent with Hajer's knowledge-based theory, Takao (2016) argued that the knowledge-sharing and social interaction increases mutual understanding of alternative knowledge in environmental research as well as the acceptance of different norms and values (Takao, 2016). In what way then does scientific knowledge permeates through policy networks and what kind of policy actors are carriers of that knowledge? And how can we conceptualize the power of carriers of scientific knowledge in policy networks? The following section will review these questions and develop the argument of science adviser's influential power in policymaking as transmitters of knowledge based on their function to "funnel" scientific knowledge in environmental policymaking.

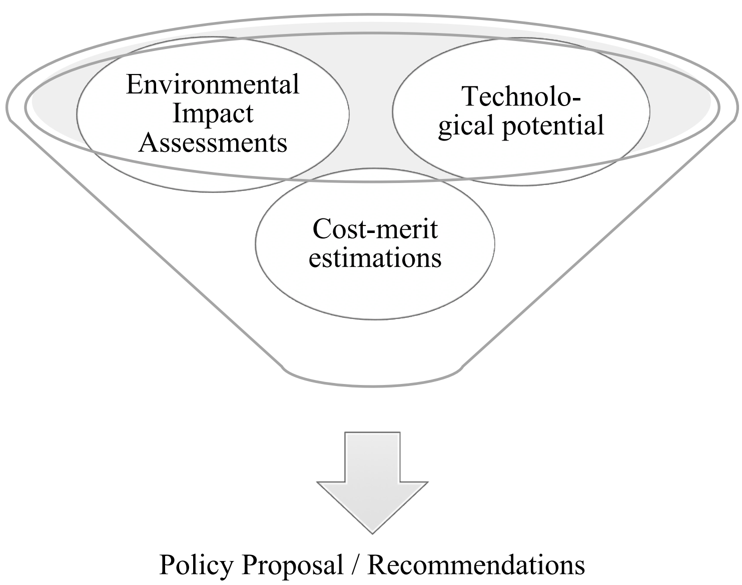
4.4 Scientific Knowledge Transmitters in Policymaking Networks

Straßheim (2010: 36) argued that the role of knowledge in networks explain the formation of social order through a reflexive learning process that originates in contradictory perceptions of individuals which motivates cooperation through shared realities and eventually leads to institutionalized knowledge in the rational government to structure societies. This raised the question about the distribution of power in knowledge networks of policymaking, and how it can be measured. As Broadbent (2018) summarized paraphrasing Max Weber: "In the study of politics the key type of relationship boils down to power, *Macht*, the ability to get one's way despite opposition" (Broadbent, 2018: 875). There are possible measures such as financial support, or the formation of political coalitions (Broadbent, 2018). However, the main argument in this dissertation stands on the thesis that knowledge exchange relations defines the power distribution in environmental policy networks that depend on expert advice; a variable that remains empirically underresearched. As the discussions about traditional linear and newer circular science-policy interfaces in Chapter 2 illustrated, one-directional (top-down) policymaking by closed elite groups does not depict contemporary policymaking anymore (Gupta, 1999), including policymaking in Japan (Chapter 3). Even though, policy network boundaries in Japanese policymaking may be still higher compared to other countries, traditional one-way linear actor interaction does not depict the whole picture.

Influential advisors become relevant in a collective and intransitive, ambiguous decisionmaking of collective actors, where one actor consists of a small collective or group itself, such as nation-states, interest-groups, governmental bodies or political parties (Tsebelis, 2002). Theoretically, a system in which one outcome wins over another to approach an ideal situation, that is a situation that is as close to actors' preferences as possible, should dominate (Tsebelis, 2002). However, actors' preferences can result in other outcomes that are farther from the ideal of the actor's preferred choice that is chosen by the collective (Tsebelis, 2002). Influential actors define the outcome because in case "the collectivity cannot make up its mind, strategic entrepreneurs will present a sequence of choices that lead to one or the other outcome" (Tsebelis, 2002: 44). Tsebelis explained this as "intransitivity." This intransitivity can cover the entire policy network such that science advisers can present "a series of choices structured appropriately [to] lead to [desired outcomes]" (Tsebelis, 2002: 44).

To illustrate the theorized power of science advisers to lead to a preferred outcome can be understood as a funneling function of transmitting selected scientific findings. This funnel, as Figure 4.1 illustrates, reduces the complexity of issues related to climate change and the environment for decisionmakers. The science adviser who summarizes key findings carries the responsibility to explain environmental science and climate change to decisionmakers to lead to effective policies that are socially acceptable and contribute to climate mitigation. A science adviser reduces the complexity of available information on issues related to climate change and connects them with relevant issue areas. For example, to determine how much renewable energy sources are technologically and economically feasible to introduce to the system may depend on environmental impact assessments of existing power plants and their harm to the environment as well as impact assessments for the construction of new power plants such as the impact of off-shore wind turbines to maritime life. The environmental impact assessments are put in context with the technological potential such as how many renewable energy sights can be build and how energy could such a power plant provide. And finally, the cost-merit factor is included as decisionmakers have to take the government budget, future impacts on the economy, and the well-being of society into account. A combination of select relevant evidence to find a solution to a problem is such a funnel function of science advisers.

Figure 4.1 Science Advisers' Information Funneling Function



Source: Author

Skilled communicators in the framing and problem setting phase in advisory processes set the tone for successful advice giving. Format of the advice, its language, and timing are keys to focus attention on the issue and its desired outcome by the policy community (UNDESA, 2015). The diversity of groups within science-policy interfaces makes full penetration across all different actors in policy negotiations unlikely and, in most cases, evidence produced is specific to a discourse group within the policy community.

In compliance to the funneling function by science advisers, cognitive filters are at place for selecting and interpreting scientific evidence within a framed issue. This information filtering process is a form of "anchoring-adjustment," that is a strategy used by experts in complex decisionmaking processes in an information rich context (Caverni & Peris, 1990). To reach a conclusion upon an issue, experts start "from an initial value that is adjusted to yield the final answer" (Caverni & Peris, 1990: 35). They create a cognitive anchor that helps to understand the problem and evidence provided to find a solution. The anchor may be defined by values, and beliefs, but the framing of the problem is just as important for the decisionmaking process and influences the outcome (Caverni & Peris, 1990). The funneling function of science advisers identified in this dissertation is consistent with both the anchoring-adjustment by decisionmakers and with the claims made by post-normal science scholarship that refutes the existence of complete neutral and independent science advice.

The framing of an issue and advice giving is a collective discursive action of a group that operates within a shared set of interests. Therefore, strategic use of evidence by a discourse coalition influences the impact in policy outcomes. These concepts find related arguments in social network theories. The discursive power of an actor relates to the social network theory concept of prominence of an actor in policymaking, that is its visibility in the network (the concept of prominence based on social network theories and how it is used as measurement for influential power is revisited in more detail in Chapter 6). In other words, an actor is prominent "if the [relationships] ties of the actor make the actor particularly visible to the other actors in the network…Prominence should be measured by looking not only at direct or adjacent ties, but also at indirect paths involving intermediaries" (Wassermann & Faust, 1994: 172).

In social network analyses, prominence – as measure for influential power – is operationalized through actors' network position. More precisely through network centrality, that is the position an actor occupies in the policy network. The more centrally located, the more prominent, hence, influential, an actor is. Wassermann & Faust (1994) argue that centrality and prestige are "two classes of prominence" or "two types of visibility" based on the relational pattern of associations between actors. A prominent or prestigious actor is an actor who is extensively involved in relationships with other actors. Social network analyses provide tools to investigate these concepts empirically. The next paragraph gives an introduction into an operationalization from social network studies. The tools and the operationalization for the empirical analyses to test the measurement of influential power are explained in more detail in Chapter 6.

Policy actors depend on information resources for the formulation of policy proposals. Eventually, the relationship between an information provider and a decisionmaker turns into a dependence-relationship to ensure constant access to information. The information seeker becomes dependent on the information provider. This form of relationship was conceptualized in Cook and Yamagishi's (1992) sociological power-dependence theory that describes the power that one actor has over another based on their exchange relationship. An adaptation of this theory is developed to measure the potential power of science advisers based on their knowledge exchange relationships.

In terms of the power-dependence theory, the power structure about the exchange network is formed by the power one actor or a cluster (or group) of actors have to either shape or influence the policy discourse. The basic principles of Cook and Yamagishi's (1992) theory predicts the distribution of power in exchange networks. They developed "a network-wide measure of power" by suggesting "that a measure based on the notion of dependence of the entire network on a particular point…might be useful in…networks" (Cook & Yamagishi, 1992: 246.).

4.5 Chapter Summary and Conclusions

The purpose of this chapter was to set out the theoretical framework through which the role of science advisers in environmental policymaking is to be explained based on the argument that the power distribution among actors in environmental policymaking is determined by the exchange of scientific knowledge. Producers and transmitters of scientific knowledge are key players in policy networks that are formed through actors' resource interdependencies. Scientific expertise is one resource on which policy actors rely to formulate political strategies, and policy proposals. Therefore, policy actors depend on other policy actors that either transmit or produce scientific knowledge. Those who control knowledge in policymaking networks, are powerful actors who shape the policy agenda.

Policy network research benefits from social network theories and methodologies. Moreover, the relation between knowledge and networks has created a strong political philosophy about the political influence of knowledge production and transmitting between policy actors. The knowledge-based theory by Hajer (1995) identified the existence of scientific consensus among policy actors as independent variable that explains the formation of policy networks and policy outcomes. Consensus is reached through cooperation and actor interaction who share information and scientific expert knowledge in the policy network of which they are part of. And to form policy networks with the goal to make use of the resources of the network and shape the policy agenda actors form exchange relationships based on shared values, beliefs, and interests (Sabatier & Jenkins-Smith, 1993; Tsebelis, 2002; Van Deemen, 1997). Therefore, discourses are created to make sense of issues. The selection of information creates the discourses that powerful actors use to influence policy outcomes. How to investigate these claims and what kind of data is used to test them will be explored in more detail in the following chapter.

5. Method and Data

5.1 Chapter Purpose and Structure

The objective of this chapter is to explain the overall research design in more detail. This includes an overview of the data, and which methods were used to collect and analyze these data to answer the research questions. This is a mixed methods study. Therefore, a definition of mixed methods is provided, and a rationale for choosing mixed methods is discussed. For this, the first half of this chapter is devoted to reviewing literature about mixed methods to provide definitions and explanations about how to develop a mixed methods research design. After describing the research design, data sources, and data collection techniques are described. Followed by an introduction into the analytical methods. The descriptions of the analytical methods provided in this chapter are limited to basic discussion. More detailed explanations about the analytical procedures, especially for the quantitative part, follow in the main empirical Chapters 6 and 7 where the analytical methods were applied. Lastly, ethical considerations and limitations of the research design will be discussed, and the chapter concludes with a brief summary and conclusions drawn from the benefit of the research about methods.

5.2 Constructing the "Explanatory Sequential" Research Design

Mixed methods stand on the collection and analysis of both quantitative and qualitative data and require integration of one into the other (Creswell, 2014). "The core assumption of this form of inquiry is that the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either approach alone" (Creswell, 2014: 4).

Mixed methods are not new, however, since the 1980s, contributions have been made for formalization and conceptualization of mixed methods procedures and terminologies. Gobo (2011) provided a thorough review of how the combination of different methods were intuitively used by sociologists in the early 20th century. Post-war methodological individualism favoured one method over the other and used either "pure" quantitative or "pure" qualitative forms of research which left the mixed methods approach dormant for several decades (Gobo, 2011).

Scholars like Plano Clark and Creswell (2011) revisited such methods by conceptualizing models and creating prototypical research designs[17]. Of these six prototypes, the research design

[17] The six prototypical mixed methods research designs are "convergent-parallel," "explanatory sequential," "exploratory sequential," "embedded," "transformative" and "multiphase." Besides the explanatory sequential design used in this study, literature describes the other five prototypes as follows: "The 'convergent parallel' design … occurs when the researcher uses concurrent timing to implement the quantitative and qualitative [components] during the same phase of the research

developed for this study is an "explanatory sequential" mixed methods research design because the "explanatory sequential design … occurs in two distinct interactive phases. [It] starts with the collection and analysis of quantitative data, which has priority for addressing the study's questions. [This] first phase is followed by the subsequent collection and analysis of qualitative data. The second, qualitative phase of the study is designed so that it follows from the results of the first, quantitative phase. The researcher interprets how the qualitative results help to explain the initial quantitative results" (Plano Clark & Creswell, 2011: 75).

The implementation of the components was done in different phases during the study. Besides the interaction of the components during the process of the study, the actual integration happened towards final steps of analyses and during the discussion of the results. In other words, multiple integration points were identified for this study. Figure 5.1 illustrates the research design and the described interaction of the components.

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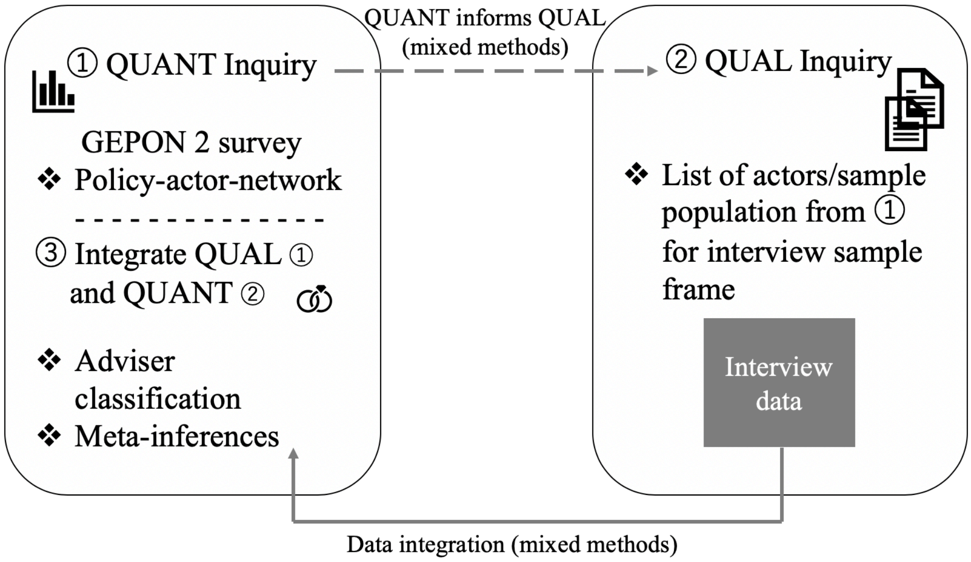
process, prioritizes the methods equally, and keeps the [components] independent during analysis and then mixes the results during the overall interpretation…[The exploratory design] begins with and prioritizes the collection and analysis of qualitative data in the first phase. Building from the exploratory results, the researcher conducts a second, quantitative phase to test or generalize the initial findings. The researcher then interprets how the quantitative results build on the initial qualitative results…The embedded design occurs when the researcher collects and analyses both quantitative and qualitative data within a traditional quantitative or qualitative design…[T]he researcher may add a qualitative [component] within a quantitative design [or vice versa]. In the embedded design, the supplemental [component] is added to enhance the overall design…The transformative design is being created within a transformative theoretical framework…The multiphase design combines both sequential and concurrent [components] over a period of time that the researcher implements within a program of a study addressing an overall program objective. This approach is often used in program evaluation where quantitative and qualitative approaches are used over time to support the development, adaptation, and evaluation of specific programs" (Plano Clark & Creswell, 2011: 74-76).

Figure 5.1 ”Explanatory Sequential” Mixed Methods Research Design



Source: Author

The core elements to develop the research design for this study are: 1) sequential, 2) overlap in timing, 3) embedded, 4) equal importance of quantitative and qualitative (QUANT/QUAL) inquiries, and 5) fixed. The research design is sequential as it started with the J-GEPON2 survey data that informs the qualitative data. Analyses of both components overlapped in timing. They were not completely in sequence but also not completely parallel. It is embedded as the purpose of adding interviews into survey data was to better understand the quantitative results of the policy network and include in-depth and rich information to enhance the overall quality of the study. The research design did not distinctly prioritized either form of inquiry. Both quantitative and qualitative parts were regarded equally important. The design is a fixed design because approaching the research questions with a combination of quantitative and qualitative inquiries was decided when the research purpose was outlined in early stages.

Four key decisions for developing the appropriate mixed methods research design were proposed: 1) the level of interaction between the components of the study (research questions, data collection, data analysis, results interpretation), 2) the relative priority of the components, 3) the timing of the components, and 4) the procedures for mixing the components (Plano Clark & Creswell, 2011). The level of interaction, that is the “extent to which the two [components] are kept independent or interact with each other” (Plano Clark & Creswell, 2011: 68) was rather high in this study. The qualitative component (interviews) was more dependent on the quantitative component (survey) than the quantitative component was on the qualitative component. That may indicate that the quantitative component had a higher priority, that is the “relative importance or weighing of the quantitative and qualitative methods for answering the study’s questions” (Plano Clark & Creswell, 2011: 69). However, the intention was to give both parts equal priority, that is, the timing of collecting and analyzing data should not determine the priority. The timing, that is, the "temporal relationship" in terms of data collection and the order in which the results are used between the components of this study, is sequential.

The quantitative survey data was collected in a research project involving a number of researchers, university professors and graduate students. The qualitative data collection for this study has been done by this researcher alone. Thus, the timing in which the data has been collected is sequential, because survey data has been collected before the qualitative data. The scope and target of the qualitative data collection is informed by the quantitative survey data. The following section elaborates on the rationale for employing mixed methods.

5.3 Rationale for Using Mixed Methods

An argument solely based on quantitative data represents a limited representation of reality. The reduction of the difference between the answers by survey respondents and their memory about an event or features of a relationship with another policy actor through standardized survey questions increases the validity of the data. Belli and Callegaro (2009: 31) argued that standardization in survey research reduces "the degree of difference between what is being reported and what exists or retrospectively has existed in objective conditions of experience." Standardization of questions is useful where different kinds of actors and stakeholders are involved. The assumption was that "variance in responses is due only to differences in the experiences (or attitudes) [brackets in original text] of the respondents" (Belli & Callegaro, 2009: 33). However, the rigidity of the survey instrument limits the information that can be drawn from it. Qualitative data is rich in meaning and contains, in the words of Geertz, "thick descriptions." Yet, with a small number of participants in qualitative research neither inferences can be drawn, nor generalization made from it (Belli & Callegaro, 2009).

The Global Environmental Policy Network (J-GEPON2) survey undertaken in Japan (explained in more detail in Section 5.5) covers a broad range of issues in environmental and energy policies. Investigating the research questions about how science is integrated in environmental policymaking quantitatively only would give an incomplete answer. Integrating qualitative research elements enriches the overall study and helps to overcome those limitations. Moreover, findings from qualitative data help to enhance the quantitative measurements for future undertakings.

Plano Clark and Creswell (2011) provided a summary list of several typologies for reasons for mixed methods. For this study a combination of the development typology, the expansion typology, the offset typology, and the sampling typology was considered. The development typology "seeks to use the results from one method to help develop or inform the other method, where development is broadly construed to include sampling and implementation, as well as measurement decisions" (Plano Clark & Creswell, 2011: 66). The sampling typology "refers to situations in which one approach is used to facilitate the sampling of respondents or cases" (Plano Clark & Creswell, 2011: 66). The development and sampling typologies presented by Plano Clark and Creswell (2011) share the feature in which the sampling for either quantitative or qualitative inquiry is informed by the other. The qualitative inquiry in this study's research design was informed by the quantitative survey data. The survey instrument and selected variables helped develop the scope of the qualitative inquiry. The sampling frame was defined through the survey respondents, and informed measurement decisions also. Decisions about the scope, the specific case, actor landscape and time frame of the study were defined by the survey. It validated the case selection and reduces the selection bias.

The expansion typology "seeks to extend the breadth and range of inquiry by using different methods for different inquiry components" (Plano Clark & Creswell, 2011: 66). The components of this study that were identified to answer the research questions (what type of science advisers exist in Japan, how they are integrated in policymaking, and what features explain their position in policymaking networks) required quantitative and qualitative forms of inquiry; policy network integration was analyzable through the survey data and questions about what features explain the form of science advice and its integration in environmental policymaking required in-depth qualitative data analyses.

The offset typology "refers to the suggestion that the research method associated with both quantitative and qualitative research have their own strengths and weaknesses so that combining them allows the researcher to offset their weaknesses to draw on the strengths of both" (Plano Clark & Creswell, 2011: 66). The target population of the interview survey were policy actors. The survey sample consists of policy actors who are important in environmental policymaking. The survey data did not include the use of qualitative interview data. The addition of qualitative inquiries in the scope of this dissertation research tried to enhance the usefulness of the survey data. The policy actor network approach of this study examines the policy network data provided by the survey, investigated the role of science advisers in the network in the context of climate mitigation policy measures and added value by integrating interview data of such actors identified as being part in such an advisory process.

Methodologically, both quantitative and qualitative inquiries are used in policy network research. They differ between the unit of analysis. Network analyses look at ties between actors. Such research is interested in questions as to how policy networks form or dissolve, who forms the core of the network and who is most central. Also, if the network is rather open or closed or if the network is diverse or uniform in terms of actor types. In order to explain the network's shape or why certain actors are more central than others relationship ties were the unit of analysis.

This research is about policy networks and proposes feasible measurements of power distribution in knowledge exchange networks. For unraveling how policy actors interact with intermediaries and science, first, functionality of existing scientific adviser classifications was reviewed to identify what kind of science advisers exist in Japan.

This study utilizes data sets that specifically consist of network data in the context of environmental policymaking in Japan. More specifically, network data to measure policy actor network integration based on the concept of knowledge and information exchange (refer to Chapter 4). It includes variables that measure concepts of "influence" or "prestige" of actors from social network theories, and their attitudes toward climate mitigation policies to test proposed measures of power.

5.4 Data Sources, and Data Collection Organization

Tables 5.1 and Table 5.2 give an overview of the data sources and the data collection-organization-analysis techniques, respectively. The data sources for the are the J-GEPON2 survey and qualitative semi-structured interviews. The survey was conducted in 2012 and 2013 and followed a purposively sampling strategy. The main sample consists of 108 organizations. The sample for the quantitative network analyses consists of 78 cases. The smaller population for the network analyses are the result of list-wise deletion of cases where respondents did not reply to the general actor information and resource exchange questions (Q7, Q8, Q9 and Q10). Hence, they were deleted from the quantitative network analyses. Section 5.5.2 revisits the discussion about missing data in more detail. From a selected sub-set of actors from the general survey population (N=108) 13 interviews with experts about science and technology policy, environmental policy and science advice practitioners were conducted in 2018[18].

[18] In 5 out of these 13 interviews, two employees of the organization participated together in the interviews. In one interview, three employees participated together in the interview. Therefore, 13 interviews and 19 participants. The average length of an interview was between 80 and 100 minutes. Integrating 8-10 interviews in quantitative analyses in a mixed methods dissertation is considered a sufficient number of cases to add value to the analyses.

During the dissertation research phase, I participated in three mixed methods research workshops, and one mixed methods summer school. There, mixed methods scholars such as Creswell, Creamer, Fetters and Gobo (scholars cited in this study) agree on the necessary number of cases of the qualitative inquiry for a dissertation study. This has also been justified with saturation. This means that especially in a study that employs elite interviews in the field of environmental science advice in environmental policymaking, available cases are limited and 13 interviews accounts for 50% response rate of potential interviewees from the GEPON2 survey that fit the need for this study (refer to Appendix).

Table 5.1 Data Sources Table

General Type	Sampling Strategy		Time of Data Collection/Number
	Target	**Method**	
Quantitative Data			
J-GEPON2 Survey	Policy actors, vested interest groups, business corporations, NGOs/NPOs (N=173)	Purposively sampling	N=108 (Network N=78) Data collection: 2012-13
Qualitative Data			
Discursive Elite Interview	Sub-set of organizations from GEPON2 population; Research facilities and advisory organizations (N=26)	Semi-structured interviews	N=13 Data collection: 2018-19

Source: Author

The raw data of the responses from the structured policy actor network survey questionnaire was stored in an excel spread sheet and analyzed with the open-source program Rstudio. All except one of the semi-structured discursive interviews were audio recorded with the consent of the informants.

Table 5.2 Data Collection-Organization-Analysis Techniques

Methodologies	Pivotal Cognitive Modes	Research Types	Gathering Structure	Data Collection Techniques	Data Management Techniques	Data Analysis Techniques
J-GEPON2 Survey (QUANT)	Questioning	Survey of policy actor networks	Structured	Questionnaire	Matrix	Network analysis
Discursive Interviews (QUAL)	Listening	Participants: experts, representatives	Moderately structured	Individual interview (in-depth, narrative, open-ended, semi-structured)	Transcription and coding (Languages: Japanese)	Narrative analysis, thematic analysis, coding

Source: Author

The following sections describe the survey instrument and the semi-structured interviews in more detail.

5.4.1 The J-GEPON2 Survey Instrument

J-GEPON2 was an elite interview survey investigating information exchange, support and cooperation relationships and political attitude among environmental and energy policy actors to reveal hidden structures in policymaking. The survey was realized through the Institute for Comparative Research in Human and Social Sciences (ICR), University of Tsukuba. The aim of the survey was to investigate the state of policy and social structure in the policymaking of climate change (Tsujinaka & Kobashi, 2015). For this, the survey project targeted political and social institutions such as governmental bodies, political parties, think tanks, industry and business corporations, environmental NGOs/NPOs (Tsujinaka & Kobashi, 2015). Table 5.3 shows the contents of the questionnaire[19].

Table 5.3 J-GEPON2 Survey Content

Question Content	Examples
Information network	Information sources, important specialized information, and information exchange with other organisations
Support and cooperation network	Support and cooperation with other organisations, and lobbying target organisations or groups
Policy attitudes	Attitudes toward greenhouse-gas reduction goals and energy policy decisions
Organisational demographics	Foundation year, number of members or employees, budget, and relationship to the government

Source: G-GEPON2 Codebook (2017)

The determination of the target population of organizations that influence policies regarding global warming for the J-GEPON2 survey underwent a series of steps in the research process (Okura, Tkach-Kawasaki, Kobashi, Hartwig, & Tsujinaka, 2015; Tsujinaka & Kobashi, 2015). In other terms, it was not random sampling, but an established procedure to identify relevant actors. The survey

[19] The English translation of the table was first published in the G-GEPON2 Codebook. The survey was conducted in Germany in 2016/17, and the results was published in 2018.

instrument and framework of the overall study benefits from such identification of the target population. Identified indicators to verify the selection were a) government agencies, or scholars participating in national and international policy formation, b) actors involved in implementing national policies for the reduction of industrial greenhouse gas emissions, and c) NGOs/NPOs and mass media participating indirectly in policies aimed at reducing greenhouse gas emissions (Okura et al., 2015; Tsujinaka & Kobashi, 2015).

Table 5.4 shows the response rates per organizational category. The overall response rate for Japan was 62.2% (108 out of 172).

Table 5.4 J-GEPON2 Target Organization Category and Response Rates

Organization Category	J-GEPON2 Target Population (N)	J-GEPON2 Responses (N)	J-GEPON2 Response Rate (%)
Government Office	23	17	73.9
Quasi-governmental Agencies	9	8	88.9
Political Parties	7	6	85.7
Business Organizations	19	16	78.9
Economic Corporations	41	21	51.2
NGOs	19	12	63.2
Foundations	30	15	50
Mass Media	13	6	46.2
Other	11	7	63.6
Total	**172**	**108**	**62.2**

Source: J-GEPON2 Codebook (2014)

Science or research facilities were not an individual organization category in the target population. This type of organization was spread out through other categories of NGOs/NPOs, quasi-governmental, incorporated agencies, and business corporations. Table 5.5 shows the number of survey responses according to the adapted actor categorization.

Table 5. 5 Adapted Organization Categories and Number of Responses

Organization Category	N
Business/Industry	37
Governmental Body	18
Foundation	8
NGO/NPO	18
Political Party	6
National Research Institute	15
Mass Media	6
Total	**108**

Source: J-GEPON2

As discussed in Chapter 2, a clear division between science adviser types is not always possible. There are a many grey areas for categorizing a science adviser according to their area of activities. The expertise of the interviewees provided input to define potential science advisers from the survey target list that will be explained in more detail in Section 5.4.2 that describes the semi-structured interview.

5.4.1.1 Considering Survey and Researcher Biases

Survey research uses standardization of questions and design to account for response bias. Different modes (method of data collection) have different coverage errors, different selection biases and different forms of measurement error. Abstract and sensitive questions in all modes generate differences in responses. Data quality deteriorates with questionnaire length. J-GEPON2 is a lengthy interview survey, face-to-face interviewing was considered to increase validity of the responses and decrease the risk of deteriorating data quality and ensures equivalence of outputs (Eva & Jowell, 2009). As an elite survey, that is a method of data collection where a number of diverse actors related to the given issue are being asked the same questions to obtain quantitative data, the inherent bias problem of the political issue approach, or political field analyses could be solved (Otake, 1990).

5.4.1.2 Missing Data

There are mainly two different ways to deal with missing data in quantitative research: either disregard cases of non-responses (list-wise deletion) or impute data where data is missing by using additional information about the case to be able to make assumptions or inferences about probable answers (data imputation) (Weins, 2006). Weins (2006) argued for data imputation above list-wise deletion because list-wise deletions would make more limited assumptions about missing data. Consequently, the number of standard errors would diminish the generalizability of the findings. However, data imputation comes with fallacies. Data imputation itself requires a comprehensive protocol and statistical analyses, where the margin for error is very slim. This adds risk of imputing more errors instead of increasing the quality of the data.

