ReSciPI

Reshaping Science-Policy Interactions in Climate Policy: International Stock-Taking and Lessons for Austria

BOKU

Universität für Bodenkultur Wien
Department für Wirtschafts- und Sozialwissenschaften

Innovative climate policy advice: Case studies from Germany, the Netherlands, Switzerland and the UK

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Abstract

This research report presents the results of a comparative case study of nine scientific advisory institutions in the field of climate change mitigation and adaptation in four different countries, namely Germany, the Netherlands, Switzerland and the UK. Its main goal is to get a profound understanding of how climate science and climate policy are effectively integrated and how innovative models could look like.

The report provides an in-depth account of different approaches to provide and translate scientific expertise for decision-making in politics and society in the area of climate change. Approaches differ in institutional terms, i.e. how an organization is set-up, in particular with regard to its orientation towards politics, and in procedural terms, i.e. the ways how knowledge brokerage is actually enacted. In addition, the report shows the manifold challenges in science-policy interactions that come along the simultaneous pursuit of saliency, i.e. relevance for political and societal actors, credibility, i.e. the technical accuracy and authoritativeness, and legitimacy, i.e. the perceived fairness of scientific advisory processes.

Part A introduces the ReSciPI project, discusses the conceptualization of scientific advice as 'knowledge brokerage' and explains the methodological approach of the case studies. Part B presents the key insights from the nine in-depth case studies. The case reports are organized along countries in order to capture the embedding of the analysed cases in the broader political and social environment. After an overview on specificities of the science-policy interface in the respective country; the case reports continue with a description and analyses of the individual case studies. The single case analyses focus on the general characteristics, the institutionalization, the main activities and the strategies to ensure effectiveness. Part C synthesizes the key results. The syntheses starts with an overview of the basic organisational features of the nine cases followed by a comparison of the specific knowledge brokerage activities, that highlights particular innovative approaches. Part C concludes the report with a discussion of common challenges and tensions in science-policy interactions.

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List of acronyms

ACRP	Austrian Climate Research Program (AT)
ARCC CN	Adaptation and Resilience to a Changing Climate coordination Network (UK)
ARR	Adaptation Strategy Rotterdam Region
ASC	Adaptation Sub-Committee (UK)
AT	Austria
ATEAM	Advanced Terrestrial Ecosystem Analysis and Modelling
BACLIAT	Business Areas Climate Assessment Tool (UKCIP, UK)
BMBF	Federal Ministry of Education and Research (DE)
BMELV	Federal Ministry of Food, Agriculture and Consumer Protection (DE)
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Security (DE)
BMWi	Federal Ministry of Economics and Technology
BOKU	University of Natural Resources and Life Sciences, Vienna (AT)
BOKU-InFER	Institute of Forest, Environmental and Natural Resource Policy at University of Natural Resources and Life Sciences, Vienna (AT)
CC	climate change
CCC	Committee on Climate Change (UK)
CCRA	Climate Change Risk Assessment (UK)
CCS	Carbon capture and storage
CH	Switzerland
CIO	ClimateImpactsOnline.com
CIRED	International Environment and Development Research Center (F)
CO_2	Carbon Dioxide
COP	Conference of the Parties (UNFCCC)

CRU	Climatic Research Unit at the University of East Anglia (UK)
CSC	Climate Service Center (DE)
CSERGE	Centre for Social and Economic Research on the Global Environment (CSERGE) at the University of East Anglia and University College London (UCL)
CXC	ClimateXChange Scotland (UK)
C2SM	Center for Climate Systems Modeling, ETH Zurich (CH)
DAS	German Strategy for Adaptation to Climate Change
DE	Germany
DECC	Department of Energy & Climate Change (UK)
Defra	Department for Environment, Food & Rural Affairs (UK)
DETR	UK Government Department of the Environment, Transport and the Regions (UK)
DLR	National aeronautics and space research centre/ Deutsches Zentrum für Luft- und Raumfahrt e.V (DE)
dynaklim	Dynamic Adaptation to the Effects of Climate Change in the Emscher-Lippe Region (KLIMZUG region, DE)
EA	UK Environment Agency (UK)
EC	European Commission
ECN	Energy research Centre of the Netherlands (NL)
ECOPLAN	Economic Research and Policy Consultancy (CH)
ENCI-LowCarb	Engaging Civil Society in Low Carbon Scenarios (research project, F/DE)
EPSRC	Engineering and Physical Sciences Research Council (UK)
ETH	Swiss Federal Institute of Technology Zurich (CH)
EU	European Union
FOEN/BAFU	Federal Office for the Environment (CH)
FONA	Forschung für nachhaltige Entwicklungen/ research for sustainable developments (DE)
FP	Framework Programme (EU)
FT	Full time
GEA	global environmental assessments
GHG	greenhouse gas
GLOBIO 3	Model for global biodiversity (NL)
GWK	Joint Science Conference of state governments (DE)
IenM	Ministry of Infrastructure and the Environment (NL)
IGBP	International Geosphere-Biosphere Programme
IHDP	International Human Dimensions Programme on Global Environmental Change
IMAGE	Integrated Model to Assess the Global Environment (NL)
INFORSE	International Network for Sustainable Energy (NGO Europe)
INFRAS	Knowledge Pool for Solutions for the Future, Consultancy (CH)
INKA-BB	Innovation Network of Climate Change Adaptation Brandenburg Berlin (KLIMZUG region, DE)
IPCC	Intergovernmental Panel on Climate Change
IT	information technology
IW Köln	Cologne Institute for Economic Research
JPI-Climate	European Joint Programming Initiative Climate
KB	knowledge brokerage
KBA	knowledge brokerage activity

KBI	knowledge brokerage institution
KfC	Knowledge for Climate research program (NL)
KfW	Kreditanstalt für Wiederaufbau (Reconstruction Credit Institute) (DE)
KIC	Knowledge and Innovation Communities
KLIFF	Climate Impact Research Lower Saxony (DE)
KlimaExWoSt	Experimenteller Wohnungs- und Städtebau, research programme (DE)
KlimaMORO	Modellvorhaben Raumentwicklungsstrategien zum Klimawandel, research programme (DE)
KLIMAZWEI	A Research Programme (2006-2009, BMBF, DE)
KLIMZUG	„Klimawandel in Regionen zukunftsfähig gestalten“, research programme (DE)
KNMI	Royal Netherlands Meteorological Institute (NL)
KomPass	Competence Centre for Climatic Consequences and Adaptation (DE)
LCLIP	Local Climate Impact Profile (UKCIP tool)
LWEC	Living with Environmental Change Programme (UK)
MeteoSwiss	Federal Office of Meteorology and Climatology (CH)
MNP	Netherlands Environmental Agency, predecessor of PBL (NL)
MRP	Major Research Providers (Scotland)
NAP/ACC	National Adaptation Programme: “Adapting to Climate Change” (UK)
NGO	non-governmental organization
NL	The Netherlands
OcCC	Advisory Body on Climate Change (CH)
OECD	Organisation for Economic Cooperation and Development
PBL	Netherlands Environmental Assessment Agency (NL)
PIK	Potsdam Institute for Climate Impact Research (DE)
ProClim-	Forum for Climate and Global Change (CH)
R&D	research and development
RAC	Réseau Action Climat France (NGO, F)
RADOST	Regional Adaptation Strategies for the German Baltic Sea Coast (KLIMZUG region, DE)
RCCPs	Regional Climate Change Partnerships (UK)
RCP	Representative Concentration Pathway
REGKLAM	Regional Climate Change Adaptation Programme for the Model Region of Dresden (KLIMZUG region, DE)
REMIND-R	Regionalized Model of Investments and Development with Ramsey-type optimal growth model
ReSciPI	ACRP research project “Reshaping Science Policy Interactions in Climate Policy: International Stock-Taking and Lessons for Austria”
RIVM	Netherlands National Institute for Public Health and the Environment
RoC	Roadmap of Change
RPP 2	second Report on Proposals and Policies under the Climate Change (Scotland) Act
SAP	Strategic Advisory Panel
SCL	saliency, credibility, legitimacy (criteria to measure effectiveness)
SCNAT	Swiss Academy of Sciences (CH)
SME	small and medium-sized enterprise
SNACC	Suburban neighbourhood adaptation for a changing climate, project (UK)

SRU	German Advisory Council on the Environment (DE)
TNO	Netherlands Organisation for Applied Scientific Research (NL)
UBA	Federal Environmental Agency (DE)
UK	United Kingdom
UKCIP	UK Climate Impacts Programme (UK)
UKCP09	UK Climate Projections 2009 (UK)
UKERC	UK Energy Research Centre (UK)
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VROM	Ministry of Housing, Spatial Planning and the Environment (NL)
WBGU	Advisory Council on Global Change (DE)
WCRP	World Climate Research Programme
€	Euro
3Di	Water Management decision support tool (KfC, NL)

Part A: Introduction

1 The *ReSciPI* project

ReSciPI – Reshaping Science Policy Interactions in Climate Policy is a joint project of the Institute of Forest, Environmental and Natural Resource Policy at the University of Natural Resources and Life Sciences, Vienna (BOKU) and the Chair of Environmental Governance at the Institute of Environmental Social Science and Geography at Albert-Ludwigs-University Freiburg. ReSciPI departs from the assumption that the complex policy field of climate change mitigation and adaptation is in urgent need of 'usable knowledge', and that sound scientific expertise is a prerequisite for more effective policies. Despite a plethora of efforts, the operative linking of substantive knowledge and political and societal decision-making still remains a daunting challenge. In this context, the overall objective of ReSciPI is to provide policy-relevant insights on effective science-policy interactions in climate policy, especially with respect to the question of how science-policy interactions can be *effectively institutionalized and how processes of knowledge brokerage between various actor groups* (including climate scientists, policy-makers, interest group representatives, civil society actors, and the media) can be fostered. ReSciPI has built on an innovative theoretical approach that goes beyond the simple, linear transfer of scientific knowledge into policy-making. ReSciPI has conceptualized science-policy interactions in an iterative and reflexive manner as *knowledge brokerage* (KB). Specifically, ReSciPI has aimed to:

1. map and analyze the institutions, actors and processes of science-policy interactions in Austrian climate policy in order to identify the strengths, weaknesses, potentials and obstacles for an effective KB (working package 1),
2. provide an overview of different forms of institutionalization of climate KB in selected industrialized countries (stock-taking survey, working package 2),
3. get a profound understanding of how climate science and climate policy are effectively integrated in innovative KB models (in-depth cases, working package 3), and
4. provide options on how institutions and processes of KB can be improved by synthesizing the empirically gained in-sights and critically reflecting with relevant stakeholders on how a more productive climate science-policy interface in Austria and beyond could look like (working package 4).

First results of working packages 1 and 2 have already been published in discussion papers and are available online:

- Hermann, A.T., A. Bauer, M. Pregernig, S. Reinecke, K. Hogl und T. Pistorius (2012): Die Interaktion von Wissenschaft und Politik in der österreichischen Klimapolitik, InFER Diskussionspapier 01/2012.
- Reinecke, S., A. Bauer, M. Pregernig, A.T. Hermann, T. Pistorius and K. Hogl (2013): Scientific climate policy advice: An overview of national forms of institutionalization, InFER Discussion Paper 2/2013.

This report presents and discusses the findings of nine in-depth case studies analysed in working package 3. More information on the project can be found at the website: http://www.wiso.boku.ac.at/rescipi.html.

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2 Climate policy in need of 'usable knowledge'

A sound evidence base for policies appears particularly relevant in the complex policy field of climate change mitigation and adaptation. The field is characterised by peculiar problem structures, including high degrees of functional and spatial interdependence, irreducible uncertainty and ignorance, as well as societal ambiguity and conflict-ladenness (Jänicke & Jörgens, 2006, Biermann, 2007, Hogl *et al.*, 2012). Hence, there exists an elevated need for politically 'usable knowledge' (Lindblom & Cohen, 1979). As a consequence of the growing pervasiveness and inherent complexity of science-related issues in climate policy the actual use and demand for expert scientific advice to inform decision-making has increased significantly and contributed to marked changes of the advisory landscape: Today, scientific policy advice not only takes place in classical formats, like IPCC-like expert panels or advisory committees, but – especially when seen from a broader, less linear perspective – takes many and much more diverse forms. Venues and modes of scientific policy advice range from IT-based integrated assessment tools to collaborative planning and decision-making forums, from ad hoc consultancy contracts to long-term thematic research programs, from intergovernmental panels to private think tanks. Within those different venues, we see an even greater variety of how scientific policy advice is enacted.

The idea that scientific knowledge can be directly transferred into politics still dominates the conceptions of many scientists and policy makers (Grundmann, 2009, Weingart, 1999). For this reason we still see many advisory bodies which follow a transfer-oriented format of 'science speaks, politics listens'. Nonetheless, we also observe in many countries the emergence of a range of new ideas and innovative approaches for how to shape and institutionalize science-policy interactions in a more interactive and reflexive way. Those more innovative forms of scientific advice promise useful policy options and guidance for environmental and climate policy.

In light of the demand for and interest in innovative ways of science-policy interactions, the ReSciPI project strove to systematically map and scrutinize different (traditional but mainly new) forms of KB as employed in various industrialized countries. While there exists a considerable body of academic literature on the setup and effectiveness of scientific advice bodies at the international level (especially on the flagship IPCC; e.g. Pielke, 2007, Beck, 2009, Beck, 2012), only some scattered research is available on national or sub-national formats within selected countries (for instance the UK, Germany, USA, or Canada). The ReSciPI project aimed a closing this research gap by focusing on national (or sometimes subnational) advisory structures and institutions. In a first research step, a stock-taking survey of 30 knowledge brokerage institutions provided a first systematic comparative account on how scientific policy advice on climate change is institutionalized and put into practice in selected countries (Reinecke *et al.*, 2013). In a second research step, nine particularly innovative KB institutions in four countries were selected and analysed in greater depth (for more details on the methodological approach see chapter 4 below). The results of the in-depth analysis are documented in this research report, which is structured as follows: The remaining two chapters of Part A briefly introduce the underlying conceptual approach (Chapter 3) and present the methodology, including sampling strategy and methods of data collection (Chapter 4). Part B presents the key insights from the nine in-depth case studies. The case reports in Part B are organized along the selected countries, i.e. Germany, the Netherlands, Switzerland and the UK (Chapters 5 to 8). Each chapter starts with an overview on specificities of the science-policy interface in the respective country; followed by a description and analyses of the individual case studies that focus on the general characteristics, the institutionalization, the main activities and the strategies to ensure effectiveness. Part C provides a synthesis of the key results, with Chapter 9 shortly summarizing the basic features of the nine KBIs, Chapter 10 focusing on prominent patterns of knowledge brokerage and Chapter 11 discussing the challenges and tensions KBIs face in order to ensure their effectiveness in climate policy advice. In chapter 12 we draw general conclusions.

3 Science-policy interactions as knowledge brokerage

The ReSciPI project builds on a conceptualization of science-policy interactions as '*knowledge brokerage*' (in short: KB). This KB perspective has been chosen in order to allow capturing all the different types of science-policy interactions, especially the more innovative forms that clearly go beyond a classical linear model of knowledge transfer. Science-policy studies have shown that the linear model has severe empirical and conceptual deficiencies (Beck & Bonß, 1995, Weingart, 1999, Pregernig, 2007c).

The linear model builds on the assumption of a clear line of separation between knowledge production (the 'science domain') and knowledge use (the 'policy domain'). The two domains are linked in a unidirectional way that can best be described with the phrase "speaking truth to power" (Price, 1981). With that, the model is based on the naïve hopes that scientists could simply do the science and hope that someone else uses the information to make good policies (Cortner *et al.*, 1999). In reality, decision makers keep on complaining about a wealth of fragmented parts of sometimes contradictory information which is perceived as useless, while scientists continue with the production of information that remains unused (Cash *et al.*, 2002). Apparently, the most prominent favoured contemporary forms of scientific policy advice, such as 'science inventories', 'state-of-knowledge reports' or advice bodies like the IPCC, often fail to exert the influence on policy-making for which they had been established in the first place (Beck, 2012, Pielke, 2010).

In this light, we applied a more iterative and dynamic understanding of science-policy interactions to our analyses. Our KB model derives its conceptual and empirical strength from a thorough combination of different theories and approaches within political sciences and science and technology studies:

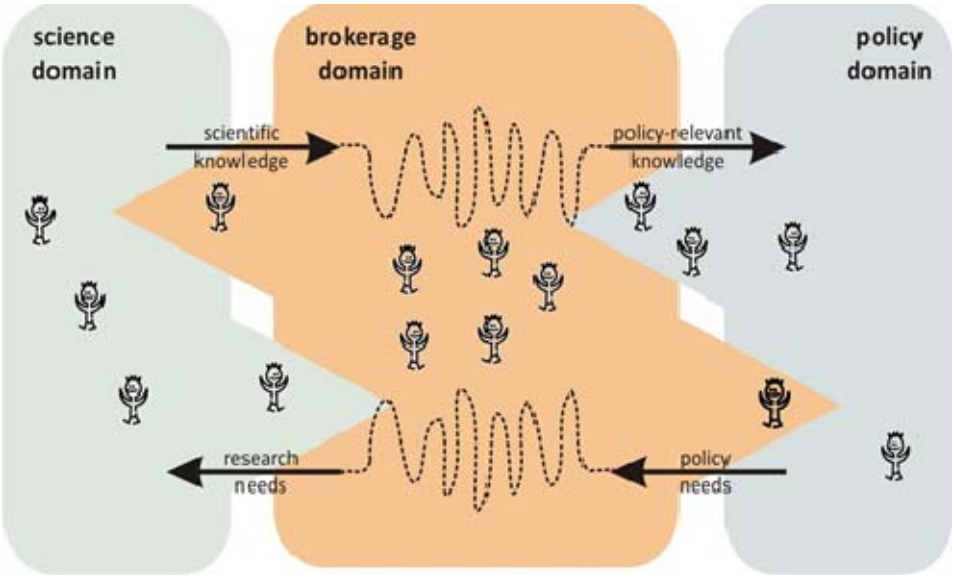
- *'Two-communities'* theories depart from the fact that scientists and policy makers live and operate in separate worlds with different and often conflicting values, reward systems, conceptions of time, and languages etc. (Caplan, 1979, Rich, 1991). Consequently, science-policy interactions tend to degenerate to a "dialogue of the deaf" (van Eeten, 1999), in which science and politics talk at cross purposes.
- Theories of *knowledge utilization* suggest that the use of research findings typically does not come in a direct and instrumental form that simply transferred knowledge into the non-scientific world for the "best of society" (Weiss, 1977, Rich, 1977, Webber, 1992, Oh, 1996, Hisschemöller *et al.*, 2001). Rather it is used in more indirect and conceptual ways where knowledge diffuses from science to policy on paths that are not pre-organized or pre-planned; an insight that was captured by C.H. Weiss (1980) with the concept of "knowledge creep". Hence, the production of generative ideas and mental models is at least as important as that of hard scientific data (Weiss, 1991, Pregernig, 2000, Pregernig, 2007b).
- *Rational actor* theories highlight the strategic aspects of the interaction between science and politics (Collingridge & Reeve, 1986, Martin & Richards, 1995, Radaelli, 1995). In the policy process political actors often use or even misuse scientific information for promoting their individual interests (Boehmer–Christiansen, 1995, Pregernig, 2007c): as a source of authority to legitimize official policies, as instruments to persuade in debates and negotiations, as a mechanism to delay or avoid action (more research helps gaining time and passes a part of the decision responsibility to science), or as a scapegoat to distract from policy reversion (politicians may change minds without losing their face or having to admit they were wrong).
- Theories of *boundary work* argue that what demarcates science from non-science is not a set of essential characteristics inherent to scientific knowledge itself, but rather the outcome of strategic, rhetorical positioning (Gieryn, 1983, Gieryn, 1999, Jasanoff, 1987, Jasanoff, 1990). In the interaction between science and policy boundaries serve various functions which sometimes appear to be contra-

dictory. While clearly discernible and undisputed lines of demarcation may protect science from politisation and ensure the political acceptability of advice, boundaries may also act as obstacles to communication, collaboration, and concerted action. A targeted management of boundaries marks a promising leverage to link knowledge to action in more productive ways (Cash *et al.*, 2002, Pregernig, 2005, Pregernig, 2007a).