Due to the controversial character of data imputation methods, list-wise deletion is used in this study. List-wise deletion was considered to provide a more reliable data set, and because the quantitative data informs the qualitative data, list-wise deletion has the additional advantage of defining the sampling frame for qualitative discursive interviews and document data collection.

5.4.2 Semi-structured Expert Interviews

To probe deeper into the triangular relationship among the policy community, science advisers (intermediaries) and scientists in-depth semi-structured interviews with science advice experts and practitioners were conducted. The intention of the interviews was to glean the perspectives of science advice practitioners in their own terms to understand their role in the environmental policy network analyzed with the survey data. The explanatory capability of the quantitative data is limited to investigate features of why science advice is integrated in the policy network the way it is. Probing into the advisers’ perspectives on their role in policymaking and relationships with policy actors, their ideas versus experiences about integrative policymaking, and their impressions of the state of scientific knowledge in environmental policymaking could only be achieved satisfactorily, and reliably, by adding qualitative discursive interviews to quantitative analyses. Hence, the interviews were an attempt to understand how scientific knowledge is used by diverse actors with different policy attitudes, how information is being shared with whom, and why some actors have a more influential, that is a strategic, position in the network than others.

The quantitative network data represent a positive exchange network. Meaning, the relationships the network uncovered were a reflection of a actors’ cooperation, their professional friendships and their means to facilitate these friendships to strengthen their position in policymaking. A negative exchange network would look into, for example, conflicting relationships, competitions, or even fights. The purpose of the qualitative interviews was to understand the latitude of the positively connotated knowledge exchange relationship between science, science advisers, and policy. The questions contents are explained in detail in section 5.6.2.

In terms of conducting expert interviews, Aberbach and Rockman (2002) researched elite attitudes, values, and beliefs for which the authors conducted interviews with members of the American Congress to examine how elites define problems and how they react to them. The study by Aberbach and Rockman (200) and those of other scholars such as Leech (2002) and Goldstein (2002) on how to prepare, conduct and code elite interviews was consulted to conduct this research. Elites are "people in decision making or leadership roles" (Leech, 2002: 663). Therefore, such interviews are used "whenever it is appropriate to treat a respondent as an expert about the topic at hand" (Leech, 2002: 663). Elites are "experts in their field" (Leech, 2002: 663). "Elite interviews can shed light on the hidden elements of political action that are not clear from an analysis of political outcomes or other primary sources" (Tansey, 2007: 767). Interviewing key actors in the political process provides first-hand testimony of their exchange interactions (Eva & Jowell, 2009).

Similar to the purposive sampling strategy of the J-GEPON2 survey, the purpose of the study and the researcher's knowledge guided the process of data collection. "The basic assumption is that with good judgement and an appropriate strategy, researchers can select the cases to be included and thus develop samples that suit their needs" (Tansey, 2007: 770). Qualitative research is criticized to lack generalizability. Such criticism overlooks that generalizability is not always the aim of qualitative research (Gobo, 2008). The purpose of generalizations is based on the search for homogenous structures. Qualitative research often looks for heterogenous structures. Random sampling risks to "exclude important respondents from the sample purely by chance" and "if the study entails interviewing a pre-defined and visible set of actors, the researcher may be in a position to identify the particular respondents of interest and sample those deemed most appropriate" (Tansey, 2007: 770).

5.4.2.1 Sampling and Interview Procedure

The sampling frame for the qualitative elite interviews was defined through the J-GEPON2 sample. Contact information of those who participated in the survey was not used as it would have been a breach of privacy. From the list of 108 respondent organizations a sub-sample of organizations such as research facilities, research and development corporations or policy consulting offices was extrapolated that consisted of 26 organizations (refer to the Appendix). Mostly, possible respondents that work in the areas of 1) climate change, the environment and/or energy policymaking, 2) international activities such as participating in climate change framework negotiations under the UNFCCC/IPCC, such as the annual COP meetings, and 3) collecting and analyzing data on the environment or climate change, either primary or secondary research were contacted. To avoid presumptions, whether an organization indicated to give policy recommendations was not relevant for the selection. This would assign an assumption of the triangulating science-intermediary-policy interface and would assume science actors are actively influencing the policy agenda, which is not always the case.

The process of contacting was as follows. The first step was to send a letter describing the research, including a description of the scope of the interview, the amount of time requested (usually 60 to 120 minutes), explaining ground rules for the interview, how the information gathered is used (consent), and how findings would be used for analysis. The letter would have an official letterhead with the organization's postal address, the name and institutional address of the contact person, a date, the researcher's name, contacts and institutional address. For demonstrating professionality, I requested an institutional email address from the University of Tsukuba Information Center that uses the University's name to demonstrate legitimacy to possible respondents. The prepared email message draft for initial contact also included a short paragraph explaining the funding for the research, and past experiences in doing research in other research projects. These measures were considered to increase the study's legitimacy.

Second, the interviewee was provided with a list of interview questions, and suggestions for possible dates and times. Some informants would send a publication, or useful documents in advance related to the topic of the research. Others sent resources or prepared a set of informative documents they used to discuss the questions during the interview. Most would give a hard copy of a most recent in-house publication or pamphlets during or at the end of the interview and were open for further cooperation. Emphasizing respectful use of the recordings, that they solely serve the purpose for this research, and would not be distribute elsewhere, all informants except one agreed to be recorded.

5.4.2.2 Content Analysis & Coding

The interview data was coded according to the central themes covered by the interview questions; the theoretical framework, research questions, and main hypothesis of this study that the involvement of scientific knowledge through intermediaries increases the influential power of an actor in policymaking defined the scope of the analysis. These themes were "knowledge exchange," "influence/attitude," and "pressure/control." The goal of the content analysis was to 1) map the use of scientific knowledge, its distribution, in terms of the organizations' function and position in the policymaking network, 2) identify latent traits of influence, pressure, or control authority may exert on science advisers and 3) their political attitude towards the government's climate change policymaking. The contents of the interview questions are listed in Table 5.6 below.

Table 5. 6 Qualitative Interview Questions Content

Theme	Questions Content
Knowledge Exchange	Do you engage in information exchange or advice-giving in policymaking with other organization? If so, with whom/what kind of organizations, and do you give advice directly to the government?
	Do you cooperate with other organizations? If so with whom/what kind if organizations, and what form of cooperation?
	What is the approximate time frame of such cooperation activities? And what motivates starting/terminating cooperation?
	In what form do you provide advice for policymaking?
Influence/ Attitude	Does your expertise influence the policy agenda? Do you analyze and/or collect climate data? What kind of information is important to you, and how do you get it?
	To what extent is your advice, or your opinion reflected in policymaking? Do you think the government does enough in terms of CO2 reduction? Who do you think influences policymaking for de-carbonization?
Control/ Pressure	During advice-giving and/or cooperation activities, do you feel in any way pressured by other organizations? Can you elaborate on that (as far as possible)?

Source: Author

5.5 Ethical Considerations

For conducting expert or elite interviews protecting the informants' anonymity and confidentiality is crucial. To ensure the informants anonymity neither the title of their affiliation nor their name are made public here when using a direct quote. Further, the interviews were conducted in Japanese. Therefore, quotes in the analyses were translated by the author.

To introduce the topic and purpose of the research, potential informants were sent a letter that included a statement regarding the use of the data[20]. The statement was as follows: "Contents of the interviews you do not wish to be included in publication will be excluded. Contents of the interviews can be published in academic reports, technical reports, books, or scientific research funding result

[20] The letter (in Japanese) can be found in the Appendix. The translation of the letter in English serves only for informing the reader about the letter's content.

report. The use of the interview results was administered under personal information protection regulations of the University of Tsukuba. Furthermore, this research entitled "Comparative Study of Science Advice in Environmental Policymaking" is conducted under the Monbukagakusho Scholarship (MEXT) for Foreign Students provided by the Japanese Government (April 2017 to March 2020)."

As all interviews (except one) were recorded, to enforce the confidentiality clause interviewees would state forms of these phrases: "please do not publish/I don't wish this to be published", or "what I can say about this is limited, but I can say that much." For example, in case interviewees would share the contents but wished to exclude the contents from the analyses they would enclose their descriptions with the phrase "please do not publish/I don't wish this to be published." Especially questions about feelings of pressure or outside control have to be handled with care. Therefore, direct quotes to illustrate the analyses in Chapters 6 and 7 are only used where appropriately, and no risk of harm is expedient.

5.6 Chapter Summary and Conclusions

The explanatory-sequential mixed methods research design improved the overall research procedure. Yet, it came with challenges. The mixing of qualitative and quantitative research methods demands rigorous application of both methods. If the main purpose of the research, and the research questions justify mixed methods the overall quality of the research and discussion of the findings increase, and inferences are valid. Literature on mixed methods is clear about not only the need for justification but also the awareness of the different research methods. The rationale discussed in this chapter demonstrated the necessity for unconventional methods to approach the topic of science advice in environmental policymaking.

Quantitatively, the focus laid on policy actor network analyses based on the J-GEPON2 survey data. The survey is a rich data set covering environmental policy actors' networks, their political attitudes, their influence in environmental policymaking, and their form of interactions with other policy actors. The aim of the survey research did not specifically include the topic of science advise in environmental policymaking. Therefore, the focus on policy actors that are relevant for producing and giving science advice and investigate the role of science advice in environmental policymaking adds value to the J-GEPON2 research.

The survey data informed the framework the qualitative in-depth inquiry in terms of data frame, scope, and limitations for the qualitative interviews with such actors involved in producing and giving science advice. This procedure defined the form of the overall research design as an explanatory-sequential research design.

The development of the research design benefited from the growing literature on mixed methods research. A clear purposeful design helped to see the scope of the research aims more clearly but also raised awareness of the boundaries. The explanatory-sequential research design was developed based on the initial research questions. Defining boundaries of the research aim put the research in context of the overall scholarly field and added value to ongoing discussions. The research design and methods are neither Japan specific nor limited to environmental policymaking. They are expected to be adaptable to research about different countries, and different policy issue areas.

6. Integration of Science Advice in Environmental Policymaking

6.1 Chapter Purpose and Structure

This chapter focuses on answering the question how science advice is integrated in the Japanese environmental policy network by integrating the quantitative network analysis with the qualitative interview analysis. Social network analyses tools are used to investigate the integration and potential power of science advisers in policymaking networks building on the theoretical outset described in Chapter 4. The analyses are based on the assumption that knowledge is a form of political power arguing that an actor is more likely to be in the center of the network occupying a strategic position – that is a position in which a science adviser has as many relationships to decisionmakers and science that increases the likelihood of an adviser to influence policymaking – if they are shown to be influential based on their knowledge exchange activities.

The chapter starts by describing forms of advice giving in Japanese environmental policymaking that were identified through the interviews. Followed by the visualization of the knowledge-exchange networks and measuring the potential power of science advisers for influencing political discourses. The research questions about the integration of science advice in a policy network and whether science advisers have the capability to act as an intermediary can be resolved through the concept of betweenness centrality, that is a measure for potential influential power applied in social network analysis because they are an indicator for the influential power of actors (Wassermann & Faust, 1994).. For this, betweenness centrality is measured because it demonstrates whether an actor has a bridge-building function between actors in a network. It is argued that actors with "high betweenness centrality are often important controllers of power or information" (Morgan, 2017). After discussing the betweenness centrality, or "bridging potential" of science advisers, the discursive hegemony of central actors, and the discursive struggle among the identified clusters of actor groups and their knowledge exchange relationships are discussed.

6.2 Identifying Forms of Advice Giving

Through the interviews, two basic forms of advice giving became clear that are consistent with the integrative model of the science-policy interface described in Chapter 2 and illustrated in Figures 2.3 and 2.4: pro-active and re-active advice giving. The re-active form dominates the Japanese science-policy interface. It describes a situation in which decisionmakers require input on a known issue for negotiating policies; decisionmakers ask experts to either give advice, if experts have knowledge on the issue, or conduct research to produce new knowledge and provide advice based on the new learned information. The pro-active form describes a situation in which an issue or problem appears and experts who understand the issue or problem offer advice to decisionmakers in order to raise awareness or increase attention to the issue. The conceptual model of the integrative science-policy interface, however, is limited in grasping the differences across the character of the formal relationship and institutional type of advisers and, more importantly, the dynamics in-between the two spheres of science and policy.

The relationship between science and policy was conceptualized through the linear bi-modal science-policy interface and the integrative circular science-policy interface (refer to Chapter 2). Both models fail to distinguish the variety of actors in the science community that are in the business of creating expert knowledge for advisory policymaking. The institutional distinguisher needs to be drawn between science advice emanating from basic research and evidence-based input from market-based research and development. The institutional setting of basic research and evidence-based advisory policymaking are two different mechanisms. From the theoretical discussion about science for policy (refer to Chapter 4), basic research has a greater distance from policymaking than market-based research. The regulatory framework that orders the integration of science advice from different institutional sources differ, also.

In Japan, national research institutes are formally related to governmental bodies, and are therefore an integral part of the policymaking network. The network analysis in the second half of this chapter demonstrates that the actual use of scientific knowledge emanating from national research institutes was, however, marginal despite their formal institutionalization as a quasi-governmental organization. The role of national research institutes in contrast to market-based private institutes such as research and consulting firms is explored in more detail in Chapter 7 arguing that regulatory mechanisms constrain the advice giving capacity of science advisers explain features of science advisers in Japan, and explain the dominance of the re-active form of advice giving from the science community. In this re-active advisory mechanism in Japanese environmental policymaking, Table 6.1 lists organizations that constituted as science advisers in the J-GEPON2 sample of the environmental policymaking network.

Table 6.1 Advisory Organizations in Japanese Environmental Policymaking

Name	Category
KEIDANREN Japan Business Federation	Business association
Global Environmental Forum	Foundation
Global Environment Centre Foundation	Foundation
Ministry of the Environment	Governmental Body
Mitsubishi UFJ Research and Consulting, Co.	Innovation Center
Mitsubishi Research Institute, Inc.	Innovation Center
Fujitsu Research Institute	Innovation Center
Japan International Cooperation Agency	National Research Institute
National Institute for Environmental Studies	National Research Institute
National Institute of Advanced Industrial Science and Technology	National Research Institute
New Energy and Industrial Technology Development Organization	National Research Institute
Japan Transport and Tourism Research Institute	National Research Institute
International Center for Environmental Technology Transfer	National Research Institute
Institute for Global Environmental Strategies	National Research Institute
Global Industrial and Social Progress Research Institute	National Research Institute
Central Research Institute of Electric Power Industry	National Research Institute
Japan Economic Research Institute	National Research Institute
Japan Ship Technology Research Association	National Research Institute
Citizens' Alliance for Saving the Atmosphere and the Earth	NGO/NPO
Kiko Network	NGO/NPO
NPO Regional Exchange Center	NGO/NPO
ICLEI Japan	NGO/NPO
Japan Refrigerants and Environment Conservation Organization	NGO/NPO
Greenpeace Japan	NGO/NPO
Conservation International Japan	NGO/NPO
Environment and Culture Research Institute	NGO/NPO

Source: J-GEPON2

From the discussion of the form of advice giving and organizations involved in advisory processes, the following sections analyses and visualizes the knowledge exchange relationships of science advisers in the science community with policy actors in the policy community, and describes the analytical methods that were introduced in Chapter 5 in more detail.

6.3 Mapping Knowledge Exchange Relationships

6.3.1 Measurements for Knowledge Exchange Relationships

Knowledge exchange activities are a measure for influential power (refer to Chapter 4). The following questions from the J-GEPON2 survey measured such knowledge exchange activities among policy actors in Japanese environmental policymaking: Respondents were asked to indicate whether they share, more precisely, whether they "give/send/share" or "receive" information about climate change, climate science, economy, or policymaking and society with other policy actors (Q7 & Q8). Q7 and Q8 consisted of mutually exclusive values, meaning that respondents indicated whether they have a relationship with another actor in the network based on knowledge exchange activities with either "yes" ("1") or "no" ("0"). The purpose of measuring the knowledge exchange relationships was to map the integration of science advisers in the policy network, inspect their potential influential power in policymaking and examine whether the assumption discussed in Chapter 4 stating that science advisers are powerful if they are knowledge hubs, is consistent with the findings.

Social network analysis is saturated with measures of knowledge exchange. And social network analysis provided expedient tools for policymaking analysis. The power of an actor was quantifiable in social network analysis through centrality measures. According to social network theories, actors that are in a central position have control over the flow of information (Morgan, 2017; Wasserman & Faust, 1994). Therefore, theoretically, an intermediary science adviser has control over the flow of information. The power distribution analysis looked into not only the ways potential power based on knowledge exchange is distributed in the entire network but also whether certain types of intermediary science advisers contribute more to environmental policymaking than others.

Based on the conceptual models of science-policy interfaces (refer to Chapter 2), and the background about Japan (refer to Chapter 1 and 3), the following statement was made about the expected network integration of the different types of science advisers (illustrated in Figure 6.1): Basic research was expected to be integrated the least, hence, the least influential because they are ideally kept apart from political debates. National research institutes were expected to be more integrated, and there for carry more potential power to influence the policy agenda than basic research because they are part of the formal advisory system in policymaking networks of governmental bodies. Finally, innovation center (issue advocates) were expected to be integrated the most because corporate research institutes dominate the scientific output in Japan (refer to Chapter 1 and 3) and their independence from governmental funding and access to the free market provides them with more financial and material resources. The degree of integration between "less integrated" to "very integrated" was scaled in four steps: "+ +" "+" "—" and "— —". The "+" as positive value indicates where the statement applies, and "—" as negative value indicates where the statement does not apply.

Figure 6.1 Expected Policy Network Integration of Science Advisers

	Network Position	
Science Adviser	**Less Integrated**	**Very Integrated**
Basic Research (Pure Scientist)	+ +	— —
National Research Institutes (Science Arbiter)	+	—
Innovation Center (Issue Advocate)	— —	+ +

Source: Author

Keeping the expected form of integration into the environmental policymaking network in mind, the following section analyzed the sampled network data and visualized the network to assess the accuracy of the expected policy network integration of science advisers.

6.3.2 Visualizing the Environmental Policy Network

Before going into the details of the analyzed networks, the method of analyzing the centrality measures and visualizing the networks is explained. The network of 78 cases (refer to Chapter 5) is rather large which makes standard illustration in a socio-matrix not useful, and nowadays, network graphs can be computed that incorporate various attributes of actors in a network[21]. Based on these socio-matrices, centrality measures were calculated, and networks plotted. The calculations for actors' betweenness centrality to identify intermediaries, and their potential influence in the policymaking network as well as the visualization of the networks were computed in RStudio. The

[21] Such a socio-matrix is used as an explanatory illustration in Chapter 7 in the context of integrating measurements of power to other attributes such as political attitude.

procedure is explained step by step in the following paragraphs[22]. The illustration of the network graphs is followed by an explanation of the results.

As described about the data organization in Chapter 5, the network exchange data was organized in a matrix. In network analysis, this is called a socio-matrix. The knowledge exchange network activities were divided between the direction of the relationship the respondents to the survey indicated: sending information to actors in the network and receiving information from actors in the network. This socio-matrix for both the information-sending and information-receiving network were read into RStudio by using the package iGraph. To protect the privacy of the 78 actor cases, anonymized IDs were used as labels. With the data organization in a socio-matrix, directed adjacency graphs, that were the relationship ties indicated by the respondents, were calculated, and color of the nodes, that are circles each representing one actor in the network, were differentiated by the actors' category. After computing the networks' centrality measures, the networks were plotted. There were significant variations in the betweenness centrality across the actors that ranged from 0 to over 1.000. Because of this high variation the node size was scaled by the degree, that is the value of PageRank times 150, plus 1.5 because of the high variation in the betweenness centrality of actors (a more detailed explanation about betweenness centrality and PageRank follows in Section 6.4). This scaling was used because, otherwise, those actors in the network with a high betweenness centrality would visually block every other actor node (Morgan, 2017). The two networks are visualized in Figure 6.2 and Figure 6.3.

The position of policy actors, including science advisers, in these networks is characterized by color and size. The more central an actor is, the larger is the node, and the closer is the node to center. Their position in the network was determined through the number of exchange relationships. This information was taken from the survey responses. To highlight the position of science advisers in this network, the differing science adviser categories were divided by their organizational category and by color. Such science advisers were national research institutes (blue node), and issue advocates. The category of issue advocates was divided further between actors from the business and industry sector (pink node) and NGOs/NPOs (green node).

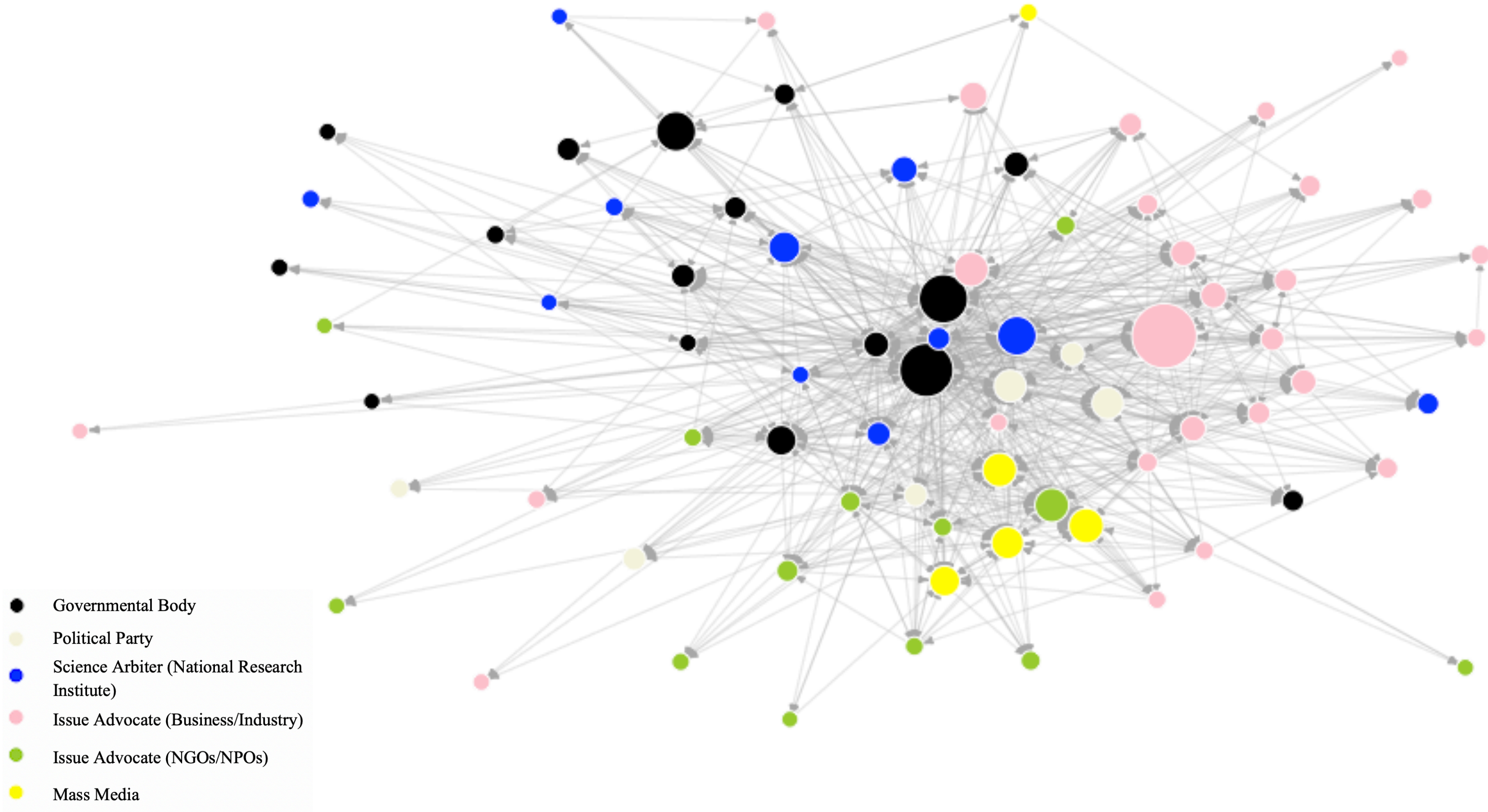
It was important to divide the direction of exchange relationship ties in the policymaking network because it demonstrates well the control of information, and its production for the advisory process. In the position of sending information into the policymaking network, a few national research institutes were closely related to governmental bodies (black node), but the size of their node revealed that their potential to influence policymaking for the environment and climate mitigation was marginal. In contrast, issue advocates from the business sector (pink node) showed a more significant position in terms of sending information into the network. Moreover, one major issue advocate from the business and industry sector, that is the large pink node connecting other

[22] The R script can be found in the Appendix.

less central issue advocates from the business and industry sector with the center of the policymaking network, showed a more significant potential influence as sending information into the network than national research institutes. The contrast of the sending information network to the receiving information network showed the role of national research institutes more clearly because here, national research institutes were more central (larger node size) when receiving information from the network. This is a representation of the legal framework in advisory policymaking that controls such organizations. Moreover, the one large issue advocate node was closer to the core of the policymaking network. This means that besides its central position as sending information into the network, governmental bodies in the center of the network were closer interrelated with advisers from the business and industry sector than with their advisers from formal advisory boards.

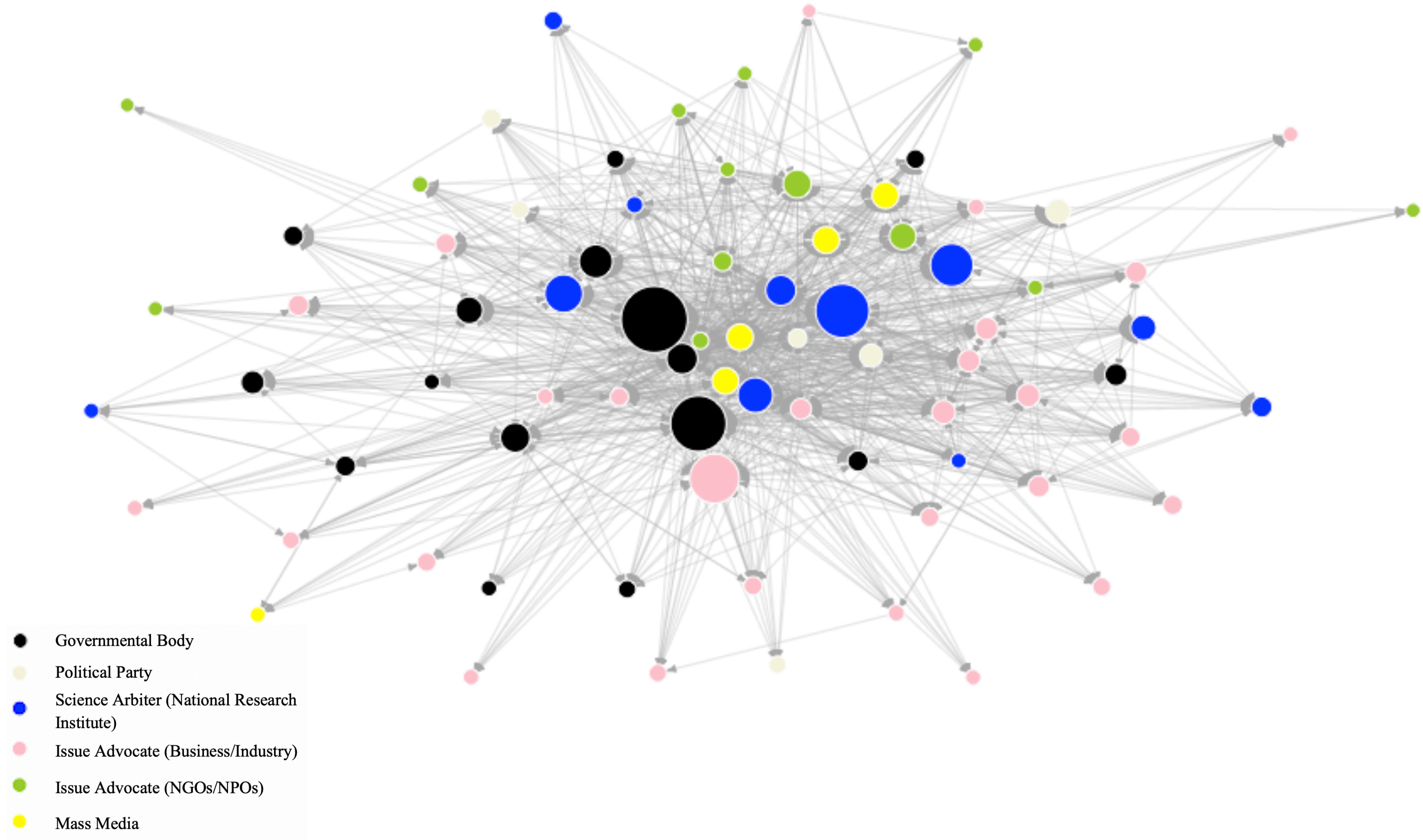
These knowledge exchange networks in environmental policymaking were interpreted through three main attributes: 1) features of actors, organizations and events, 2) the form and features of the connections in terms of their symmetry/asymmetry, multiplexity, and transitivity, and 3) features of the network's structure in terms of density or closeness, connectivity, and differentiation into sub-networks. The following paragraphs describe the networks according to these three attributes respectively for both networks and will then highlight key features and differences that are specific to each network.