- Building on the notion of boundary work, the concept of *'boundary organization'* takes a closer look at institutions that facilitate this communication and provide mediating functions between science and policy (Guston, 1999). Existing at the frontier of the two distinct social realms, boundary organizations bear different responsibilities for each domain. They draw their stability not from isolating themselves from external political authority but precisely by being responsive to opposing, external authorities (Guston, 2001, Cash & Clark, 2001).

Before the background of the above-mentioned set of theories and perspectives, our KB approach perceives scientific policy advice as a social *process*, which typically unfolds in recurring instances of joint action between scientists, policy-makers, interest groups, the media and citizens and, with that, goes well beyond the production and transfer of a product (e.g. a written report). Moreover, such concept draws no clear a-priori line of demarcation between the two domains, but rather sees the boundary between them as constantly re-negotiated and, in many cases, as permeable and dynamically shifting (Jasanoff, 1987, Jasanoff, 1990, Gieryn, 1983, Gieryn, 1999). Accordingly, science and policy come together in a hybrid *brokerage domain* in which they negotiate the relevance and cogency of knowledge claims – while still keeping their particular identities and operating conditions as specific societal subsystems (see Figure 1). Based on this multi-theory analytical framework the presented in-depth case studies explore different forms and practices of climate KB and assess their effectiveness.

Figure 1: Science-policy interaction as knowledge brokerage



One of the key questions in the ReSciPI project was how knowledge brokerage is actually enacted in practice. In the first stage of our international comparison, i.e. the stock-taking survey of 30 climate KBIs in various countries (see Reinecke *et al.*, 2013), we identified a set of typical ***knowledge brokerage activities*** (KBA). By means of systematic inductive stock-taking we arrived at seven broader types of

activities, in the sense of distinct patterns that occurred in multiple cases of our sample. The different activity types together with distinctive approaches of how to enact them are presented in Table 1.

Table 1: Types and subtypes of knowledge brokerage activities

Type of KBA	Sub-types
KBA1 Knowledge needs and research gaps identification	- state-of-knowledge reviews - research evaluation /validation - user consultation
KBA2 Coordination and networking activities	- peer networking - stakeholder networking - pure 'match-making'
KBA3 Compiling and translating scientific information	- scientific assessments - science translation approaches
KBA4 Decision support	- decision support tools - capacity building
KBA5 Policy analysis, evaluation and development	- policy analyses / evaluation - develop policy / draft legislation
KBA6 Personal policy advice and consultation	- chief scientist - designation to advisory bodies - *ad hoc* advice to policy - quasi-political representation
KBA7 Public outreach	- internet-based - classical mass media - 'enacted' forms

Besides the activities that KBIs engage in, the ReSciPI project was also interested in the **effectiveness** of different types of KBIs. Despite the different views on what constitutes effectiveness it is widely considered as one of the key success criteria for scientific-policy advice in the scholarly as well as in the corresponding political debates. In a more instrumental reading, effectiveness stands for the influence that KB institutions and activities wield on political debates and decision-making. Influence can be evidenced directly in the uptake of recommendations and policy options and hence changes in policies. Since the often indirect influence of science on politics generally occurs over long time periods and is not straightforwardly observable (Pregernig, 2006), the scholarly literature proposes to draw on *interim criteria* for effectiveness of scientific policy advice. In particular, research on the policy impacts of global environmental assessments (GEA) singled out three characteristics of assessments as '*proximate pathways to effectiveness'*, that is, the criteria of saliency, credibility, and legitimacy (Cash *et al.*, 2003, Farrell *et al.*, 2006, Mitchell *et al.*, 2006). *Saliency* refers to the perceived relevance or value of the assessment to particular groups who might employ it to promote policy changes; *credibility* stands for the

perceived authoritativeness or believability of the technical dimensions of the assessment process to particular constituencies; and *legitimacy* is targeted at the perceived fairness of the assessment process to particular constituencies.

In recent years, the three criteria of saliency, credibility and legitimacy (SCL) have not only been employed on environmental assessments in a narrower sense, but they have been used for evaluating a broad range of science-policy interfaces, especially in the field of environmental policy. One aspect that has not yet been sufficiently addressed in the literature is the question of how SCL characteristics are ultimately enacted in specific advisory settings. Our analyses aim at contributing to the closing of this research gap; therefore, we focus on the specific *strategies* that advisory institutions deliberately employ to ensure saliency, credibility and legitimacy of their advice and, in the end, foster their political and societal influence.

4 Methodology

Case studies

The study of innovative knowledge brokerage institutions followed a qualitative case study approach (George & Bennett, 2005). Building on the survey of 30 knowledge brokerage institutions in 11 OECD countries that was conducted in Work Package 2 of the project (see Reinecke *et al.*, 2013), nine particularly insightful cases were selected for further in-depth analysis (Table 2). The selection criteria for the cases included: variance on the forms of institutionalization (i.e. research programs, research institutes, and advisory services), thematic focus (including advice on mitigation and adaptation), their innovativeness (in terms of institutionalization or activities) and their relevance for and visibility in climate policy in their respective countries. In addition, we decided to concentrate on four countries (i.e. Germany, the Netherlands, Switzerland and the UK) to be able to carve out how a country's socio-political context influences science-policy interactions (Renn, 1995, Jasanoff, 1986, Jasanoff, 2005, Jasanoff, 2012).

In order to gain in-depth insights into the activities of the selected KBIs and trace their actual influence in political and societal decision-making, we selected and analysed 2-4 prominent *exemplary activities* per case. The selection of the exemplary activities draws on their representativeness for the KBI (i.e. the episode belongs to the core activities of the KBI), the episodes' innovativeness in terms of science-policy interactions (for example particularly interactive or participatory approaches), and the variety of KB activities (see Table 1). Furthermore, a specific emphasis was laid on science-*policy* interactions rather than science-society interactions. Exemplary activities differ in type, size and duration and include complete projects, KB studies, core services and functions of the KBI and specific products. The number of selected episodes varies among the KBIs depending on how many were needed in order to appropriately illuminate the case. Table 2 lists the analysed KB institutions and exemplary activities. The KBIs are listed per country in chronological order of their initiation.

Table 2: List of cases of knowledge brokerage institutions and activities

Country	KB institution	Episodes
Germany	*PIK*	1. Personal policy advice 2. Commissioned Reports 3. Climate Impacts Online portal 4. Engaging civil society in low carbon scenarios
	KLIMZUG	1. Roadmap of Change 2. Piloting resilient urban development 3. RADOST-Tour – Baltic Sea Coast 2100
	CSC	1. „Klimanavigator“ platform 2. Climate signal maps 3. Climate fact sheets 4. Adaptation planning support in regions
Netherlands	*PBL*	1. Exploration of Pathways towards a Clean Economy by 2050 2. IMAGE 2.4 3. Assessing an IPCC Assessment
	KfC	1. Hotspot Haaglanden Region 2. Hotspot Rotterdam Region 3. Theme 7 – Governance of Adaptation 4. Theme 8 – Decision Support Tools
Switzerland	*ProClim-*	1. OcCC – Organe Consultatif sur les Changements Climatiques 2. Parliamentary Group “Climate Change”
United Kingdom	*UKCIP*	1. ARCC Coordination Network 2. Local Climate Impact Profile - LCLIP 3. Communicating the United Kingdom Climate Projections - UKCP09
	CCC	1. Setting and monitoring the UK carbon budgets (CCC) 2. Progress reports on adaptation policies (ASC)
	ClimateXChange Scotland, CXC	1. Call down service 2. Informing the Scottish Adaptation Programme 3. Aligning science to policy: Policy Milestones

Data collection and analysis

The single case studies of KBIs and exemplary activities draw on document analysis and interviews. Analysed documents encompass, for instance, strategic documents and reports of the KB institutions (e.g. annual work programs, evaluation reports), public relations documents (e.g. mission statement, website, press relations) and project reports (especially of the selected exemplary activities). The insights from the document analysis were iteratively extended and enriched with information from qualitative semi-structured expert interviews (Bogner *et al.*, 2009). Around three to nine interviews were conducted for each of the nine KBI cases, 51 interviews in total. Interviews were conducted face-to-face and by telephone or Skype. The interviewees included:

- Experts at the strategic level of the KB institution: actors involved in defining/deciding the institutes' strategy or corporate identity (e.g. the director, executive director, general secretary, chair of steering committee);
- Experts of the KBI prominently involved in the selected exemplary activities (e.g. project leaders, senior researchers);

- Representatives of ministries and other branches of government: officials who supervise or commission research, who are involved in planning research activities at the KBI, or who deliberately use research results;
- Other 'customers' e.g. administrative representatives in regions or municipalities involved in exemplary activities either as commissioners and/or involved stakeholders.

All interviews were tape-recorded and transcribed[1]. Afterwards, the interviews were interpreted by means of qualitative methods of content analysis (Mayring, 2000, Kohlbacher, 2006) partly deductively along a set of predefined analytical dimensions and assessment criteria and partly inductively. In broader terms, three dimensions guided the analysis and comparison of the cases: The politico-cultural and policy-specific context of the respective KB institution, the KB activities, including interactions with customers or addressees, and the effectiveness of the KBI and the selected exemplary activities in terms of saliency, credibility and legitimacy.

[1] To guarantee anonymity, the interviewees are referred to by the KBI abbreviations and consecutive but randomly assigned numbers (i.e. PBL 1, PBL 2, etc., CCC 1, CCC 2, etc.).

Part B: National case studies

5 Germany

5.1 Overview on climate policy advice in Germany

During the first decade of international climate negotiations Germany has taken a role as front runner. It, for example, hosts the secretariat of the UNFCCC and in the negotiations on the Kyoto Protocol former Environmental Minister Angela Merkel played a crucial role in mediating between developed and developing countries. Nationally, Germany has actively pursued a reduction of GHG emissions and, consequently, fostered the increased use of renewable energies though regulative and market-based policy instruments. This has earned Germany the label of a leader in mitigating climate change (Hustedt, 2013, Klein, 2012). The comparatively high importance of climate policy, at least until the beginning of the financial crisis, is reflected in a widely diversified landscape of scientific advisory institutions of which the three analysed KBIs (PIK, KLIMZUG and CSC) present distinct phases and approaches.

Important foundations for German climate policies were laid already in the 1980s and early 1990s by the parliamentary Inquiry (Enquête) Commission on “Preventive Measures to Protect the Atmosphere”. Scientists and parliamentarians discussed concerns about climate change and its expected impacts, and formulated ambitious objectives regarding the reduction of GHG emissions (Enquete-Kommission "Vorsorge zum Schutz der Erdatmosphäre" des Deutschen Bundestages, 1991). At about the same time several non-university research institutions and think tanks, including the Potsdam Institute for Climate Impact Research (PIK, 1992; see chapter 5.2) and the Wuppertal Institute for Climate, Environment, and Energy (1991), were founded for the purpose of establishing Germany as a leading site for climate change science and to provide a sound scientific basis for climate policy (Hustedt, 2013). Other university and non-university research institutions – most prominently the Max–Planck Institute for Meteorology, several Helmholtz centres (including the Alfred-Wegener Institute), the Institute for Meteorology and KlimaCampus at the University Hamburg – also orient their activities toward research on climate change and represent important actors in climate research and policy advice. In many cases these research institutions are represented by prominent scientists, e.g. Prof. Schellnhuber, Prof. Latif or Prof. von Storch, who sometimes promote quite antagonistic positions in both, scientific debates and publicly through the media (Böcher & Töller, 2012). Despite these disputes, Germany shows a general public consensus on the existence of anthropogenic climate change. Even after the Climategate affair only little climate scepticism can be observed in Germany (Hoppe *et al.*, 2012). It is mainly reduced to few single voices, such as the European Institute for Climate and Energy EIKE, in the public discourse.

The broad landscape of climate change research institutions is complemented by several organizations which maintain close relationships to ministries and government, i.e. particularly the Federal Environment Agency (UBA) and two independent scientific advisory bodies – the German Advisory Council on Global Change (WBGU) and the German Advisory Council on the Environment (SRU). While the UBA serves as a governmental research agency mainly for the Ministry for Environment, Nature Conservation, and Nuclear Safety (BMU), the two advisory bodies gather and analyse scientific findings to advise the federal government (Böcher & Töller, 2012, Hustedt, 2013, Hoppe *et al.*, 2012, Weingart & Lentsch, 2008).

Over the last decade, the increasing political attention for adaptation to climate change has contributed to a further diversification of the advisory landscape. In this context, the Competence Center for Climatic Consequences and Adaptation (KomPass) at the UBA supports the German Strategy for Adaptation to Climate Change (DAS) by identifying vulnerable areas and regions, assessing climate change impacts,

and pointing out opportunities and challenges of adaptation measures in close collaboration with all relevant stakeholders (CSC 1, 2, Hustedt, 2013, 101). In addition, several applied research programs, including KLIMAZWEI (2006-2009) and the regionally focused KLIMZUG (2008-2014; see chapter 5.3), were established. Also as a support of climate change adaptation the Climate Service Center Germany (CSC) (see chapter 5.4), in which an interdisciplinary team of researchers compiles and passes on scientific expertise tailored to the needs of users, was established by the German Government as a central element of its "high-tech strategy climate protection" (Bundesministerium für Bildung und Forschung, 2007) and the DAS (CSC 1, 2, 3).

Overall, we find a diversified landscape of knowledge brokerage institutions that provide scientific expertise to inform German mitigation and increasingly adaptation policy. Particularly along with the emergence of adaptation policy we observe a trend toward participatory approaches of policy advice. Knowledge organizations within this context increasingly orient themselves toward targeting new addressees and providing tailored, practice-oriented information for users.

5.2 Potsdam Institute for Climate Impact Research (PIK)

5.2.1 General description of PIK

The Potsdam Institute for Climate Impact Research (PIK) is an independent, non-university research institute engaged in the integrated and interdisciplinary study of global change and its impacts on ecological, economic and social systems. Its purpose is to examine the Earth system's capacity for withstanding human interventions and to devise strategies and options for a sustainable development of humankind and nature (Wissenschaftsrat, 1999). The non-profit institute was founded in 1992 as member of the Leibniz Association[2] by the Ministry of Science and Technology and the Ministry of Science, Research and Culture of the State of Brandenburg on instigation by the German Science Council (Wissenschaftsrat, 1999). A large part of the overall budget (ca. 28 million euros in 2011) is covered by the Federal Republic of Germany and the Federal State of Brandenburg (in total ca. 11 million euros in 2011, equal shares). Beyond that the institute is, inter alia, funded by national or EU research grants(Leibniz Gemeinschaft, 2012).[3]

5.2.2 Institutionalization

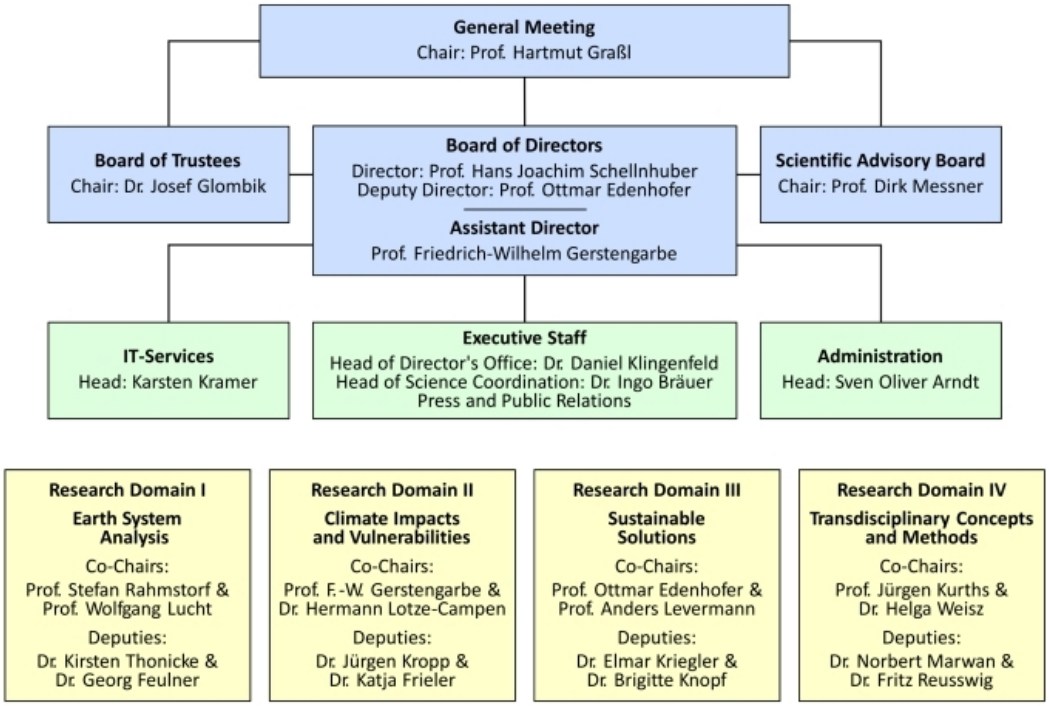
PIK is located in Potsdam and is headed by Professor H.J. Schellnhuber. It employs approx. 320 national and international researchers with diverse disciplinary backgrounds, ranging from natural to social sciences and communication professions (Leibniz Gemeinschaft, 2012). Research is conducted in four domains: 1. Earth System Analysis, 2. Climate Impacts and Vulnerabilities, 3. Sustainable Solutions, 4. Transdisciplinary Concepts and Methods. These domains are supported by the executive staff (including director's office, scientific coordination and press and public relations), administration and IT-services. A Board of Directors is responsible for the overall management and direction developing for instance the research programmes (consulting all staff), working plans and annual reports. The Board of Trustees (so called "Kuratorium") is composed of currently 9 independent members representing the

[2] The Leibniz Association is an umbrella organization of 87 independent research institutions in the public interest that conduct research, provide infrastructure for research and perform research-based services for the public, policy makers, academia and business: http://www.leibniz-gemeinschaft.de/.

[3] http://www.pik-potsdam.de.

federal and state government as well as research institutions and society (NGOs). It controls the Director and appoints the Scientific Advisory Board. It decides upon all fundamental aspects of the institute which guide the overall research activities. The Scientific Advisory Board encompasses 12 independent international researchers that advise PIK regarding, for instance, the medium term research planning and development and evaluates all research, advice and services annually in a report which may decide upon continuation of and changes to core projects (Wissenschaftsrat, 1999, Leibniz Gemeinschaft, 2007). The General Meeting is the major constitutional body of the registered association where all members (incl. representatives of the State of Brandenburg and the Federal Republic as major funders) convey on an annual basis to change the statutes of the association, approve annual reports and to elect the "Kuratorium".

Figure 2: organizational chart PIK



Source: retrieved from http://www.pik-potsdam.de/institute/organization

PIK is regularly evaluated by the Leibniz Senate on contents and structure on behalf of the state governments' Joint Science Conference (GWK).[4] Moreover, in 1994 the predecessor of the GWK commissioned the German Science Council to externally evaluate PIK regarding its research quality and organization (Leibniz Gemeinschaft, 2007, Wissenschaftsrat, 1999).

5.2.3 Activities

In line with PIK's declared intention to produce the information necessary for decision making for sustainable development the institute engages in a variety of knowledge brokerage activities (KBA). PIK's KBAs strongly complement and make use of its research expertise in the field of Earth System analysis. A core activity is the *compilation and translation of scientific information (KBA3)*. For instance, PIK is

[4] http://www.leibniz-gemeinschaft.de/.

conducting integrated environmental assessments, and therewith considerably contributes to the IPCC's mitigation working group. Likewise a major part of its applied research involves developing scenarios and models for (global) natural and social systems employing state-of-the-art computer simulations and integrated data sets (Leibniz Gemeinschaft, 2007, van der Sluijs, 2002). By applying higher resolution levels (e.g. regional) PIK aims at enhancing the 'prospective' or 'alarming' practical relevance of these models and simulations.[5] While many of PIK's efforts concentrate on the improvement of the science basis of policy advice, the institute is also active in translating scientific information into accessible formats, such as reports, working papers, brochures, fact sheets, or online research briefs. Its interactive maps on "tipping elements", for instance, indicate and visualize core components of the Earth System that could tip with an on-going human intervention on Earth.