Figure 6.2 Knowledge Exchange Network: Sending Information (Q7)



Data Source: J-GEPON2; Figure: Author

Figure 6.3 Knowledge Exchange Network: Receiving Information (Q8)



Data Source: J-GEPON2; Figure: Author

1) Features of actors, organizations, and events: Besides Fukushima in 2011, the policy events relevant for the knowledge exchange networks, that were probed in the interviews for investigating the environmental policy actor network in Japan, were the change in administration from LDP to DPJ in 2009, and environmental policy decisions under different administrations in years ranging from 2009 to 2012 regarding varying CO2 reduction target proposals by each government. The actors (nodes) in the network were organizations such as political parties (beige node), governmental bodies (black node), NGOs/NPOs (green node), and business and industry corporations and public and private research institutes active in environmental policymaking (pink node) in Japan[23]. The boundary (limitation) of the network was defined through the purposively sampling frame of the policy actors and their knowledge exchange activities represented in the directed ties. The overall knowledge exchange was relatively reciprocal, however, there were a number of cases where the connections were not reciprocal.

2) Form and features of the connections: The knowledge exchange networks are multiplex structures that represent the general environmental policymaking network and actors involved environmental policymaking in Japan. Both networks had high connectivity throughout the entire network. This means that, we do not observe the formation of groups that were not connected to the most central actors who form the core either directly or through intermediaries. Overall, both networks appeared to be fairly similar. However, a closer look revealed key differences. If we divided the networks into quadrants from the center (Figure 6.4 below) we see that there is a difference in the symmetry between the two networks. The network of sending information into the network showed more asymmetry than the receiving of information from the network. Even though, we can see cross-sectorial (cross-categorical) exchanges between various actors, we can also see that actors from similar categories tended to be clustered together with limited inter-categorical integration within the clusters (Figure 6.5 below). The core surrounding governmental institutions implies that the connections of other policy actors in the policy network relied on administerial bodies to facilitate cross-categorical connections. And in fact, national research institutes (science arbiters) were one type of cross-categorical facilitators, even though, their centrality measures imply they did not occupy a strategic position to potentially influence policymaking and did not build strong connecting bridges between the science community and the policy community. The measurements for centrality is explained in more detail in Section 6.4 where the "bridging potential" is discussed.

[23] The list of the 78 cases used for analysis can be found in the Appendix.

Figure 6.4 Network Symmetry Comparison

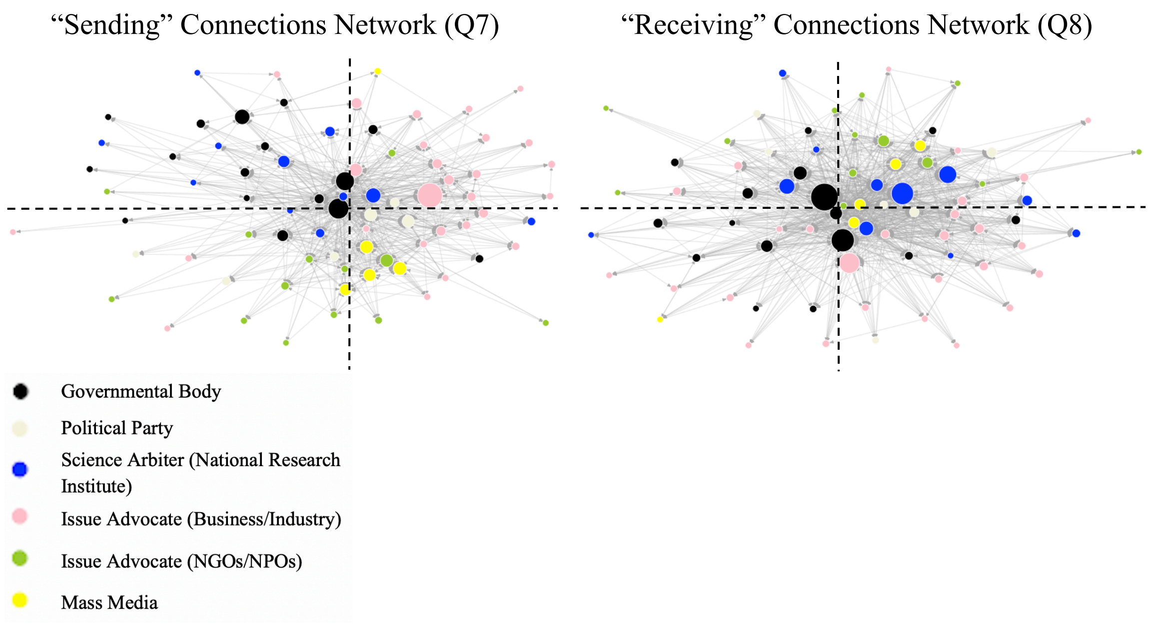


Figure: Author

Figure 6.5 Networks’ Structure Comparison

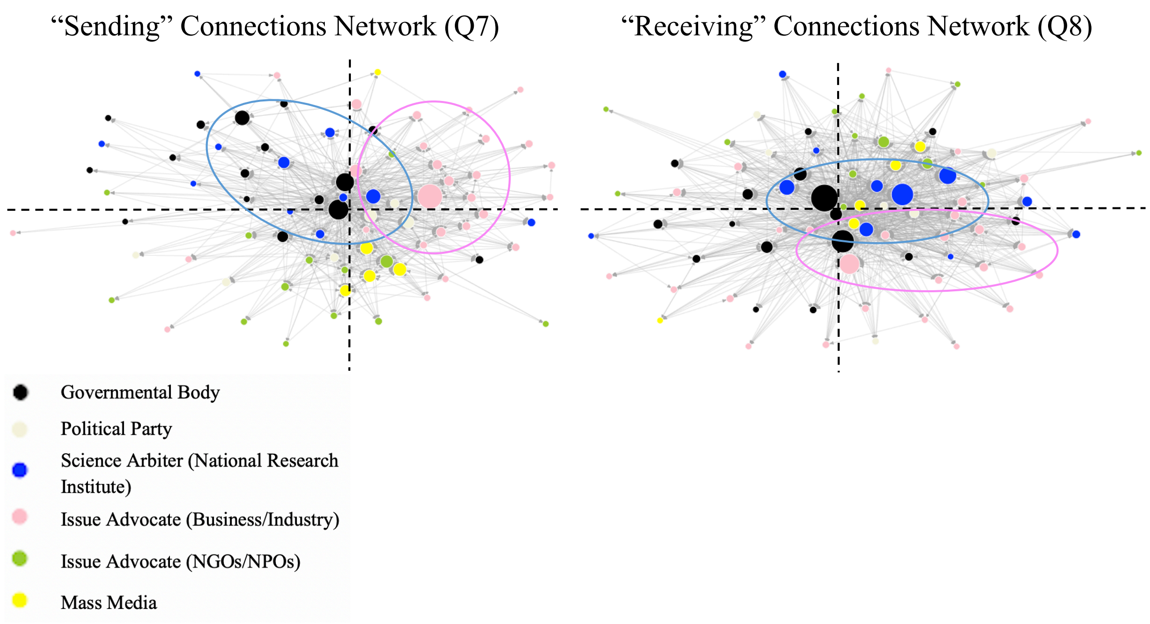


Figure: Author

3) Features of the networks' structure: Overall, the networks were fairly dense. Some actors were closer to one another while others were farther from the center. The density of the information receiving network was higher than for the information sending network. This implies that the broad range of actors rely on similar, or same information resources. Issue advocates from the business and industry sector (pink) were overall closer to the core than other issue advocates (greens). Yet, as the analyses in Chapter 7 shows, despite their position in the knowledge exchange network, issue advocates did not evaluate their potential influence in policymaking as significant. Moreover, the "bridging potential" that is discussed in the following section was consistent with this evaluation of their potential power in policymaking. As highlighted in Figure 6.5, in terms of sending information into the network, issue advocates from the business and industry sector formed a close cluster in which one organization facilitates the connection to other policy actors (the larger pink node among the smaller pink nodes.) If we look at the size of the vertices, we can see that national research institutes (blue) are less important for sending information into the network. They are more central and have stronger ties in terms of receiving information from the center of the network. This implies that national research institutes, depend on facilitating ties from governmental bodies (black) which is consistent with the findings from the interviews of a re-active science-policy interface in Japan as explained in the previous section. The discussion about features of the role of national research institutes is revisited in Chapter 7.

6.4 "Bridging Potential" of Science Advisers

6.4.1 Defining "Bridging Potential" of Science Advisers

The purpose of analyzing actors' network integration is based on the argument that actors who are influential are usually located in strategic positions within the network, and actors in intermediary positions would unify the network which makes them influential (Wasserman & Faust, 1994). They supposedly build a bridge between science and policy in order to ensure neutrality and independence of science and increase legitimacy and trust in political decisions (refer to Chapter 1). Hence, it was theorized that intermediary science advisers shape policy discourses.

The power of an intermediary was measurable in terms of degree of centrality. The concept of centrality from social network analysis measured the importance of an actor. Network centrality increases with the number of connections such an actor has within the policymaking network because centrality increases by the number of connections of an actor (Wasserman & Faust, 1994). It might happen that the more connections a strategically positioned adviser had to science institutions, the more it pulled science institutions closer towards the center of the policy network which could explain the "politicization of science" (refer to Chapter 2).

Theoretically, the existence of a science adviser connecting the policy community with the science community does not pull science into political debates. It allows the science community to stay distant from the center of the policy community, and to be protected from influence of political debates, as well as interests and values of other policy actors. Positional analysis in policymaking, as discussed in the previous section, investigated whether this theory applied and visualized the connections of science advisers, science and policy actors through which we could see whether science institutions in Japan are under the risk of being politicized.

According to the assumption that an intermediary builds a bridge between the science community and the policy community, applied centrality measures was "betweenness centrality" that is a measure for the bridging potential of an actor (Morgan, 2017). The bridging potential illustrated the likelihood of an actor to act as an intermediary and how influential that role would be. Therefore, this measure was well equipped to investigate the potential influence of science advisers in policymaking and reveal their position in policymaking networks. How to measure the betweenness centrality is explained with the following formula (Figure 6.6). In simple terms, the sum of the fractions of all pairs of nodes is calculated by dividing all shortest paths that go through actor A by all shortest paths between every node in the network (Morgan, 2017).

Figure 6.6 Betweenness Centrality of an Actor

$$\sum_{for\ all\ pairs\ of\ nodes} \frac{fraction\ of\ shortest\ paths\ that\ go\ through\ actor\ A}{all\ shortest\ paths\ between\ every\ node}$$

Source: Morgan, 2017

This allows to empirically investigate the space between science and policy. Common science-policy interface models are limited in finding evidence for what is happening between science institutions that are supposedly outside of political debates and the policy community of policy planners and decisionmakers. Calculating these centrality measures is one part of the quantitative analyses to investigate the questions how science advisers are integrated in environmental policymaking and to what extent science advice influences policymaking. The following section discusses the operationalization introduced above in accordance to the theoretical framework of power through knowledge exchange.

6.4.2 Measuring "Bridging Potential" of Science Advisers

For analyzing the bridge function of an actor, the direction and the number of connections matter. Therefore, the network structure defining variables for "sending" and "receiving" of connections were analyzed separately. The number of connections was important because the average number of ties illustrated the likelihood of an actor in the network to be in a central, thus, influential position. The more ties an actor receives or sends, the more this particular actor may influence the discourse of the network. Besides the average number of connecting ties, the two centrality measures, PageRank and betweenness were calculated. PageRank, originally devised by Google founders Larry Page and Sergei Brin measured the influence of webpages, accounts for the direction of connections and weighs them (Disney, 2015). Therefore, PageRank added value to the interpretation of the bridging potential of an actor through betweenness centrality. Using betweenness[24], that is the extent to which a particular actor lies on the shortest path between other actors, it was possible to analyze whether an actor was likely to be in a bridging position and hence, acting as an intermediary. Table 6.2 summarizes the calculations for degree average, PageRank, and betweenness centrality for the actors' relational connections.

[24] An explanation about the centrality measures calculated with iGraph in RStudio is provided in the iGraph manual accessible here: https://igraph.org/r/doc/betweenness.html (Last access: June 15, 2019).

Table 6.2 Knowledge Exchange Network Centrality Measures

Name	**Category**	**Out-degree Average ("Sender")**	**In-degree Average ("Receiver")**	**PageRank ("Sender")**	**PageRank ("Receiver")**	**Betweenness Centrality ("Sender")**	**Betweenness Centrality ("Receiver")**
Japan Business Federation (Keidanren)	Business/Industry	0.2963	0.43519	0.05154	0.03968	0	0
Tokyo Electric Power Company (TEPCO)	Business/Industry	0.16667	0.18519	0.01372	0.01097	0	102.6171
Global Environmental Forum (GEF)	Foundation	0.06481	0.10185	0.00751	0.00665	6.60636	12.66069
MOFA International Cooperation Bureau	Governmental body	0.15741	0.2963	0.01453	0.02149	484.7061	578.875
MOE Global Environmental Bureau	Governmental body	0.42593	0.56481	0.04116	0.05711	1068.982	151.868
METI Industrial Science and Technology Policy and Environmental Bureau	Governmental body	0.26852	0.37037	0.03661	0.04635	583.014	691.2496
MEXT Research and Development Bureau	Governmental body	0.08333	0.13889	0.01181	0.01102	67.06053	44.80034
Mitsubishi UFJ Research and Consulting	Issue Advocate (Business/Industry)	0.12963	0.15741	0.00991	0.01080	0.3588235	1.866685
Mitsubishi Research Institute, Inc.	Issue Advocate (Business/Industry)	0.13889	0.19444	0.01112	0.01064	0	3.290068
Fujitsu Research Institute	Issue Advocate (Business/Industry)	0.08333	0.11111	0.00769	0.00661	5.970858	0.9329887
Japan Transport and Tourism Research Institute (JTTRI)	Issue Advocate (Business/Industry)	0.02778	0.05556	0.00607	0.00567	1.790115	1.81859

Name	Category	Out-degree Average ("Sender")	In-degree Average ("Receiver")	PageRank ("Sender")	PageRank ("Receiver")	Betweenness Centrality ("Sender")	Betweenness Centrality ("Receiver")
International Center for Environmental Technology Transfer (ICETT)	Issue Advocate (Business/Industry)	0.01852	0.06481	0.00607	0.00550	0	0
Global Industrial and Social Progress Research Institute (GISPRI)	Issue Advocate (Business/Industry)	0.0463	0.18519	0.00749	0.01097	0	0
Central Research Institute of Electric Power Industry (DENKEN)	Issue Advocate (Business/Industry)	0.13889	0.27778	0.01071	0.01568	0	0
The Japan Economic Research Institute (JERI)	Issue Advocate (Business/Industry)	0.02778	0.07407	0.00625	0.00583	7.754278	1.009512
Japan Ship Technology Research Association (JSTRA)	Issue Advocate (Business/Industry)	0.03704	0.05556	0.00756	0.00606	1.732576	0.6106732
Citizen's Alliance for Saving the Atmosphere and the Earth	Issue Advocate (NGO)	0.09259	0.16667	0.00943	0.00955	49.01398	33.55782
KIKO Network	Issue Advocate (NGO)	0.13889	0.2963	0.01078	0.01839	0.9940476	112.9773
Greenpeace	Issue Advocate (NGO)	0.08333	0.12963	0.00894	0.00701	0	80.8367
Research Institute for Culture and Environment	Issue Advocate (NGO)	0.02778	0.0463	0.00656	0.00489	0	0
Institute for Global Environmental Strategies (IGES)	National Research Institute	0.14815	0.36111	0.01283	0.02064	76.28684	146.3155

Name	Category	Out-degree Average ("Sender")	In-degree Average ("Receiver")	PageRank ("Sender")	PageRank ("Receiver")	Betweenness Centrality ("Sender")	Betweenness Centrality ("Receiver")
Japan International Cooperation Agency (JICA)	National Research Institute	0.15741	0.2963	0.02014	0.02831	141.1173	48.65396
National Institute for Environmental Science (NIES)	National Research Institute	0.24074	0.4537	0.02719	0.04413	223.8277	234.4636
National Institute of Advanced Industrial Science and Technology (AIST)	National Research Institute	0.12963	0.25	0.01141	0.02542	152.947	292.3405
New Energy and Industrial Technology Development Organization (NEDO)	National Research Institute	0.14815	0.37963	0.01532	0.03323	4.714386	8.858388
DPJ	Political Party	0.21296	0.21296	0.02042	0.01286	210.4118	45.51806
LDP	Political Party	0.21296	0.23148	0.01991	0.01447	0	0

Data Source: GEPON2 Japan; Table: Author

Scientific evidence is used to increase the potential to shape and propagate certain interests and to eventually increase trust in policy proposals and policy outcomes. Hence, the use of trustworthy sources and reliable evidence increases the influence in policymaking (refer to Chapter 4). And if intermediaries are influential controllers of information in policymaking networks that rely on such evidence, applying measures for power distribution across actors in the network through the bridging potential of intermediaries in the network is feasible to understand how power is distributed across various policy actors and to see whether an intermediary holds influential power.

If we look at the results overall for betweenness centrality, we can confirm that the International Cooperation Bureau of MOFA, the Global Environmental Bureau of MOE, MOE's incorporated National Research Institute NIES, and the Industrial Science and Technology Policy and Environmental Bureau of METI form the center of the network. Let us take a closer look into some of the important actors in environmental policymaking and their potential power based on knowledge exchange ties respectively.

MOE is the most important information source in environmental policymaking for other policy actors. The Ministry has a significant betweenness centrality from the sender position of 1,068.98. But the Ministry's betweenness centrality shows a drastic reverse from the receiver's position. There, its betweenness centrality is, compared to its role as a sender, only 151.87. The case of MOE is the only one where the difference between the importance of the accumulated connections (PageRank) and its betweenness centrality varies between the two roles as sender and receiver of information to members of the network. The degree average and PageRank values for MOE for both, as sender and receiver of information in the network imply that the Ministry should be in control of the policy agenda. However, this is not consistent with earlier findings that METI and the business and industry sector have more control over the policy output (Okura et al., 2015) and, as analyses Section 6.5 show, often overrules MOE in terms of national climate mitigation policy decisions.

METI's betweenness centrality from the sender's position is about half of MOE's with a value of 583.01, yet, as the data shows, METI is the second most important information hub in environmental policymaking. METI is in fact the most central body in the network in the position as receiver of information with a value of 691. 25 compared to MOE's 151.87. The control over policy output in environmental policymaking by METI and the business and industry sector can be explained when we look at the PageRank value. *Keidanren*'s connections in the overall policy network have much weight at 0.05154 "Sender" PageRank and 0.03968 "Receiver" PageRank. The betweenness centrality value for METI's receiving position at 691.25 implies that the overall policy actor network considers the Ministry as the controller of policy output. Such policy actors like *Keidanren*, MOE and METI form information hubs. These results in which neither national research institutes nor issue advocates are similar information hubs nor have substantial bridging potential in knowledge exchange networks have to be discussed in terms of the *tatewari* advisory structure that has high boundaries in which each ministry has its own advisory board (refer to Chapter 3)[25].

The way the void between science and policy is filled is not evenly distributed, but rather opts towards science with a greater distance to policy. From these findings of the bridging potential of intermediary science advisers in environmental policymaking, the weight of connections might be therefore more important than the betweenness of intermediaries. To understand the actors' positions and centralities in context of Japanese environmental policymaking, the following section integrates the discussions of the findings from the interviews.

6.5 Discursive Hegemony and Inter-ministerial Barriers

Environmental policymaking and climate change deal with complex contested issues that differ in opinions and interests across diverse actors. Hence, the positional analysis of intermediaries has to be put into context of political discourses, if we want to understand policy outcomes because in policymaking discourses matter. And as Humphreys (2009) explained the power of an actor depends partly on whether that actor can shape and propagate certain interests (refer to Chapter 4).

As has been pointed out by previous research, the link between science and policy in Japan is fairly weak (refer to Chapter 3). While the previous sections discussed the actor landscape in terms of who science advisers are and how they are integrated in environmental policymaking this section describes key features of the discursive struggle in environmental policy networks by integrating qualitative interview data in the analyses.

The dominant discourse in Japan is to ensure economic growth and energy security. Nevertheless, Japan is an important contributor to the International Framework. Its contribution lays for example in the international cooperation in R&D with developed countries, and in international cooperation to implement energy efficient systems in developing countries. Approaches to CO2 reduction, and de-carbonization to zero-net emissions as the International Framework decided in Paris in 2015 is divided between domestic opinion and international demands. As one of the industrialized countries Japan carries historical responsibility for climate change. Therefore, the International Framework expects the Japanese government to put forward long-term, stringent and effective mitigation plans. Yet, the basic argument of energy industries and METI is broadly speaking the following. Compared to other countries' lower energy efficiency, before Japan pursues a path that potentially harms its economic performance and competitiveness, increasing the energy efficiency of other countries first would contribute to global CO2 reductions more effectively.

[25] The feature of national research institutes and issue advocates is revisited in more detail in Chapter 7.

In accordance to the policy instruments set by the International Framework, such as joint implementation (JI), or joint credit mechanism (JCM), the government of Japan promotes projects that cooperate with foreign governments in order to assist with technological transfer, development, and energy grid-implementation. In the top-down policy implementation mechanism national research institutes such as NEDO, RITE, NIES, or FFPRI play a key role in managing projects promoted by the ministries. The management of research projects includes tasks such as allocate resources by the ministries, promote further research projects, assist in local project management and evaluate the progress to eventually provide policymakers with input for policy formulation or adaptation. Depending on the institute, some conduct primary research investigations while also manage ministry's resources, while other institutes do not engage in primary research activities, and mainly perform an executive role. National research institutes provide decisionmakers with information for the formulation of guidelines and policy recommendations. It is especially their executive function to manage governmental resources that defines the role of national research institutes in environmental policymaking.

As interests and attitudes towards environmental policies and climate mitigation measures as well as the foci of promoted projects differ between the ministries, the interpretation of available climate data, or the modelling of climate projections depend on the general attitude towards de-carbonization, and what measures to apply to achieve the zero-net emission goal. For example, NEDO and RITE specialize on economy, industry, and energy as their budget is allocated by METI through the Ministry of Finance. The budget of NIES and FFPRI is allocated by MOE, therefore, their standpoint is based on the environmental perspective. The projects these institutes manage and promote differ according to their ministries policy orientation.

Policy recommendations and statistical climate modelling by NIES differs substantially from policy recommendations and statistical climate modelling by RITE. The basic statistical environmental data might be the same, but basic assumptions differ that define the model researchers draw from to inform the formulation of policy recommendations. Such basic assumptions are for example about how much renewable energy, nuclear energy, or fossil fuels Japan's energy system should have, or whether the calculations of the costs to promoted renewable energies are based on a three-year trajectory or twenty-year trajectory. The attitude towards these basic assumptions make significant differences for the projects that research institutes undertake or allocate to gather evidence that informs the ministries' policy recommendation.

For policy recommendations for the environment and climate mitigation to be considered by decisionmakers they are drafted around the predominant discourse that is "cost-efficiency." The cost-effective argument poses a significant hurdle for accelerating the promotion and implementation of renewable energies in the environmental and energy policy mix. Energy policymaking is under the authority of METI, that has historically strong connections to heavy industries and businesses represented by *Keidanren*. Among non-state policy actors, *Keidanren* is one of the most influential actors in policymaking. Even though, the stronghold of METI and *Keidanren* is difficult to penetrate, many businesses and industries shifted towards the global renewable energy discourse. In April 2017, a group of Japanese companies formed the Japan Climate Leaders' Partnership (JCLP) to promote and assist in de-carbonizing businesses and industries. Executive member companies are for example Aeon, Daiwa House, Fujitsu and RICOH. The group consists of 114 members as of September 2019 and has since its establishment to date submitted 19 policy proposals to the government.

The discursive divide between these groups is based on the difference in opinion about cost and energy security. The difference whether policy recommendations are based on projections with a short-term or long-term perspective. A short-term perspective favors the dominance of nuclear energy or fossil fuels, as these established sources of energy are cheaper over a course of two to three years. Renewable energies become more cost-effective over a course of 10 to 20 years. Renewable energies are still in the early stages in Japanese policymaking because the opinion towards renewable energy in terms of Japan's potential, or how much renewable energy the energy mix should include is a contested issue even among experts and scientists.

In this discursive struggle between the dominating business-industry and environmental positions, much of the effort of the executives goes into securing a strong position for their ministry, which takes on the shape of "power-games" and has created high inter-ministerial barriers. One public administrator explained this with the lack of a coordination office in the mechanism of proposing and promoting research projects to produce scientific evidence between different ministries (the discussion about the coordination office will be revisited in a later paragraph).

> "Each time METI and MOE have a big fight between each other. And what they do is they set up a committee to discuss emission targets under the Ministry for the Environment and another under METI. So, they have two different committees set up under each ministry and they also select different committee members." (Y/2018/08/27)

In consequence, interaction between advisory institutions from different areas of expertise on a horizontal pane in contrast to the vertical structure (*tatewari*) is scarce if it happens at all. Not only boundaries between the advisory structure for each ministry are high, information distribution is regulated and limited. For example, METI has access to data from industries; and industries do not share information openly with other ministries or research institutes which pose significant difficulties in terms of climate modelling by environmental researchers.

MOE and its related research institutes such as NIES have no direct access to CO2 emission data from energy industries or heavy industries such as steel or iron. And even though METI has access to data from the industry sector, even they sometimes do not obtain all the information they require. As it turned out during the interviews, the dominance of electric power companies in Japan causes even frictions between such industries and METI. Nevertheless, METI's dominance over energy policy affects environmental policymaking and hinders the formulation of long-term CO2 reduction targets or other commitments under the International Framework. METI's quick reaction in dominating the policy agenda towards adapting the energy policy mix in 2012 after Fukushima made it more difficult for MOE to propose long-term CO2 reduction plans, or proposals for intended national determined contributions (INDC) as demanded by the International Framework.

> "When the Ministry for the Environment wanted to start discussing the emission reduction target for 2030 METI said there is no meaning to start discussing INDCs when you don't know how much nuclear power plants are acceptable." (Y/2018/08/27)

Japan has been a "nuclear energy enthusiast" (Kagawa-Fox, 2012: 11). Nuclear energy is still considered by many as clean energy and key to achieve de-carbonization. Up until into the 2010's, the environmentalist position was associated with a pro-nuclear position. Since Fukushima, environmental social movements, and especially anti-nuclear movements gained momentum that is gradually changing the public discourse in Japan. However, the penetration of the policy agenda is closely intertwined with economic growth, hence, business and industry. It is not only the discursive hegemony, but also established protocols and guidelines that excert regulatory pressure on science advisory procedures. These aspects will be revisited in Chapter 7.

6.6 Chapter Summary and Conclusions

This chapter analyzed how science advice is integrated in a knowledge exchange network of environmental policymaking and integrated the analyses of the discursive struggle within inter-ministerial "power-games" in environmental policymaking. The method of analyzing the network integration through knowledge exchange relationships was based on the assumption that control of the flow of knowledge about climate change and its related issues is a measure of power; a theory informed by Rouse's (1987) philosophy of power of knowledge and Hajer's (1995) knowledge-power theory in international environmental policymaking and regime formation. Therefore, the core assumption was that science advisers would be influential but possibly latent actors in environmental policymaking. And social network analyses tools were used to identify these latent traits of potential power distribution.

Somewhat contrary to the expected form of integration of science advisers as described in Section 6.3 and illustrated in Figure 6.1 in which national research institutes were expected to be somewhat integrated (+ —) and innovation center (issue advocates) were expected to be most integrated (+ +), the analyses showed that the advice-giving capacity of both types of science advisers in terms of their network position and degree of integration in environmental policymaking in Japan is quite weak. In consequence, bridging-potential to facilitate a relationship between policy and science was surprisingly low.

Although it has been postulated that knowledge is a resource of power, theoretically, other factors may weigh more in a case where administrative boundaries are high, and where information in a policy actor network is not shared evenly across all actors. As we could observe, issue advocates from the business and industry sector appear far more reluctant to share information throughout the network than NGOs/NPOs. National research institutes are interlocked with public administration not through providing evidence by national research institutes into policymaking but through other factors such as regulatory boundaries that includes dependence on financial and material resources.

The interlock of national research institutes in policymaking may have more administrative reasons as they are overall more receiving in the knowledge exchange networks than sending scientific knowledge. The relatively low bridging potential and influence of issue advocates was surprising. The following chapter explores this theme in more detail by integrating the interview data further in the quantitative analyses. The following chapter analyzes the influential power of science advisers to shape the policy agenda, discusses their potential influential power in relation to the policy actors' attitudes, and presents key features of the Japanese science-policy interface.