PIK produces several products tailored at *supporting decisions (KBA4)* like the interactive "Climate Impacts Online" platform (see below). With these tools, PIK seeks to help various decision makers to identify and support sustainable pathways for long-term climate protection. They build upon the *analysis and development of* regional and global *policy options (KBA5)*, which PIK conducts in particular within the research domain on "Sustainable Solutions". With this research PIK can provide input to on-going policy processes that are, for instance, concerned with the development of adaptation strategies, like the water resource management of the federal state of Brandenburg.

PIK is furthermore engaged in *networking and coordinating with peer institutions as well as with practice (KBA2).* It has built up or coordinates quite a few national and international research networks and efforts in order to broaden and solidify the knowledge basis, e.g. the Global Climate Forum or by hosting the Technical Support Unit (TSU) of the mitigation working group for IPCC. To facilitate the take up of research in practice, PIK also networks with actors outside academia. For instance, it serves as co-location centre for Climate-KIC, one out of three Knowledge and Innovation Communities (KICs) of the European Network of Innovators. Climate-KIC is a collaborative research network of private, public and academic actors that seeks to accelerate and stimulate innovation.

Beyond that PIK's policy support often embarks *personal consultation (KBA6)*, where lead scientists and in particular the director, Prof. Schellnhuber, provide advice to the policy arena (e.g. German Government, UNFCCC) in bilateral dialogue or in more institutionalized ways like through academies of science or advisory bodies (PIK 3).

One related concern is the improvement of research in the field by *systematically identifying research gaps (KBA1)* in particular by understanding and reducing persisting uncertainties. With that, PIK seeks to enhance the existing information basis which its policy advice is built on.

Typically, PIK mainly targets climate science peers as well as regional, national and international decision makers from the policy (state administration, international organizations, such as UNFCCC or World Bank) and business communities (e.g. through Climate-KIC). Beyond that also the public and media are addressed (Wissenschaftsrat, 1999) and the institute engages in various activities that *reach out (KBA7)* to these heterogeneous target groups. Beyond more classical interviews and articles in journals, TV, or the radio its strategy also encompasses a whole set of education and information products, such as newsletters, a board game, a public climate library and museum ("weather factory") as well as lectures for students ("Science & Pretzels series").[6]

[5] http://www.pik-potsdam.de.

[6] http://www.pik-potsdam.de.

Exemplary activity 1: Personal policy advice

Personal policy advice at PIK builds an important part of the knowledge brokerage activities of the institute, yet is not understood as a formal requirement of the work at the PIK but rather as a private concern of staff members (PIK 3). Personal advice at PIK strongly builds upon the professional experience and reputation of individual researchers as well as the high scientific standing of the research institution in the international and German context (PIK 3, cf. references in Bundesregierung, 2008). Personal policy advice takes varied forms depending upon the dialogue partner and situation. Personal advice at PIK implies staying in constant contact with decision makers from policy, business, or NGOs at various occasions (e.g. in formal and informal meetings like UNFCCC side events), for instance, to provide ongoing policy developments ad hoc with policy relevant insights.

In more formalized variants, chief and senior researchers at PIK serve as members in national or international advisory committees and boards. Especially, the highly renowned and communicative director, Professor Schellnhuber, serves as a primary contact person for the German Government as well as for international organizations like the European Commission, UNFCCC, or World Bank,[7] for which PIK has become one of the most important scientific sources and dialogue partners on the issue of climate change.

Schellnhuber served *inter alia* as Chief Scientist of the German Chancellor during the EU presidency in 2007 and is a long-standing member of the WBGU, the German Advisory Council on Global Change.[8] Moreover, he is a member in various academies of science (US National Academy of Science, Leopoldina, or the Royal Society) which requires individual members to engage with and inform policy makers or the public on a constant basis. Especially, through the WBGU, which has been chaired by Schellnhuber since 1992, PIK has significantly influenced national and international climate policy, for instance the 2°C goal underlying Kyoto 1997 or German mitigation and adaptation policy (PIK 3, see also Bundesregierung, 2008).

While maintaining in constant dialogue with policy and society about research results marks an important practice for PIK, this responsibility also bears severe pitfalls. PIK's strong influence on and closeness to politics have earned the institute and especially the person Schellnhuber quite some criticism: Heated discussions arose in government and media around the re-nomination of Schellnhuber as WBGU chair, whereas it remains unclear whether the indignation is grounded in concrete concerns about the lacking legitimacy of the candidate with a supposed hidden ideological agenda or rather in the inconvenience that PIK insights on the highly controversial issue of climate change has for particular actors.[9] In particular the long-lived advisory relationship with chancellor Merkel severely fired back on the reputation of the individual researcher Schellnhuber and the institution as a whole (PIK 3).

Exemplary activity 2: Commissioned Reports

Personal dialogue also marked the gateway for a research report that was commissioned to PIK by the World Bank in 2012 (PIK 3). The report "Turning down the heat: Climate Extremes, Regional Impacts, and the Case for Resilience" (World Bank, 2012) assesses the likely impacts and risks that could be associated with a 4°C warming within this century. The report is a review study, jointly compiled by PIK,

7 http://www.pik-potsdam.de.

8 Die ZEIT Online, 03 May 2013: http://www.zeit.de/politik/deutschland/2013-05/schellnhuber-fdp-streit .

9 Spiegel Online; 02 May 2013. http://www.spiegel.de/wissenschaft/natur/wbgu-neue-umwelt-politikberater-der-bundesregierung-berufen-a-897730.html, Die ZEIT Online, 03 May 2013: http://www.zeit.de/politik/deutschland/2013-05/schellnhuber-fdp-streit; PIK 3.

Climate Analytics[10] and senior researchers at the Global Expert Team for Climate Change Adaptation of the World Bank (World Bank, 2012). It builds upon and synthesizes the most recent and peer reviewed research on the extent and impact of climate change in different regions of the world. The report focuses on developing countries and regional vulnerabilities, e.g. agriculture and livelihood security for Sub-Saharan Africa; sea-level rise, coral reef and coastal destruction in South East Asia; as well as water stress and its effects on power supply in South Asia.

As a review report it provides no new scientific insights as such, but rather summarizes and reaffirms the results and rigor of existing studies (like those of the IPCC and PIK) regarding the likely catastrophic impacts of a rise in global temperature by 4°C (Kammen, 2013). Comprising warnings rather than explicit recommendations or options for actions, the report's function is mainly to bring the issue to the attention of political actors. The report is meant to "shock […] into action" (World Bank, 2012). In this respect, the date of publication right before the international negotiations at the Conference of the Parties (COP 18) in Doha as well as executive summaries in several UN languages (English, Arabic, Chinese, French, Russian, and Spanish), but also the political backing by World Bank Group President Jim Yong Kim are targeted at revitalizing the international political attention for the mitigation issue.

Although actual policy effects of such "alarming" reports are hard to trace, the report is said to have decisively shaped the international debates at COP 18 (PIK 3), despite the rather humble progress (Simonis & Sommer, 2013). The UNFCCC webpage also highlights the report as one of four important scientific studies which underline the "the urgency to act"[11]. Contributing authors from PIK, esp. Prof. Schellnhuber, have significantly contributed to the launching and dissemination of the key findings to policy and economy (PIK 3). Especially for the major client, the World Bank, the report is widely portrayed as a successful catalyst for mainstreaming mitigation and adaptation, as well as general disaster risk concerns in its operations.[12]

In reference to the report, the World Bank has produced different products, e.g. a YouTube presentation on the findings for Africa, which, however, also proposes solutions not originating from the report or taken out of context.[13] By elaborating the policy challenges rather than concrete policy options, PIK avoids being reproached for political propaganda leaving the practical substantiation to the more legitimized political actors. Yet by the same token, this approach meant to assure scientific neutrality whilst being politically relevant ("honest broker") also sets the stage for misinterpretation or, in the worst case, political appropriation.

Exemplary activity 3: Climate Impacts Online portal

ClimateImpactsOnline.com (CIO) is an internet portal, which is currently in its piloting phase and thought to serve as decision support tool in politics or business, but also the interested public. [14] The interactive

[10] http://www.climateanalytics.org/publications; Climate Analytics is a German non-profit organization around concerned climate change (policy) experts promoting science-based policy. Further cf. http://www.worldbank.org/en/news, press release June 19, 2013.

[11] It is the first report named besides the most recent reports by UNEP, World Economic Forum and IPCC; http://unfccc.int/key_steps/doha_climate_gateway/items/7389.php.

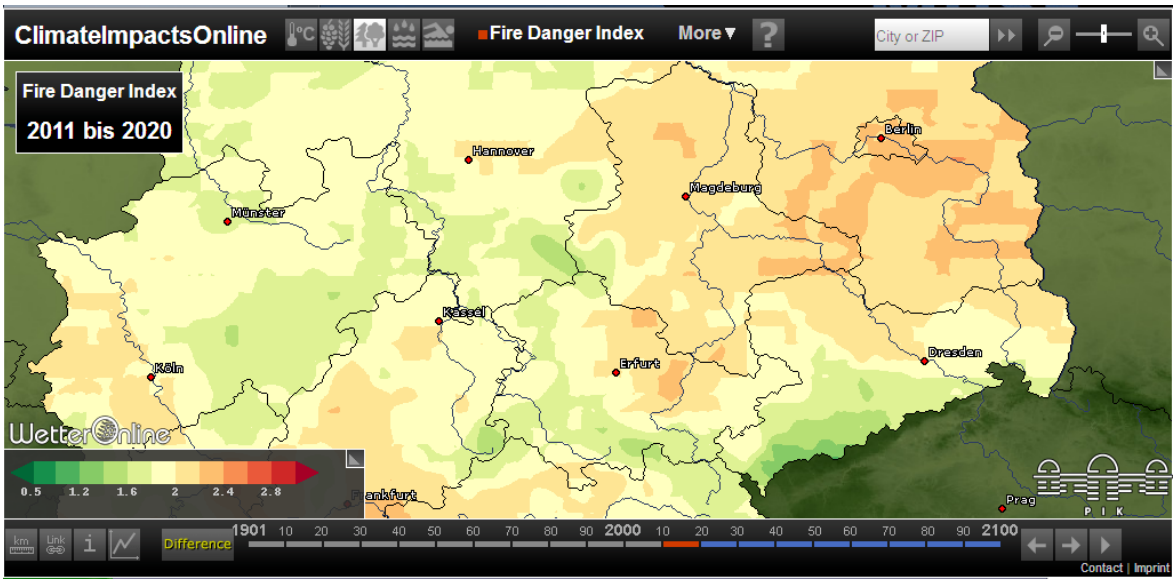
[12] http://www.worldbank.org/en/news, press release June 19, 2013. (cf. Kammen, 2013).

[13] https://www.youtube.com/watch?v=7njmXZL0Sx8. The video provides 3 solutions for Africa (and the world): heat and rain tolerable crops, expanded energy access, green growth. In contrast, the report raises the energy issue mainly for South Asia, and propagates no explicit policies or technical solutions as the video does (e.g. energy expansion or "support Green Growth").

[14] in German KlimaFolgenOnline: http://www.klimafolgenonline.com/

tool was jointly developed by PIK and the company WetterOnline[15] as part of the collaborative "Climate Impact Expert System" project, which is funded by the EU through Climate-KIC.[16] CIO is "client server"-based and free of charge. Users can run the animated colour maps anytime online on their own computers.[17] The simplified maps visualize the expected regional impacts of global climate change across different temporal and spatial scales in Germany for the sectors hydrology, forestry, agriculture, energy, tourism and health (see Figure 3). Parameters such as temperature, crop yields, ground water recharge or the risk of forest fires are available for three different levels of resolution (national, federal and district level) with a time slider at the bottom of the page allowing switching between decades. The maps build on an assorted simulation model chain drawn from and tested in the PIK research project CLIMREG and the 8.5 Representative Concentration Pathway (RCP).[18]

Figure 3: Screenshot of PIK's ClimateImpactsOnline



Source: retrieved from http://climateimpactsonline.com/

The idea is to provide users with a knowledge basis for informed decisions on adaptation in various sectors, mainly through maps but also through additional, more detailed material (tables and diagrams on singular sectors or parameters). This way, users may reconsider whether or not, for instance, a certain land use management scheme should be rethought vis-à-vis a projected increase in droughts.

Considering the anonymity of online tools it is difficult to make clear statements about the actual use of CIO in different concrete decision contexts. Nonetheless, PIK has set several measures in place that allow a broad application of the tool, e.g. an English version of the German tool and an online guidance on the major elements of the tool. Climate KIC also plans to have similar tools available for various other regions in the world. Therefore, PIK has already promoted the pilot version at the UNFCCC Climate

15 WetterOnline is a prominent weather data provider company in Germany: http://www.wetteronline.de/.

16 http://www.climate-kic.org/case-studies/project-computes-climate-change-impact/ (last accessed August 2013).

17 CIO brochure http://climateimpactsonline.com/pdf/CIO_brochure_engl.pdf.

18 8.5 RCP is the most extreme among the IPCC CO_2 emissions scenarios assuming an increase of GHG emissions of 8.5Gt/year, for more details see: http://climateimpactsonline.com/.

Change Conference in Qatar at the end of November 2012. In addition, the platform enables a direct interactive exchange between users via email or social media and a user support section allows users to ask researchers questions or to give feedback. Based thereon and on a larger test study with users from German public institutions the tool is revised.[19] Overall the tool has received very positive feedback from users regarding the graphic realization and usability, but less positive feedback from scientific peers regarding data accuracy because it only builds upon a small set (chain) of models and realization (PIK 4).[20] PIK is about to address this trade-off between usability and scientific accuracy.[21]

Exemplary activity 4: Engaging civil society in low carbon scenarios

A major approach of PIK to generate solution oriented knowledge on (climate) systems is through assessing and modelling the respective dynamic processes in the earth (and political) system (e.g. in computer simulations). Considering the high complexity of the subject matter, PIK strongly pursues joint projects with scientific and academic institutions (Leibniz Gemeinschaft, 2007). More recently, PIK has also become concerned with societal controversies around (global) environmental change issue and therefore collaborates more intensively and extensively with stakeholders from practice or with artists (Jürgens, 2004, de la Vega-Leinert *et al.*, 2008).[22] One project that combines dialogue with practice partners and classical scenario development in a co-production effort is ENCI-LowCarb "Engaging Civil Society in Low Carbon Scenarios." In this collaborative EU project (FP7), conducted between 2009 and 2011, low carbon scenarios were developed in parallel for Germany and France. In each country one prominent climate research institute and one NGO partner were involved (Germany: PIK and Germanwatch; France: CIRED and RAC France), overall communication and networking was delegated to INFORSE-Europe.[23]

PIK was mainly concerned with developing a hybrid energy-economy model for Germany (REMIND-D) that covers different sectors of the energy system; heat, transport and electricity. The model allows to generate cost-optimal scenarios for the long-term development of the German energy system, e.g. for an 80% GHG reduction by 2050 (2°C global temperature rise). In contrast to 'typical' modelling exercises PIK modellers have repeatedly consulted with the coordinating NGO Germanwatch and other stakeholders (e.g. administration, trade unions, enterprises, consumer associations) from different economic sectors. Based on the input from the stakeholders PIK has developed the underlying parameters of the scenarios to facilitate a "reality check". In roundtable gatherings and interactive and professionally moderated sector workshops, different stakeholder groups that purposefully also included potential "blockers" were asked about their acceptance of different low carbon policy measures for different sectors. Based thereon a set of efficient, effective and acceptable low carbon policies were defined (and others excluded, e.g. nuclear energy or CCS) and translated into the model when technically feasible[24]. The final model was again presented to and discussed with the same stakeholders. Both the major assumptions underlying the models as well as the potential scenarios have genuinely been co-produced with stakeholders, which also assessed in how far different low carbon pathways were "desirable". Overall

19 CIO brochure: http://climateimpactsonline.com/pdf/CIO_brochure_engl.pdf.

20 These allow delivering singular values rather than a whole range of values, which are easier to read for non-professional users, however, the approach also increase the remaining uncertainties (PIK 4).

21 cf. "weitere Planungen" at: http://www.klimafolgenonline.com/ .

22 http://www.pik-potsdam.de.

23 http://enci-lowcarb.eu/. The French NGO partner Reseau Action Climat initiated the overall project and also served as the overall coordinator (PIK 2).

24 The resolution of the model partly impaired to have very specific measures (e.g. practices at household level) reflected; Interviews (PIK 1, 2).

the dialogue with stakeholders was a major goal of the project meant to increase the relevance of the scenarios by enhancing ownership and provoking discussion among proponents and opponents (PIK 1, 2).

The final scenarios have been launched to decision makers from government and administration (e.g. UBA, BMU, BMWi) and (partly also) to economy in events and written form (brochures, newsletters), but also through the attached European network of civil society organizations and research institutions (PIK 1).[25] While policy makers were not involved in the dialogue itself to minimize the political influence over the results, they have been a major addressee of the research results: the scenarios were thought to help them to identify the political options in response to the desired future pathways of the concerned stakeholders (PIK 2). The German scenarios have been evaluated as highly relevant by policy makers, however, also as coming too late: The respective decisions ("Energiewende") were already taken in early 2011 after the nuclear accident in Fukushima, i.e. before the official project ending. In this context, the research partners could, nonetheless, draw from their involvement in the project and engage as experts in the on-going debates about the energy pathways that Germany should take.[26] Beyond that the ENCI-LowCarb scenarios are hardly directly used, besides occasions where Government agencies employ them as models to compare their own scenarios with (PIK 2).

5.2.4 Strategies to achieve knowledge brokerage effectiveness

PIK exhibits a strong record of high quality science in its field of expertise and of practice oriented policy advice and transfer activities. In contrast, concerns about the societal acceptance and legitimacy of its research are less relevant or have just recently gained attention. With regard to transparency PIK's approach is more straightforward.

Saliency

PIK is mainly focused at conducting interdisciplinary research on long term trends in (global) climate and bio-physical system. To ensure the solution orientation of this research PIK develops scenarios and models that help informing decisions that increasingly also cover *regional* impacts and vulnerabilities and higher temporal and spatial resolution levels to make them even more directly usable for concrete decisions (de la Vega-Leinert *et al.*, 2008, van der Sluijs, 2002).[27] Likewise a range of research activities and products, especially in its designated "Sustainable Solutions" domain (decision support tools, maps, policy briefs etc.) are explicitly produced to serve as decisions support basis in politics, economics and civil society. Also organizationally, the institution seeks to heighten its connectivity to practice, e.g. through the Board of Trustees with representatives from federal and state government and stakeholders from NGOs, but also with collaborative installations, such as Climate-KIC.

Credibility

The major strategy to provide eventually usable information is by conducting state-of-the-art research that is peer reviewed and interdisciplinary, if required in collaboration with or networks of other high profile institutes. Correspondingly, the institute employs a high amount of renowned researchers (typically PhDs or higher) and pursues a role as 'honest broker' that "according to good scientific practice" also

[25] European Network engaging Civil society in Low Carbon scenarios", http://www.lowcarbon-societies.eu/.

[26] From April to May in 2011 an Ad-hoc Commission was appointed by the Federal Chancellor to prepare an energy strategy (without nuclear energy) developing options and suggestions for an energy transition pathway towards renewables. http://www.bundesregierung.de/Content/EN/Artikel/_2011/04/2011-04-04-ethik-kommission_en.html?nn=447030.

[27] http://www.pik-potsdam.de.

explicates the uncertainties inherent in scenarios.[28] A substantive record of external evaluations confirms the high ("world class") quality and "innovativeness" of its research" (Leibniz Gemeinschaft, 2007), (Wissenschaftsrat, 1999). PIK's scientific excellence is, moreover, regularly evaluated by a Scientific Advisory Board. A few researchers however, e.g. Hans von Storch, evaluate the pro-active promotion of PIK research results to policy and public as problematic and perceive the institute as "climate change alarmist" (Storch & Krauß, 2013) .