7. Power Potential of Science Advisers and the Japanese Science-Policy Interface

7.1 Chapter Purpose and Structure

The purpose of this chapter is to examine attributes of the integration of expert advice in environmental policymaking in Japan. (refer to Chapter 6). While Chapter 6 answered the questions about who science advisers are, and how they are integrated in environmental policymaking (research question group (1) and (2)), that as intermediary between science and policy, science advisers in Japanese environmental policymaking did not have either the reputation or the strategic position in the network to effectively facilitate a bridge between policy and science. This chapter investigates attributes of science advisers to explain their network position (research question group (3)) because in science and technology studies attributes of "scientific culture" are considered a causal factor for the magnitude of the distance between science and policy, as well as science and society (Cortner, 2000: 23). Such attributes are, for example, objectivity (neutral or unbiased scientific inquiries by the science community), freedom from political values, attitudes, and the regulatory framework.

Findings are discussed in the same manner as in Chapter 6, that is through the integration of the results of the quantitative survey and qualitative interviews. The analyses are illustrated with select quotes from employees of national research institutes, private research institutes, consulting firms, and bureaucrats who were appointed during the set-up phase of the Council for Science, Technology and Innovation and worked for the greater part of their careers for improving the advisory system in Japanese policymaking.

The chapter is structured as follows: First, the political attitude of policy actors regarding the de-carbonization issue and the potential for science advisers to influence the policy agenda is analyzed. Then, the power potential of science advisers is calculated based on knowledge exchange relationships. The measured power potential is put in relation to actors' political attitude to highlight what kind of policy attitude on climate mitigation in Japan dominates policymaking. Results for national research institutes and innovation center respectiviley are drawn out and highlighted. The last section discusses features of the Japanese science-policy interface where we find market-based research at the core for evidence production and provision in policymaking and builds the bridge between science and policy.

7.2 Science Advisers in Policymaking Towards De-Carbonization

Does political attitude affect the number of exchange relationships actors have in policymaking networks? As explained in Chapter 4, interests and values of actors are underlying factors that influence the choices of actors with whom to form a relationship (Van Deemen, 1997). Because the network formation based on knowledge exchange activities depends on actors pre-defined world-views and preferred information sources, we have to think about how to test for these factors. Interests and values are abstract cognitive constructs that change over time but are difficult to analyze empirically. The analyses in this chapter try to account for the effect of these cognitive factors that are assumed to define knowledge exchange activities. A closer look into the responses of the J-GEPON2 survey provides insights into the political attitude and potential influential power of actors in Japanese environmental policymaking.

Measurements for potential influential power in policymaking and political attitude are listed in Table 7.1. These measurements are the following questions from J-GEPON2 survey: Q28, Q32, and Q40 were analyzed for the actors' potential influence in policymaking, and Q37 and Q41 were analyzed to investigate the actors' political attitude towards de-carbonization.

Table 7.1 Select J-GEPON2 Survey Questions (Translated)

Measurement for potential influence in policymaking	***Q28***	On June 10, 2009, at a press conference Prime Minister Aso announced a CO2 reduction goal of 15% by 2020 (base year 2005). To what extent was your organization's opinion reflected in this announcement? Please choose one answer among the following five choices.
	Q32	On December 11, 2009, Prime Minister Hatoyama decided a CO2 reduction target of 25% by 2020 (base year 1990) at an advisory board meeting in the Cabinet Office. To what extent was your organization's opinion reflected in this decision? Please choose one answer among the following five choices.
	Q40	For COP17, Prime Minister Noda declared to retract from the Second Commitment Period of the Kyoto Protocol. To what extent was your organization's opinion reflected in this declaration? Please choose one answer among the following five choices.
Measurement for political attitude	***Q37***	The following question is about COP17 in Durban, November and December 2011. The Noda administration announced to proceed with the plan of the 25% CO2 reduction target by 2020 (base year 1990) if the new international framework including USA, and China will be set. What is your organization's opinion regarding this? Please choose one answer among the following choices.
	Q41	Regarding the national reduction plan asked in Q37, what is your organization's opinion regarding COP15, in Copenhagen in December 2009? Please choose one answer among the following choices.

Source: J-GEPON2; Translation: Author

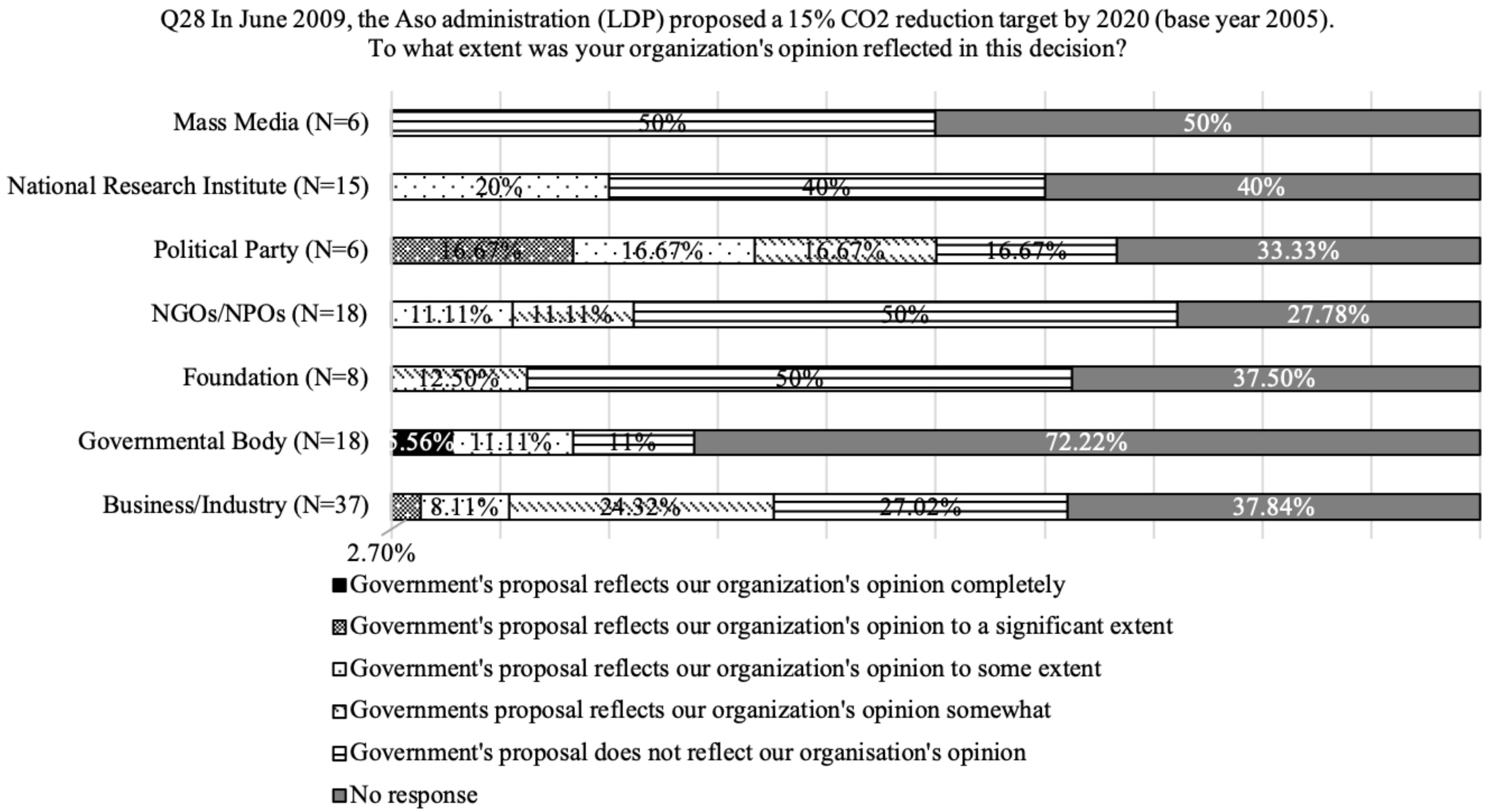
The responses were grouped by actor categories. As explained in Chapter 5, the actor categories used here differ slightly from the main categories used in the survey instrument because science advisory organizations, consultants, and research and development branches were distributed throughout the categories that were used in the survey. The actors were grouped in the following categories: Business/Industry, Foundation, Governmental Body, Mass Media, National Research Institute, NGOs/NPOs, and Political Party.

The following three figures, (Figures 7.1, 7.2, and 7.3) show descriptive statistics of the responses for Q28, Q32 and Q40. Overall, all three questions show a relative high rate of non-response. Meaning, policy actors, regardless of their type, did not give an answer. For some, it might be the case that they did not want to reveal their political attitude because it is a sensitive topic or others, for example, lacked sufficient knowledge about details of their organization's standpoint and input regarding national CO2 reduction target negotiations.

In accordance to the science adviser classification explained in Chapter 2, private research institutes and consultants are categorized as issue advocates because they aim to limit the choices for decisionmakers and provide policy options to assist quicker decisionmaking processes. However, as the analyses in Chapter 6 showed, advisers from the private sector are less directly integrated in policymaking than national research institutes in terms of the knowledge exchange activity measurement. Moreover, through all three questions illustrated above, the vast majority of national research institutes showed to not influence political decisions in such a way as it would reflect their expertise in CO2 reduction targets set by the Japanese government. Their potential influence in such policy decisions did not vary in 80% of the cases with the change in administration from LDP to DPJ in August 2009. However, the remaining 20% showed to find their input more reflected in policymaking during the DPJ legislation.

Even though the DPJ approached the climate change issue more proactively at first, trying to set more ambitious targets at the beginning of their administration period in fall 2009, only a few weeks into their legislating period the DPJ administration withdrew from the second commitment period of the Kyoto Protocol (KP CP2) in 2009 which caused much confusion about the party's political paths. The withdrawal from KP CP2 was for the greater part to the benefit of the business and industry sector. The responses on to what extent the organizations' opinion was reflected in the decision by the DPJ government to withdraw from KP CP2, 21.62% of the business and industry sector said the government's decision did reflect their organization's opinion, 10.81% said their organization's opinion was reflected to a significant extent, 18.91% said to some extent, and 5.41% said their organization's opinion was reflected somewhat. That is in total more than half of the business and industry sector that saw their opinion in the government's decision reflected to some degree. In contrast, 20% of the responses from national research institutes said that their organization's opinion was reflected to some degree, and 40% said their organization's opinion was not reflected in that decision.

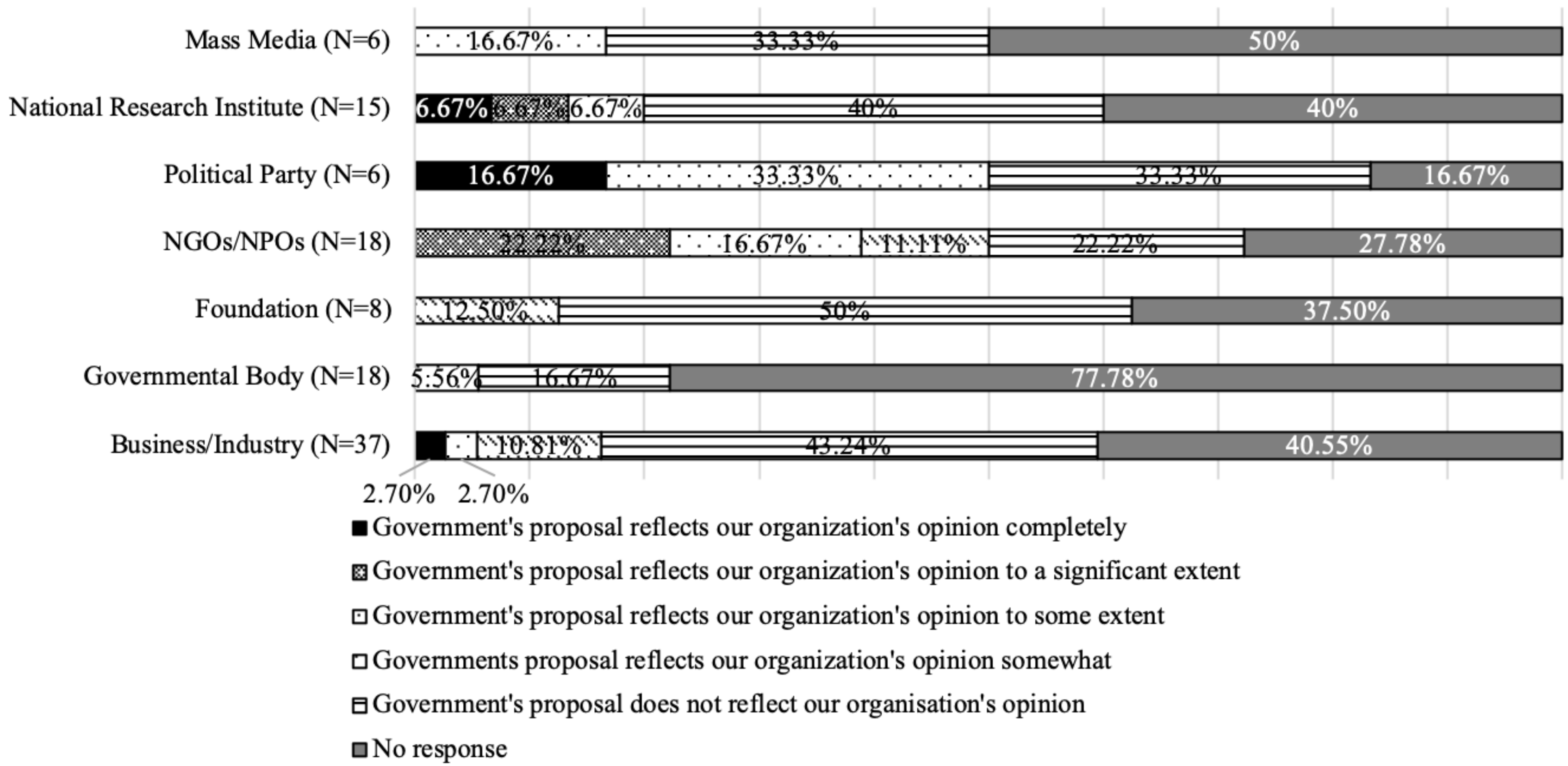
Figure 7.1 J-GEPON 2 Survey Q28 Descriptive Statistics



Data source: J-GEPON2; Figure: Author

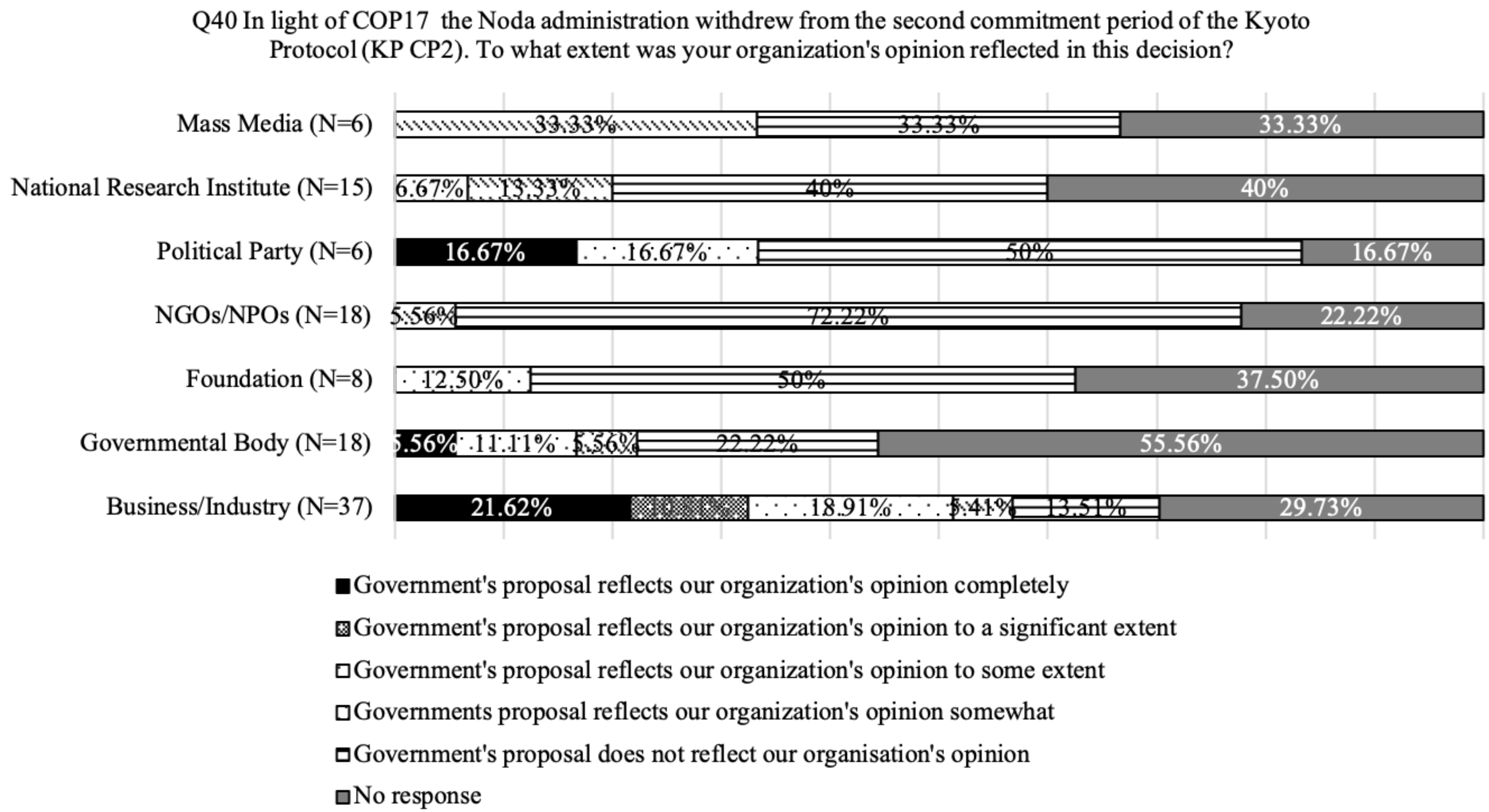
Figure 7.2 J-GEPON 2 Survey Q32 Descriptive Statistics

Q32 In December 2009 the Hatoyama administration (DPJ) proposed a 25% CO2 reduction target by 2020 (base year 1990). To what extent was your organization's opinion reflected in this decision?



Data source: J-GEPON2; Figure: Author

Figure 7.3 J-GEPON 2 Survey Q40 Descriptive Statistics



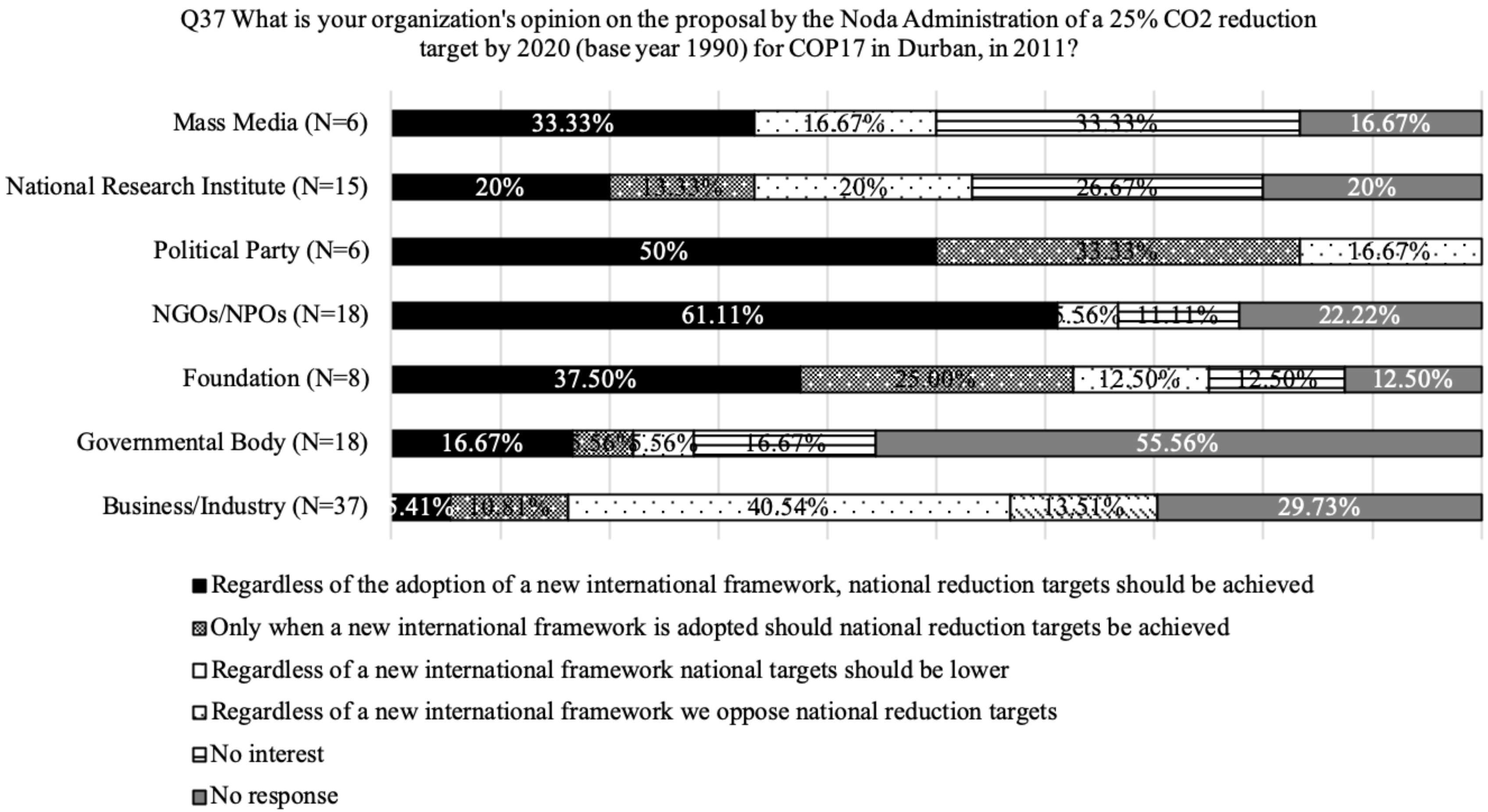
Data source: J-GEPON2; Figure: Author

These figures may point to the typical strong ties the business and industry sector has with government bureaucracy, and indicates that the business and industry sector is in fact a driver of environmental and energy policymaking in Japan. In terms of the connection between business and industry with government bureaucracy, Zakowski (2015) argued that party officials of the DPJ were eventually trying to get more support from the business and industry sector to secure more support for their government, and also to improve the party's conflicting relationship to the bureaucracy that was known to be in control of policymaking in general. This may partly be an explanation for the seemingly incompatible standpoints of a more stringent CO2 reduction target the party favored versus the withdrawal from KP CP2. DPJ officials recognized climate change as a vital issue and campaigned for it to some extent, but it can destabilize a government in Japan if more emphasis is put on it on the policy agenda, or if the manner to include it more dominant on the policy agenda lacks a clear strategy or support.

As the interview research revealed, bureaucrats of the Ministry for the Environment were hoping for a more stringent and proactive climate change policy path by the DPJ, but these expectations were soon replaced with confusion and disappointment. While the DPJ administration provided a case in which scientific advice was actively integrated in policymaking, this would not last long. The great differences in the environmental policy path of the DPJ showed what other research had analyzed that inner-party differences on core policy issues increased the party's instability (Maeda & Tsutsumi, 2015; Zakowski, 2015).

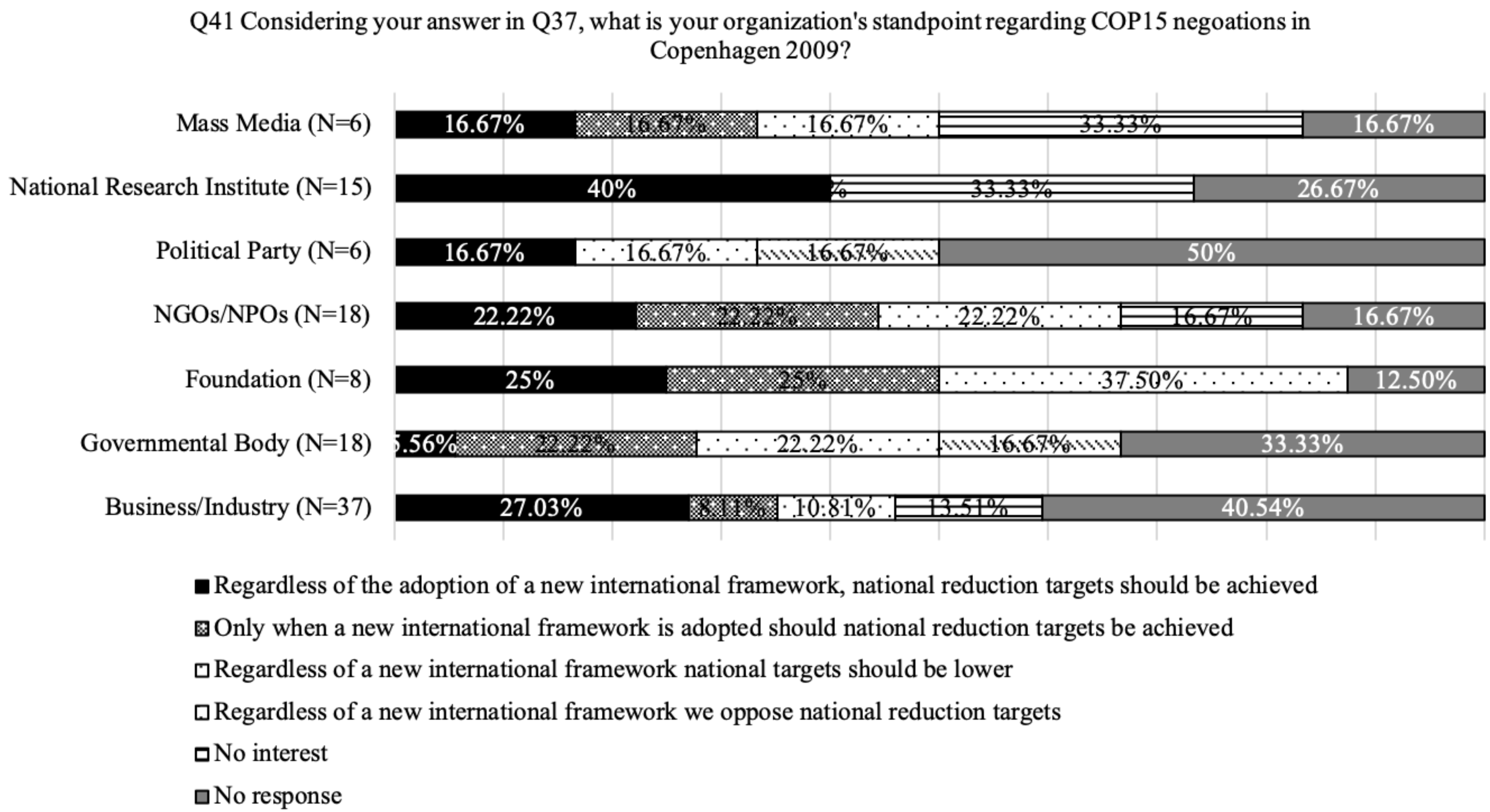
The discussion now turns to the question what political attitude these policy actors have regarding climate mitigation measures. and 7.5 illustrate whether environmental policymaking in Japan support climate mitigation measures set by the International Framework. Q37 and Q41 of the survey probed into this topic by asking the respondents about their organization's opinion regarding the proposal by the Noda administration (DPJ) of a 25% CO2 reduction target by 2020 with 1990 as base year for COP 17 in Durban, in 2011 (Q37), and regarding the COP15 negotiations in Copenhagen, in 2009 (Q41). The data showed that the standpoint of national research institutes is divided between a greater emphasis on more stringent environmental policies as the International Framework asks and not considering international guidelines for domestic policies at all. The business and industry sector are either for a lower CO2 reduction target in general or for policies that are detached from international guidelines.

Figure 7.4 J-GEPON 2 Survey Q37 Descriptive Statistics



Data source: J-GEPON2; Figure: Author

Figure 7.5 J-GEPON 2 Survey Q41 Descriptive Statistics



Data source: J-GEPON2; Figure: Author

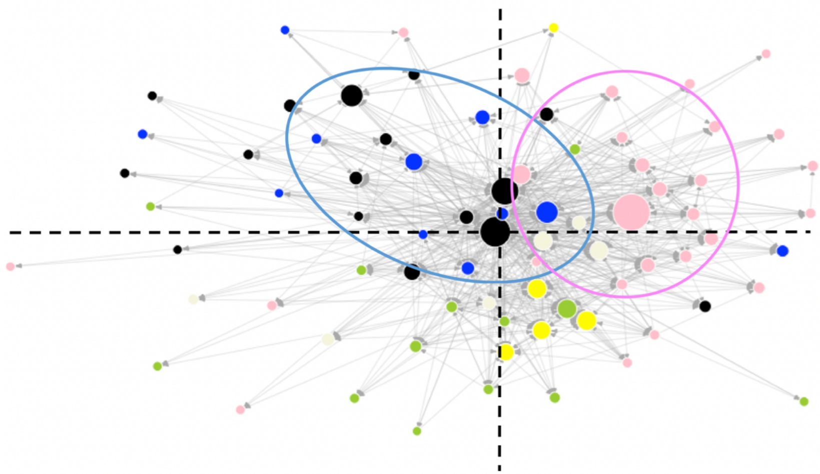
A key point in understanding environmental policymaking in Japan is recognizing how the actors interact with each other, whether actors with different attitudes and opinions interact with each other and what kind of information sources of evidence policy planners and decisionmakers draw on the *tatewari* advisory structure that is known to have high boundaries (refer to Chapter 3). Connecting the analyses about actors' attitudes and potential influence in policymaking with the network analyses of Chapter 6 we can conclude that a cross-sectoral or cross-attitudinal interaction in environmental policymaking in Japan is doubtful. To illustrate, Figures 7.6 and 7.7 display jointly the knowledge exchange networks from Chapter 6 with the figures on policy actors' potential power to influence policymaking and their political attitude[26].