Legitimacy

Generally, participatory and dialogue approaches involving stakeholders are applied at PIK for a "reality check" rather than for more socially robust and legitimate research (de la Vega-Leinert *et al.*, 2008). Consequently, legitimacy basically comes as a by-product to relevance and often the dialogue activities with stakeholders are "outsourced" to research partners with respective core competences (PIK 1, 2, Jürgens, 2004). More recently, however, the idea of grasping the different views in society and hence enhancing the acceptance has received increased attention, be it with an own designated research domain ("Transdisciplinary Concepts and Methods") or with singular project designs, e.g. for the ATEAM (Jürgens, 2004) or the ENCI-LowCarb project ("Sustainable Solutions" domain; see below).[29] Moreover, an active dissemination strategy heightens the overall transparency and with that legitimacy of PIK's research. Information on PIK projects and outputs is generally easily accessible online, e.g. in the publication section. An own "Press and Public Relations Office" assures that research is actively communicated to the policy, business and civil society communities (Leibniz Gemeinschaft, 2007). Multiple information products are also targeted at the broader public, be it online, through classical media or in more enacting ways, like with the library, museum or board games. However, potential for improvement persists regarding the access to information on internal governance processes (roles and responsibilities, annual reports, members etc.).

5.3 KLIMZUG

5.3.1 General description of **KLIMZUG**

KLIMZUG is a research programme ("Managing climate change in the regions for the future") that focuses on adapting to climate change in seven German pilot regions between 2008 and 2013.[30] The programme was initiated by the German Ministry of Education and Research (BMBF) whereas the networks in the pilot regions are typically driven and coordinated by the involved partners from both, academia and practice.

The networks aims at integrating adaptation to climate change into regional governance by identifying regional and urban vulnerabilities and developing, implementing and testing structures, institutions and procedures for adaptation. Beyond that the regional networks pursue a close cooperation between researchers, local enterprises, political decision makers, administration and other social groups.

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28 http://www.pik-potsdam.de.

29 http://enci-lowcarb.eu/.

30 dynaklim: Emscher-Lippe region (Ruhr region), INKA BB: Brandenburg-Berlin, KLIMZUG Nord: metropolitan area Hamburg, KLIMZUG Nordhessen: Northern Hesse, Nordwest2050: metropol. region Bremen-Oldenburg, RADOST: German Baltic Sea, REGKLAM: metropolitan area of Dresden; cf. http://www.klimzug.de/.

Thematically, the relevance of the adaptation issue varies between and within different regions, e.g. among sectors, such as natural resource management and agriculture, energy, traffic, tourism or health and social work. Accordingly also climate mitigation arises as an interlinked issue for some networks and (sub-)projects (KLIMZUG 1, Bardt *et al.*, 2012).[31]

The budget of the programme for the whole period encompasses 83 million euros with each region receiving up to 15 million euros. The projects within the regions are co-financed with practice partners covering around 50% of their costs, research institutions, in contrast, are funded 100% (Bardt *et al.*, 2012).

5.3.2 Institutionalization

The overall programme lead is held by the Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) in Cologne[32]. An international Advisory Board advices the programme on the implementation of its main goals, the research process as well as networking activities. The Climate Service Center in Geesthacht (see chapter 5.4) advises and supports the interdisciplinary projects, mainly by refining the results of climate research and conveying the findings to the practice partners from politics, administration, economy or the broader public.[33]

The Cologne Institute for Economic Research (IW Köln) supports the process in terms of public relations, cross communication and networking. For instance, IW Köln provides the joint presentation of KLIMZUG to the public and facilitates the communication among the seven regions (e.g. via conferences)[34] and beyond, especially with business. In newsletters, but also in its concomitant research study experiences and lessons learnt in German adaptation research and practice are drawn together (KLIMZUG 1).[35] Furthermore, the BMBF has installed a group of experts, with one expert serving as 'mentor' for each region attending all meetings and events and advising on strategic developments. The HU Berlin (FONA programme) additionally investigates the improvement of communication structures and processes (KLIMZUG 1).

Typically, each regional network is coordinated by a partner consortium encompassing (non-)university research institutions as well as practice partners such as business networks and associations, individual business enterprises, educational institutions and regional or local administrative bodies and partly also civil society. In the singular regions the number of partners varies considerably. The network coordinator in charge of project management and implementation often, but not always, is a research partner (KLIMZUG 1, 3, 4).

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31 http://www.klimzug.de/.

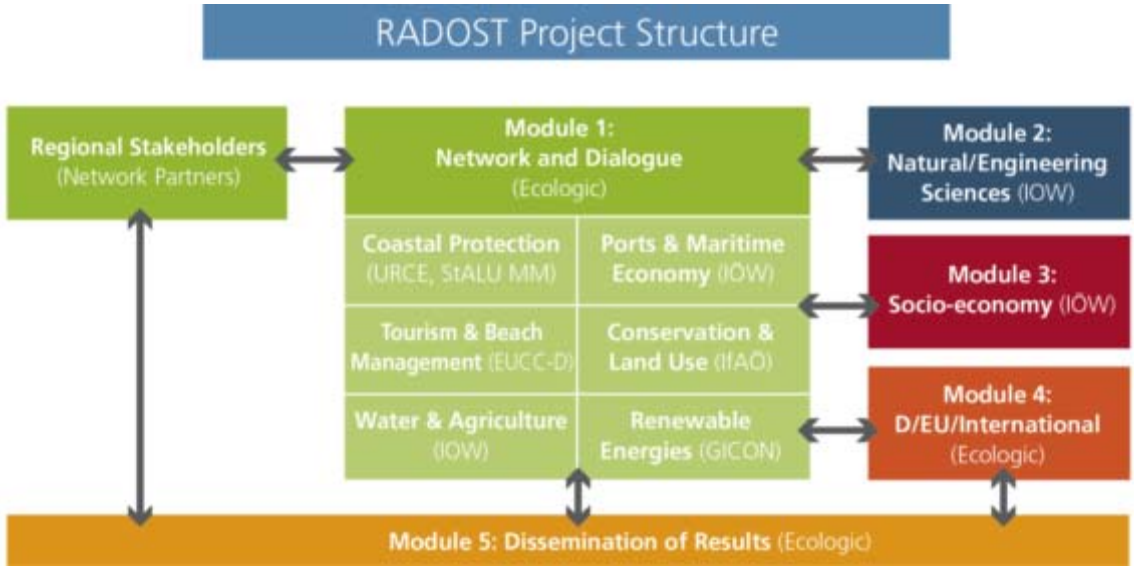
32 in English: German Aerospace Center; department environment, culture, sustainability.

33 cf.: http://www.klimzug.de/; KLIMZUG 1, 5.

34 see e.g. KLIMZUG Newsletter 1/2013 and 4/2011.

35 Research also covers pilot projects beyond KLIMZUG, e.g. in the adjacent KlimaMORO and KlimaExWoSt programs (http://www.klimamoro.de/ and http://www.bbsr.bund.de/BBSR/DE/FP/ExWoSt/exwost_node.html) with which there exists a vivid exchange on experiences and best practices.

Figure 4: Exemplary regional project structure (RADOST)



Source: retrieved from: http://klimzug-radost.de/en

The regional networks typically build upon existing cooperative structures. The activities within the regional networks are generally organized along different subject areas or "clusters" that consist of several research and practice sub-projects. Typically the number of practice oriented projects increases in the course of implementation when the regional practice network expands.[36]

Generally, there is also a regional forum set in place, i.e. a general assembly composed of all consortium partners or sub-project representatives that regularly meet to decide upon the strategic direction and implementation. An advisory board with members from academia and practice oversees all projects in the respective region. Within each region an internal evaluation of the practice projects and overall research governance approach is undertaken, e.g. by one project partner, a concomitant research project or one designated subject area/cluster (KLIMZUG 1, 3).[37]

5.3.3 Activities

Due to the regional approach of KLIMZUG, the thematic foci and activities vary between different regions and correspond to the competences and the needs identified by the consortium partners. Nonetheless, with the general aim of the programme to increase the awareness about and the capacities to adapt to future climate change the different pilot regions share approaches and common features (KLIMZUG 1).

Overall a strong emphasis is set on so called "roadmap" or other planning processes, i.e. activities that build the grounds for the development of regional adaptation options or strategies. Accordingly, the *development of practical (policy) measures (KBA5)* and instruments for *decision support (KBA4)* has been a key concern, especially in the practice sub-projects. These typically involve decision makers from policy, administration, economy, or civil society. The deliverables are practice-oriented and encompass

[36] http://www.klimzug.de/.

[37] http://www.klimzug.de/,

(IT-)tools, paper based or online guidance and manuals which aim at facilitating the consideration of adaptation in planning processes in concerned sectors, like tourism, agriculture, forestry, water management, traffic, energy, buildings, education and health care (KLIMZUG 1, 3, 4) [38].

Examples are the interactive climate maps in KLIMZUG Nordhessen to support local and regional land use planning,[39] the catalogue for adaptation measures in structural design and buildings for the model region Dresden (REGKLAM),[40] and the free online "Pflug-Lotse" (plough navigator) supporting agricultural low-water-input practices in Brandenburg (INKA-BB).[41] In addition, also concrete policy or management measures, plans or concepts have been developed. Examples include municipal planning measures against flooding in dynaklim[42] and technical water defence systems for buildings and dykes that have been developed and discussed with users in KLIMZUG-Nord.[43]

Another central common KB activity is *networking (KBA2)*, i.e. the build-up of new or strengthening of existing cooperation among different stakeholders from academia, business, politics and society within and between the regions. Accordingly, basically all regional networks engage in organizing so called annual 'regional forums' that bring together the different actors for discussion of and exchange about, regional vulnerabilities, research results, options and measures (KLIMZUG 1). Furthermore, quite a few activities take place in order to facilitate the exchange between the KLIMZUG regions and beyond (nationally and internationally). An interim (2011) and a final general conference, for instance, serve the exchange of lessons learnt among the regions (KLIMZUG 1). Regarding common working areas (e.g. sector or process related) different KLIMZUG regions have also (self-)initiated joint event series on shared issues, like "communication and education", "regional and city planning", "communal water management", "economic aspects of adaptation to climate change". [44] Moreover, a vivid exchange also takes place with (stakeholders in) adjacent research pilot projects "KlimaMORO" or Klima-ExWoSt".[45]

Evidently, the compilation and translation of the research (KBA3) on the underlying technical and physical issues is an important basis for the roadmap processes. These cover, for instance, the conducting of integrated assessments of regional climate change impacts, the development of scenarios for different climate related parameters such as water, vegetation, but also for socio-technical aspects such as infrastructure, resource management and policy measures or civil engagement (KLIMZUG 5). In all regions interdisciplinary research projects thus mark the building blocks for the overall strategy development as well as the concomitant practice-oriented pilot projects. For example, an own local current model (GETM) has been developed for the western Baltic Sea in the region RADOST and vulnerability assessments of singular sectors (city traffic) have been conducted in KLIMZUG Nordhessen (KLIMZUG 1).[46]

The KLIMZUG programme also pursues an active public outreach (KBA7) and documentation strategy beyond the actual direct beneficiaries and partners of the project. The IW Köln is mainly responsible for

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38 For selected examples cf. KLIMZUG Newsletter. 1, 2 & 3 /2013 & 4/2011.

39 http://klimzug-nordhessen.de/.

40 http://www.regklam.de/home/.

41 KLIMZUG Newsletter. 4/2012.

42 KLIMZUG Newsletter. 3/2012; http://www.dynaklim.de/.

43 http://www.klimzug.de/, http://klimzug-nord.de.

44 KLIMZUG Newsletter. 1/2013 & 4/2011; http://www.klimzug.de/.

45 The awarded model town of Syke is one such project whose local adaptation regulation is basically built upon the research results within KlimaEXWoSt. (KLIMZUG 2).

46 KLIMZUG Newsletter. 4/2011.

this external representation via newsletters, videos or podcasts for non-professional audiences.47 However, also the regional projects themselves have developed multiple, innovative information formats targeted at educating the broader public, students or pupils. KLIMZUG-Nord for instance has produced comic books ("Klimanovelle") to transfer knowledge and insights inside and beyond KLIMZUG NORD, currently on the topics: 'development of climate scenarios', 'nature conservation in the estuary of the river Elbe' and 'rain water management', more issues will follow (KLIMZUG 4).[48] Dynaklim has installed the so called „river talks" in the series „KlimaWandel(n)" in cooperation with two art projects. The "river talks", held in 2013, allow visitors to experience the central concerns and solutions regarding communal water management in alternative, more engaging and sensual ways.[49] As part of the RADOST-Tour „Ostseeküste 2100 – auf dem Weg zu regionaler Klimaanpassung" ("Baltic Sea Coast 2100 – On the Way to Regional Climate Adaptation") several evening discussions (for instance in the German Ocean Museum, Stralsund) were explicitly targeted at a local public audience informing about potential climate change impacts on the (coast of the) Baltic Sea.[50] Considering the plethora of different and often quite innovative advice practices in each of the several dozens of research and practice-oriented sub-projects in the seven KLIMZUG regions, the list of best practice examples as well as the following in-depth descriptions of concrete activities of scientific advice remains fairly selective and imperfect.

Exemplary activity 1: Roadmap of Change

Overall, KLIMZUG aims at providing guidance for regional decision makers to adapt to climate change impacts and to enhance the general resilience of the regions. This idea also guides the so called "Roadmap of Change" (RoC) process which builds the central working framework for the work in the KLIMZUG region 'nordwest 2050'. The final deliverable ("Roadmap of Change") is meant to give direction for long-term adaptation in the metropolitan area of Bremen-Oldenburg until 2050 and to offer concrete possible adaptation strategies and measures until 2020.

The ROC process encompasses 4 phases. It builds upon multiple cooperative research projects that deliver climate scenarios and vulnerability assessments for the region, as well as an overview over the innovation potentials in the region vis-à-vis the climate change challenges (phase 1). This research is complemented by the so called "vision2050" which builds upon the insights from 17 practice projects in the region (phase 2). The process develops the 'vision' (an illustrated brochure) of a possible resilient and adapted future for the metropolitan area Bremen and Oldenburg and provides orientation for twelve thematic areas, such as governance, land use planning, gender equality, consumption, education and value change, energy, agriculture, harbour logistics, coastal protection, or tourism.[51] The "vision 2050" builds the basis for a selection of possible action pathways under the conditions identified for different scenarios in phase 1. Experts from more than 30 regional institutions collaborate in phase 3 on sectoral road mapping processes for four central clusters (1. region, 2. energy, 3. nutrition, 4. harbour and logistics). Eventually, the results are fed into an integrated overall "Roadmap of Change" in phase 4.

Participation is a core principle in the 'nordwest2050' KLIMZUG project and primarily serves to enhance the practicability and acceptance of the identified adaptation strategy and measures (KLIMZUG 3). Therefore a central working group on the "Roadmap of Change" has been installed encompassing 25 regional actors from politics, administration, business (associations) and civil society which continuously

47 http://www.klimzug.de/.

48 http://klimzug-nord.de.

49 http://www.dynaklim.de/.

50 http://klimzug-radost.de/RADOST_Tour_2012.

51 www.nordwest2050.de.

oversee the roadmap development process and jointly draft and produce the final integrated strategy in the course of several workshops. An expert audience can comment online on a preliminary version of the roadmap report. The final "Roadmap of Change" will be presented to decision makers in the region at the final conference of nordwest2050 in February 2014.[52]

So far it is too early to discuss the practical use of the Roadmap as core product of the project region nordwest2050 since it is still in its finalization phase. Basically, the RoC is not a fully-fledged adaptation strategy, but rather provides guidelines for different actors and institutions in the region on how to adapt to climate change and to increase their resilience in the medium and long-term.[53] With the KLIMZUG region covering two states the political possibilities for a direct transfer into one policy (e.g. state adaptation strategy) are limited. Accordingly, a major responsibility for implementation remains with the regional actors from business and policy in the partner network (called "Frischköpfe") as well as with the 25 regionally well-respected members of the RoC working group to serve as change managers and to pursue the practical implementation of the RoC after the project ends. This strong reliance on individual engagement, however, might favour economically more attractive topics (transport, energy, agriculture) over issues such as gender, change in values or education (KLIMZUG 3).

Exemplary activity 2: Piloting resilient urban development

Like many other regions, the region KLIMZUG-Nord is highly concerned about developing adaptation strategies and options in urban contexts. Under the overall theme "integrated urban development strategies" one of the practice oriented sub-projects (T2.3) seeks to identify the challenges as well as options for such future urban development. In a nutshell, it is a highly interdisciplinary project that seeks to develop adaptation measures and strategies for different types of settlements in the metropolitan area of Hamburg.

It evaluates existing and develops more climate adjusted (resilient) settlement models and concepts as well as planning instruments that also secure a high living quality. The sub-project builds upon the research of several other sub-projects and cross-cutting areas in the region: The "estuary management" theme, for instance, informs the development of more flooding resilient settlement patterns. The cross cutting subject area "Economy" identifies the relevant socio-economic conditions for urban development planning in and around the city of Hamburg. The cross-cutting theme "Governance" supports the sub-project in developing instruments that address climate change induced land use conflicts and pilots innovative forms of process management at different spatial levels (communicative planning and social learning).

Based on this expertise the sub-project in cooperation with partners from the building sector has tested different dialogue and participation formats in four piloting municipal and communal areas (Luechow-Dannenberg, metropolitan area of Hamburg, Elmshorn, and Stade) that represent distinguished types of settlements.[54] Stakeholders representing business or administrative professionals (e.g. from the water sector) but also local residents have been invited to participate in dialogue events targeted at developing a multi-functional land-use concept. In the piloting community of Elmshorn, for instance, the applied social learning events ("Lern-Aktions-Allianz"), i.e. workshops with different professional stakeholders (park, water authorities, major office) aimed at improving the regulatory dimension of estuary management of the river Kruecke (KLIMZUG 4).

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52 www.nordwest2050.de; see also: kurz+bündig No. 6; URL: http://www.nordwest2050.de/index_nw2050.php?obj=file&aid=11&id=357&unid=82305c6c89690db560426a06391b163e.

53 kurz+bündig No. 6.

54 http://klimzug-nord.de.

In the districts of Hamburg along the river Wandse, in contrast, an extensive citizen consultation with residents took place to discuss potentially highly contentious issues such designating urban water retention areas in the settlements. These workshops have been complemented with an online discussion on the so called "DEMOS" platform around the issues of flooding and adaptation measures. The platform received over 800 contributions. To answer remaining open questions a moderation service was installed (KLIMZUG Nord 2011).[55]

While it is generally complicated to draw concrete conclusions about the actual use of the still on-going research, the project has already produced a plethora of 'products'. For instance, the urban development models can directly be employed for urban planning processes by business and administration professionals that have also already been 'trained' on their use in the course of the 'Lern-Aktions-Allianz'. In the case of the dialogue with local residents (in workshops or online), the practical focus was mainly on creating awareness for flooding risks among the public and on building up the understanding and acceptance of urban planning measures (KLIMZUG 4).

Exemplary activity 3: RADOST Tour – Baltic Sea Coast 2100

One prominent example of the extensive knowledge transfer and outreach efforts in KLIMZUG is the so called RADOST-Tour: "On the Way to Regional Climate Adaptation" (KLIMZUG 1). In September 2012, researchers and partners from the RADOST KLIMZUG region have gone "on Tour" in several cities along the coast of the Baltic Sea to discuss the issue of coastal adaptation with stakeholders. Joining into a parallel initiative of the BMBF ('future project: EARTH') the tour covered 16 different events on different issues.

Depending upon the major concerns in the respective city, the different dates were dealing with questions of coastal protection, the sea level rise, coastal erosion, water quality, renewable energy, marine biodiversity as well as international adaptation experiences, the role of urban planning and dialogue and communication for adaptation. Ten day-events have been organized that were mainly designed for the in-depth and technical exchange with regional decision makers (e.g. heads of state administration, municipalities and business associations) on the preliminary project results.[56]

At the 17th "water conference" in Guestrow, for instance, RADOST network partners from the environmental state agency of Mecklenburg-Vorpommern (LUNG) together with research institutions and civil society representatives discussed the major challenges and policy options for the Baltic Sea as regards the regional implementation of the European Union Marine Strategy Framework Directive which requires states "to achieve good environmental status in the Community's marine environment at the level of marine regions or sub-regions" (DIRECTIVE 2008/56/EC). The six evening-events, in contrast, targeted and were well visited by the broader local public. In accordance, information was 'wrapped' in more accessible formats such as short movies, poster exhibitions or guided tours, as in the case of the German ocean museum Stralsund.