As the centrality measures in Chapter 6 showed, there was a significant difference in the position of national research institutes and innovation center in the environmental policymaking network between sending information into the knowledge exchange network and receiving information from the knowledge exchange network. In terms of the scaled number of directed relationships that was out-degree and in-degree average, as well as the measurement for weighted relationships (PageRank), and the measurement for the bridging-potential (betweenness centrality) as summarized in Table 6.2, Section 6.4.2 showed that science advisers were less senders of information in the knowledge exchange policymaking network, but more receivers of such relational ties. Therefore, the political attitude of science advisers is an insignificant variable to explain the integration of science advice in knowledge exchange policymaking networks.

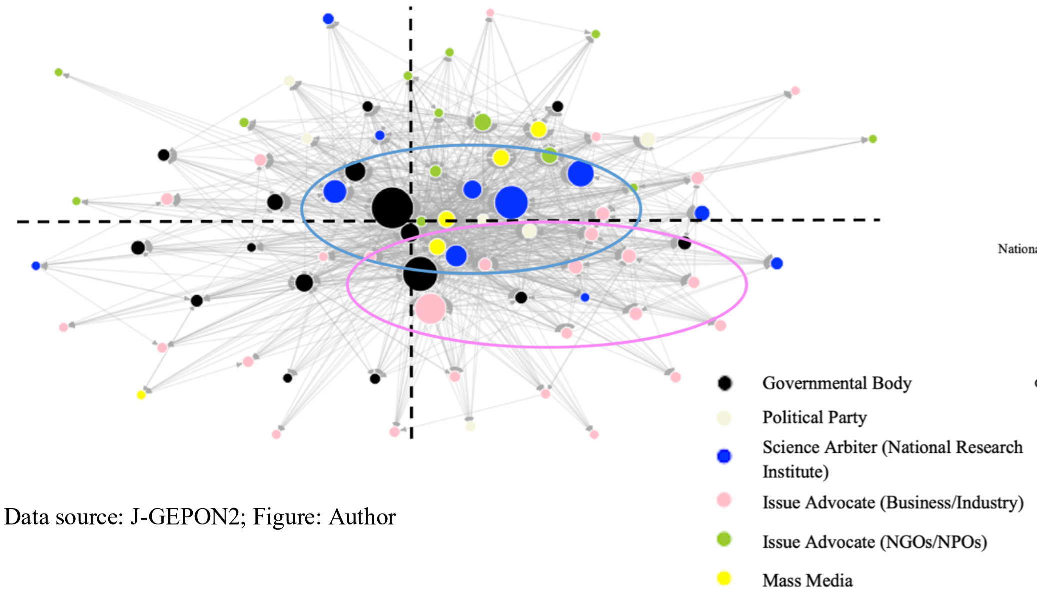
[26] Displaying results jointly is a concept borrowed from mixed methods research. In mixed methods research this tool is referred to as "Joint Display" (Fetters, 2018). The purpose of a joint display here is to assist the reader in connecting the findings from these two discussions. By doing so, the joint display provides a visual aid.

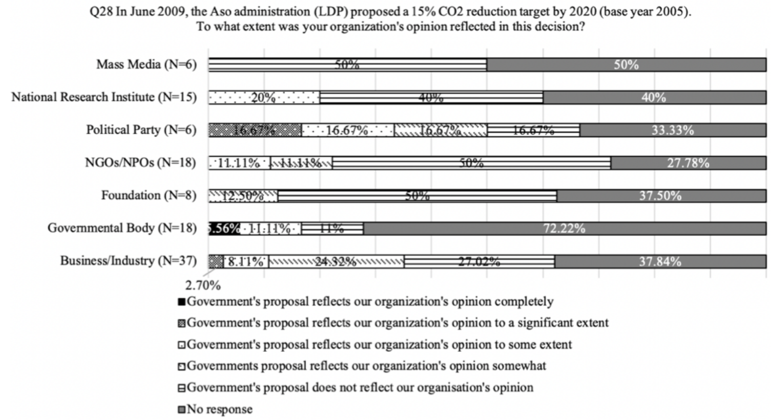
Figure 7.6 Joint Display: Knowledge Exchange Networks and Political Influence

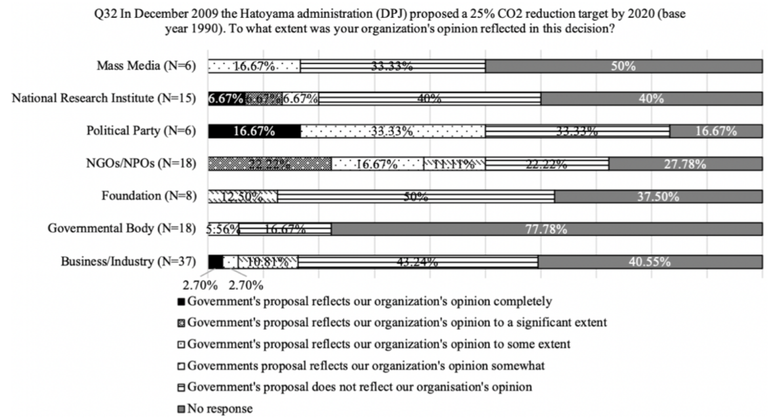
“Sending” Connections Network (Q7)

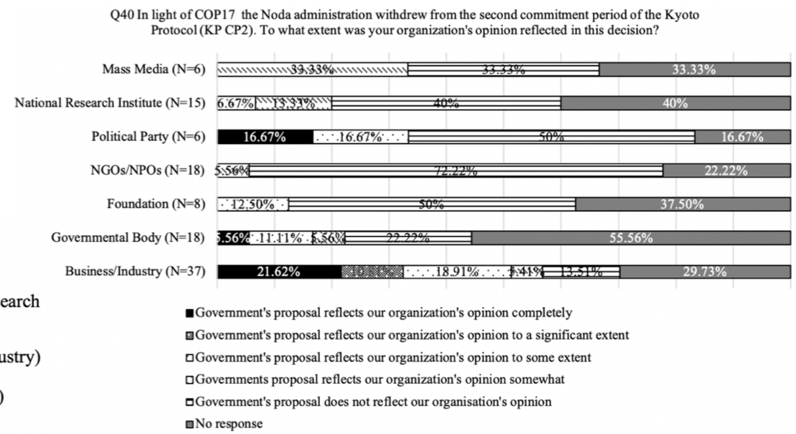


“Receiving” Connections Network (Q8)



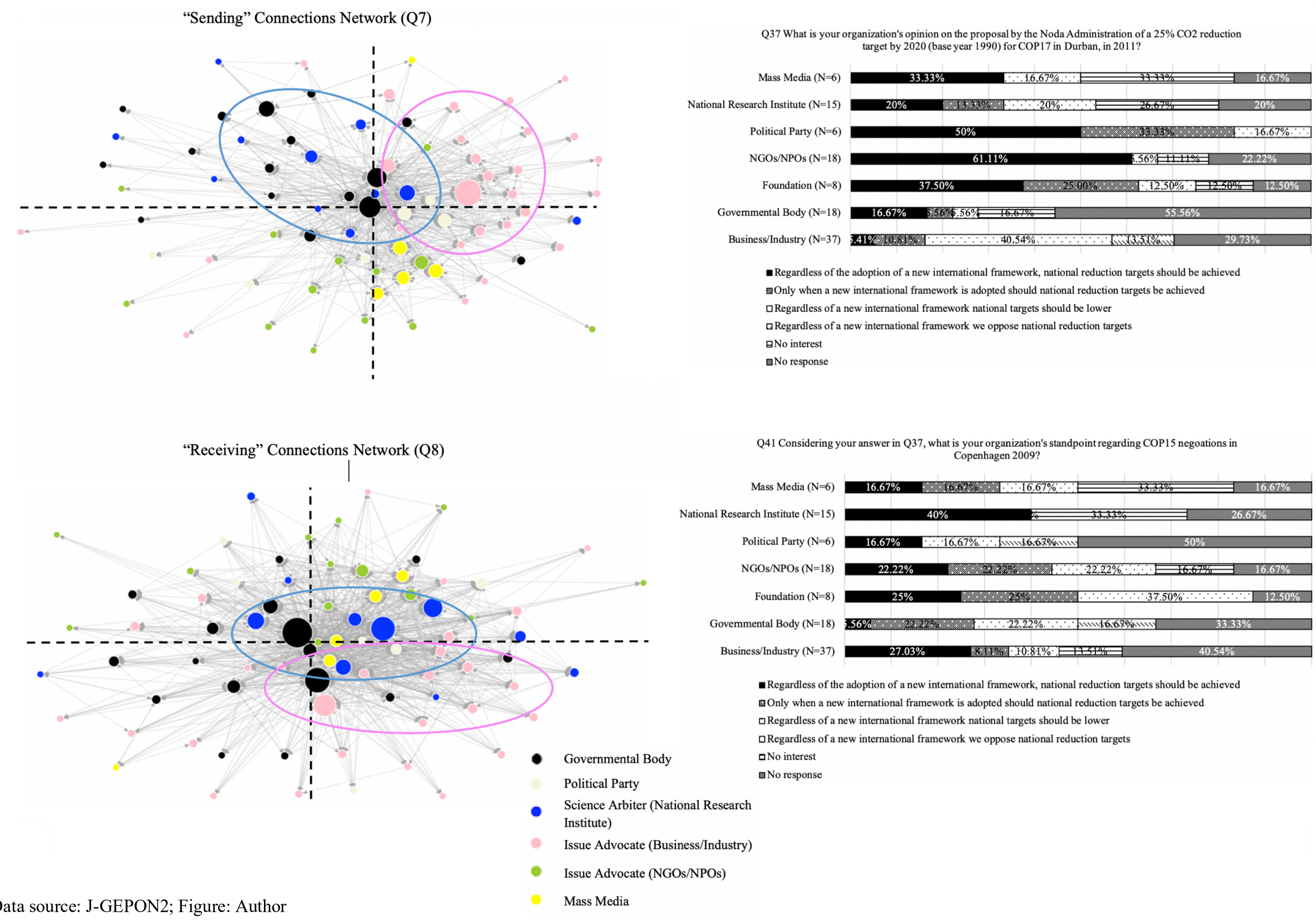






Data source: J-GEPON2; Figure: Author

Figure 7.7 Joint Display: Knowledge Exchange Networks and Political Attitude



Data source: J-GEPON2; Figure: Author

While this section analyzed the role of science advisers descriptively, the following section is devoted to connecting measurements of power according to social network analysis theories with the political attitude and potential influence in policymaking as discussed above to add another dimension to the measurement of the power potential of science advice in environmental policymaking

7.3 Science Advisers' Power Potential through Knowledge Exchange Relationships

Within the propositions of the power-dependence theory as explained in Chapter 4, Cook and Yamagishi (1992) developed a method to calculate the distribution of power in exchange networks. This method is adapted and applied here. There are few limitations that need to be considered for applying this method. To calculate the power dependence, Cook and Yamagishi used the number of exchange activities over a period of time between two actors in which N times of exchange activities are consecutive values from 0 to n (for example n times exchange activities per day, per week, or per month) in which n is any natural number. The data for calculating the power dependence based on knowledge exchange activities here is a binary set of data of an environmental policy actor network. It does not include information about the number of exchange activities over a period of time; it is a snapshot of a policy actor network.

In the explanations about the variables in the previous section, the type of network data is drawn from responses of environmental policy actors whether they would have a knowledge or information exchange relationship with other policy actors from a closed list of actors used in the survey. It is a binary data set because the possible answers were either "Yes" or "No" (1 or 0). The binary data set in form of a socio-matrix is illustrated in Figure 7.8. To simplify, example actors A, B, C, D, and E represent a hypothetical policy actor. First, to prevent loops (connections an actor has to oneself) the space where an actor meets itself between the row and the column, meaning, where for example row A meets column A, row B meets column B, and so forth, are coded with "0." The data in Figure 7.8 serves as an example and does not reflect actual answers by the interviewees. Moreover, in the following analyses organization names and their answers regarding with whom they have an exchange relationship are anonymized to protect the interviewees' privacy.

Figure 7.8 Knowledge Exchange Network Actor Relation Illustration

	A	B	C	D	E
A	0	1	0	0	1
B	1	0	1	1	1
C	0	1	0	0	0
D	0	1	1	0	1
E	1	1	0	1	0

Figure: Author; Based on Cook and Yamagishi (1992)

Cook and Yamagishi's (1992) power-dependence theory proposed two principles that determine the dependence: "value" and "availability." Power distribution is determined by the sum of dependence-ties within the entire network among all actors. According to Cook and Yamagishi (1992), the principle that power actor A has over B "is a function of B's dependence upon A for x, [that is] the resource actor A controls" (246). Additionally, it is determined by the value actor B puts in resource x and "the availability of resource x from alternative sources" (246). Based on the assumption that political attitude influences the formation of relationships between actors who share same or similar values, interests and goals add to the value and availability principles a third principle: "preference."

Power-dependence is built on the assumption that "the dependence of actor B upon actor A…is determined by how much more value B gets from an exchange with A" (Cook & Yamagishi, 1992: 246). In the adaptation to knowledge exchange in science-policy interfaces the dependence is determined not only by the value actor B gets from the exchange, or the availability of scientific evidence compared to other sources of information, but also by the preference actor B has for available alternative resources. The principle of information source preference becomes relevant in terms of policy actors' interests, and attitudes considering the proposed function of an intermediary to funnel scientific evidence as explained in Chapter 2.

There are two possible ways to deal with these principles. First, we can assume that value, availability, and preference are constant and do not change. To simplify their theory, Cook and Yamagishi (1992) considered value to be a constant variable that does not change for either actor in the network. In an experimental data set, the simplification of the principles might work. However, real-world exchange network data have to deal with circumstances in which values of actors, available sources and preferences are not constant. What relational exchange an actor considers valuable and what kind of knowledge resources they prefer may change over time especially concerning issues of climate change because of many uncertainties emanating from climate science.

The principles may be influenced by external factors such as sudden natural disasters, and changing climate conditions due to global warming, or internal factors such as organizational membership, institutional structures, or culture.

Even though, it is assumed that value, availability, and preference change over time, the data is limited in terms of accounting for change. However, an approximate is achieved by looking at change from the concept of stability. Stability might be easier to test than change. The control measurement of network stability is used to test for the relative stability of the sampled network. Thus, even though accounting for change is difficult, it becomes negligible if the actual network shows significant stability. The external factor of the Fukushima disaster is used for the stability control measurement, testing to what extent Fukushima affected the structure of the environmental policy network. If the network is relatively stable and has not been affected by such a major event such as Fukushima, the given policy actor network is relatively stable.

Both value and availability of alternatives apply when adapting to the knowledge exchange networks. However, a core idea that the eventual interlock between actors in an exchange network where no change or negligible change of values and availabilities exist might be weaker in a knowledge exchange network than in a material exchange network. Another core idea states that if an interlock occurs neither actor can make further changes within the network (Cook & Yamagishi, 1992). If this applies, that would mean scientific advisers in an interlocked state in a relatively stable network have much less influential power than originally assumed. This leads to the question to what extent the environmental policy network depends on scientific advisers. To test this, the power distribution within the network has to be considered. The idea of latent relationships in the network states that where latent relationships exist, their removal "from the network [affects] the distribution of power throughout the exchange network" (Cook & Yamagishi, 1992: 255).

Cook and Yamagishi (1992: 255) defined the "power of an actor in the network as the maximum number of exchange relationships [an actor] can achieve." This means for the knowledge exchange network, an actor's power potential in the exchange network is defined as the maximum number of connections about knowledge exchange activities (K_{it}) the actor (*i)* can receive from other actors in the network at a given point in time (*t*) as illustrated in Figure 7.9.

Figure 7.9 Actor's Maximum Potential Power

$$Power_i = max\{K_{it}\}$$

Figure: Author; Based on Cook and Yamagishi (1992)

Simply said, based on this concept, the operationalization of actors' power in a policy network can be calculated from the above described binary socio-matrix (Figure 7.8) of actor relationships by taking the sum of choices an actor received. This is illustrated in Figure 7.10 below.

Figure 7.10 Illustration of an Actor's Achievable Power within a Network

Socio-matrix of knowledge-exchange activities:

	A	B	C	D	E
A	0	1	0	0	1
B	1	0	1	1	1
C	0	1	0	0	0
D	0	1	1	0	1
E	1	1	0	1	0

Sum of knowledge-exchange activities:

A	B	C	D	E
2	4	2	2	3

Figure: Author; Based on Cook and Yamagishi (1992)

Power becomes quantifiable through the number of relationships actors have for which it is possible to distinguish between directed connections. In other words, where the respondents in the survey indicate whether they engage in information or knowledge exchange with other actors, giving information become ties where an actor sends information to another actor, and receiving information become ties where an actor receives information from another actor. The structure of the socio-matrix is equalized between two reciprocal actions. This procedure allows to analyze the integration of actors in the network, and measures their influence based on knowledge exchange. Therefore, in a knowledge exchange network, the maximum exchange ratio is the sum of "sending" (Kg_{it}) and "receiving" (Kr_{it}) activities, hence, labelled as K_{it}. This is achieved through the following formula (Figure 7.11):

Figure 7.11 Maximum Number of Exchange Relationships

$$max\{K_{it}\} = max\{Kg_{it}\} + max\{Kr_{it}\}$$

Figure: Author

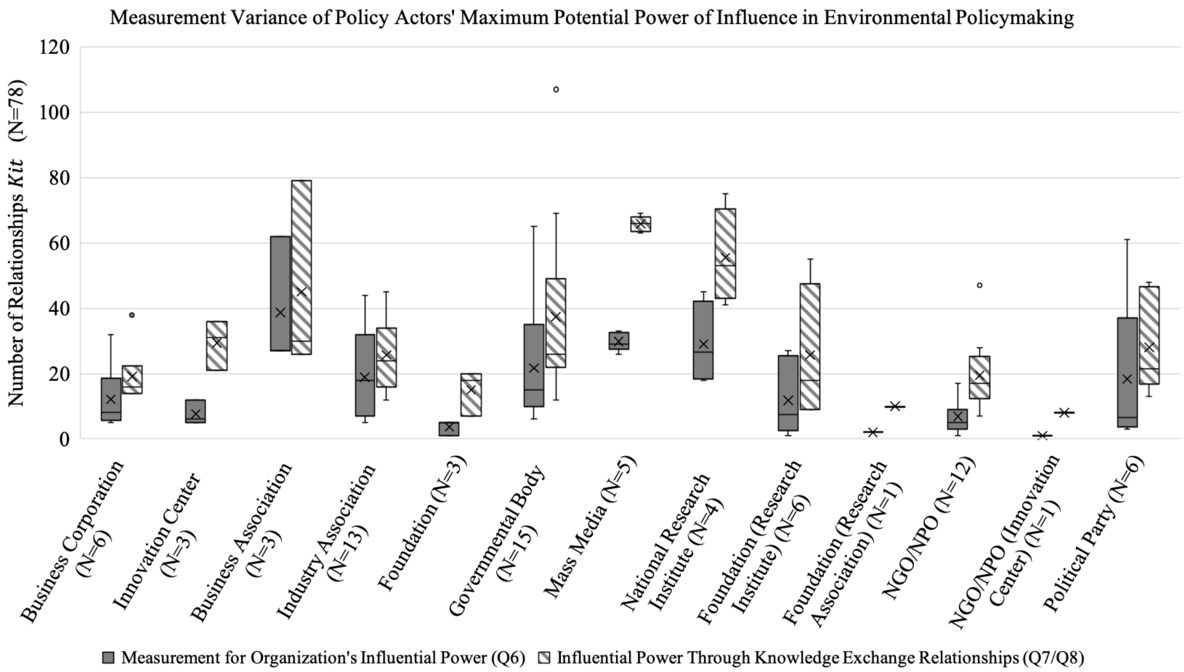
Unifying the knowledge exchange directions simplifies the analytical method because it reduces the dependent variable to one. This method operates under the assumptions that there exists a potential cognitive error in the data of actors' responses about describing their knowledge exchange activities from memory. Also, communication works two ways, meaning, it is a reciprocal action between the sender and the receiver of communication activities and, as explained in Chapter 2, advice giving in a circular science-policy interface is an interactive relationship. The following section explores the relationship between the power potential based on the maximum power potential through knowledge exchange activities K_{it} and political attitude as well as the potential of science advisers to influence the policy agenda.

7.4 Science Advisers' Potential Influence and Political Attitude in Environmental Policymaking Towards De-Carbonization

Applying social network analysis and social network theories on knowledge exchange activity data as performed in Chapter 6 was one part of the method to measure influential power of science advisers in policymaking. This part of the analysis measured their position in the policymaking network and their bridging potential connecting the science community and the policymaking community. The next step to measure the potential influence of science advisers in the policy agenda operationalizes power of knowledge theories. The operationalization was performed through the actors exchange relationship activities in knowledge networks of policymaking, because policy networks are knowledge networks that cannot exist without scientific evidence to be used for making effective environmental policies (Straßheim, 2010). To include a control factor in these analyses, the knowledge exchange relationship was analyzed alongside the survey variable measuring policy actors' influence by asking respondents whether or not they thought the organizations from the provided list were influential in terms of environmental and energy policymaking; Q6 in the J-GEPON2 survey.

The potential power of these organizations measured through their knowledge exchange activities (Q7/Q8; refer to Chapter 6) aligned with the measure of influential power of Q6 is illustrated in Figure 7.12. The data demonstrated the measurement variance of policy actors' maximum potential power to influence the policy agenda. For both, national research institutes and innovation center, their integration in the knowledge network of policymaking through exchange activities (Q7/Q8) assigned them more influential power than assessed by the policy community overall (Q6). In fact, the qualitative interview research that is discussed later in this chapter confirmed this skewed image of being integrated in formal policymaking networks but holding little influential power. It has been argued before that science advisers did not influence the policy discourse in Japan, nor did they have significant bridging potential between the science community and policy community (refer to Chapter 6). Consequently, the question about who holds influential power in knowledge networks if not the science community or their knowledge transmitters surfaced. Moreover, what kind of political attitude dominated the de-carbonization policy discourses in Japan by among influential actors in the knowledge networks.

Figure 7.12 Influential Power of Policy Actors



The following figures provide insights into these questions about who did have more potential power to influence the policy agenda, and what kind of political attitude these actors had by connecting the measurement for influential power and attitude through knowledge exchange activities. These measurements are the aforementioned and descriptively discussed survey questions Q28, Q32, and Q40 for the actors' potential to influence the policy discourse, and Q37, and Q41 for the actors' attitude on the de-carbonization issue. Before discussing the data in more detail, an explanation how to read these figures follows.

The x axis contains the individual case responses from the survey population listed according to actors' categorical categories. The primary y axis on the left contains the value of the aforementioned maximum number of exchange relationships K_{it} (Figure 7.11). The secondary y axis on the right contains the response values of the three survey questions Q28, Q32, and Q40. These values (as introduced in Chapter 5) are as follows:

1	2	3	4	5
Almost all suggestions considered	Many suggestions considered	Some suggestions considered	Few suggestions considered	No suggestions considered

The first observation was that most cases responded that no suggestions were considered for all three measured policy discourses (value 5); the proposed 15% CO2 reduction target to 2005 base year during the LDP administration in 2009, the proposed 25% CO2 reduction target to 1990 base year by the newly elected DPJ administration in 2009, and the retraction from the second commitment period of the Kyoto Protocol KP CP2 by the DPJ government in 2011.

Science advice emanating from national research institutes, innovation center, or other institutions in the R&D sector was comparatively weak among various actors in the policymaking network. Also, the responses showed rather high variation in terms of the organizations' potential influence based on knowledge exchange activities. The four main national research institutes were relatively influential in terms of knowledge exchange activities. Their direct input in policymaking for de-carbonization varies between the three discourses.

A notable observation was that the influence in the policy discourse between the business and industry sector, and national research institutes as well as NGOs/NPOs showed a demarcation between the two governments; LDP and DPJ. The two policy discourses during the DPJ government (2009-2012) included more input from national research institutes and NGOs/NPOs than the LDP in 2009.

Cases of strong discursive influence in contrast to relatively weak influential power based on knowledge exchange were somewhat surprising. These cases may not apply to the theory of political power through knowledge exchange activities. These results did not clearly show a direct relation between the measurement of influential power through knowledge exchange activities, and the potential influence in selected policy discourses towards de-carbonization in the measured time frame of 2009 to 2011. Other confounding variables the data in this analysis did not cover such as material resources exchange need to be investigated, therefore, further analysis that is beyond the scope of this dissertation is proposed.