As concerns the actual practical effects of the event series, the Tour is often reflected as successful since it attracted a broad audience (KLIMZUG 1). Yet, the information of the broader public about the respective local concerns is mainly limited to raising awareness. Beyond the mere transfer of project results to a broader public, the more professional day events were held with senior decision makers from local governments, administration and business (often partners from the regional RADOST network). This was sought to promote future and further existing long-term cooperation between science

55 http://klimzug-nord.de.

56 http://klimzug-radost.de/en/RADOST_Tour_2012, also: KLIMZUG Newsletter. 4/2012.

and practice on coastal adaptation.[57] Therefore an actual practical effect may highly depend upon individual engagement to make use of this newly acquired social capital beyond the project end. Pre-existing partnerships (e.g. in tourism) may be advantaged in bringing the knowledge into action (KLIMZUG 1).

5.3.4 Strategies to achieve knowledge brokerage effectiveness

Due to the contingency of the different context-tailored regional KLIMZUG projects a straightforward evaluation of the overall KLIMZUG programme is rather impaired. In line with the overall requirements of the program initiator BMBF a common infrastructure, concomitant research and parallel applied approaches and mechanisms can be identified that genuinely pursue a balanced transfer of knowledge for practice that is highly relevant to practice, highly scientifically credible and, particularly in the practice oriented projects, considerate of the social acceptance of results.

Saliency

Overall practical needs and research application are at the heart of the programme that seeks to support the development of adaptation strategies in different regions of Germany that are 'embedded in the respective culture of the regions (Bardt *et al.*, 2012). Accordingly, all sorts of relevant stakeholders are heavily involved in the partner networks in each region or in singular (practice oriented) projects (KLIMZUG 1). From the very beginning the research focus within each region was thematically aligned to the regional needs and competences of the partners in the network (KLIMZUG 1). As highlighted in the introductory description of the activities, besides the applied scientific projects (guidance, manuals etc.) particularly the practice oriented projects seek to deliver and pilot multiple technical, economic and political measures and solutions.

Credibility

While the practice-orientation and applicability of the research in KLIMZUG definitely is a major principle also the credibility of the underlying science of the practice-oriented conclusions is a concern that the regional projects address by means of involving renowned university and other research organizations as major partners in the regional projects, often also as project leaders. Project regions typically heavily draw on academic, peer reviewed research regarding the climate and socio-economic models and scenarios that their adaptation measure build upon. In this regard, but not exclusively, they can seek support from the Climate Service Center which qua strong academic standing provides an essential scientific authority to the results (KLIMZUG 1). Scientific advisory boards at the level of the overall KLIMZUG program and in the regions further enhance the overall credibility of the research undertaken in KLIMZUG.

Legitimacy

KLIMZUG generally pursues a proactive documentation and information dissemination strategy that contributes to the overall transparency and societal acceptance of the programme. A vast amount of different information and documentation formats and first outputs are easily accessible for most of the projects yet most projects are still on-going. In contrast, the direct access to internal governance details and decision making procedures is rather limited. Moreover, the participation of stakeholders from business and politics in transdisciplinary networks is contributing to the overall acceptance of the projects. Beyond the actual project partners, additional practice actors join the practice-oriented sub-projects (e.g.

[57] http://klimzug-radost.de/en/RADOST_Tour_2012.

piloting studies) in all regions. Regional projects also typically have a research area/cluster on governance or society in which different participatory approaches are employed to reconcile potential conflicts and enhance public acceptance (KLIMZUG 1, 3, 4).

5.4 Climate Service Center (CSC)

5.4.1 General description of CSC

The Climate Service Center (CSC) is seen to be the central information and advisory service at the interface between science and knowledge users in economy, politics and society in Germany.[58] The institution was founded in 2009 on initiative of the Federal Government as part of its "High-Tech-Strategy for Climate Change" (BMBF, 2007) and the "German Strategy for Adaptation to Climate Change" (The Federal Government, 2008). Qua mandate the CSC should enable informed decisions under the German Climate Change Adaptation Strategy and accordingly advise municipal, communal, state but also business decision makers on their respective adaptation strategies. Linked with major research institutions and user groups in Germany, the CSC acts as the national contact point for all questions relating to climate change (research), including mitigation, and actively provides and brokers client-tailored climate information for the use of decision-makers in politics, administration, economy, and for the broader public in Germany (BMBF, 2007).[59]

For its initiation phase (June 2009 to May 2014) the centre receives financing mainly from the Federal Ministry for Research and Education (BMBF).[60] Beyond 2014, the centre is likely to be restructured into a full, independent and university-based member of the Helmholtz Association, meaning that CSC would become "self-financed" and with that mainly dependent upon project based funding (EU FP7, BMBF) and customer fees for services, which denotes only a small proportion of current funding (CSC 1, 2, Helmholtz-Gemeinschaft, 2013).

5.4.2 Institutionalization

The centre is based in Hamburg at the Geesthacht Centre for Materials and Coastal Research of the Helmholtz Association, Germany's largest private research corporation (GmbH).[61] It currently comprises 33 researchers, plus guest researchers, from natural and social sciences as well as communication experts in five departments. Besides the directorate (lead by Prof. Guy Brasseur) that is concerned with the overall strategic planning and general management, three topical departments (see Figure 5) develop, compile and communicate research in the areas of i) *Climate Systems* (data management on climate change), ii) *Natural Resource Management* (adaptation research with respect to biodiversity, (agro) forestry and water management) and iii) *Economy and Policy* (economic and political consequences of climate change). The *Communications* department assures that all topics are conveyed to abroad audience in a user-benign way.

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58 http://www.climate-service-center.de/index.html.en.

59 Deutsche Meteorologische Gesellschaft. Mitteilungen (03/2009: http://www.dmg-ev.de/gesellschaft/publikationen/pdf/dmg-mitteilungen/2009_3.pdf.), cf also: http://www.climate-service-center.de/index.html.en.

60 See: Förderkatalog der Bundesministerien: BMBF, BMU, BMWi, BMELV, BMVBS http://foerderportal.bund.de/foekat/jsp/StartAction.do?actionMode=list.

61 http://gkss.helmholtz.de/index.html.de; http://www.helmholtz.de/.

Figure 5: CSC organizational chart

Source: retrieved from: http://www.hzg.de/about_us/organigramm/csc/index.html.de

A Strategic Advisory Panel (SAP) with 15 national and international climate experts from civil society, business and academia advises the director on the general strategy and design. Principally the CSC is accountable to the Helmholtz Association as host organization. In 2012, the overall progress of the recently established institution was evaluated by the funding BMBF after an initial 2.5 years (CSC 1). Moreover, activities under the German Strategy for Adaptation to Climate Change and its "Action Plan Adaptation" are supposed to be regularly externally evaluated regarding results, process, and progress (BMU, 2011).

5.4.3 Activities

CSC perceives its own role as that of a "pilot" ("Lotse") that facilitates knowledge transfer between climate science and practice and consequently seeks to provide relevant client-tailored climate information. The CSC does this by *compiling and translating (KBA3)* recent climate *research* results into user-benign formats. Particularly the 'Climate Systems' department runs own customer-oriented climate simulations or integrated assessments, initiates own practice-oriented research projects and develops various user tailored products based on internal or external research (CSC 1, 2).

Its product portfolio covers various formats tailored to different user groups ranging from more classical state of knowledge reports (CSC reports), articles, position or background papers to statistics, animations, photographs, videos, newsletter, a climate TV, a 'view points' or News Scan section on the homepage about the latest climate chance science and policy developments. Beyond information for climate change "professionals," CSC provides various products for the general public *(KBA7),* like the Climate Wiki, which is one of various web-based climate information platforms.

The CSC has also developed a range of different (IT-based) *decision support tools (KBA4)* that synthesize research results, climate model data or climate impact assessments in customized ways, e.g. Klimadatenatlas, or climate signal maps (see separate description). The CSC has further established an online inquiry function on its webpage through which specific user information needs can be *matched with climate expertise (KBA2)* in-house or externally.[62]

[62] http://www.climate-service-center.de/010674/index_0010674.php.de.

Identifying existing knowledge needs (KBA1) in different concerned societal domains (politics, business, media etc.) is an important activity of the CSC that precedes the development of different research and service products. This takes place in a bottom-up way either, as described, via direct demand-driven inquiries, via research contracts (e.g. for collaborative research projects) or via systematic surveying, as conducted by the Natural Resource Management department with stakeholders from the agriculture and water sectors (Climate Service Center, 2011), as well as stakeholder dialogue events, e.g. with the finance sector (Sustainable Business Institute, 2009).[63]

The CSC also promotes the *networking and coordination (KBA2)* between a scattered national and international climate research landscape as well as with stakeholders. For instance, the CSC actively supports the building up of a European Network of climate services within the European Joint Programming Initiative (JPI) Climate. The "Klimanavigator" (see separate description), in contrast, is an online-based climate research coordination platform specifically tailored to the German climate research landscape (CSC 3). The so called CSC-network embraces and ties together existing climate science (service) institutions in academia, business or administration with national, regional, local or sectoral decision makers in politics, business and finance. The exchange with stakeholders is sought to allow for relevant feedback by practitioners on on-going and impulses for future research and services[64].

The CSC supports various practice oriented research programmes and projects. Within the joint research effort KLIFF, for instance, CSC is concerned with the assessment of regional climate vulnerability and impacts on different sectors in Lower Saxony, e.g. agriculture, forestry, water and coasts.[65] In KLIMZUG (see separate description) CSC serves as the central climate research advisor that informs the practical projects and decision makers in politics, administration, and business with use-tailored climate science (*compile and translate information KBA3*). Apart from different customized (IT-based) tools that may be employed, CSC also offers workshops, guidance or manuals to *build the capacities (KBA4)* of stakeholders in KLIMZUG to make active use of climate models in practice or to autonomously deal with inherent uncertainties (Mayer, 2012).[66]

Exemplary activity 1: "Klimanavigator" platform

The "Klimanavigator" (English: "Climate Navigator") is an internet-based information platform which is coordinated and hosted by the CSC.[67] It is supposed to serve as a "gateway to climate knowledge in Germany" (Schuck-Zöller, 2013) and mainly addresses the issue that relevant information and contacts are hard to identify among the vast amount of available information and institutions scattered across different media (CSC 3). The portal provides a user-benign and unified overview over the existing climate research in Germany and is mainly targeted at professional users from politics and business, but also the media (multiplier) as well as research and education organizations (CSC 3).

The "Klimanavigator" builds upon and is jointly organized by a network of more than 50 (initially 30) different climate research institutions in Germany and was initiated in 2010 by the CSC together with the members. Principally all relevant climate research institutions, including practice oriented projects, are welcome to join, whereas membership is free of charge to trigger an incremental extension of the network. The members form the Partners' Assembly, the central strategic and conceptual decision making

63 Deutsche Meteorologische Gesellschaft. Mitteilungen (03/2009: http://www.dmg-ev.de/gesellschaft/publikationen/pdf/dmg-mitteilungen/2009_3.pdf.). Interviews: CSC 1, 2.

64 http://www.climate-service-center.de/index.html.en.

65 http://www.kliff-niedersachsen.de.vweb5-test.gwdg.de/?page_id=17.

66 Described for singular regions in the interviews (CSC 1, 4); see also: http://www.climate-service-center.de/index.html.en.

67 http://www.klimanavigator.de/, also accessible via CSC.

body convening once per year. CSC serves as coordination office for the portal and deals with the technical, conceptual and coordination concerns. This organizational set up as well as the fact that the platform features an own corporate identity and design are supposed to assure the independence of the Klimanavigator (CSC 3).

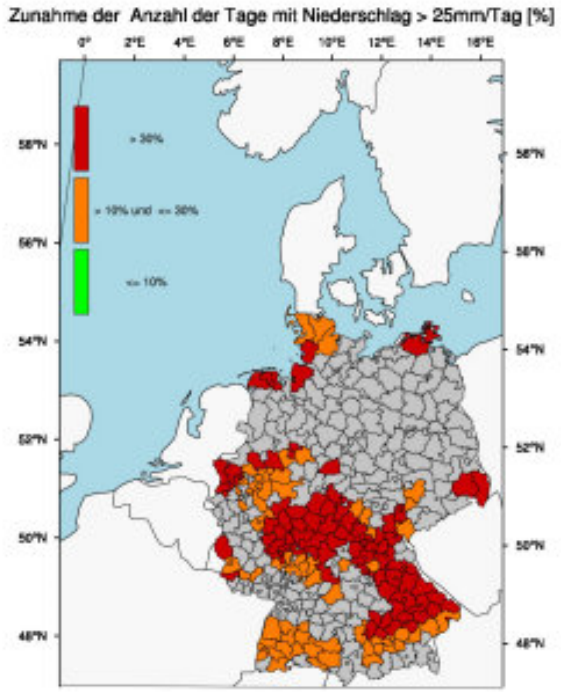
The web portal is thematically subdivided into three searchable major informational sections: (1) self-portrayal of all member institutions, (2) press releases from and about members and (3) climate dossiers. A fourth section on events is currently planned (CSC 3). The climate dossiers mark the most prominent and frequented service on the web platform (monthly users: ca. 2,500; CSC 3). Dossiers are short background papers to inform users on recent, national climate research topics. Like the majority of the contents on the platform, they are initiated and coordinated by (groups of) members that also compile the respective contents on basis of their research expertise. CSC supports the editing of the information within and as crucial part of the editing committee with currently seven members.[68] This committee oversees the process and reviews the final product in terms of user-orientation and understandability and decides upon further development and all principle questions. CSC also appoints an external expert for the scientific review (CSC 3).
Tracing the actual use and application of the overall information about the climate science landscape and the Dossiers is difficult beyond counting users, since the portal allows free and anonymous access. A feedback section for the dossiers has been installed to allow users to ask questions and comment, which is, however, hardly used. CSC thus asked students at the University Lueneburg to evaluate the usability of the platform. They gave concrete feedback for editorial improvement and still criticized the overly technical language. CSC further plans a user survey to identify concrete use contexts and needs (CSC 3).

Exemplary activity 2: Climate signal maps

A prominent example for a *decision support tool (KBA4)* that CSC provides, are the climate signal maps. The maps shall allow users to evaluate future climate change variations across regions in Germany as well as the robustness of these assessments (CSC 1, Climate Service Center, no year). Climate signal maps are simplified country maps that visualize potential scenarios for different climate parameters (for 2036-2065 compared to 1966-1995) as relevant, for example, for the agricultural, tourism, nature conservation or water sectors. The colours range from green to red “signalling” the severity of expected changes for the respective regions and parameters (see Figure 6). Regions for which no robust statement about the potential climate changes can be made – based on a tripartite robustness test – are coloured in grey (CSC 1).

[68] http://www.climate-service-center.de/index.html.en.

Figure 6: Screenshot of Climate Signal map



Source: http://www.climate-service-center.de/031443/index_0031443.html.de

The signal maps are developed and continuously updated by the department “Climate Systems” and build on ensembles of different regional climate change models that CSC ‘runs’ – in-house or within joint projects. Projections are modelled at high resolution levels (e.g. municipalities, natural or economic regions; CSC no year) and with that are both, more robust in scientific terms (vs. singular models) as well as better tailored to the actual decision making realms compared to singular models based on global and national resolution levels.

On the webpage a pre-selected set of maps is available free of charge on the most prominent parameters such as rise in winter and summer precipitation, in temperature or in rain days. Beyond that, individualized maps on specified parameters for certain regions may be ordered and are then processed in correspondence to the information needs of clients (subject to charges). In such cases the client also defines the threshold beyond which climate parameters are seen as “green” (i.e. no or minor change) “yellow” (medium) or even “red” (major) from their perspectives (CSC1).

The direct use or application is genuinely hard to trace, especially of the online based default maps since basically everybody can anonymously download and employ the maps. Only in the case of ordered maps the direct usability is given. Overall the maps are not intended to be straightforwardly applied and may rather be useful for awareness raising and agenda setting, also because of data accuracy reasons: The different displayed medial climate change signals explicitly represent a whole range of possible changes in regional climate parameters and not an exactly quantifiable value, and even remain grey if uncertainties are too high (CSC1).

Exemplary activity 3: Climate fact sheets

In contrast to more generic information products, climate fact sheets are a prominent example of individualized, i.e. client-tailored, and in principal fee-based products that the CSC offers. Climate fact sheets are mainly targeted at decision makers in industry and finance or their 'multipliers', such as associations. In a nutshell, they are short and easy-to-read brochures of 4-6 pages developed at the department "Climate Systems" and contain climate information on individual countries or regions worldwide that are of interest to the respective client. Clients order and use these fact sheets, for instance, to inform their investment decisions in industry and finance about the potential climate change on their sectors or locations of operation (CSC 2).

Prominent and successful examples are the climate fact sheets that have been produced for 42 countries in Eastern Europe, Africa, Latin America and Asia. They have been developed jointly with and upon request of the KfW Bank which demanded concise, standardized and country-specific information on climate change for their operations as a development bank (CSC 2). Despite the general idea of an individualized and commercial service, these climate fact-sheets are also available to other users free of charge and can be ordered via an online form (CSC 2).

In these climate fact sheets the historical and potential future development of the most relevant climate variables, e.g. temperature, precipitation, dry spells, heavy rains or sea level rise, is analysed and displayed (also via graphs) for the respective country or cross-border region over 30 year periods until 2100. Moreover, they give reference to the employed data and clarification about the reliability of statements and on how to interpret the projections. The historical, current and future projections build upon extensive literature review and data from a whole ensemble of global and highly resolved regional climate projections to ensure their scientific reliability, consistency and accuracy vis-à-vis multiple different climatic data sets available. [69]

For an accurate use, the CSC also provides an online manual with instructions on how to read and interpret the climate fact sheets which also further explicates the underlying data basis and methods also regarding the remaining uncertainties (Climate Service Center, 2013). The pilot country fact sheets have been designed in response to the concrete needs of and co-produced with the client (KfW) and are supposed to be considered by the responsible KfW officers in the respective regions in any relevant decision processes, e.g. regarding future investments into relevant sectors. In explicit reference to the CSC fact sheets the bank states its own commitment "to design the financing packages so that analysis of the consequences of climate change is taken into account alongside investment solutions designed to combat these consequences."[70] In addition, the fact sheets have induced a broad interest among various user groups beyond KfW, why now CSC plans further fact sheets on specific locations of production (e.g. cities).[71]

Exemplary activity 4: Adaptation planning support in regions

A core task of the CSC is the assistance of the KLIMZUG programme (see separate description).[72] In line with its role to facilitate the exchange of practice with climate specialists, it engages in and, if de-

69 http://www.climate-service-center.de/index.html.en.

70 https://www.kfw-entwicklungsbank.de/International-financing/KfW-Entwicklungsbank/Environment-and-climate/Unser-Engagement/Anpassung-an-den-Klimawandel/.

71 presentation by Brasseur et al. at the 3rd CSC annual conference in cooperation with KfW: "Klimawandel – Wandelklima: Krisen als Chancen nutzen" Frankfurt am Main, 17. - 18. Januar 2013. URL: http://www.climate-service-center.de/imperia/md/content/csc/jahrestagung_2013/csc_jt2013_brasseur.pdf .

72 http://www.climate-service-center.de/index.html.en.

sired, also moderates different types of technical events for and across the KLIMZUG regions and provides scientific and technical support to the regional projects (CSC 1, Mayer, 2012).

The service encompasses activities such as the identification and interpretation of a suitable set of climate model data. In addition CSC offers targeted moderation or training service to single regional networks as well as the whole KLIMZUG network (CSC 2, 4). Especially in the initial phases trainings were provided on the basic climate science (models, data, and uncertainties) covering also questions on practical interpretation and application (CSC 4). These advice services allow practitioners and (non-climate) scientists within the different KLIMZUG projects to use this data for their purposes autonomously and accurately (CSC 4, Bülow *et al.*, 2012).