Figure 7.13 Influence in Policy Discourses

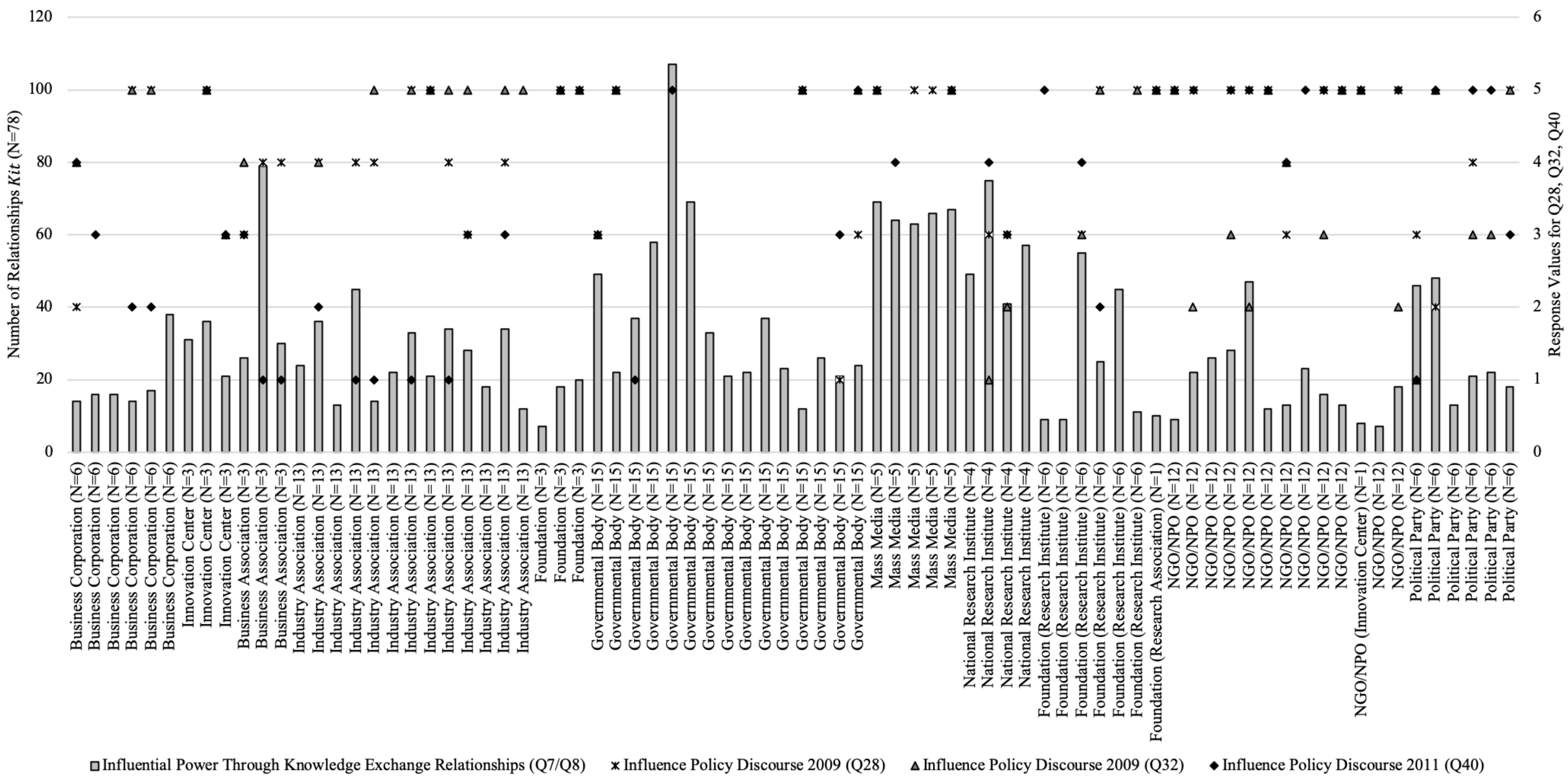


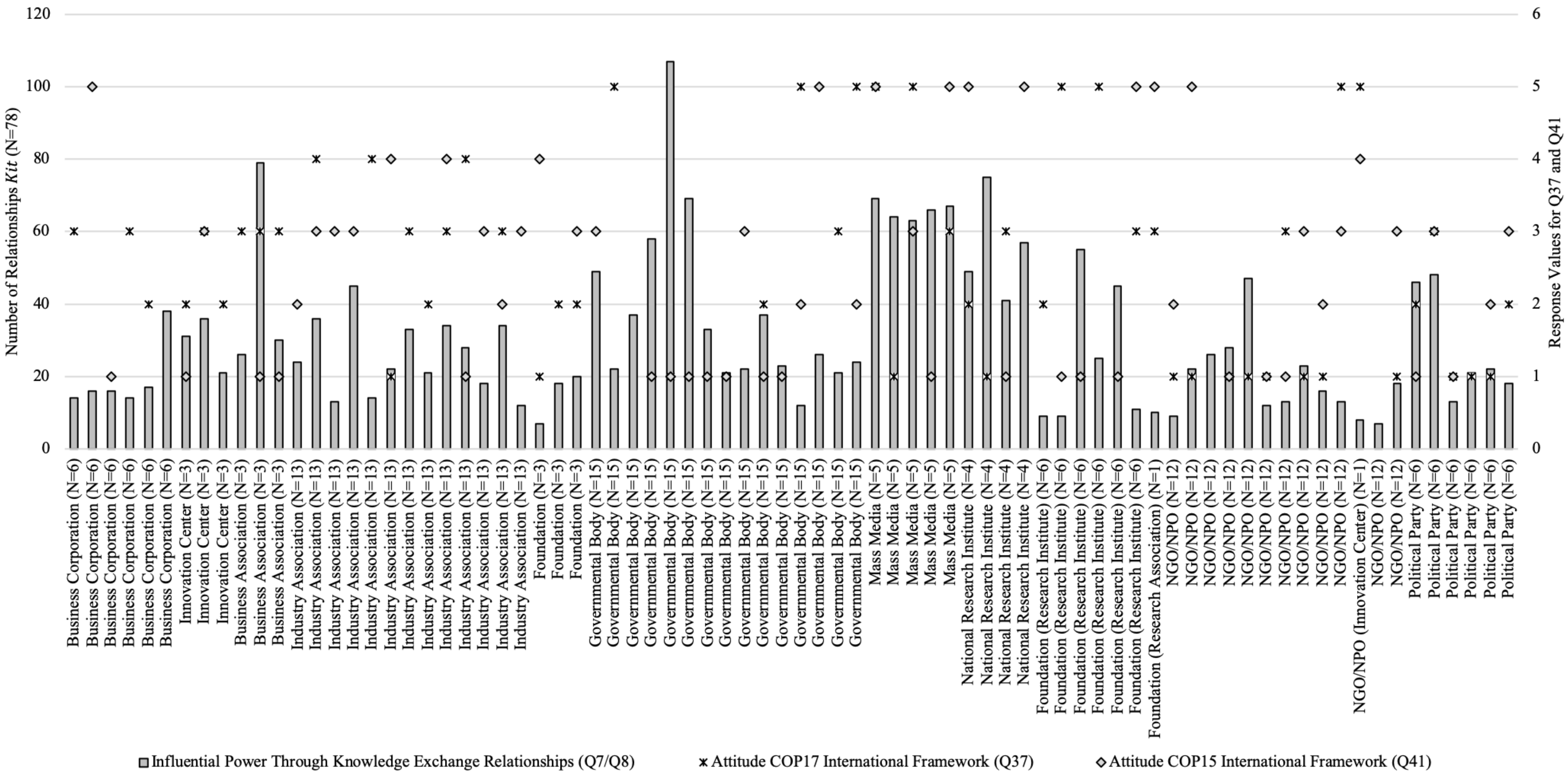
Figure 7.14 illustrated the political attitude among policy actors and science advisers towards climate mitigation measures in relation to their potential influential power in knowledge networks. In regard to the development of a new international framework after the Kyoto Protocol, respondents to the J-GEPON2 survey were asked to what extent their organization agreed with a potential new framework prior to the Paris Agreement (COP21) in 2015. Policy actors and science advisers were asked about what the government should do in their opinion regarding the international framework under the IPCC. More specifically, in case of Japanese policymaking negotiations, to investigate their political attitude toward climate mitigation and de-carbonization measures under the framework, such policy actors and science advisers were asked about their opinion regarding the CO2 mitigation proposals by the DPJ government in 2009 for COP15 and 2011 for COP17. Their policy attitude was measured with the following values:

1	2	3	4	5
Follow target unconditionally	Follow target with international standards	Set standards higher than international standards	Don't follow target	No interest

Figure 7.14 reads similar to the previous Figure 7.13. The x axis contains the individual case responses from the survey population listed according to actors' organizational categories. The primary y axis on the left contains the value of the aforementioned maximum number of exchange relationships K_{it} (Figure 7.11). The secondary y axis on the right contains the response values of the two survey questions (Q37 and Q41) regarding the political attitude towards the international framework that was supposed to replace the Kyoto Protocol.

For both, the 2009 COP15, and the 2011 COP17 negotiations for a new international framework, the attitude among Japanese environmental policy actors varied between each of the above five standpoints. Among the for national research institutes that replied to the questions about COP15 and COP17 negotiations, the highest value of potential influence based on knowledge exchange activities were in favor of following CO2 reduction targets unconditionally. Meaning, no matter of a new post-Kyoto framework, the Japanese government should follow a stringent climate mitigation measures. The one national research institute with the lowest value of potential influential power based on knowledge exchange activities was also in favor of following the target proposed by the government in 2009 unconditionally, and was in fact favoring higher targets than proposed by the government in 2011. While these cases may be promising for Japanese environmental policymaking, the data about the attitude among the national research institutes in this sample also demonstrated that the issue of climate mitigation even among national research institutes was not a priority issue.

Figure 7.14 Policy Actors' Attitude Towards De-Carbonization

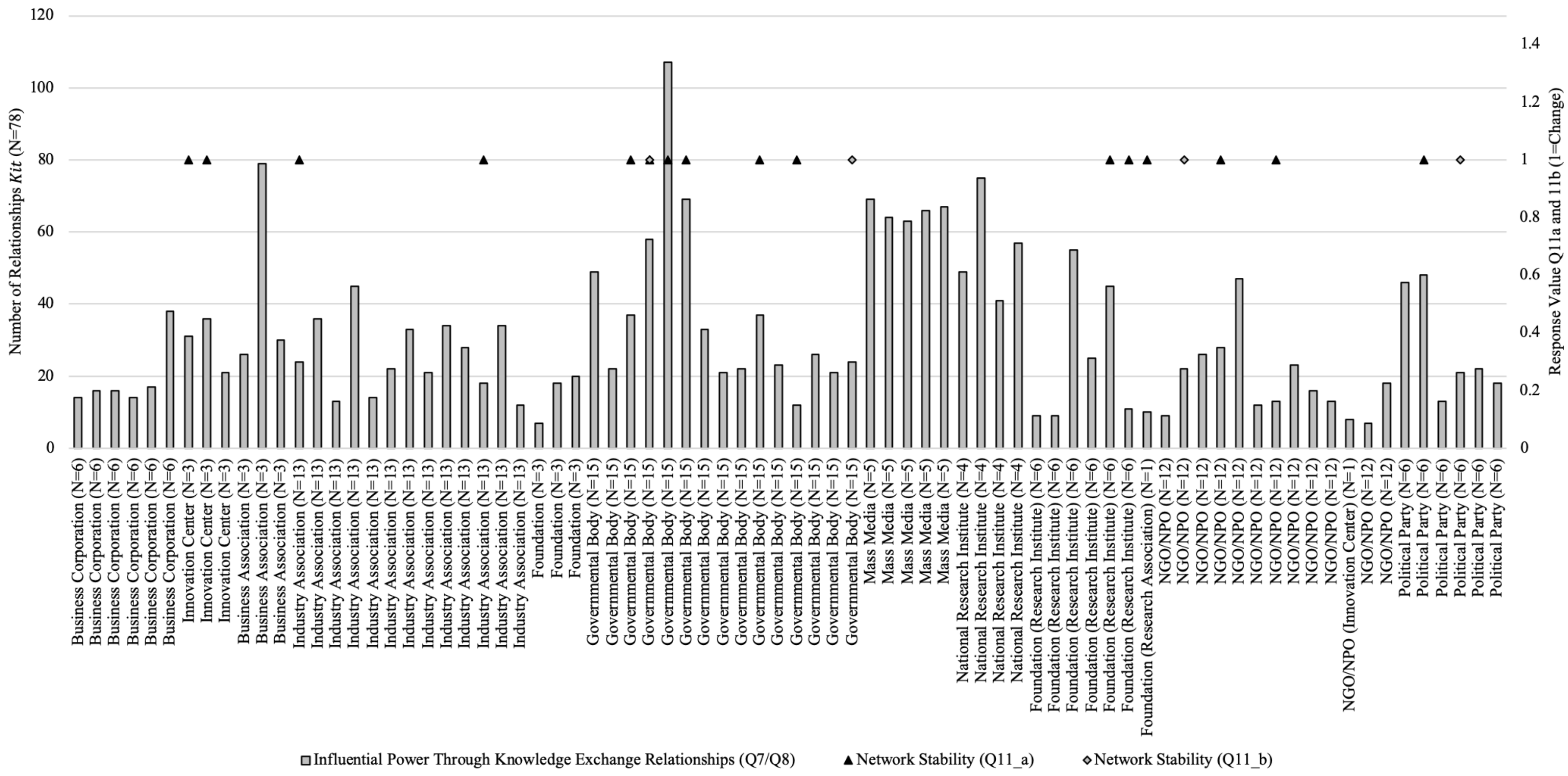


The last point in this section addresses the question about the generalizability of the findings discussed above. For this, the stability of the network was measured because a considerable stable environmental policymaking network increases the generalizability of the sampled network and for drawing meta-inferences from the findings for the scholarly field. The stability of the network was measured with the effect of Fukushima on the relationships in the environmental policymaking network. The Fukushima effect on the policymaking network was measured with questions about forming or dissolving relationships. These survey questions (Q11) were formulated as follows:

A New/renewed information exchange/cooperative relationship with other organizations or industries. / **1** Yes **2** No If possible, please name the organizations/industries. ( )
B Terminated information exchange/cooperation relationship with other organizations or industries. / **1** Yes **2** No If possible, please name the organizations/industries. ( )

Figure 7.15 illustrated the stability of the network. For the illustration, the formation and dissolving of relationships in the knowledge exchange network respectively was, similar to the figures above, put in relation to the potential power of actors according to their knowledge exchange relationships. From the entire sample (N=108), 16 organizations formed new relationships after Fukushima; 6 governmental bodies, 3 foundations, 2 NGOs/NPOs, 2 innovation center, 2 industry associations, and 1 political party. 4 organizations dissolved such a relationship after Fukushima; 2 governmental bodies, 1 NGO/NPO, and 1 political party. That is a change rate of 21.6% of the sampled environmental policymaking network. This change rate concerned the energy and environmental policymaking network of the J-GEPON2 population. It cannot infer the extent other policymaking networks were affected by Fukushima.

Figure 7.15 Network Stability: Changes in Relationships after Fukushima



The purpose of the discussion above was to investigate the relationship between science advisers' potential power in environmental policymaking calculated through their knowledge exchange activities in relation to their potential to influence the environmental policy discourse and their political attitude. The thesis was that science advisers are powerful actors shaping policy discourses and accumulating influential power because they are controllers of information and build a bridge between science and policy to enhance political legitimacy and protect science from the influence of political debates. However, the data showed that in Japanese environmental policymaking such science advisers are much less influential than the general theoretical framework would expect. The following section delves into the question what features of science advisers can explain their network position by discussing contents of the qualitative interviews.

7.5 Features of the Japanese Science-Policy Interface

7.5.1 Regulation without Coordination

As explained in Chapter 3, the general advisory board (CSTI) to the Japanese government is similar to the American external advisory organization PCAST that is directly linked to the White House. But there are significant structural differences in its inner workings. PCAST has several coordination offices that have the authority to coordinate project proposals by each ministry. Japan's CSTI is, similarly, directly located in the Cabinet Office and regulated under the Cabinet Offices Law. However, the effectiveness of this system is criticized by practitioners in terms of structural weaknesses. Where coordination offices in PCAST in fact coordinate and have administrative power to make decisions there is no collaborative interaction between the ministries in Japan, and the Council members lack administrative power; they cannot make final decisions. The Council is therefore mostly a vehicle to present proposals or decisions that had been reached between Council members in smaller, informal meetings. Formal meetings usually decide what has been negotiated in informal settings. The Council is no space to exchange opinions freely or to have a lively discussion. It is a highly regulated space where the members must follow the set rules and do not disrupt the protocol. Ministries appoint experts from national research institutes or universities on a rolling-basis to the Council, however, appointees are under pressure to present the ministry's standpoint and not say anything that would potentially harm it.

Even though the prime minister holds main administrative authority to determine the course of the policy, it is not his judgement alone that determines it; the prime minster relies on advice to make a final judgement. However, power games over the policy agenda between the members reduce the Council's productivity. For instance, Council members emphasized that a collaboration between METI and MEXT on the development on solar cells would increase the development of renewable energy. But because each ministry submits its own project proposals to fund research they are evaluated independently. Moreover, executive members from each ministry try to control the direction of the discussion within the Council to get more funding for their ministry. In regard to the prescribed failed science communication, as it turned out, even proposals to the Council for projects about science communication tend to be rejected. Such initiatives have to be taken on by individual researchers with little amount of funding and limited human resources while administrative labor increases.

7.5.2 Regulatory Straitjacket

Bureaucracy has much control over research in public research institutes. The degree of freedom for choosing research topics, or to what extent researchers from a public institute are consulted prior to formulate project proposals and budget funding from the government depends on the issue. Researchers are sometimes not given the freedom to develop their own ideas if outcomes were related to policymaking.

> "Some research institutes are more advised from government officials and in some cases, researchers are not allowed to come up with their own research, if the outcome has something to do with policymaking in Tokyo. If the research would have negative influence [on policymaking] then bureaucrats will sometimes come and say: please do not show the results." (Y/2018/08/27)

The top-down pressure has changed somewhat over the last few decades. However, ongoing inter-ministerial conflicts dominate policy discourses that affect the access to resources for national research institutes. National research institutes feel a change in which they are pulled closer into policymaking as they are increasingly asked to contribute more directly to policymaking. In other terms, they are contacted more often, and occasionally are integrated more actively in problem setting and project plan formulation compared to twenty years ago, as institute heads interviewed for this research have reported.

> "Scientific advice to policymaking is all in all weak. I think the aspect that we cannot suggest smoothly is gradually improving for a long time. Contribution [to politics] is becoming smoother. By 'smooth,' I mean chances [to give input] have increased. Contacts have increased. But sometimes we are not understood. Vice versa, we have to be careful to create balance on the researchers' side when they end up doing research out of their personal interest. That happens, too. It is necessary to skillfully merge the researchers' motivation with the demand." (I/2018/10/30)

This change, however, is a double-edged sword. Accumulation of data in environmental science and climate change monitoring is a decades-long process. Policymaking asks for quick solutions and funding periods for research projects have become shorter which limits basic research. That means that while governments try to integrate scientific advice and scientific findings more into policymaking, it puts more pressure on scientific research to create output in a much shorter period of time. To meet the high demand for quick output and increase competitiveness with industry-based research, the time frame for publicly funded research projects at universities or national research institutes is gradually getting tighter.

> "The research time frame is recently getting shorter. All in all three years. Sometimes five years. Three years is most common. The general reason for why it's getting shorter is that results are demanded quickly. The last Nobel Laureate from Japan said so, too. Results are demanded quickly, that is why it is difficult to do basic research. These words are becoming a sign for that long-term research is becoming more and more difficult." (I/2018/10/30)

Another interviewee summarized this as follows:

> "Sci"ntists say now that Japan has a long history of basic scientific output, but nowadays, Japan is moving towards industrial science. Industry has no patience. This is a big dilemma. …Universities are gradually moving closer to business" (K/2018/12/19).

Generally, national research institutes supervise and manage research projects. It depends on the institute whether they conduct research and generate data themselves at the same time as being engaged in primary research activities. While FFPRI or NIES for example do conduct their own research, NEDO does not.

> "[We] supervise and manage. We manage the field. That is different from research." (I/2018/10/30)

The managing function of government resources is a key feature of national research institutes in environmental policymaking. The Japanese science-policy interface demonstrates substantial distance of science community from policy community. In regard to the conceptual focus of this study – that is, science for policy and the influence of science in policymaking, and the assumption stated by the literature that the role of science advice in environmental policymaking is weak – one interviewee raised an interesting point:

> "For example, when I gave a speech at [location], scientists don't know about politics. Scientists often don't know about the public criticism of their own field. In Japan, it is more

putting political knowledge into science than scientific evidence into politics? At some point maybe." (K/2018/12/19)

Researchers however understand their work as apart from policy community. And the dominance of industrial science puts pressure on basic research to compete on the market. Other concerns raised were that science and scientific data are not awarded much respect by government officials and political decisionmakers. The role of science in policymaking was summarized as follows:

"There is a very weak linkage [between science and policy] in Japan. Of course, as far as the greenhouse effect is concerned the government cannot neglect science. And they discuss policies on the basis of science…But generally speaking, the present government – but not only the present – generally the government does not respect science very much." (A/2018/07/04)

As pointed out in Chapter 1, during the establishment of the EA and NIES in the 1970's, the government emphasized that scientific research would be completely independent from policymaking in order to prevent crises in the society related to bad political decisionmaking from happening again. Basic researchers such as environmental scientists at NIES or meteorologists at the Japan Meteorological Agency consider their work and the selection of research projects to be independent from Tokyo.

If national research institutes do not provide much scientific advice, the question arises where scientific advice in Japanese policymaking comes from. In the conceptualization of science advisers and science-policy interfaces, the key types besides national research institutes, included issue advocates, which in case of Japan are innovation centers, hence, market-based research. This form of advice can also be understood as encompassing consultants. Corporations conduct research on a contractual basis to provide decisionmakers with evidence they require to formulate strategies or policy proposals. According to one such private-sector consultant,

"We conduct survey research to be of use for our customer. We clarify the customer's position and assist to strengthen the customer's position. In terms of political positions, we work to strengthen MOE's or METI's position." (H/2018/12/26)

The consultant adapts to the customer's position and consulting sometimes entails that such advisers recommend to a certain decision with available data based on the customer's position. They provide the customer such as MOE or METI with data and facts that strengthen their respective position and increase the ministry's trustworthiness. Within policy negotiations under the overall contested issue such as climate change that affects many issue areas, from health and social welfare to labor and business or energy, reaching consensus is more likely if data provided by the government and its administrative bodies is used.

Regarding the implementation of the Emission Trading Scheme in Japan, for example, advisory organizations other than national research institutes such as private consultants or corporate research institutes are important sources for evidence. Due to their flexible positioning, they conduct survey research from substantially different positions; the environmental position and the economic, trade and industry position. It depends on the extent of consulting service to produce evidence based on which policy recommendations or proposals are written, and it depends on the contract between the customers who are policy actors and the service providers who are market-based researchers, whether the information provided contains a policy recommendation.

For science advice practitioners, "consulting" and "advice giving" differ. Advice, or scientific advice is based on a scientific opinion such as the IPCC as interviewees explained. In other words, scientific advice emanating from scientific institutions is methodically based on their respective focus. Other forms of evidence production for policymaking emanating from research and data service providers adapts to the customers' standpoint. However, in these situations evidence providers may be caught in the middle of the inter-ministerial power-games as several of the interviewees explained. Especially where environmental policymaking and climate change is concerned pressure and political power games are more flamboyant because of the issue's controversial nature. The more controversial the political issue is, the more power-games between policy actors occur.

Market-based evidence production however affects the flow of information. As there is a customer-service provider contractual relationship rather than cooperation, the produced knowledge is a protected good and not shared openly.

> "Yes, I feel that, too. Information is not shared openly. If it is about a controversial topic, how to analyze data and interpret facts, each player discusses [topic] based on its personal goal. It's also important where to effectively publish [the information]. Effective publishing means that information is not open." (H/2018/12/26)

The features about science advisers and the science-policy interface in Japanese environmental policymaking revealed in the analyses above may be consistent with the criticism raised by former prime minister Hatoyama as illustrated in the introduction into the theme of this dissertation on page 1; a lack of independent science advice to advice the government that predates Fukushima and appears to afflict every Japanese regime. However, the changes science advise practitioners are experiencing over the last two decades are not all negative as the Japanese government recognizes the need for better integration of science advice in policymaking and tries to accommodate changing needs and demands in the regulatory system. Nevertheless, the tightening regulatory straitjacket and increasing public demand hinder a better integration of science advice in environmental policymaking.

7.6 Chapter Summary and Conclusions

Increasing demand for better integrated scientific advice in policymaking challenged the Japanese science-policy interface that was characterized by substantial distance between the science community and policy community. Coleman's study (1999) and the study by Low et al. (1999) identified three attributes that explain difficulties in the Japanese science community. That is, first, the bureaucratic weight that weighs down research institutes in universities, second, the organizational patterns of research institutes (*kenkyū-jo*) and third, the internal politics that is linked with the organizational structure, and the way they are administered. These attributes may be linked with habit of information sharing, or the lack thereof, that was critized. Adding to this scholarly discussion, key findings drawn from this research are the following.

The criticized lacking respect for science addressed by the informants for this study may be due to a difference between short-term thinking of governmental bodies and their demand for prompt evidence, in contrast to the slow motion of science and environmental monitoring that takes several years, sometimes ten to twenty years, to collect and analyze data. Because of high administerial and institutional boundaries, and power-games among ministries, it was difficult to set long-term targets and realize effective national projects. These conflicts between the ministries were an obstacle to science advisory procedures and decreased their efficacy.

Regarding the position of science advisers in the policymaking network (refer to Chapter 6), representatives of research institutes often indicated their willingness to become more actively integrated in advisory procedures. However, in terms of their features that defines their position, they often opined that the institutional constraints of established top-down procedures limit the actual input they can give. While there are few exceptions, most national research institutes worked as allocators and managers to control and supervise public resources. While the managing function of government resources was a key feature of national research institutes in environmental policymaking and explicates the low bridging potential of science advisers between the science community and the policymaking community. Issue advocates, or evidence advocates, served to increase trust and reliability in ministries and their governmental bodies.

The tightening straitjacket around basic research eventually creates more hybrid forms of science-policy interfaces in environmental policymaking where researchers depend on a mixture of public and private funding. Rarely, national research institutes took a pro-active position in issue raising. But not necessarily because they do not want to, but the regulatory straitjacket made it difficult to do so. Because words of advice or policy recommendations did not originate from public research or pure scientists but from research supervisors and managers in form of other institutes or departments, the binary model of science-policy interfaces described in Chapter 2 exhibits substantial weaknesses for capturing the integration of science advice in Japanese policymaking.

Even though the political attitude might not be a feasible predictor for actors' potential power based on knowledge exchange activities, the data provided insights into what kind of actors favor which position in regard to CO2 reduction targets under the international framework. Even among national research institutes, and other advisory organizations, the attitude towards CO2 reduction targets the government should set in regard to the international framework for de-carbonization varies. Actors with more influence in the policy discourse and administrative power had a more passive standpoint that holds back more proactive decisions to make changes in environmental policymaking. These results may be specific to Japan considering the structural advisory processes in policymaking as explained in Chapter 3.

In consideration of further research, the results discussed in Section 7.4, showed that political attitude might be not a good predictor for actors' position in a knowledge exchange network. The data for analyzing knowledge exchange relationships in this case was insufficient to argue for a correlation between actors' relationships in knowledge politics and their political attitude towards de-carbonization measures prior to the Paris Agreement. Additionally, non-responses were higher than for other variables because non-state policy actors were reluctant to offer an opinion about their attitude.

8. Conclusions: Science Advice in Environmental Policymaking

8.1 Reviewing Purpose and Findings

It was argued that environmental policymaking in most industrialized countries, including Japan, have failed to create effective climate mitigation policies that ensure the limiting increase of the global mean surface temperature below 1.5ºC because the scientific voice for the environment was widely ignored since scientists first tried to make decisionmakers aware of the severity and effect of anthropogenic climate change since the 1960s. In case of Japan, science advice to the government has been under public scrutiny after Fukushima as the failed crisis management after the catastrophe in the nuclear power plant revealed inherent systemic weaknesses of including experts and scientists in decisionmaking. Since then, the importance of science advice for governments receives greater attention in policymaking overall. To investigate these claims, this study examined the role of science advice in environmental policymaking networks in Japan, their potential power in influencing the policy agenda, their attitude towards de-carbonization, and tried to draw out features of the science-policy interface specific to Japan.

The theoretical framework of knowledge-power theories argued that scientific expertise is an invaluable source of information for policy actors to empower their overall dominance in policymaking to eventually shape the policy agenda. Through the theoretical concept of the potential power of intermediary science advisers in policymaking that connect the science community with the policymaking community, a more pro-active integration of science advice could not be observed in Japanese environmental policymaking. Key features that explained their position in the network were, first, that a tightening regulatory straitjacket around national research institutes and demanding quicker and more comprehensive scientific evidence hindered the advisory function of national research institutes. Secondly, boundaries in government advisory procedures remained and were difficult to overcome. Thirdly, ongoing inter-ministerial rivalries in the fight for resources and dominance over the policy agenda as well as closed advisory policymaking where horizontal interaction between different advisory committees was rarely possible across ministries and diminished the overall possibility for outside science advisers to enter the policymaking network.

Potential power in policymaking was investigated through knowledge exchange relationships by applying social network analysis' centrality measures. These centrality measures analyzed policy actors' influential power emanating from their location in the policymaking network based on the number of relationship ties. These relationship ties were defined through the actors' knowledge exchange activities. In terms of knowledge-power theories, in the core of science advice to governments lays knowledge exchange activities. Transmitters of scientific expertise to policies were considered to have influential power in Japanese policymaking. Surprisingly, neither national research institutes nor issue advocates appeared to occupy an influential position in Japanese environmental policymaking analyzed through knowledge exchange relationships.

Through positional analysis of policy actors' knowledge networks in Chapter 6, the case of Japan demonstrated a more distant and unbalanced relationship between the science community and the policymaking community than expected. The country's internationally known high reputation of science and technology as well as advanced R&D and popularity of research positions in the labor market as described in Chapter 3, suggested decisionmakers would put more value on the integration of science advice in policymaking. Moreover, this sentiment transcended to the public as a comparatively high rate of skepticism on expert knowledge was identified already by Hartwig et al. (2016) and Satoh et al. (2018). The network position and centrality, hence, potential influence in policymaking according to social network centrality measures, for issue advocate science advisers were surprisingly low. This means they were much less central, or influential, in environmental policymaking than expected. And these actors themselves assessed their own role as less influential in policymaking than expected.

The discrepancy in the findings in contrast to the expected position of science advisers in the environmental policymaking network may require a different theoretical approach. The theoretical framework based on Western philosophical ideas considered scientific knowledge in form of science advice as public good. But as the analyses in Chapter 7 showed, scientific knowledge is a protected good and not shared openly with everybody. Also, previous literature discussed how the changing focus from basic to applied research in Japan privatized knowledge (Low et al., 1999).

In Japan, despite large investments in science and R&D, and having a centralized authority in the government under the CSTI, science advice to the government was largely criticized to be locked out of policymaking, to lack either neutrality, or agency over their own activities, or even be ignored by decisionmakers. The findings confirm the general criticism raised in the literature that science advice did not reach the government as its path is far and their voices unheard. As long as the advisory procedures are top-down, a tighter integration of outside science advice in policymaking is unlikely. Moreover, the regulatory straitjacket confines national research institutes which were supposed to produce and disseminate advice and creating better public policies towards de-carbonization in an executive role to manage and supervise ministerial resources rather than contributing their expertise to policymaking. This was revealed through interviews that were conducted for this research that contextualized the results from the quantitative network analyses where national research institutes demonstrate a higher centrality in the network as being the receiver of knowledge exchange relationships rather than being senders of scientific expertise in policymaking.

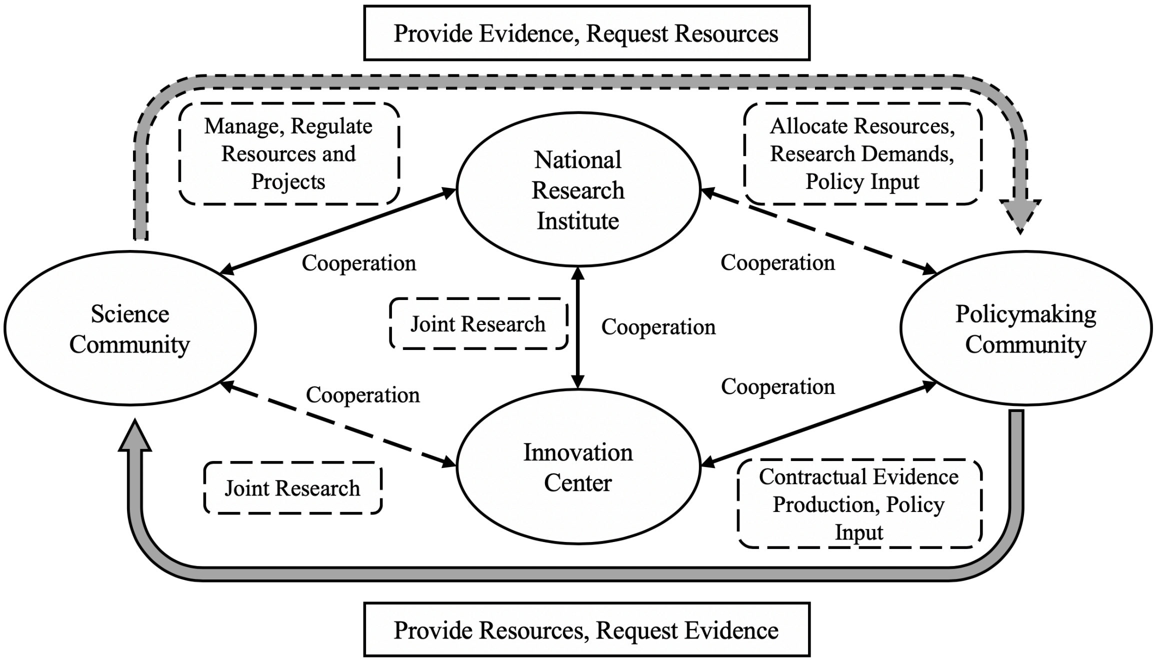
National research institutes were expected to produce reliable output more quickly through programs decided by government authorities based on socio-economic needs that are of importance at the time of program building in order to be able to timely integrate evidence into policymaking.