The CSC has also developed a manual "with and for" (Bülow *et al.*, 2012) practitioners which builds on practical experience with statistical methods in the KLIMZUG projects. This input was captured – inter alia – in the course of a two day workshop in Hamburg in 2012. The brochure consists of smaller profiles of the different statistical methods and explicates when and how to best employ the method in practice. The brochure may be reviewed and extended if needed (Bülow *et al.*, 2012).[73]

Recently, the CSC's departments 'Natural Resource Management' and 'Economy and Policy' engage in technical workshops or networking events, for instance, on communal water management. They provide a synthesis of knowledge on economic aspects of adaptation to climate change, which shall further inform and build the capacities within the KLIMZUG networks for future adaptation projects (CSC 4, Mayer, 2012). Increasingly events and even some technical trainings are moderated by network partners themselves and the CSC then just serves as one contributing (climate) expert among others (CSC 4). [74] This transfer of facilitation responsibility from "master to student" somewhat reflects the success of the CSC in building up climate science literacy and confidence in its use in various KLIMZUG regions (CSC 4).

5.4.4 Strategies to achieve knowledge brokerage effectiveness

In terms of enhancing the effectiveness of its "brokering" role on climate change in Germany, the CSC heavily draws on different mechanisms and strategies to provide knowledge that is both highly salient to its potential user groups and by the same token adheres to the highest standards of scientific accuracy. In contrast, less attention is given to measures that might increase the legitimacy and societal acceptance of its services.

Saliency

The development and production of use-oriented services is a key concern for CSC as reflected in the overall rhetorical claims (mission statements), but also in the way it is organized and puts its advice service into practice. Accordingly, the portfolio of different user-benign formats marks a cornerstone for its practical relevance (CSC 2). In addition, user knowledge needs are taken into consideration at various stages and ways and well beyond the genuine possibility to issue concrete inquiries and research contracts. With different dialogue events, like three sectoral workshops in the course of its foundation, but also via its Advisory Panel as well as the through the CSC network CSC wants to assure that research is generally better linked to practical concerns (CSC 1, 3). Moreover, an extensive surveying of more than 1,000 people informed the research within the Natural Resource Management Department on ma-

[73] KLIMZUG Newsletter. 1/2013. CSC 4.

[74] KLIMZUG Newsletter. 1/2013.

jor concerns of public and private actors in the key sectors, water and agriculture (CSC 1, 2, Climate Service Center, 2011).

Credibility

The importance of scientific credibility for the work of the CSC is high and explicitly pursued (CSC 1, 2, 3). For instance, CSC purposefully conducts its own research to assure that the models informing its services are the best available in terms of scientific accuracy. Accordingly, the ratio of academic staff with PhDs in relevant disciplines is very high. Moreover, the CSC – esp. through the network but also through its staff members – has established strong links with other renowned scientific institutions in Germany and beyond, e.g. by engaging in joint research projects. Staff members also often serve – at least part time – as active researchers in (inter) national climate research institutions and consequently the centre can display a comparably broad range of peer reviewed publications (CSC 1). The CSC positions itself as an intermediary ("Lotse") between research and society that conducts and communicates research in a committed and responsible manner, particularly with regard to clarifying remaining uncertainties in its models (CSC 1, 3). Such strong focus on basic science research, long-term trends and accurate modelling (displaying rather ranges of parameters than concrete values) as basis to inform decisions may, however, undermine the practical usability and limit influence to raising awareness and setting political agendas.

Legitimacy

Qua mandate the CSC follows a very "(inter)active" climate information dissemination strategy. With its own specialized communication department and a range of openly accessible and integrated information that can be found well arranged on its webpage and different – partly independent – information platforms, the centre supports the overall transparency of its advice processes and products (CSC 2). In contrast, access to background information (governance and internal procedures) is partly restricted. Stakeholder participation is limited to a few venues where exchange with user groups is sought to increase its use relevance (e.g. Advisory Panel and network) but never explicitly for the purpose of increasing the societal acceptance or the consideration of different potentially conflictive views. One reason could be that CSCs activities are mainly targeted at informing rather than reconciliation, which implies different more dialogic services than the ones in use. The balanced representation of potential knowledge users especially in the CSC and Klimanavigator networks is a concern that CSC critically reflects upon internally and intends to address soon (CSC 3).

6 The Netherlands

6.1 Overview on climate policy advice in the Netherlands

Climate policy has a long tradition in the Netherlands. After first mitigation measures dating back to the late 1980s, the Rio Declaration in 1992 triggered a more comprehensive Dutch climate policy. The Netherlands was one of the first European countries to develop a domestic mitigation policy in the early 1990s, for instance through the National CO_2 Reduction Strategy (Ministry of Housing, 1994). However, only very little political attention was paid to climate adaptation issues until the beginning of the 2000s "[…] because some actors felt this would mean that the Netherlands was accepting climate change and would therefore pay less attention to climate mitigation" (van Bommel & Kuindersma, 2009, 25).

An elaborated institutionalized architecture for climate policy advice supports Dutch climate policy. For a long time, a small set of knowledge organizations has provided scientific expertise to decision makers. Among them particularly departmental research institutes, like the Environmental Assessment Agency PBL (see chapter 6.2) and the Royal Netherlands Meteorological Institute KNMI, have played an outstanding role. Two of our analysed cases, the Netherlands Environmental Assessment Agency (PBL) and the research programme Knowledge for Climate (KfC) constitute important KBIs in the Netherlands. Particularly the central role of PBL is unique in comparison to other countries (Hoppe, 2013): It is one of three politically independent Dutch planning bureaus which aim at evaluating current and future policy developments and policy options in specific policy sectors. Besides, researchers employed at university research institutes and research centres, such as the University of Amsterdam, Wageningen University and Research Center or University of Rotterdam, contribute their scientific expertise to climate policy making (PBL 1, 2, KfC 7).

Along with the emergence of adaptation policy as a political issue we observe a broadening of the group of knowledge brokerage institutions. A range of applied non-university research institutes have become important actors in climate science-policy interaction, like the Rathenau Institute or the Netherlands Organization for Applied Research (TNO), as well as sector-specific think tanks, like the independent institute for applied knowledge on water, subsurface, and infrastructure Deltares. At the same time, adaptation policy lead to more deliberative patterns in climate policy which primarily reflect in interactive programs that bring together experts, citizens, stakeholders, and policy makers. For instance, within the framework of the national Delta Programme (from 2007) political and societal stakeholders from different political levels and researchers develop policy options to prepare Dutch water policy for the impacts of climate change. Another increasingly prominent forum for science-policy interactions are applied research programmes. From 2004 on the Climate Changes Spatial Planning (CCSP) (2004-2011) and the Knowledge for Climate programme (KfC) (2008-2014) (see chapter 6.3) have been installed. The CCSP program encompassed both mitigation and adaptation research and was oriented toward enhancing joint learning between different actors in spatial planning, whereas KfC mainly deals with adaptation issues and primarily serves the knowledge integration between various stakeholders and researchers via its regionally-based Hotspot approach.

A look at the Dutch science-policy landscape in climate policy reveals that neo-corporatist features today are accompanied by more deliberative patterns. PBL represents a typically Dutch version of an environment agency that is closely related to Dutch neo-corporatism. By comparison, deliberative patterns reflect in a high degree of integration and coordination among stakeholders' practical expertise and researchers' scientific knowledge that comes along with a strong orientation toward the research findings' applicability for a broad spectrum of actors. The high degree of coordination also includes the incorpora-

tion of climate sceptic perspectives which are increasingly present in politics, for instance through the populist Party of Freedom (PVV) and the media (Hoppe *et al.*, 2012). This adds a new dynamic to Dutch climate policy and climate policy advice that have not been contested in the Netherlands for more than two decades (Hoppe *et al.*, 2012).

6.2 PBL Netherlands Environmental Assessment Agency

6.2.1 General description of PBL

The Netherlands Environmental Assessment Agency PBL is one of three politically independent Dutch planning bureaus, which serve as specific, inter-sectorial, and interdepartmental assessment and policy-analysis agencies for policy makers (PBL Netherlands Environmental Assessment Agency, 2012b). PBL is the planning bureau for strategic policy analysis in the fields of environment, natural, and spatial planning. It has a strategic focus and seeks to "[…] contribute to improving the quality of political and administrative decision-making by conducting outlook studies, analyses and evaluations in which an integrated approach is considered paramount."[75] The agency deals with a broad spectrum of issues, such as the investigation, documentation, and discussion of the current environmental, ecological, and spatial quality or the exploration of future social trends influencing environmental, ecological, and spatial quality. An additional task is the identification of possible strategic options for achieving government objectives in the fields of environmental, nature, and spatial policy.

PBL is the successor of the Netherlands Environment Assessment Agency MNP which was established in 1996 as part of the Netherlands National Institute for Public Health and the Environment (RIVM). In 2005 MNP was separated from the RIVM due to political considerations. In 2008, on the basis of a Royal Decree and a decision of the Dutch Cabinet, the Ministry for Housing, Environment, and Spatial Planning (VROM) established PBL in its current form through a merger of the Netherlands Environment Assessment Agency MNP and the Netherlands Institute for Spatial Research RPB. Although PBL is currently a government agency under the Ministry for Infrastructure and the Environment (IenM), it operates as a politically independent planning bureau (Pesch *et al.*, 2012, PBL Netherlands Environmental Assessment Agency, 2012b).

Dutch ministries, most notably the Ministry for Infrastructure and the Environment, allocate the vast majority of PBL's funding, about 97% in 2012. The annual budget in 2012 added up to 33.8 Million euros. Since 2009 the annual budget significantly diminished from around 42 Million euros. Further budget cuts of about 25% are to be expected in the period from 2011 to 2019 due to government decision. Besides the public funds, PBL receives external funding, mainly through participation in international research projects.

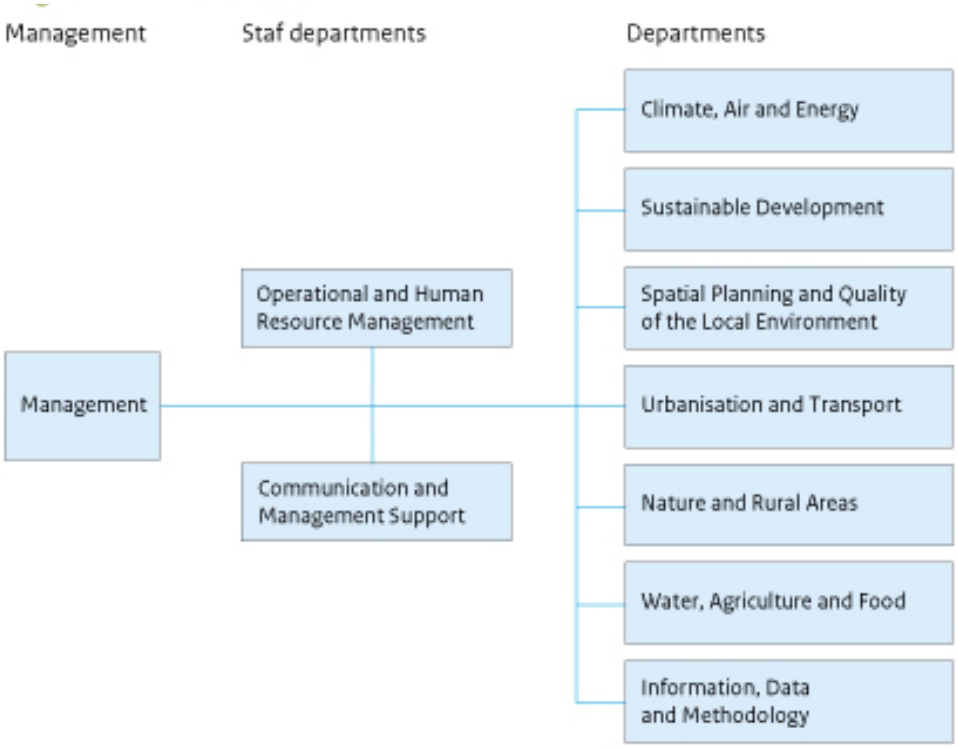
6.2.2 Institutionalization

The Netherlands Environmental Assessment Agency is located in Bilthoven (headquarters) and The Hague (staff departments and management). Overall, it employs about 270 people among which 200 are permanent staff members (2012). The planning bureau is equipped with seven Departments and two Staff Departments (see Figure 7). One department is explicitly dedicated to research and policy advice on climate, air and energy. The PBL Management consists of PBL director Prof. Maarten Hajer,

[75] http://www.pbl.nl/en/.

Deputy Director Dhr. Reinier van den Berg, secretary staff, department heads, and Chief Scientific Advisor Prof. Arthur Petersen (PBL Netherlands Environmental Assessment Agency, 2012b).

Figure 7: Organizational Structure of PBL



Source: http://www.pbl.nl/en/aboutpbl/organisation

Internal and external evaluation mechanisms address the organizational, scientific, and relational dimension of PBL's work: On behalf of the Ministry for Infrastructure and the Environment the PBL Advisory Board regularly oversees the quality of the agency's work and working methods, mainly by providing advice on the periodical PBL working programmes. The board is appointed by the IenM and usually composed of representatives of universities, businesses, and local and regional government bodies (PBL Netherlands Environmental Assessment Agency, 2012b). The evaluations by the Advisory Board have been carried out every four years until today. Additionally, PBL conducts regular self-evaluation audits on its scientific work, societal relevance and in future also on its role within the Dutch policy advisory system and the relation to its stakeholders (see PBL Netherlands Environmental Assessment Agency, 2012b). Furthermore, on the request of the Advisory Board, an *International PBL Audit Committee* evaluated the quality and relevance of PBL research from an international perspective. The assessment covered organizational issues, scientific quality and content as well as the relation between PBL, policy makers, and society (International PBL Audit Committee, 2013).

6.2.3 Activities

PBL's agenda setting is both demand- and supply-driven, however, PBL is foremost a policy-analysis agency which orients itself toward the demands of policy makers. The PBL Work Programme defines the agency's working areas, issues, and deliverables. It includes, but is not limited to, the constantly recurring outputs PBL is legally required to generate, like specific assessment reports. Several ministries, most notably the IenM, the PBL Advisory Board, and the different PBL departments are able to

hand in proposals for future research foci. The management gathers all these suggestions and synthesizes them into a draft version of the work programme. Afterwards, the main clients, the Directors General of the departments, and the Advisory Board jointly finalize the document. The ultimate decision on the Work Programme resides with the PBL Director (PBL Netherlands Environmental Assessment Agency, 2012b). Besides long-term planning, various national and international actors commission scientific work to PBL on shorter notice. Frequent clients are different Dutch ministries, the Dutch Parliament, Dutch political parties, the European Parliament, the European Commission or international organizations, such as UNEP and OECD. Formally any request needs first to be presented to the Minister for Infrastructure and the Environment (PBL Netherlands Environmental Assessment Agency, 2012b). In addition to the primarily solicited research, PBL also conducts unsolicited research on its own initiative. However, in climate issues this is less frequently the case than in other departments because the department's core function is seen in delivering policy-relevant expertise (PBL 1).

PBL's most significant knowledge brokerage activities are the *compilation and translation of scientific knowledge* (*KBA3*) as well as *policy analysis and policy evaluation* (*KBA5*). Often both advice activities jointly appear in one report or study. Works which aim at gathering and rendering scientific knowledge are the independent integrated assessments on sustainable development, energy and climate change, biodiversity, transport or land use. For instance, the Assessment of the Living Environment Report (PBL Netherlands Environmental Assessment Agency, 2010b) investigates and documents the current environmental, ecological, and spatial quality of the Netherlands. Moreover, the agency conducts studies on scientific, economic, and governance aspects of societal developments, like the Nature Outlook (van Oostenbrugge *et al.*, 2011) or the Exploration of Pathways towards a Clean Economy by 2050 study (Ros *et al.*, 2011). These kinds of studies often draw on integral quantitative analyses using various calculation models and a systems approach. PBL also conducts scenario studies on the Dutch environment and nature every four years and develops prestigious integrated modelling frameworks for the national and international level, like the global biodiversity model GLOBIO3[76] or the Integrated Model to Assess the Global Environment (IMAGE)[77]. The agency hosts respective websites where these models are described in more detail and the underlying data is publicly accessible. Since 2011 PBL additionally issues a Working Paper Series in which it compiles current scientific knowledge on specific topics.

Besides, the agency supports decision making by providing policy analysis and policy evaluation. Instances for studies that assess and evaluate current climate policies are on the national level the Co-Impacts of Climate Policies on Air Polluting Emissions in the Netherlands (Hammingh *et al.*, 2010). Another example is the evaluation of the European Commission's Proposal to Calculate Member States' Targets for Emissions not Included in the Emission Trading System (Verdonk, 2011). Furthermore, PBL analyses future national and international policy developments. A unique example compared to other countries is the Election Manifesto Analysis Choices Outlined 2013-2017 (PBL Netherlands Environmental Assessment Agency & CPB Netherlands Bureau for Economic Policy Analysis, 2012). In this context PBL examines the environmental policies and measures proposed by the Dutch political parties prior to national elections. Legally required outlook studies, like the Exploration of Pathways towards a Clean Economy by 2050 (Ros *et al.*, 2011), identify possible strategic options for decision makers. Furthermore, Trend Reports like The Energetic Society (Hajer, 2012) explore future societal trends in order to allow decision makers to better cope with these emerging challenges.

In addition to the core activities outlined above, PBL engages in *personal policy advice and consultation* (*KBA6*) for political actors. PBL advises the Dutch government on environmental issues in various ways: The agency provides targeted information in order to support the preparation of Cabinet's and Sub-

[76] http://www.pbl.nl/en/dossiers/biodiversity/models; http://www.globio.info/.

[77] http://themasites.pbl.nl/tridion/en/themasites/image/; http://epanet.ew.eea.europa.eu/european_epas/countries/nl.

Councils' discussions and decisions. Moreover, PBL staff advises federal advisory councils like the Council for Infrastructure and the Environment[78]. On administrative level, PBL researchers participate in departmental meetings, such as ad hoc task forces (PBL Netherlands Environmental Assessment Agency, 2012b). Not only the government receives scientific advice from PBL, but also the Dutch parliament is equipped with tailored information. Researchers attend meetings of parliamentary committees and for instance provide technical briefings on selected PBL reports or present PBL's perspective in Parliamentary Hearings (PBL Netherlands Environmental Assessment Agency, 2012b).

Compared to the other knowledge brokerage activities mentioned above, *public outreach* (*KBA7*) has only played a subordinated role in PBL's advice activities until today. However, the dissemination of the agency's findings to a broader audience than its 'traditional' clients shall be enhanced in the next few years (PBL 1, 4). PBL uses rather traditional ways of informing the public about climate change questions, like press releases and comments on national and international policy developments. Examples are public statements on outcomes of the COP15 Conference in Copenhagen (PBL Netherlands Environmental Assessment Agency, 2012b). Furthermore, a FAQ section on the website provides general information on the main working fields of PBL[79]. The agency increasingly makes use of new social media, like weblogs, in order to distribute and disseminate its findings. Additionally, the Communication Section produces videos, e.g. the video on Pathways to Achieve Global Sustainability Goals by 2050, and special web applications on specific PBL reports, e.g. the app Roads from Rio + 20[80].

Exemplary activity 1: Exploration of Pathways towards a Clean Economy by 2050

The Exploration of Pathways project represents a classical outlook study which PBL frequently conducts as solicited research. The study intended to *compile and translate* available scientific knowledge on energy systems for policy makers (*KBA3*) as well as to *analyse, develop and evaluate* current Dutch energy policy (*KBA5*). Following the example set by the European Commission in March 2011, the Dutch Cabinet decided to develop a similar roadmap outlining how greenhouse gas emissions could be reduced by 80% by the year 2050 based on 1990 emission levels (PBL 5). Thus, the Dutch Ministry for Infrastructure and the Environment commissioned the study "Exploration of Pathways towards a Clean Economy by 2050: How to Realise a Climate-Neutral Netherlands" (Ros *et al.*, 2011) as a collaborative research project to PBL, the Energy Center of the Netherlands ECN, and TNO Innovation Now.

In a first step the project analysed and evaluated current Dutch energy policy. Afterwards, the researchers employed a modelling framework in order to trace back the potential future pathways of climate-friendly energy use based on the goal of a greenhouse gas emission reduction of 80% in 2050 (Ros *et al.*, 2011). Eventually, PBL provided tailored scientific information in the form of "learning pathways", i.e. possible solutions and measure packages to reach the envisioned goal, and offered a variety of recommendations for policy makers. The specific conclusions range from first steps to be taken over a proposed time frame, such as the increased use of bio-energy and the fostering of CCS, to suggestions for the potential role of the government in this future energy transition (Ros *et al.*, 2011).