Findings of the research projects were selected and framed to meet the purpose of the proposed policies. The top-down governmental structure of science and technology promotion policies not only enforced inter-ministerial conflicts, but also were shown to be very rigid and unresponsive to cooperative discussions when setting up annual budgets. According to Nagano (2016), annual budgets were decided without science experts but they were expected to carry out the programs that were decided by authorities without taking their opinion on the feasibility of the programs into account. Meaning, those who decided the scope and budget of the projects were not scientists, and evaluation of project proposals was not done by scientists either (Nagano, 2016).

The programs change within a very short period of time, and the research periods are being reduced even further. Most common were projects of two- to three-year periods and even one-year periods nowadays are not uncommon. Long-term projects of five years or more are rare. Climate change impact assessments and environmental monitoring require long-term strategies to collect, analyze, and interpret data. Therefore, other types of evidence producers and providers filled the void of scientific advisers in Japanese policymaking that are market-based research institutes, corporations, or consulting firms.

Litfin (1994) predicted that science and policy would have a closer relationship in the near future and intermediaries, that are transmitters or interpreters of scientific knowledge between the science community and the policy community would play a crucial role. A closer relationship in case of Japan is one of a more detailed and tighter regulatory framework with more detailed guidelines of how policy actors are supposed to consider scientific expertise. A Japan-specific science-intermediary-policy interface could be conceptualized (Figure 8.1). Further research is recommended to investigate whether similar models exist in different countries. As the model shows, the space between the science community and policymaking community is occupied with national research institutes and innovation center. While national research institutes rather allocate resources by the government to the science community in order to produce scientific evidence and provide fewer direct policy input (hence, the dotted arrow), the relationship between policy and innovation center is stronger in terms of evidence production for policy input (hence, the solid arrow). To some extent, cooperative projects connect various actors from different areas. That is cooperation in form of joint research projects, or cooperation in form of assisting project management.

Figure 8.1 Japanese Science-Intermediary-Policy Interface



Source: Author

In terms of Pielke's (2007) conceptual science adviser types introduced in Chapter 2, that are pure scientists, science arbiters, issue advocates, and honest brokers of policy options, the type of science advisers identified in case of Japan fit partly in science arbiters, issue advocates, and honest brokers of policy options. While national research institutes may be partly science arbiters because they are incorporated in the policymaking processes in terms of their institutional association with governmental bodies, and lack an independent, pro-active position to produce and disseminate science advice, innovation center partly fit into the category of issue advocates and brokers of policy options. If the customer, that is a policy actor such as governmental body or political decisionmakers, requests advice and evidence on an issue, the innovation center would tailor the content of evidence and advice on such aspect relevant for the customer. For example, perspective on de-carbonization has different foci from the point of view of the ministry for environment, or from the point of view of the ministry for economy, trade, and industry. As the position of such a science adviser fits the evidence and advice content to the need of the customer, they do not follow a personal agenda, as environmental NGOs/NPOs would do.

8.2 Relationship to Previous Research

As Litfin (1994) and Rouse (1987) argued, science is not as neutral or free from political ideology than expected. A recent study about Japan's energy policy path since Fukushima, and the remaining lack of a clear long-term CO2 reduction target by the Wuppertal Institute and Institute of Energy Economics (2018: 7) also argued that the increasing integration of "scientific knowledge of energy technology opportunities, potentials, benefits and costs, and energy policy options have changed tremendously."

After overcoming the pollution crisis in the 1960s and 1970s, awareness about global environmental issues increased, and the Japanese government moved towards establishing Global Environmental Policies (GEP) during the 1980s. National identity-making with the discourse of being gentle and in harmony with nature has historical, religious, and philosophical roots which the government of Japan used to frame environmental policymaking as "the government wanted to present Japan as a 'green', environmentally friendly country, one that was applying a qualified approach to the global ecosystem" (Kagawa-Fox, 2012: 4). The dominance of applied science and customer oriented R&D in Japan (refer to Chapter 3) allowed the assumption that the more applied and customer oriented R&D exists to meet social needs the higher is the societal value and societal acceptance for science in the general public. Relating the technological dominance, and the discourse around Japan's low-carbon energy efficiency to the socio-environmental discourse in which Japanese society identifies itself to be "gentle to nature" (*kankyō ni yasashii*), we could also assume that the existence of a strong discourse around environmental friendliness positively affects the societal value and societal acceptance of environmental science.

Previous research found evidence that societal trust in the output of environmental science in Japan in relation to environmental policymaking was surprisignly weak (Hartwig, 2016; Satoh et al., 2018). Society appreciates environmental friendliness and "wants to be gentle to nature" but at a low cost. Regardless of the omnipresent *kankyō ni yasashii* discourse, discussions about what Japan ought to be doing in terms of de-carbonization is dominated by energy efficiency and cost issues. Testing the assumption about the societal value of environmental science is beyond the scope of this research, yet, as the science community is considered a societal institution (refer to Chapter 2) and considering the argument that science itself carries culture, the analyses provide implications for the scholarly discussion about science and technology policy in Japan.

The science-policy interface of Japanese environmental policymaking demonstrated a significant distance between science and policy. Even though, attempts by the government revising the regulatory framework to improve the integration of science during the last two decades resulted in clearer guidelines, institutional changes and increased relational ties. The insiders' views from the interviews conducted for this study demonstrated that hurdles to effectively integrate science advice, and distance between the science community and the policymaking community remain.

The establishment of socio-political institutions for the environment during the 1970s as a result of the pollution crisis formed a science-policy interface where the distance between environmental science and environmental policymaking was intentional (Kameyama, 2017). And the intended independence of environmental science from policymaking affected the exclusion of science in policymaking. This explained why scientific advice is either controlled within the hard core of the policy network or ignored if not part of it.

The limitations of the theoretical framework of this research in relation to the findings revealed a conflict between the demand for neutral and independent science advice to advise the government and the criticism Japan would not have and never had such an advisory system in policymaking (Taira & Hatoyama, 2011; *Nature*, 2011). Criticism of a lack of independent or neutral scientific advice in Japan overlooks the scholarly discussion about post-normal science where the core argument is that entirely neutral scientific inquiries and independent standpoints in advice giving realistically do not exist (Gupta, 1999; Litfin, 1994). This conflict demonstrates that scholarship is unclear about independence or neutrality in scientific inquiry, and what constitutes scientific advice-giving for policymaking. The intentionally created distance between environmental science and environmental policymaking positively affects potential for neutrality and independence. The demand to close the gap between the science community and the policymaking community risks diminishing this institutionally established independence.

Science advice to the government in Japan, therefore, emanates from somewhere else. It is not only the regulatory straitjacket wrapped around national research institutes that could not contribute as much as expert knowledge into policy outcomes as they were hoping for, scientists generally understand their role as apart from politics. The demand to produce evidence quicker in order to compete with market-based research and corporations is creating uneasiness and may affect skepticism in scientific output. That science advice emanates from basic science in Japan is scarce is not only a structural problem, it is also a question of responsibility if the policy output based on the given advice leads to failure.

Generally, responsibility for political decisions lays in the hands of decisionmakers (Arimoto et al., 2016). Therefore, protecting independence of scientists and emphasizing diversity in political opinions and issues by the Science Council of Japan is a form of protection for science that explains why closing the gap between science and policy in Japan by directly integrating science in policymaking is unlikely, and why the vast area between these two fields is filled with other types of organizations or corporations that inform policymaking.

These discussions demonstrate that the conceptualization of science advice to governments requires a different theoretical framework and a different philosophical argument than were presented here, as it leads to the question of being unable to distinguish science from advocacy in policymaking because expert advisers blur into issue advocacy. This points to concerns regarding how much science actually should be in policymaking and how much politics can science tolerate without being influenced by interests and values of political actors. One possible answer is that science should be in politics as much as it needs, to provide independent, and objective evidence to solve socio-economic problems and create better public policies to solve the climate change crisis. If expert advice is ignored, political outcomes are most likely to fail (Bäckstrand, 2004; Arimoto, 2018).

A dominant theme that affects the content of discourses created by issue groups in the policy network is the cost issue. The different issue groups identified in Japanese environmental policymaking define cost in terms of what policies to propose differs significantly in the issue area of environmental policymaking which causes conflicts. Birkland argued that the conflict increases the more an issue penetrated and institutionalized on the agenda. The cost issue for de-carbonozation is a key element around which all issue groups have to frame their discourses in order to be heard by the government and society at large. Climate mitigation and de-carbonization is an institutionalized issue on the "decision agenda" (Birkland, 2016). However, "even when a problem is on the agenda, there may be a considerable controversy and competition over how to define the problem, including the causes and the policies that would most likely solve it" (Birkland, 2016: 204). A dominant theme that affects the content of discourses issue groups create in the policy network is cost. The different issue groups identified in Japanese environmental policymaking define cost in terms of what policies to propose differs significantly in the issue area of environmental policymaking which causes conflicts.

If we consider the concept of post-normal science, the claim that policymaking in Japan lacks independent scientific advice cannot be explained with the dominance of applied science if basic research is itself inherently political. But if the culture and metaphysical context of modern scientific thought implies that science is inherently political it then refutes the idea that independent science advice exists at all. Therefore, Japan cannot be criticized for not having something that may not exist. Answering this transcending philosophical question is beyond the scope of this research, but it is important to keep it in mind to discuss how science advice is integrated in environmental policymaking in Japan. It may add to the discussion that addresses how independent science advice in policymaking can be achieved. But before we can find the answers to these questions, we need to find ways of investigating the integration of science advice in environmental policymaking and how much truth we will find in these claims.

8.3 Limitations of the Research

This research has been primarily concerned with environmental policymaking in Japan and the role that science advisers play in policy outcomes based on knowledge exchange power theories. Therefore, the generalizability of the science-policy interface drawn from environmental policymaking may be limited because other issue areas such as health and welfare may take on different forms and face fewer conflicts.

Further, the data frame for the qualitative interviews was defined based on the J-GEPON2 survey sample. The reason for this decision was made upon the set goal to integrate qualitative data analyses into the quantitative network analyses in order to understand the implications of the quantitative findings. Limiting the data frame accordingly resulted in a quality data set with focus on environmental policy actors.

Methodically, knowledge as a source of influential power in policymaking is measurable through social network analysis centrality measures (Wasserman & Faust, 1994; Morgan, 2017). The policy actor network approach illustrated how policy actors are tied together based on their information exchange. According to Latour (2006) it is the ties, the connection of actors in a group, that social scientists should be concerned with. That is, the group formation, not the group itself, is never stable; it changes constantly. New ties form, existing ties dissolve. Because of this the group itself is empirically very difficult to grasp. Therefore, a data set about such a group or network can only be a snapshot of a certain moment in time. However, accounting for the relative stability of a network through a control variable increases generalizability of the findings as was done in Chapter 7.

8.4 Problems During the Research

Problems that arose during the research were methodical. Mixed methods research was promising to add value to the research questions and the scholarly discussions. As powerful as mixed methods research designs are, they also pose challenges to the researcher as applying both quantitative and qualitative research methods require rigor. A substantial amount of time during the research was invested in obtaining analytical skills for quantitative methods.

8.5 Implications for Mixed Methods Research

Drawing out key features of science advice in Japanese policymaking and propose the science-intermediary-policy interface specific to Japan was possible by applying a mixed methods research design as has been performed in this project. Separating the analyses about science advice in Japanese environmental policymaking between the quantitative inquiry and the qualitative inquiry without integrating them would lead to different conclusions.

Moreover, by integrating qualitative interviews into quantitative network analyses it could be revealed that the findings were partly inconsistent with the theoretical framework of power of knowledge in policymaking through the control of the flow of scientific knowledge that had been laid out in Chapter 4. This was a surprising and important outcome of this research. By understanding these key features, it is possible to substantially enhance further recommended research.

8.6 Research Recommendations

Corporate research institutes and consulting firms are skillful in shifting between different standpoints depending on customers' positions; the environmental position, or the economic, trade and industry position. The question I want to draw out here and motivate further research is whether marked-based research and evidence provision for strengthening policy positions is contributing to dependent, hence, not neutral advisory policymaking as literature has argued, or whether independence from political regulations and the "distance" of basic science from the policy community – that are the boundaries within the *tatewari* advisory policymaking – affects the quality of advice giving positively. As previous literature has claimed, despite the custom and requirement to appoint researchers to ministerial advisory boards, advice produced through these procedures may not be independent or neutral (Yoshikawa, 2016).

It exists a broad array of varying terms for what this study labelled science adviser. The varying terms are a sign of inconsistencies within the scholarly field and demonstrate the need for a unifying theory to explain science advice in policymaking from an institutional perspective as well as from an actor network perspective. Therefore, research to solve the terminology problem is highly recommended.

The topic of science advice to governments is complex and multi-disciplinary. With the acceleration of re-evaluating the relationship between science and policy during the last decade, scholarly attention is gradually increasing, and practitioners are gaining more confidence. Further research is indispensable to see whether the model of the integration of the different types of science advisers in Japanese environmental policymaking (see Figure 8.1) is unique or whether we can find similar dynamics in other cases. Not only comparing with other countries but also testing the developed model on other policy issue areas must be considered to either prove or disprove the generalizability of the Japanese model. Further research may also incorporate fuller data sets.

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Appendix A: Select J-GEPON2 Japan Survey Questions

Measurements for influential power
Q6　次の中で、地球温暖化に関する政策に対して影響力を持つと思われる組織すべてをお知らせください。かなりの影響力を持っているか、少しの影響力を持っているかに分けてお答えください。 Source: J-GEPON2
Translation
Q6 How influential are the following organizations in policymaking concerning global warming/climate change? Please indicate your opinion of the level of influence of each organization. If you think an organization is not influential, do not check anything.

Measurements for influencing policy discourses/agenda-setting

Q28 2009 年 6 月 10 日、麻生首相は記者会見で、「2020 年に 2005 年比 15%削減」を次期削減目標として表明しました。その内容に、あなたの組織の意見はどの程度反映されましたか。次の選択肢の中からお答えください。

1	2	3	4	5
ほぼすべて反映された	かなりの程度反映された	ある程度反映された	あまり反映されなかった	ほとんど反映されなかった

Q32 2009 年 12 月 11 日、鳩山首相は、内閣閣僚委員会において「2020 年に 1990 年比 25%削減」を次期削減目標として決定しました。この決定に対して、あなたの組織の意見はどの程度反映されましたか。次の選択肢の中からお答えください。

1	2	3	4	5
ほぼすべて反映された	かなりの程度反映された	ある程度反映された	あまり反映されなかった	ほとんど反映されなかった

Q40 COP17 において、野田首相は「2013〜2018 年の第二約束期間への不参加」を表明、京都議定書から離脱する見通しとなりました。この表明に対して、あなたの組織の意見はどの程度反映されたとお考えですか。次の選択肢の中からお答えください。

1	2	3	4	5
ほぼすべて反映された	かなりの程度反映された	ある程度反映された	あまり反映されなかった	ほとんど反映されなかった

Source: J-GEPON2

Translation

Q28 On June 10, 2009, at a press conference Prime Minister Aso announced a CO_2 reduction goal of 15% by 2020 (base year 2005). To what extent was your organization’s opinion reflected in this announcement? Please choose one answer among the following five choices.

1	2	3	4	5
Almost all suggestions considered	Many suggestions considered	Some suggestions considered	Few suggestions considered	No suggestions considered

Q32 On December 11, 2009, Prime Minister Hatoyama decided a CO_2 reduction target of 25% by 2020 (base year 1990) at an advisory board meeting in the Cabinet Office. To what extent was your organization’s opinion reflected in this decision? Please choose one answer among the following five choices.

1	2	3	4	5
Almost all suggestions considered	Many suggestions considered	Some suggestions considered	Few suggestions considered	No suggestions considered

Q40 For COP17, Prime Minister Noda declared to retract from the Second Commitment Period of the Kyoto Protocol. To what extent was your organization’s opinion reflected in this declaration? Please choose one answer among the following give choices.

1	2	3	4	5
Almost all suggestions considered	Many suggestions considered	Some suggestions considered	Few suggestions considered	No suggestions considered

Measurements for information and knowledge exchange
Q7 地球温暖化に対する政策に関して、あなたの組織と接触し、あなたの組織から情報を与える関係にある組織はございますか。あてはまる組織すべてをお知らせください。 Q8 地球温暖化に対する政策に関して、あなたの組織と接触し、相手から情報を得る関係にある組織はございますか。あてはまる組織すべてをお知らせください。 ※ 勉強会やシンポジウムのような会合等で情報交換をする関係の場合は、問 7 と問 8 の両方に該当するものとしてお答えください。 Source: J-GEPON2
Translation
Q7. Please check all the organizations, to which your organization provides information (including advice, joint workshops, etc.). Q8. Please check all the organizations from which your organization receives information (including advice, joint workshops, etc.).

Measurements for "Fukushima Effect" on the policy network

Q11あなたの組織では、2011年に東日本大震災が発生した後、地球温暖化をめぐる他の組織や業界との関係は変化しましたか。次にあげる項目それぞれについてお答えください。

A 情報交換関係や支援協力関係を新たに、または再び結んだ組織や業界があった

/ **1** あった **2** なかった

差し支えのない範囲で具体的な組織名や業界名をお答えください。

( )

B 従来の情報交換関係や支援協力関係がなくなった組織や業界があった

/ **1** あった **2** なかった

差し支えのない範囲で具体的な組織名や業界名をお答えください。

( )

Source: J-GEPON2

Translation

Q11 After the Great East-Japan Earthquake in 2011, did your organization change their relationship with other organizations or industries involved in climate change policies?

A New/renewed information exchange/cooperative relationship with other organizations or industries.

/ **1** Yes **2** No

If possible, please name the organizations/industries.

( )

B Terminated information exchange/cooperation relationship with other organizations or industries.

/ **1** Yes **2** No

If possible, please name the organizations/industries.

( )

Measurements for environmental policy attitude

Q37 2011 年 11〜12 月にダーバンで開催された COP17 についておうかがいします。野田政権は、「米中等主要排出国の参加する新たな国際的枠組」を「2020 年に 1990 年比 25%削減」目標の前提とする方針でした。これに対するあなたの組織の立場はどのようなものでしたか。次の選択肢の中からお答えください。

1	2	3	4	5
新枠組の実現に関わらず国内削減目標の達成を目指すべき	新枠組が実現したときのみ国内削減目標の達成を目指すべき	新枠組を実現の上で国内削減目標を下方修正すべき	新枠組の実現に関わらず国内削減目標に反対	関心が無かった

Q41 問 37 でおたずねした新枠組と国内削減目標について、2009 年 12 月にコペンハーゲンで開催された COP15 当時では、あなたの組織の立場はどのようなものでしたか。次の選択肢の中からお答えください。

1	2	3	4	5
新枠組の実現に関わらず国内削減目標の達成を目指すべき	新枠組が実現したときのみ国内削減目標の達成を目指すべき	新枠組を実現の上で国内削減目標を下方修正すべき	新枠組の実現に関わらず国内削減目標に反対	関心が無かった

Source: J-GEPON2

Translation

Q37 The following question is about COP17 in Durban, between November and December, 2011. The Noda administration announced to go forth with the plan of the 25% CO2 reduction target by 2020 (base year 1990) if the new international framework including USA, and China will set. What is your organization's opinion regarding this? Please choose one answer among the following choices.

1	2	3	4	5
Follow target unconditionally	Follow target with international standards	Set standards higher than international standards	Don't follow target	No interest

Q41 Regarding the national reduction plan asked in Q37, what is your organization's opinion regarding COP15, in Copenhagen in December 2009? Please choose one answer among the following choices.

1	2	3	4	5
Follow target unconditionally	Follow target with international standards	Set standards higher than international standards	Don't follow target	No interest

Appendix B: List of Policy Actors Present in the Measured Policy Network

Name	Category
Japan Association of Corporate Executives (Doyukai)	Business association
Japan Business Federation (Keidanren)	Business association
Japan Chamber of Commerce and Industry	Business association
Itochu Corporation	Business corporation
Marubeni Corporation	Business corporation
Mitsubishi Heavy Industries, Ltd.	Business corporation
Sumitomo Corporation	Business corporation
Kobe Steel, Ltd.	Business corporation
Tokyo Electric Power Company	Business corporation
World Conference of Religions for Peace Japan	Foundation
Global Environmental Forum	Foundation
Global Environmental Centre	Foundation
Ministry of Foreign Affairs, International Cooperation Administration	Governmental Body
Ministry of Foreign Affairs, Foreign Policy Bureau	Governmental Body
Ministry of Foreign Affairs, Ambassador for Global Environmental Affairs	Governmental Body
Ministry for the Environment, Global Environmental Bureau	Governmental Body
Ministry for Economy, Trade and Industry Industrial Science and Technology Policy, and Environmental Bureau	Governmental Body
Ministry for Economy, Trade and Industry, Manufacturing Industries Bureau	Governmental Body
Ministry for Land, Infrastructure and Tourism, Maritime Bureau	Governmental Body
Ministry for Land, Infrastructure and Tourism, Meteorological Bureau, Global Environment, and Marine Department	Governmental Body
Ministry for Land, Infrastructure and Tourism, Policy Bureau	Governmental Body
Ministry of Finance, International Office	Governmental Body
Ministry of Finance National Tax Agency, Taxation Department	Governmental Body
Ministry for Agriculture, Fisheries and Forestry Minister's Secretariat, Environmental Policy Division	Governmental Body
Ministry for Agriculture, Fisheries and Forestry, Forestry Agency, Private Forest Department	Governmental Body

Ministry for Education, Culture, Sports, Science and Technology, Research and Development Bureau	Governmental Body
Japan Petrochemical Industry Association	Industry association
Petroleum Association of Japan	Industry association
Japan Federation of Hire-Taxi Associations	Industry association
Federation of Electric Power Companies	Industry association
Japan Aluminum Association	Industry association
Japan Fluorocarbon Manufacturers Association	Industry association
Japan Chemical Industry Association	Industry association
Japan Federation of Construction Contractors	Industry association
Japan Automobile Manufacturers Association	Industry association
Japan Paper Association	Industry association
Japan Iron and Steel Recycling Institute	Industry association
Japan Iron and Steel Federation	Industry association
Japan Department Stores Association	Industry association
Mitsubishi UFJ Research & Consulting	Innovation Center
Mitsubishi Research Institute, Inc.	Innovation Center
Fujitsu Research Institute	Innovation Center
NHK Nippon Hoso Kyokai	Mass Media
Kyodo News	Mass Media
Jiji Press	Mass Media
Asahi Newspaper	Mass Media
Mainichi Newspaper	Mass Media
Japan International Cooperation Agency	National Research Institute
National Institute for Environmental Studies	National Research Institute
National Institute of Advanced Industrial Science and Technology	National Research Institute
New Energy and Industrial Technology Development Organization	National Research Institute
Japan Transport and Tourism Research Institute	National Research Institute
International Center for Environmental Technology Transfer	National Research Institute

Institute for Global Environmental Strategies	National Research Institute
Global Industrial and Social Progress Research Institute	National Research Institute
Central Research Institute of Electric Power Industry	National Research Institute
Japan Economic Research Institute	National Research Institute
Japan Ship Technology Research Association	National Research Institute
Citizen's Alliance for Saving the Atmosphere and the Earth	NGO
Kiko Network	NGO
NPO Regional Exchange Center	NGO
ICLEI Japan	NGO
Japan Refrigerants and Environment Conservation Organization	NGO
Greenpeace Japan	NGO
Conservation International Japan	NGO
Earth Day Tokyo	NGO
Environment and Culture Research Institute	NGO
Old Paper Network	NGO
Japan Environment Council	NGO
DPJ	Political Party
LDP	Political Party
People's First Party	Political Party
Japanese Communist Party	Political Party
Social Democratic Party	Political Party
Parliamentarians for Global Action (GLOBE Japan)	Political Party
Japanese Consumers' Co-operation	Voluntary Association
RENGO Trade Union Confederation	Voluntary Association

Appendix C: Sub-set List of Actors for Interviews

Name	Category
KEIDANREN Japan Business Federation	Business association
Global Environmental Forum	Foundation
Global Environment Centre Foundation	Foundation
Ministry of the Environment	Governmental Body
Mitsubishi UFJ Research and Consulting, Co.	Innovation Center
Mitsubishi Research Institute, Inc.	Innovation Center
Fujitsu Research Institute	Innovation Center
Japan International Cooperation Agency	National Research Institute
National Institute for Environmental Studies	National Research Institute
National Institute of Advanced Industrial Science and Technology	National Research Institute
New Energy and Industrial Technology Development Organization	National Research Institute
Japan Transport and Tourism Research Institute	National Research Institute
International Center for Environmental Technology Transfer	National Research Institute
Institute for Global Environmental Strategies	National Research Institute
Global Industrial and Social Progress Research Institute	National Research Institute
Central Research Institute of Electric Power Industry	National Research Institute
Japan Economic Research Institute	National Research Institute
Japan Ship Technology Research Association	National Research Institute
Citizens' Alliance for Saving the Atmosphere and the Earth	NGO
Kiko Network	NGO
NPO Regional Exchange Center	NGO

ICLEI Japan	NGO
Japan Refrigerants and Environment Conservation Organization	NGO
Greenpeace Japan	NGO
Conservation International Japan	NGO
Environment and Culture Research Institute	NGO

Appendix D: Introductory Contact Email Message

△△様

初めまして、平素より大変お世話になっております。

筑波大学大学院のハルトヴィッヒ・マヌエラと申します。まず、突然このような不躾なメールを差し上げるご無礼をお許しください。

大変無礼なお願いで恐縮でございますが、この度はインタビューへの協力をお願いできないかと考え、ご連絡をさせていただきました。

私事で恐縮ですが、現在筑波大学で環境政策に関する研究を行っております。特に、環境政策を作る上で、科学的助言又は助言者の方がどのような役割を果たしているのかという点に注目しており、これまでにも国費外国人留学生として文部科学省の助成を受け、日本学術振興会・課題設定による先導的人文学・社会科学研究推進事業・領域開拓プログラム「エネルギー政策・言説の日独地域比較」、「地球温暖化への取り組みに関する調査」などの調査・研究を筑波大学人文社会国際比較研究機構の協力で実施してきました。

つきましては、大変お忙しいところ申し訳なく思いますが、環境政策についてイニシアティブを発揮されてきた△△様に是非インタビューにご協力をいただくことはできないかと考え、ご連絡をさせていただいた次第です。勝手ではございますが、このメールに調査の趣旨説明を添付させていただきますので、ご査収いただけましたら幸いです。

直接を目に掛かってお願いするのが筋ではございますが、まずはメールにて失礼いたします。

お忙しい時期にお手数をおかけして申し訳ございませんが、どうぞご検討いただけましたら幸いです。どうぞよろしくお願いします。

Manuela Hartwig

••
Manuela HARTWIG, Ph.D. Candidate
マヌエラ・ハルトヴィッヒ 博士後期課程

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••

Appendix E: Semi-Structured Interview Contact Letter and Consent

2018(平成 30)年 10 月 1 日
住所と名前

筑波大学人文社会科学研究科・大学院
ハルトヴィッヒ　マヌエラ

環境政策過程における科学的助言に関するインタビュー調査　主旨説明書

1. インタビューの目的・主旨

地球環境問題を解決し、持続可能な発展の道を歩んでいくためには、安定した政策枠組みと複数の関係者の協力が重要となります。とりわけ、 科学的な知識をかみ砕いて社会に対してわかりやすく伝える「専門家」は、科学と政策の関係を促進する重要な役割を担っています。しかしながら、日本においては科学的な知識の政治化や、政策ネットワークの閉鎖性・垂直性が指摘されており、そのことが、専門家の自律性や政策目標を達成するための持続可能かつ効果的な気候緩和措置を開発する上で障害となるという問題点が指摘されてきました。 そのような批判にこたえるために、本研究では、混合法の研究デザインを用いた政策・アクターネットワークアプローチを通して、日本の政策決定過程に科学的助言がどのように活用されているかを明らかにしたいと考えております。

2. お伺いしたい事項

主に下記の内容をおうかがいできればと考えております。ご多用中大変恐縮ではございますが、60 分～120 分程度お時間をいただけましたら幸甚に存じます。

・政策戦略を作るため科学的助言の扱い
・国内外の政策過程に関係あるアクター・ステークホルダーとの協力、コミュニケーション、情報交換
・国内外の地球温暖化に対する交流仕組み

インタビューのお時間をいただける場合、事前におたずねしたい事項をまとめて電子メールか郵送で送付させていただきます。

3. データの公表について

調査結果は、公表を希望されない部分を除き、学会報告、学術論文、書籍、科学研究費補助金研究成果報告書等で公表される可能性があります。調査結果は「国立大学法人筑波大学大学個人情報保護規程」に従って適正に管理いたします。なお、この調査は、文部科学省の国費外国人留学生助成事業『環境政策における科学的助言・比較政策過程研究』の研究助成(2017 年度～2019 年度)によって実施されます。

■責任者・連絡先
筑波大学大学院　人文社会科学研究科　国際日本研究専攻
ハルトヴィッヒ・マヌエラ （大学院・博士後期課程）

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TEL: +81-(0)80-4425-1531
EMAIL: manuela.g-hartwig.xd@alumni.tsukuba.ac.jp

Appendix F: Semi-Structured Interview Question Contents

2018 年(平成 30 年)10 月 1 日

筑波大学人文社会科学研究科・大学院
ハルトヴィッヒ・マヌエラ

環境政策過程における科学的助言に関するインタビュー調査　事項

インタビュー調査ご協力をいただき、誠にありがとうございます。なお、おたずねしたい事項を送付させていただきます。下記の内容をお伺いたいと考えております。

・政策戦力を作るため科学的助言の扱い
・国内外の政策過程に関係あるアクター・ステークホルダーとの協力、コミュニケーション、情報交換
・国内外の地球温暖化に対する交流仕組み

インタビュー調査　事項

◆貴組織では、政策案などについて、他の団体や組織と情報交換をしたり、アドバイスをしたりすることがありますか。
ある場合は、どのような団体や組織でしょうか。また、政府に直接助言を含む情報交換をすることはありますか。

◆貴組織では、他の団体や組織と協力して活動を行うことはありますか。
ある場合は、どのような団体や組織でしょうか。また、どのような活動について、協力をされていますでしょうか。

◆他の団体や組織と協力する場合、一般的に言って、どのくらいの期間にわたって一緒に活動をしますか。また、どのようなきっかけで他の団体や組織との協力が始まったり、終わったりするのでしょうか。

◆他の団体や組織への政策的な助言やアドバイスはどのように行われるのでしょうか。

◆他の団体や組織へ政策的な助言やアドバイスをするなかで、他の団体や組織からの圧力やプレッシャーを感じることがありますか。差支えのない範囲で、どのような事例があるか教えてください。

◆あなたの専門知識や活動が世論や政策アジェンダに影響があったと感じたことはありますか。

♦貴組織では、既存の気候に関するデータを分析したり、独自のデータセットを作成したりすることがありますか。
貴組織にとって、どのような種類の情報が重要だとお感じになっていますか。また、その情報はどこから入手されていますでしょうか。

また、貴組織にとってより重要なのは、国内の情報でしょうか。それとも海外の情報でしょうか。

♦貴組織の提案、意見、または意見は、政策にどの程度反映されているとお感じになりますか。
地球温暖化の解決と CO2 削減に向けて、政府の取り組みは十分だとお感じになりますか。
地球温暖化の解決と CO2 削減に向けて、どのような団体や組織がもっとも影響力があると感じておられますか。またそれはなぜでしょうか。

■責任者・連絡先
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Appendix G: Interview Supplement

Manuela G. Hartwig
Ph.D. Candidate
Graduate School of Humanities and Social Sciences
University of Tsukuba

Supplement to Interview Survey "Science Advice in Environmental Politics"

1.1 How would you classify the following organizations? You can choose up to 2 answers per organization. If neither category fits, you can choose "other". If that is the case, please provide information for why neither of the classifications fit and what classification would be appropriate in your opinion in the free space below. *(Please refer to the additional text file for explanations about the provided classifications.)*

	Science Arbiter	Pure Scientist	Issue Advocate	Knowledge Broker	Other
	↓	↓	↓	↓	↓
(国際機関)					
(1) 気候変動に関する政府間パネル(IPCC)········	☐	☐	☐	☐	☐
(2) 国連環境計画(UNEP) ······················	☐	☐	☐	☐	☐
(3) 世界気象機関(WMO) ······················	☐	☐	☐	☐	☐
(4) 経済協力機構(OECD)······················	☐	☐	☐	☐	☐
(5) 世界銀行(World Bank) ····················	☐	☐	☐	☐	☐
(6) 国際エネルギー機関(IEA) ··················	☐	☐	☐	☐	☐
(7) 国連開発計画(UNDP)······················	☐	☐	☐	☐	☐
(8) 国際自然保護連合(IUCN) ··················	☐	☐	☐	☐	☐
(9) 気候変動枠組条約の事務局(UNFCCC) ········	☐	☐	☐	☐	☐
(10) アジア開発銀行(ADB) ····················	☐	☐	☐	☐	☐
(11) アジア太平洋経済社会委員会(ESCAP) ········	☐	☐	☐	☐	☐
(12) 国際原子力機関(IAEA)····················	☐	☐	☐	☐	☐
(13) 国連食糧農業機関(FAO) ··················	☐	☐	☐	☐	☐
(14) 国際熱帯木材機関(ITTO)··················	☐	☐	☐	☐	☐
(15) 地球環境ファシリティ(GEF) ················	☐	☐	☐	☐	☐
(国際 NGO)					
(16) 世界自然保護基金(WWF Global)··············	☐	☐	☐	☐	☐
(17) グリーンピース(Greenpeace International) ·····	☐	☐	☐	☐	☐
(18) 世界資源研究所(WRI)······················	☐	☐	☐	☐	☐
(19) 地球の友(FoE International)················	☐	☐	☐	☐	☐
(20) 持続可能な開発のための世界経済人会議	☐	☐	☐	☐	☐
(21) イクレイ－持続可能性をめざす自治体協議会	☐	☐	☐	☐	☐
(22) ワールドウォッチ研究所(Worldwatch Institute)·	☐	☐	☐	☐	☐
(23) 気候行動ネットワーク(CAN) ················	☐	☐	☐	☐	☐
(24) シエラクラブ(Sierra Club)··················	☐	☐	☐	☐	☐
(政府官庁)					
(25) 外務省経済局経済協力開発機構室 ············	☐	☐	☐	☐	☐
(26) 外務省国際協力局気候変動課 ················	☐	☐	☐	☐	☐

	Science Arbiter	Pure Scientist	Issue Advocate	Knowledge Broker	Other
	↓	↓	↓	↓	↓
(27) 外務省総合外交政策局 ························	□	□	□	□	□
(28) 外務省地球環境問題担当大使 ················	□	□	□	□	□
(29) 環境省水・大気環境局大気環境課 ············	□	□	□	□	□
(30) 環境省地球環境局環境保全対策課 ············	□	□	□	□	□
(31) 環境省地球環境局地球温暖化対策課 ··········	□	□	□	□	□
(32) 経済産業省産業技術環境局 ··················	□	□	□	□	□
(33) 経済産業省資源エネルギー庁省エネルギー・新エネルギー部 ····························	□	□	□	□	□
(34) 経済産業省製造産業局化学物質管理課 ········	□	□	□	□	□
(35) 国土交通省海事局安全基準課 ················	□	□	□	□	□
(36) 国土交通省気象庁地球環境・海洋部地球環境業務課 ··································	□	□	□	□	□
(37) 国土交通省気象庁気象研究所 ················	□	□	□	□	□
(38) 国土交通省総合政策局 ······················	□	□	□	□	□
(39) 国土交通省都市局公園緑地・景観課 ··········	□	□	□	□	□
(40) 財務省国際局開発政策課 ····················	□	□	□	□	□
(41) 財務省国税庁課税部 ························	□	□	□	□	□
(42) 農林水産省生産局農産部農業環境対策課 ······	□	□	□	□	□
(43) 農林水産省食料産業局バイオマス循環資源課 ··	□	□	□	□	□
(44) 農林水産省大臣官房環境政策課 ··············	□	□	□	□	□
(45) 農林水産省林野庁森林整備部研究・保全課 ····	□	□	□	□	□
(46) 農林水産省林野庁林政部 ····················	□	□	□	□	□
(47) 文部科学省研究開発局環境エネルギー課 ······	□	□	□	□	□
(独立行政法人)					
(48) 環境再生保全機構 ··························	□	□	□	□	□
(49) 国際協力機構(JICA) ·······················	□	□	□	□	□
(50) 国立環境研究所(NIES) ·····················	□	□	□	□	□
(51) 産業技術総合研究所(AIST) ·················	□	□	□	□	□
(52) 新エネルギー・産業技術総合開発機構(NEDO)·	□	□	□	□	□
(53) ジェトロ・アジア経済研究所(IDE-JETRO) ····	□	□	□	□	□
(政党および議員連盟)					
(54) 民主党 ····································	□	□	□	□	□
(55) 自由民主党 ································	□	□	□	□	□
(56) 国民の生活が第一 ··························	□	□	□	□	□
(57) 公明党 ····································	□	□	□	□	□
(58) 日本共産党 ································	□	□	□	□	□
(59) 社会民主党 ································	□	□	□	□	□
(60) 地球環境国際議員連盟(GLOBE Japan) ········	□	□	□	□	□
(経済団体)					
(61) 経済同友会 ································	□	□	□	□	□
(62) 日本経済団体連合会 ························	□	□	□	□	□
(63) 日本商工会議所 ····························	□	□	□	□	□
(業種別団体)					
(64) 石油化学工業協会 ··························	□	□	□	□	□
(65) 石油連盟 ··································	□	□	□	□	□
(66) 全国銀行協会連合会 ························	□	□	□	□	□

		Science Arbiter	Pure Scientist	Issue Advocate	Knowledge Broker	Other
		↓	↓	↓	↓	↓
(67)	全国ハイヤー・タクシー連合会	☐	☐	☐	☐	☐
(68)	全日本トラック協会	☐	☐	☐	☐	☐
(69)	電気事業連合会	☐	☐	☐	☐	☐
(70)	日本アルミニウム協会	☐	☐	☐	☐	☐
(71)	日本ガス協会	☐	☐	☐	☐	☐
(72)	日本フルオロカーボン協会	☐	☐	☐	☐	☐
(73)	日本化学工業協会	☐	☐	☐	☐	☐
(74)	日本建設業連合会	☐	☐	☐	☐	☐
(75)	日本自動車工業会	☐	☐	☐	☐	☐
(76)	日本製紙連合会	☐	☐	☐	☐	☐
(77)	日本鉄リサイクル工業会	☐	☐	☐	☐	☐
(78)	日本鉄鋼連盟	☐	☐	☐	☐	☐
(79)	日本百貨店協会	☐	☐	☐	☐	☐
(企業)						
(80)	JFE スチール	☐	☐	☐	☐	☐
(81)	ソフィアバンク	☐	☐	☐	☐	☐
(82)	旭硝子	☐	☐	☐	☐	☐
(83)	伊藤忠商事	☐	☐	☐	☐	☐
(84)	関西電力	☐	☐	☐	☐	☐
(85)	丸紅	☐	☐	☐	☐	☐
(86)	東日本高速道路	☐	☐	☐	☐	☐
(87)	三菱 UFJ リサーチ&コンサルティング	☐	☐	☐	☐	☐
(88)	三菱重工	☐	☐	☐	☐	☐
(89)	三菱商事	☐	☐	☐	☐	☐
(90)	三菱総合研究所	☐	☐	☐	☐	☐
(91)	住友商事	☐	☐	☐	☐	☐
(92)	新日鐵住金	☐	☐	☐	☐	☐
(93)	神戸製鋼所	☐	☐	☐	☐	☐
(94)	中部電力	☐	☐	☐	☐	☐
(95)	電源開発(J-POWER)	☐	☐	☐	☐	☐
(96)	東京ガス	☐	☐	☐	☐	☐
(97)	東京電力	☐	☐	☐	☐	☐
(98)	富士通総研	☐	☐	☐	☐	☐
(NPO 法人)						
(99)	地球環境と大気汚染を考える全国市民会議(CASA)	☐	☐	☐	☐	☐
(100)	国際協力 NGO センター(JANIC)	☐	☐	☐	☐	☐
(101)	アジア太平洋資料センター(PARC)	☐	☐	☐	☐	☐
(102)	気候ネットワーク	☐	☐	☐	☐	☐
(103)	地域交流センター	☐	☐	☐	☐	☐
(104)	日本消費者連盟	☐	☐	☐	☐	☐
(105)	市民フォーラム 21・NPO センター	☐	☐	☐	☐	☐
(社団・財団法人)						
(106)	WWF ジャパン	☐	☐	☐	☐	☐
(107)	イオン環境財団	☐	☐	☐	☐	☐

	Science Arbiter	Pure Scientist	Issue Advocate	Knowledge Broker	Other
	↓	↓	↓	↓	↓
(108) イクレイ日本－持続可能性をめざす自治体協議会	□	□	□	□	□
(109) オゾン層・気候保護産業協議会(JICOP)	□	□	□	□	□
(110) グリーンピース・ジャパン	□	□	□	□	□
(111) CI（コンサベーション・インターナショナル）ジャパン	□	□	□	□	□
(112) 運輸政策研究機構	□	□	□	□	□
(113) 海外環境協力センター(OECC)	□	□	□	□	□
(114) 環境情報科学センター(CEIS)	□	□	□	□	□
(115) 環境情報センター(EIC)	□	□	□	□	□
(116) 建築環境・省エネルギー機構(IBEC)	□	□	□	□	□
(117) 国際環境技術移転センター(ICETT)	□	□	□	□	□
(118) 省エネルギーセンター(ECCJ)	□	□	□	□	□
(119) 世界宗教者平和会議日本委員会(WCRP)	□	□	□	□	□
(120) 地球・人間環境フォーラム(GEF)	□	□	□	□	□
(121) 地球環境センター(GEC)	□	□	□	□	□
(122) 地球環境産業技術研究機構(RITE)	□	□	□	□	□
(123) 地球環境戦略研究機関(IGES)	□	□	□	□	□
(124) 地球産業文化研究所(GISPRI)	□	□	□	□	□
(125) 電力中央研究所	□	□	□	□	□
(126) 日本エネルギー経済研究所(IEE Japan)	□	□	□	□	□
(127) 日本経済研究所(JERI)	□	□	□	□	□
(128) 日本船舶技術研究協会(JSTRA)	□	□	□	□	□
(129) 日本品質保証機構(JQA)	□	□	□	□	□
(130) 日本野鳥の会	□	□	□	□	□
（マス・メディア）					
(131) NHK	□	□	□	□	□
(132) 共同通信社	□	□	□	□	□
(133) 時事通信社	□	□	□	□	□
(134) 朝日新聞	□	□	□	□	□
(135) 読売新聞	□	□	□	□	□
(136) 日本経済新聞	□	□	□	□	□
(137) 毎日新聞	□	□	□	□	□
（環境 NGO・その他）					
(138) アースデイ JP	□	□	□	□	□
(139) 環境文化研究所	□	□	□	□	□
(140) 古紙問題市民行動ネットワーク	□	□	□	□	□
(141) 地球環境行動会議(GEA)	□	□	□	□	□
(142) 日本科学者会議(JSA)	□	□	□	□	□
(143) 日本環境会議(JEC)	□	□	□	□	□
(144) 日本生活協同組合連合会(Co-op)	□	□	□	□	□
(145) 日本労働組合総連合会	□	□	□	□	□

Appendix H: R Script Template for Plotting Networks with iGraph

```
library(igraph)

# read a CSV file. Run the script with one .csv file. After
plotting run the script again with the other .csv file.
data = read.csv("Q7_network.csv")
data = read.csv("Q8_network.csv")

# get the number of organizations
N = length(data[,1])

# use IDs as labels of organizations.
# If using their names, add a column of their names.
labels = data[,1]

# making adjacency matrix for igraph.
# data[,-(1)] means all data except the first column.
# [examples 1] data[,2:5] = data of 2-5th columns.
# [examples 2] data[,-(10:107)] = all data except the 10-107st
columns.
# [examples 3] data[1:10,] = data of the 1-10st rows.
g = graph.adjacency(as.matrix(data[,-(1)]), mode="directed")

# get colors from color.txt
colors = scan("color.txt",what=character(),sep="\n")
V(g)$color = colors

# In case wanted: remove loops
# g <- simplify(g)

# density, transitivity and reciprocity
graph.density(g)
transitivity(g)
reciprocity(g)

# indegree
inarrow = degree(g, mode="in")
write(inarrow, "gepon_info_inarrow.txt", append=F, ncolumns=1)

# betweenness
between = betweenness(g)
write(between, "gepon_info_between.txt", append=F, ncolumns=1)

# PageRank (a kind of indegree)
pagerank = page.rank(g, directed=TRUE)$vector
write(pagerank, "gepon_info_pagerank.txt", append=F, ncolumns=1)

# Getting arguments from above prepared text files
degree = pagerank * 150

# To change the scale of the vertexes to make differences more
visible change the value in degree = pageranke * n and use
```

```
vertex.size=1.5+degree instead of vertex.size= 1.5+ sqrt
(degree)*0.5.

# Outputting a graph
plot(g, vertex.label=NA, vertex.size=1.5+sqrt(degree)*0.75,
     vertex.frame.color="white",
     edge.width=0.3, edge.arrow.size=0.3,
     layout=layout.fruchterman.reingold, asp=0)
legend("topleft", legend=c"Governmental Body","Political
Party","Science Arbiter", "Issue Advocate (Business/Industry)",
"Issue Advocate (NGOs/NPOs)", "Mass Media"),
       col=c("black", "beige", "blue", "pink", "yellowgreen",
"yellow"),
       pch=19, cex=0.5)

#to detach package igraph
detach(package:igraph)
```

Appendix I: Power Distribution and Network Centrality Values

Name	Category	Out-degree Average ("Sender")	In-degree Average ("Receiver")	PageRank ("Sender")	PageRank ("Receiver")	Betweenness Centrality ("Sender")	Betweenness Centrality ("Receiver")
Japan Association of Corporate Executives (Keizai Doyukai)	Business association	0.09259	0.14815	0.00864	0.00834	21.42861	18.14598
Japan Business Federation (Keidanren)	Business association	0.2963	0.43519	0.05154	0.03968	0	0
Japan Chamber of Commerce and Industry (JCCI)	Business association	0.10185	0.17593	0.00981	0.00906	0	2.492254
Itochu	Business corporation	0.05556	0.07407	0.00718	0.00619	16.22368	0
Marubeni	Business corporation	0.06481	0.08333	0.00761	0.00617	0	0
Mitsubishi UFJ Research and Consulting	Business corporation	0.12963	0.15741	0.00991	0.01080	0.3588235	1.866685
Mitsubishi Heavy Industries, Ltd.	Business corporation	0.06481	0.08333	0.01058	0.00899	1	2.660317
Mitsubishi Research Institute, Inc.	Business corporation	0.13889	0.19444	0.01112	0.01064	0	3.290068
Sumitomo	Business corporation	0.0556	0.07407	0.00738	0.00619	0.4444444	6.236069

Name	Category	Out-degree Average ("Sender")	In-degree Average ("Receiver")	PageRank ("Sender")	PageRank ("Receiver")	Betweenness Centrality ("Sender")	Betweenness Centrality ("Receiver")
Kobe Steel	Business corporation	0.07407	0.08333	0.00804	0.00681	1.580952	0.8928571
Tokyo Electric Power Company (TEPCO)	Business corporation	0.16667	0.18519	0.01372	0.01097	0	102.6171
Fujitsu Research Institute	Business corporation	0.08333	0.11111	0.00769	0.00661	5.970858	0.9329887
Japan Transport and Tourism Research Institute (JTTRI)	Foundation	0.02778	0.05556	0.00607	0.00567	1.790115	1.81859
International Center for Environmental Technology Transfer (ICETT)	Foundation	0.01852	0.06481	0.00607	0.00550	0	0
World Conference of Religions and Peace Japan (WCRP)	Foundation	0.02778	0.03704	0.00644	0.00464	0	0.08695652
Global Environmental Forum (GEF)	Foundation	0.06481	0.10185	0.00751	0.00665	6.60636	12.66069
Global Environment Centre Foundation (GEC)	Foundation	0.05556	0.12963	0.00803	0.00918	5.774574	0

Name	Category	Out-degree Average ("Sender")	In-degree Average ("Receiver")	PageRank ("Sender")	PageRank ("Receiver")	Betweenness Centrality ("Sender")	Betweenness Centrality ("Receiver")
Institute for Global Environmental Strategies (IGES)	Foundation	0.14815	0.36111	0.01283	0.02064	76.28684	146.3155
Global Industrial and Social Progress Research Institute (GISPRI)	Foundation	0.0463	0.18519	0.00749	0.01097	0	0
Central Research Institute of Electric Power Industry (DENKEN)	Foundation	0.13889	0.27778	0.01071	0.01568	0	0
The Japan Economic Research Institute (JERI)	Foundation	0.02778	0.07407	0.00625	0.00583	7.754278	1.009512
Japan Ship Technology Research Association (JSTRA)	Foundation	0.03704	0.05556	0.00756	0.00606	1.732576	0.6106732
MOFA International Cooperation Bureau	Governmental body	0.15741	0.2963	0.01453	0.02149	484.7061	578.875
MOFA Foreign Policy Bureau	Governmental body	0.0463	0.15741	0.00684	0.00952	0	1.781834
MOFA Ambassador for Global Environmental Issues	Governmental body	0.12963	0.21296	0.01321	0.01748	9.693651	8.847109

Name	Category	Out-degree Average ("Sender")	In-degree Average ("Receiver")	PageRank ("Sender")	PageRank ("Receiver")	Betweenness Centrality ("Sender")	Betweenness Centrality ("Receiver")
MOE Global Environmental Bureau	Governmental body	0.42593	0.56481	0.04116	0.05711	1068.982	151.868
METI Industrial Science and Technology Policy and Environmental Bureau	Governmental body	0.26852	0.37037	0.03661	0.04635	583.014	691.2496
METI Manufacturing Industries Bureau	Governmental body	0.12037	0.18519	0.01438	0.01286	6.959668	4.819654
MLIT Maritime Bureau	Governmental body	0.06481	0.12963	0.01079	0.01085	102.4821	95.19016
MLIT Meteorological, Global Environment and Maritime Department	Governmental body	0.07407	0.12963	0.00815	0.00820	2.885256	0.6107143
MLIT Policy Planning Bureau	Governmental body	0.14815	0.19444	0.02788	0.02013	112.8905	220.8686
MOF International Affairs Bureau	Governmental body	0.08333	0.12963	0.01249	0.01388	0	0
MOF National Tax Agency and Taxation Department	Governmental body	0.03704	0.07407	0.00629	0.00629	0	0

Name	Category	Out-degree Average ("Sender")	In-degree Average ("Receiver")	PageRank ("Sender")	PageRank ("Receiver")	Betweenness Centrality ("Sender")	Betweenness Centrality ("Receiver")
MAFF Minister's Secretariat and Environmental Policy Division	Governmental body	0.08333	0.15741	0.00718	0.01049	0	0
MAFF Forestry Agency and Private Forest Department	Governmental body	0.08333	0.11111	0.00711	0.00614	11.1051	4.742507
MEXT Research and Development Bureau	Governmental body	0.08333	0.13889	0.01181	0.01102	67.06053	44.80034
Japan International Cooperation Agency (JICA)	Incorporated administrative agency	0.15741	0.2963	0.02014	0.02831	141.1173	48.65396
National Institute for Environmental Science (NIES)	Incorporated administrative agency	0.24074	0.4537	0.02719	0.04413	223.8277	234.4636
National Institute of Advanced Industrial Science and Technology (AIST)	Incorporated administrative agency	0.12963	0.25	0.01141	0.02542	152.947	292.3405
New Energy and Industrial Technology Development Organization (NEDO)	Incorporated administrative agency	0.14815	0.37963	0.01532	0.03323	4.714386	8.858388

Name	Category	Out-degree Average ("Sender")	In-degree Average ("Receiver")	PageRank ("Sender")	PageRank ("Receiver")	Betweenness Centrality ("Sender")	Betweenness Centrality ("Receiver")
Japan Petrochemical Industry Association (JPCA)	Industry association	0.08333	0.13889	0.00959	0.00974	0	0
Petroleum Association of Japan (PAJ)	Industry association	0.12037	0.21296	0.01219	0.01201	7.682331	20.59878
Japan Federation of Hire-Taxi Association	Industry association	0.03704	0.08333	0.00796	0.00752	6.710014	3.852133
Federation of Electric Power Companies (FEPC)	Industry association	0.18519	0.23148	0.01407	0.01175	13.72207	4.329202
Japan Aluminum Association (JAA)	Industry association	0.05556	0.07407	0.00913	0.00798	11.15525	5.514322
Japan Fluorocarbon Manufacturers Association (JFMA)	Industry association	0.09259	0.11111	0.01199	0.01181	6.483385	20.17497
Japan Chemical Industry Association (JCIA)	Industry association	0.12963	0.17593	0.01447	0.01286	25.07526	27.08538
Japan Federation of Construction Contractors (NIKKENREN)	Industry association	0.08333	0.11111	0.01666	0.00853	2.263492	1.035157

Name	Category	Out-degree Average ("Sender")	In-degree Average ("Receiver")	PageRank ("Sender")	PageRank ("Receiver")	Betweenness Centrality ("Sender")	Betweenness Centrality ("Receiver")
Japan Automobile Manufacturers Association, Inc. (JAMA)	Industry association	0.12963	0.18519	0.02265	0.01379	126.5091	29.77212
Japan Paper Association (JPA)	Industry association	0.11111	0.14815	0.01192	0.00985	14.20855	2.644228
Japan Iron and Steel Recycling Institute (JISRI)	Industry association	0.06481	0.10185	0.00828	0.00849	0	0
Japan Iron and Steel Federation (JISF)	Industry association	0.12963	0.18519	0.01489	0.01341	90.36418	95.57278
Japan Department Stores Associations	Industry association	0.03704	0.07407	0.00667	0.00584	0	0
NHK	Mass Media	0.26852	0.37037	0.02241	0.01698	0	0
Kyodo Newspaper	Mass Media	0.22222	0.37037	0.02069	0.01698	173.8619	21.73908
Jiji Newspaper	Mass Media	0.22222	0.36111	0.01899	0.01687	2.25	268.5421
Asahi Newspaper	Mass Media	0.25926	0.35185	0.02321	0.0167	0	529.5865
Mainichi Newspaper	Mass Media	0.25	0.37037	0.02239	0.01698	0	14.90697
Citizen's Alliance for Saving the Atmosphere and the Earth	NGO	0.09259	0.16667	0.00943	0.00955	49.01398	33.55782
KIKO Network	NGO	0.13889	0.2963	0.01078	0.01839	0.9940476	112.9773

Name	Category	Out-degree Average ("Sender")	In-degree Average ("Receiver")	PageRank ("Sender")	PageRank ("Receiver")	Betweenness Centrality ("Sender")	Betweenness Centrality ("Receiver")
ICLEI Japan	NGO	0.03704	0.07407	0.00607	0.00542	0	2.316508
Japan Refrigerants and Environment Conservation Organization (JRECO)	NGO	0.0463	0.07407	0.00894	0.00574	11.78063	5.615424
Greenpeace	NGO	0.08333	0.12963	0.00894	0.00701	0	80.8367
Conservation International Japan	NGO	0.0463	0.10185	0.00682	0.00716	11.04825	12.30517
Earth Day Tokyo	NGO	0.06481	0.05556	0.00731	0.00551	0	0.08695652
Research Institute for Culture and Environment	NGO	0.02778	0.0463	0.00656	0.00489	0	0
Old Paper Network	NGO	0.02778	0.03704	0.00644	0.00464	0	0
Japan Environmental Council (JEC)	NGO	0.07407	0.09259	0.00778	0.00571	3.665079	2.341746
DPJ	Political party	0.21296	0.21296	0.02042	0.01286	210.4118	45.51806
LDP	Political party	0.21296	0.23148	0.01991	0.01447	0	0
People's Life First Party	Political party	0.0463	0.07407	0.00804	0.00743	0	0
JCP	Political party	0.09259	0.10185	0.01172	0.00844	109.0651	126.4644
SDP	Political party	0.09259	0.11111	0.01201	0.00911	0	2.614432

Name	Category	Out-degree Average ("Sender")	In-degree Average ("Receiver")	PageRank ("Sender")	PageRank ("Receiver")	Betweenness Centrality ("Sender")	Betweenness Centrality ("Receiver")
Parliamentarians for Global Action (GLOBE Japan)	Political party	0.08333	0.08333	0.01214	0.00768	108.6554	3.948775
NPO Regional Exchange Center	Voluntary association	0.02778	0.05556	0.00625	0.00522	0.6699134	0.07692308
Japanese Consumer Cooperation (co-op)	Voluntary association	0.09259	0.11111	0.00825	0.00587	46.02948	8.14889
Japanese Trade Union Confederation (RENGO)	Voluntary association	0.11111	0.12963	0.01081	0.00876	0	8.942521

Data Source: J-GEPON2 Japan

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