In regular meetings PBL exchanged views with ministry officials on all research steps' methods and content. Besides the report, PBL disseminated its findings to ministry officials via short presentations (PBL 5). The different blocks of measures should have provided the basis for discussions among the ministry and various stakeholder groups in order to derive specific roadmaps. However, this process has never started due to election-related government changes. Hence, also the planned roadmap was not written.

78 http://en.rli.nl/.

79 e.g., http://www.pbl.nl/en/dossiers/climatechange/faqs.

80 http://roadsfromrio.pbl.nl/.

Eventually, the findings are currently used in order to inform a recently initiated process of the Social and Economic Council of the Netherlands on revising Dutch energy policy, in which PBL also contributes expertise to policy development (PBL 5).

Exemplary activity 2: IMAGE 2.4

The Integrated Modelling of Global Environmental Change (IMAGE) 2.4[81] is a prime example for PBL's policy advice through modelling and the high degree of reflexivity of the agency's work. The modelling framework *compiles and translates scientific knowledge* (*KBA3*) in order to contribute to international and national policy making. In the mid-1980s the National Institute for Public Health and the Environment (RIVM) developed a first, simple version of the model in order to deepen the understanding of the relationships between human activities and climate change (Bouwman *et al.*, 2006). Today the IMAGE team further develops and constantly refines the model under the authority of PBL. The dynamic integrated framework aims at advancing the scientific understanding of environmental changes by "quantifying the relative importance of major processes and interactions in the society-biosphere-climate system"[82] in order to facilitate and support decision makers at the national and international level.

The IMAGE model provides scientific information on dynamic and long-term perspectives and on the systemic consequences of global change. Hence, it provides a basis for analysing the effectiveness of various policy options that address global change (Bouwman *et al.*, 2006)[8]. An internationally composed Advisory Board constantly assesses the model's scientific quality and derives recommendations on improvements in the model itself, the development of strategies for future research, and to the scientific and policy network of the IMAGE team (Bouwman *et al.*, 2006). In the case of specific projects regular meetings with ministry officials take place. The team summarizes its findings for policy makers and policy analysts, which represent the main target group, primarily in the form of reports or presentations in meetings (PBL 6). Furthermore, the IMAGE website[83] provides extensive information on the model details and used data, on how the scenarios are built as well as on the project findings. A separate section offers related studies and reflects on uncertainties for the framework's main modules.

Over the last decade, IMAGE has informed decision making on the national and international level: For instance, the IMAGE team equipped representatives of the Dutch and European delegation to the COPs with general scientific information as well as assessments of certain efforts and measures. In doing so, the advice considerably contributed to the development of concrete measures and strategies in international climate policy. The model findings also constituted the basis for further policy advice: For instance, IMAGE results fed into other modelling frameworks in various PBL projects directed at the international and national level. Moreover, the IMAGE data were referenced in the IPCC reports (PBL 6).

Exemplary activity 3: Assessing an IPCC Assessment

The project 'Assessing an IPCC Assessment' is a commissioned work by the IenM and shows how PBL strives for securing objectivity and inclusiveness of different perspectives. After media reports on errors in the 4th Assessment Report of the IPCC in January 2010, the Dutch Parliament asked the Minister for the Environment to investigate the implications of these errors for the Netherlands (PBL 7). Hence, the minister commissioned an assessment of the reliability of the IPCC report's regional chapters. The evaluation of the effects of potential errors on the overall conclusions drawn in the report was also part of the request (PBL Netherlands Environmental Assessment Agency, 2010a).

81 http://www.pbl.nl/en/dossiers/biodiversity/models; http://themasites.pbl.nl/tridion/en/themasites/image/.

82 http://www.pbl.nl/en/dossiers/biodiversity/models.

83 http://themasites.pbl.nl/tridion/en/themasites/image/.

PBL carried out the assessment in four steps: First, PBL launched a public website for one month that enabled all Dutch climate experts to submit potential errors in the regional chapters of WG II. In doing so, the agency explicitly aimed at incorporating sceptical perspectives as well. Second, PBL staff members conducted an analysis of the scientific literature cited in the IPCC report and the conclusions drawn from it. Third, iterative communication with the respective IPCC authors on the draft findings took place. Fourth, after discussing the findings and deriving the conclusions the draft document passed through an extensive review process by selected internal and external, national and international experts (PBL Netherlands Environmental Assessment Agency, 2010a). The Royal Netherlands Academy of Arts and Sciences appointed an independent supervisory scientific committee in order to review and accompany PBL's work in scientific terms. Additionally, at the beginning of the project close consultations on the study's design took place with the environmental minister (PBL 7).

Eventually, PBL published its findings in a report which they handed over to the Dutch Cabinet and the Dutch Parliament as main addressees. However, the report received only little feedback due to a changed Dutch government with less interest in climate issues. Moreover, the upcoming elections reset the ministers' priorities (PBL 7).

6.2.4 Strategies to achieve knowledge brokerage effectiveness

PBL's work shows various efforts in order to strengthen the effectiveness of its scientific policy advice. The bureau has a pronounced orientation toward relevance for stakeholders' needs and scientific credibility. By comparison, legitimacy is only moderately important until now. However, PBL increasingly attempts to enhance the fairness and inclusiveness of its scientific endeavours.

Salience

The policy-relevance of research is a core value of PBL. It is reflected in the development process and content of the overall working programme and constitutes an important selection criterion for single projects (PBL Netherlands Environmental Assessment Agency, 2012b). Overall, the agency follows the 'post-normal science' approach, i.e. it provides knowledge for urgent decisions under conditions of high uncertainty. Research findings in this regard need to become available when they are needed to inform political discussions and governmental decision-making. Despite its frequently highlighted political independency, the planning bureau maintains strong ties with the Dutch Ministry for Infrastructure and the Environment on all levels. The PBL office in The Hague allows for close interaction between the ministries and the agency. PBL synchronizes not only its Work Programme, but also single commissioned projects with the ministry's needs in periodical meetings (PBL 2, 5). Particularly in climate policy we find a strong orientation toward the knowledge needs of the ministry (PBL 1). PBL also seeks to extend its contacts beyond representatives of the government and the ministries. Particularly the interaction with the Dutch parliament as well as provinces and municipalities shall be further strengthened over the coming years (PBL Netherlands Environmental Assessment Agency, 2012b). The broader societal relevance of PBL's work is assessed in different ways by external reviews: The PBL Advisory Board supervises the societal relevance of the Work Programme. The International Scientific Evaluation deals with questions surrounding the science-policy-society interface and PBL's role at it. Furthermore, the second self-evaluation report which will be issued in 2014/2015 shall focus on the planning bureaus' position within the Dutch system of scientific advice to policy and society (PBL Netherlands Environmental Assessment Agency, 2012b).

Credibility

PBL considers scientific quality as a key principle of its research (PBL 2, 4). The agency conceives itself as a "learning organization" that continuously "[…] invests in the quality of its staff and the continuity and quality of its products"[84]. A component of research quality is the use and development of theoretical and conceptual approaches that correspond to the state-of-the-art in the respective disciplinary fields. The agency frequently highlights its scholarly expertise in various environment- and climate-related domains, for instance when PBL points out that its staff writes a considerable number of peer reviewed journal articles or when the self-evaluation report indicates that a huge amount of PBL staff members hold a PhD or even a professorship. Furthermore, PBL underlines that scientific journal contributions represent an important output of PBL's scientific work[85] and that the agency contributes its expertise to the IPCC (PBL Netherlands Environmental Assessment Agency, 2012b). Additionally, PBL emphasizes the diversity of approaches and methods applied (PBL Netherlands Environmental Assessment Agency, 2012b).

A range of internal and external review mechanisms indicates that PBL intensively reflects on the quality of its scientific work and products. Internal and external reviewers provide their comments on all kinds of PBL publications and projects. In seminars PBL staff and occasionally also people from outside PBL critically examine single projects at the beginning, halfway, and at the end of the research (PBL Netherlands Environmental Assessment Agency, 2012b). A special component of the agency's quality control system is the position of the Chief Scientist. The Chief Scientist supervises whether PBL adheres to the procedures and standards and whether these need to be changed (PBL 2, 4). He also leads the PBL Academy which offers various possibilities for advancing the education of PBL staff. The internal and external audits by PBL itself, the PBL Advisory Board or the International Scientific Audit Committee aim at critically monitoring the scientific relevance and content. Furthermore, PBL has issued procedures for dealing with and communicating uncertainties of research findings in the document "Guidance for Uncertainty Assessment and Communication" (PBL 4) and adheres to the Dutch protocol for research assessment, the Standard Evaluation Protocol of the Royal Netherlands Academy of Arts and Science (PBL Netherlands Environmental Assessment Agency, 2012b). Another aspect to highlight the scientific quality of the organization is the collaboration with national and international partners. PBL conducts joint projects with Dutch and international university and non-university research institutes as well as other policy- analysis agencies. Furthermore, the planning bureau participates in a range of national and international scientific networks (PBL Netherlands Environmental Assessment Agency, 2012b, PBL Netherlands Environmental Assessment Agency, 2013).

Legitimacy

Regarding the perceived fairness of PBL's policy advice both transparency and stakeholder participation shall be further enhanced in near future. Currently, the organizational structure and internal mechanisms are highly transparent mainly via the PBL Self-evaluation Report (PBL Netherlands Environmental Assessment Agency, 2012b) and the International Scientific Audit (International PBL Audit Committee, 2013). Project results are made publicly available both on paper and in digital versions. A working paper that was issued only very recently emphasizes the necessity of making assessments more transparent in order to achieve higher levels of credibility and legitimacy (Strengers *et al.*, 2013).

Stakeholders are engaged to foster the legitimacy of PBL's findings and recommendations. Following the post-normal science approach, the agency incorporates a variety of perspectives and approaches to increase the robustness of its results and conclusions. PBL and policy makers do already interact in

84 http://www.pbl.nl/en/aboutpbl.

85 http://www.pbl.nl/en/aboutpbl.

various ways. The exchange of information with the Dutch parliament as well as provincial and local authorities shall be even strengthened in the next years. Another effort is the improvement of the link between PBL and the Dutch society which is envisaged in a respective report (Vasileiadou *et al.*, 2013). Besides these face-to-face contacts, PBL employs digital means to get in touch with its stakeholders. The agency is also explicitly open to opposing perspectives, like climate sceptic points of views from researchers and other actors. They even try to purposefully integrate these into their research, via talks to climate sceptic parties, and offer room for debate on crucial and contested issues, like the platform on the IPCC Assessment (PBL 7).

6.3 Knowledge for Climate (KfC)

6.3.1 General description of KfC

The applied research programme Knowledge for Climate strives "[t]o develop the scientific and applied knowledge required for climate-proofing the Netherlands and to create a sustainable knowledge infrastructure managing climate change"[86]. More concretely, KfC generates advice for adaptation policy through cooperation between governments, the business community, non-profit organizations, and scientific research institutes. The research devotes special attention to questions of spatial planning and infrastructure, fresh water supply, flood risk management, rural areas and cities, the governance of adaptation, and decision support tools.

In July 2007, the Dutch Cabinet approved the establishment of the Knowledge for Climate program as a successor to the *BSIK* Research Programs *Living with Water*, *Habiforum*, and *Climate Changes Spatial Planning*. Then, the former *Ministry of Housing, Spatial Planning, and Environment* (now: *Ministry for Infrastructure and the Environment*) issued a call for proposals. Two consortia of research organizations (Wageningen University and Research Center and Free University of Amsterdam on the one side and Utrecht University, the Dutch Royal Meteorological Institute KNMI, TNO Built Environment and Geosciences, and Deltares on the other side) handed in competing proposals. The ministry invited the two consortia to merge their separate proposals and eventually accepted the joint submission (KfC 1, 4). The first tranche of projects started in 2008 and the last research projects are expected to be finished by the end of the year 2014[87].

KfC's total budget adds up to 100 Million euros. The environmental ministry awarded 50 Million euros from the Economic Structure Enhancing Fund, a federal fund which finances environment related research from the income of recently discovered Dutch natural gas resources. The regional areas and topical tracks have to raise the other half of the budget. That is, local and regional authorities, municipalities, private companies, non-profit organizations as well as university and non-university knowledge organizations co-finance KfC research projects with their own money (KfC 1, 3, 4).

6.3.2 Institutionalization

The *Knowledge for Climate Foundation* represents the organizational hub of the program by connecting the different operating bodies and institutions (KfC 2). The foundation has jointly been founded by Wageningen University and Research Center and University of Utrecht. It is led by Prof. Pier Vellinga from Wageningen University (KfC 7). The organizational structure of the KfC programme can be distinguished between bodies which are concerned with the design and management of the overall program and those which are closely related to the projects themselves (see Figure 8).

In terms of the overall policy of the KfC programme two institutional bodies play an important role: The *Executive Board* consists of three members and represents the KfC Foundation. It takes responsibility for the programmes' overall planning and prioritization, evaluation of project proposals, management, scientific quality assurance, and budgetary questions. The *Supervisory Board* monitors and advises the Executive Board twice a year on the functioning as well as current and future overall policies and state

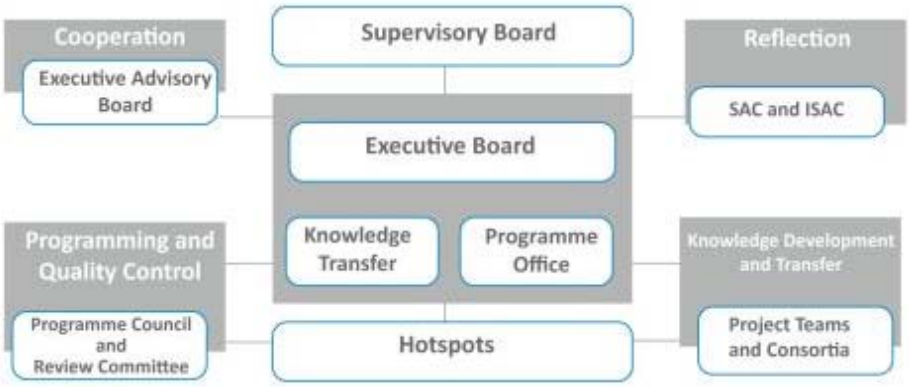
[86] http://knowledgeforclimate.climateresearchnetherlands.nl/programme/mission-and-approach.

[87] http://knowledgeforclimate.climateresearchnetherlands.nl/programme/mission-and-approach; http://knowledgeforclimate.climateresearchnetherlands.nl/programme/initiators.

of affairs. The five to seven members are accountable to the Executive Board and the Dutch Ministry for Infrastructure and the Environment (KfC - Knowledge for Climate, 2008).

Additionally, three more remote advisory councils periodically counsel the Supervisory Board and the Executive Board from the scientific as well as the societal angle: The Executive Advisory Board, the International Scientific Advisory Council, and the Societal Advisory Council. The *Executive Advisory Board* consists of representatives of different ministries and research organizations, discusses strategic issues with the Executive Board, and gives recommendations, such as on the overall strategies for cooperation, knowledge transfer or the utilization of funds. By comparison, the *International Scientific Advisory Council* monitors the scientific progress and quality of the KfC work. The council formulates its advice on the future direction of various scientific components of the KfC programme and its scientific evaluation twice a year. The *Societal Advisory Council* composed of representatives of provinces, businesses, water boards, and non-profit organizations controls the societal relevance and the achieved societal impact. The body derives recommendations from these findings concerning the prospective direction of practical program elements and societal evaluations (KfC - Knowledge for Climate, 2008).

Figure 8: Organizational Structure of KfC



Source: http://knowledgeforclimate.climateresearchnetherlands.nl/organisation

The daily execution of the programme is subject to three bodies: The *Programme Board* takes an advisory task in both the programing and the preparation of KfC evaluations. Its 22 members, which are representatives of the KfC foundation, the Hotspots, knowledge institutes, Knowledge Transfer section, advice the Programme Office on the general state of affairs, the use of resources for certain projects, on the annual plans and potential project review procedures. Furthermore, the Programme Office and the Knowledge Transfer section deal with the research programme's everyday business. The *Programme Office* is mostly concerned with the actual execution of KfC in administrative terms. The *Knowledge Transfer* section aims at effectively sharing the knowledge on climate change adaptation generated within the programme with potential knowledge users. Besides pure knowledge dissemination, the section promotes the application of developed knowledge in stakeholders' everyday practices (KfC 2)[88].

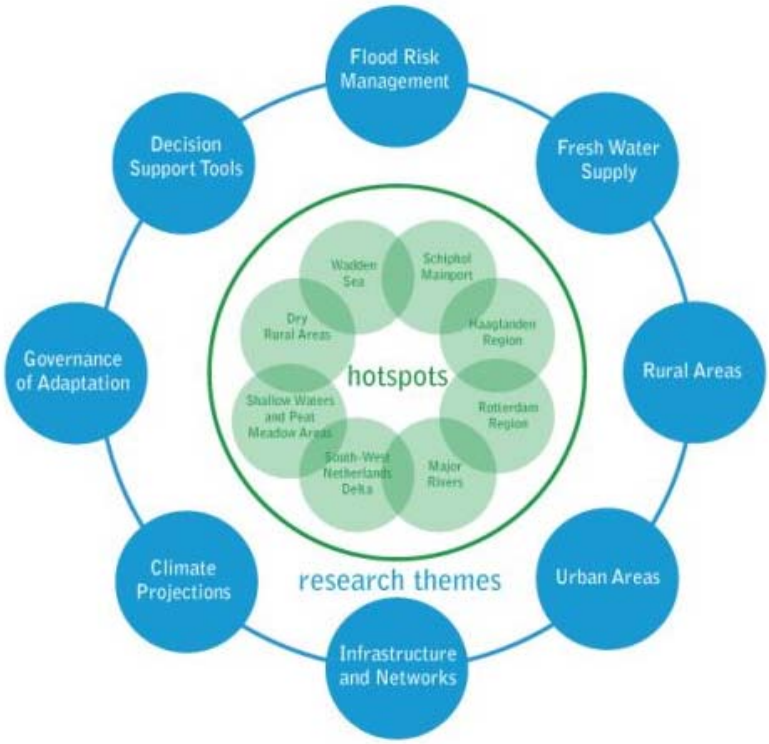
KfC's actual research is conducted within Hotspots and Themes. The eight *Hotspots*[89] are distinct politically chosen areas that are spatially distributed over the Netherlands and in which broad-based teams work together. Representatives of local and regional authorities, water boards, municipalities, NGOs,

[88] http://knowledgeforclimate.climateresearchnetherlands.nl/organisation/knowledgetransfer.

[89] The eight Hotspots are: Mainport Schiphol, Haaglanden Region, Rotterdam Region, Major Rivers, South-West Netherlands Delta Region, Wadden Sea Region, Dry Rural Areas, and Shallow Waters and Peat Meadow Areas.

local and regional businesses, and research institutions collaborate in regionally based research. More concretely, these actors jointly formulate research questions on relevant regional topics through an iterative, participatory process and search for project co-funding. The Hotspots direct the projects' execution and aim at aligning area-based specific with overarching, generic knowledge questions. The applied research within the Hotspots is complemented by academic work within eight cross-cutting, thematically sorted *Themes*[90] (see Figure 9).

Figure 9: KfC's hotspot and theme



Source: http://knowledgeforclimate.climateresearchnetherlands.nl/programme/hotspots-and-themes

Themes' research does not only address a certain region, but approaches more comprehensive, cross-regional questions that are more strongly oriented toward the scientific State of the Art. However, the research topics are appointed in dialogue with stakeholders from the Hotspots and about half of the Themes' research projects follow a collaborative action research approach. A consortium of researchers from different knowledge organizations conducts the research in each Theme. One representative of a university research institute, the Consortium Leader, coordinates the different organization's work as well as the cooperation with the stakeholders (KfC 7, 8).

On the project level, project leaders are obliged to regularly report on content-related and financial development to the Hotspot Coordinator or Theme Consortium Leader, the Programme Office, and the

90 The eight Themes are: Climate Proof Flood Risk Management, Climate Proof Fresh Water Supply, Climate Adaptation for Rural Areas, Climate Proof Cities, Infrastructure and Networks, High-quality Climate Projections, Governance of Adaptation, and Decision Support Tools.

Executive Board. In October 2012 the Mid-term Assessment[91], a scientific and societal presentation and evaluation, took place in Amsterdam. The Hotspots and Theme Consortia presented their progress and current stage of work as well as the reflections of the International Scientific Advisory Council. A second event in which the project findings and an overall assessment of the programme's success shall be presented will take place by the end of 2014 when KfC's funding period ends (KfC 1, 4).

6.3.3 Activities

From the beginning, the KfC research programme was clearly intended to meet the knowledge demands of stakeholders in terms of the emerging challenge of climate change adaptation. The *first tranche* of research addressed first urgent knowledge needs on short-term questions and foresight studies. A regionally based, bottom-up process characterizes this phase: Stakeholders and researchers jointly identified research questions and frequently collaboratively conducted the research within the Hotspots. The *second tranche* of projects tackles important long-term issues and comprehensive adaptation questions that go beyond the Hotspots' regional scope. The Programme Board collected the knowledge needs of the different Hotspot stakeholders in workshops and, then, handed over the climate change adaptation questions to the researchers. The scientists afterwards derived sound scientific questions and translated the stakeholders' knowledge demands into scientific Themes and single research projects. Some of the latter are conducted as collaborative action research projects. Finally, the *third tranche* of research projects focuses on the synthesis and concrete implementation of the findings generated in the previous phases. It is once again conducted within the Hotspots and concentrates on the development of Regional Adaptation Strategies and options (Molenaar & Oudkerk Pool, 2012, Lammers, 2012).

The three tranches of KfC research projects cover a broad range of knowledge brokerage activities. The overall goal of the KfC programme is the support of *policy development* (*KBA5*). In the third programme phase concrete adaptation measures and strategies shall be formulated in Regional Adaptation Strategies or 'Visions', depending on the respective Hotspot authorities and the expected and favoured political status of the documents (KfC 1). An example for such a strategy is the planned Adaptation Strategy Rotterdam Region (Molenaar & Oudkerk Pool, 2012).

All the other advice activities of KfC shall provide the basis for and support this goal: The *identification of knowledge needs and research gaps* (*KBA1*) represents a core task of the first programme phase. Scientists and stakeholders developed applied research projects through iterative, participatory processes in all eight Hotspots in order to answer urgent knowledge needs. The identification of research gaps is subject of the Themes which are more strongly oriented toward scientific criteria (KfC 7, 8). Additionally, particularly the Hotspot approach and the collaborative action research projects conducted within Hotspots and Themes support *coordination and networking* (*KBA2*) between scientists and different stakeholder groups.

The *compilation and translation of scientific knowledge* (*KBA3*) constituted a core task of the research programme. The projects generated tailored knowledge, for instance, by developing scenarios for adaptation or conducting vulnerability assessments for cities and rural areas. For instance the project Region Specific Climate Information for Haaglanden and Rotterdam generated data and information on future developments of climate change and its effects for these two regions (Molenaar & Oudkerk Pool, 2012, Lammers, 2012). Scientific and popular scientific publications resulting from these efforts prove to be the most prominent form of knowledge dissemination. Scientific and non-scientific articles, popular sci-

[91] http://knowledgeforclimate.climateresearchnetherlands.nl/organisation; http://knowledgeforclimate.climateresearchnetherlands.nl/midtermassessment2012 .

entific books, brochures, fact sheets on projects, PhD theses, posters, presentations, conference proceedings or project reports support the distribution of KfC's findings. *Capacity building and decision support* (*KBA 4*) presents another important aspect of KfC's policy advice. This mainly takes place in research of Theme 8 Decision Support Tools which explicitly strives for enhancing Dutch adaptation policy by providing specifically developed support tools. Instances of such tools are projects which develop and visualize adaptation risks, like the project 3Di Water Management Applicable for End Users that visualizes flooding in order to enable easy and quick decisions (van Ierland, 2012)[92].

The Knowledge Transfer section strives for *public outreach* (*KBA7*) of the research findings in various ways in order to reach scientists, decision makers, and beyond. A prominent example for the section's work is the Climate Impact Atlas[93] that discloses spatial information on climate change impacts in the Netherlands. It also organizes conferences for scientists and broader audiences, such as the Deltas in Times of Climate Change 2010 Conference, or sets up exhibitions, such as the Climate as an Opportunity 2010 Exhibition[94]. Further ways to publicly disseminate the KfC findings are brochures, newsletters, press releases, social media accounts, and the provision of the KfC website[95].

Exemplary activity 1: Hotspot Haaglanden Region

Haaglanden Region is one of the most relevant political regions in the Netherlands and represents one of the eight KfC Hotspots. Jelmer Ridder, an employee of The Hague Region, coordinates the Hotspot's work in terms of administration and content. Regional questions addressed in the Hotspot concern especially water storage and drainage capacity, the costal position and the region's security aspect, greenhouse cultivation, and the consequences of climate effect for investment climate[96].

The Project HSHL 3.4 is concerned with developing the actual Regional Adaptation Strategy (RAS) Haaglanden in the form of a report and booklet which represents the Hotspot's overarching goal of *policy development* (*KBA5*)[97]. Therefore, decision makers from municipalities, water boards, and provincial authorities work together in a "project team" (KfC 6), the so-called Official Coordination Committee, in order to elaborate the strategy. Several consecutive steps will contribute to the RAS: First, a Knowledge Assembly will compile city- and region-specific research findings from both, Hotspot and Theme projects. In a second step, stakeholders shall reflect on this draft version from their practical point of view within workshops and at events where presentations will be held. The committee will actively disseminate the knowledge particularly to various municipal and provincial departments because they have the impression that so far exclusively the environment departments have an increased awareness of adaptation issues. Finally, the project team revises and finalizes the strategy documents. The final adaptation strategy will be directed at policy makers, private businesses, and citizens. Additionally, it will be presented in specifically organized meetings and events (KfC 6 Lammers, 2012).

Since the adaptation strategy shall be finished by the end of 2014, it is only partly possible to assess the actual use of KfC-related policy advice. Nevertheless, the research projects and their findings have so

92 http://www.deltares.nl/en/product/1767530/what-is-3di-water-management.

93 http://www.climateresearchnetherlands.nl/results/from-sketchbook-to-climate-atlas.

94 http://kennisvoorklimaat.klimaatonderzoeknederland.nl/klimaat-als-kans.

95 http://knowledgeforclimate.climateresearchnetherlands.nl/organisation/knowledgetransfer.

96 The Hague Region, which is Hotspot Coordinator, the Delfland Water Board, the Province of South Holland, and nine Haaglanden municipalities have cooperated with various university and non-university institutes, such as Wageningen University, Erasmus University Rotterdam, Deltares, the Royal Dutch Meteorological Institute KNMI.

97 Furthermore, the testing and application of *decision support* tools (*KBA4*) plays an important role in Haaglanden Region (see Exemplary Activity 4).

far allowed for identifying problems, particularly regarding water management and heat stress, and generated academic knowledge on these aspects which supported awareness-raising from the interviewees' perspective. Furthermore, specific decision making tools, like the 3Di simulator which produced flooding scenarios, which were developed within KfC project have already been utilized for regional planning, such as security plans. Another important advancement represents the intensified interaction among local and regional authorities, private actors, and researchers (KfC 6).

Exemplary activity 2: Hotspot Rotterdam Region

Rotterdam Region is the most important Dutch economic region and constitutes another of the eight Hotspots of the KfC program. Arnoud Molenaar from the City of Rotterdam serves as an intermediary between scientific and non-scientific actors by coordinating the different parties' cooperation. Due to its peculiarities the Rotterdam Region pays particular attention in adaptation questions to its port, transport issues, and housing in order to assure the area's climate proofing and attractiveness for living and working (Molenaar & Oudkerk Pool, 2012).

The Project HSRR 3.4 Adaptation Strategy Rotterdam Region (ARR) represents the centrepiece of the Hotspot's work. It aims at finalizing the ARR by synthesizing three so-called blocks of (more or less collaborative) KfC research – Block I: Rotterdam Adaptation Strategy; Block II: Regional Climate Agenda Urban Region; and Block III: Societal Cost Benefit Analysis – and, thus, *develops* concrete climate change *policy* (*KBA5*) through the elaboration of the Adaptation Strategy Rotterdam Region[98]. The first part Rotterdam Adaptation Strategy describes and analyses the effects of climate change primarily for the city and indicates effective and achievable measures. Within the second block, drawing on the downscaling of national climate scenarios stakeholders assessed the urgency to take action on the local level within a range of sub-regional workshops. Third, in order to investigate the added economic value of actual integrated climate measures scientists developed a societal cost-benefit analysis for the Rotterdam region. Against this background stakeholders were able to select and decide on concrete strategies. The overarching Project HSRR 3.4 will be carried out by employees of the City of Rotterdam. It will compile the three blocks' findings as well as results from further Rotterdam-related KfC projects (from the Hotspots and Themes) into a final report, the Regional Adaptation Strategy Rotterdam Region. The Hotspot Coordinator intends to hand over the preliminary document to the Hotspot stakeholders in order to receive feedback on the information and the derived options for action. Afterwards, a last revision of the report shall take place (KfC 5 Molenaar & Oudkerk Pool, 2012).

Besides the Regional Adaptation Strategy document, the Hotspot's final output will encompass several thematic background reports on the most important themes for the Rotterdam region that are written by the employees of the City of Rotterdam (KfC 5). Furthermore, the research reports will be made accessible for the stakeholders. All these documents particularly address decision makers. In addition to these written products, the City of Rotterdam as Hotspot Coordinator will set up a governmental implementation process in order to assure the transfer of knowledge into political and societal action (KfC 5 Molenaar & Oudkerk Pool, 2012).

Exemplary activity 3: Theme 7 – Governance of Adaptation

Theme 7 Governance of Adaptation is one of eight KfC Themes with particular policy relevance because it aims to contribute to the development and implementation of adaptation governance. The

[98] Besides, single projects are particularly concerned with *compiling and translating scientific knowledge* (*KBA3*).

Theme Consortium consists of national and international university research institutes[99] and integrates scholars from different disciplinary fields like public administration, economics, political science, spatial planning, law, environmental studies, and psychology. The consortium lead is held by Prof. Termeer from Wageningen University and Research Center who is responsible for management and coordination of the Theme. The cross-regional research in this Theme addresses diverse stakeholders from the Hotspots Haaglanden, Rotterdam, Major Rivers, South-West Netherlands Delta, Shallow Waters and Peat Meadow Area, Dry Rural Areas, and Wadden Sea.

Overall, the Theme focuses especially on *policy analysis and development* (*KBA5*) and *decision support tools* (*KBA4*). Against the background of complex adaptation governance challenges, such as responsibilities, uncertainties, and contested knowledge, it wants to support the "adaptive capacity of society so that future climate changes can be confronted" (Termeer *et al.*, 2012). An example for a policy analysis project is the Project 2.2 Realizing Climate Robust Multifunctional Land Use through System Synchronization, which studies the case of the Roofpark Rotterdam. Drawing on interviews, participatory observation of project meetings, and document analysis, it deals with the overarching question on how to synchronize multiple domains, such as "public – private; policy – knowledge; government – society" (Termeer *et al.*, 2012), in order to facilitate innovative function combinations. In the project area, a business development district, several existing land use functions are already present, and need to be taken into account in future plans. These include a primary sea defence levee and large underground city heating and electricity infrastructure running adjacent to the levee. Over time, various actors ranging from the local water board to energy and construction companies became involved. After a decision making and implementation process of 15 years the park is currently being constructed. However, it still continues to face challenges in the interaction between different actors involved. Therefore, the project investigates how actors interact and come to work together to develop multi-functional land uses in order to inform the Hotspot and support enhanced cooperation among the various involved actors (KfC 7 Termeer *et al.*, 2012).

The Project 3.2 "Implementing Climate Adaptation Policies: Public Policies and Private Initiatives" constitutes an example for the development of a decision support tool. It asks how policy instruments should be designed to stimulate the supply of climate adaptation services by private parties in an efficient, flexible, legitimate, and fair way. More concretely, a PhD student develops an auction tool for water storage. Therefore, in a hypothetical auction experiment for so-called Blue Services farmers shall participate in a multi-day internet auction and state their desired payment for having their land contracted for temporary storage of peak rainfall to prevent undesirable flooding downstream. The auctions are designed in close collaboration with the stakeholders. The project devotes special attention to the duration and characteristics of the Blue Service (based on the wishes of the water board and the possibilities in the study area), agglomeration bonuses (usefulness of measures can depend on the services offered and bidding behaviour of others), possible auction variations (uniform or discriminatory), and the time and risk preferences of individual farmers. On a more general level, the project tests designated policy instruments in close cooperation with the Hotspots and shall enable ex-ante assessments of the acceptability of such policy instruments[100] (KfC 7).

Both projects disseminate their findings via presentations, reports, and workshops which are directed at local, regional, and national ministry officials and further stakeholders. Additionally, in both cases PhD theses and scientific journal articles will be written in order to distribute the generated knowledge within the scientific community (KfC 7). Since both projects have started a few months ago, it is not possible to identify actual impacts and use yet. Although most projects are not finished yet, according to the inter-

[99] Wageningen University, Free University Amsterdam, Radboud University Nijmegen, Erasmus University Rotterdam, Utrecht University, University of East Anglia, Carl von Ossietzky University, and Stockholm University.

[100] http://knowledgeforclimate.climateresearchnetherlands.nl/governanceofadaptation/WP3-allocating-responsibilities-risks

views the Theme has already contributed to awareness-raising for adaptation issues and the importance of social sciences for the implementation of adaptation policy (KfC 7).

Exemplary activity 4: Theme 8 – Decision Support Tools

The Theme 8 Decision Support Tools represents one of the eight more scientifically oriented, cross-regional KfC research themes with particular policy orientation. It aims at developing and enhancing *decision support tools* (*KBA4*) in order to support *policy analysis, evaluation, and development* (*KBA5*). The research devotes special attention to cross-cutting spatial and infrastructure planning processes and policies at local, regional, and national level. Prof. van Ierland from Wageningen University leads the research consortium that consists of Dutch university and non-university research institutes[101]. The majority of researchers are economists. These scientists mainly collaborate in joint research projects on case studies with stakeholders form the Hotspots Haaglanden Region, Dry Rural Areas, Major Rivers, Shallow Waters and Peat Meadow Areas as well as several provinces and municipalities, and the Delta Program (van Ierland, 2012).

The overarching goal of this Theme is the development the 3Di Water Management tool, an interactive visualization tool for flood risks that shall enable easy and quick decisions. For the purpose of addressing the stakeholders' needs, the scientists organized three workshops in order to gather and, later on, further specify the actors' interests (KfC 8). Afterwards, within the framework of different work packages, the researchers developed a range of scenarios and cost-benefit-analyses which, then, fed into the tool. During the elaboration of the tool regular interaction with stakeholders, especially with water boards, took place, primarily in the form of informal discussions on the progress of the tool development and to assure the incorporation of the practice perspective (KfC 8). After the finalization, the tool was provided to decision makers and an interactive web portal, which provides real-time information supply to actors, was set up. The researchers presented and still present their tool and findings to mainly local, regional, and national decision makers and stakeholders in the form of workshops on the use of the tool, flood maps, and a newsletter. In doing so, it particularly addresses water boards and city planners, but also the Delta Commisariat (KfC 8). Furthermore, the results are presented at international scientific conferences, in scientific journals, and PhD theses.

Overall, the 3Di tool shall eventually contribute to an enhanced elaboration of the Regional Adaptation Strategies, particularly in all those Hotspots which are concerned with flooding issues. So far the tool has already been able to inform spatial planning and infrastructure development policies, especially in the case of the Haaglanden Region which developed regional security plans and a new concept to better cope with urban heat islands planning (KfC 6, 8). Another possibility for the tool's employment is the planning of dykes by the water boards (KfC 8).

6.3.4 Strategies to achieve knowledge brokerage effectiveness

Overall, we found that the KfC program strives for the effectiveness of its findings in various ways. Compared to other research programs salience proves to be a highly intended aspect for KfC, whereas scientific credibility and particularly legitimacy of advice appear to be of relatively minor importance.

[101] Wageningen University and Alterra Research Center, Free University Amsterdam, Deltares, TNO Innovation for Life, PBL Netherlands Environmental Assessment Agency, and Technical University Delft.

Salience

Meeting the stakeholders' knowledge needs on climate change adaptation takes the highest priority for KfC. The program assures the perceived relevance of its findings through internal and external mechanisms. Research questions and research projects are highly demand-driven and developed in iterative, participatory ways in the Hotspots. Also regarding the topics for the Themes the different stakeholders were able to bring in their knowledge needs. Another aspect that emphasizes the strong orientation toward the practical relevance of the generated results is that in both Hotspots and Themes researchers and stakeholders together conduct collaborative action research. The strong orientation toward the applicability of research and its findings reflects in the conception of Hotspots as "real life laboratories where knowledge is put into practice"[102]. A societal program evaluation, conducted by KfC itself, underlines the strongly applied character of research. In addition to the internal mechanisms, KfC aims at assuring the societal relevance and impact of its outputs by the Societal Advisory Council which advises on future steps in various program elements and the societal program evaluation.

Credibility

Scientific authoritativeness and believability are comparatively less vigorously promoted but still accentuated. KfC research combines the applied, stakeholder research approach with "high quality scientific knowledge"[103]. Particularly the development of cross-cutting Themes which are independent from the region-base Hotspot approach shall guarantee that the applied research is accompanied by state-of-the-art research that meets international standards. Scientists publish the outcomes of both applied and basic research projects in academic peer reviewed journals in order to assure and prove scientific soundness. Moreover, the development, execution, and publication of PhD theses indicate the research program's scientific quality (KfC 7, 8). An evaluation of the program's scientific quality regularly takes place. Cooperation projects with well-known international scientists, particularly in the Themes, underline scientific authoritativeness and believability. The cooperation with national and international research programs and knowledge organizations emphasizes the scientific relevance of KfC research. Additionally, KfC institutionalized an external mechanism in order to guarantee scientific credibility. The International Scientific Advisory Board periodically assesses the scientific aspects and supports the internal scientific evaluation of the program.

Legitimacy

In comparison to salience and credibility, legitimacy plays only a minor role. Nevertheless, a variety of strategies aims at securing the perceived fairness of the research process within the KfC program. While the overall program structure is publicly accessible, the Hotspots' and Themes' actual research is less visible. For instance, it is difficult to find out who exactly works on which topic because of the confusing structure of the KfC database. Furthermore, it is not clear how the projects proposals are evaluated and how the funding is distributed among the different Hotspot and Theme projects (KfC 1). Hotspots and Themes provide their Mid-term Review Reports (Termeer *et al.*, 2012, Lammers, 2012, Molenaar & Oudkerk Pool, 2012, van Ierland, 2012). These offer a good overview of research activities, but are only released two yearly. Scientific and non-scientific publications are to be found on the website[104]. Despite the considerable stakeholder engagement, the participatory research mainly aims at ameliorating the findings' significance (KfC 1, 3, 7).

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103 http://knowledgeforclimate.climateresearchnetherlands.nl/programme/mission-and-approach.

104 http://knowledgeforclimate.climateresearchnetherlands.nl/hotspots/rotterdam-region; http://knowledgeforclimate.climateresearchnetherlands.nl/governanceofadaptation.

7 Switzerland

7.1 Overview on climate policy advice in Switzerland

Switzerland is a comparatively small country with a unique political system and culture. It exhibits a federal state structure that is characterized by a pronounced direct democracy and the integration of four language groups. First attempts of climate policy were made in 1986 by the Air Pollution Control Concept of the Swiss Federal Council. However, first legal measures, i.e. the CO_2 law that includes a CO_2 levy, were not taken until 1999 when against the background of the Kyoto Protocol the public and political understanding of climate issues enhanced and a broad consensus among different interest groups could finally be found (Bundesamt für Umwelt BAFU, 2010, Lehmann & Rieder, 2002).

Corresponding to the small size of Switzerland also the advisory landscape in climate policy is comparatively narrow and consists of only a few institutions. The analysed case ProClim- constitutes a central hub within this field (see chapter 7.2). Already in 1988 Swiss climate scientists founded ProClim- as research and policy advice network (ProClim, 2011b). ProClim- co-hosts and supports the Parliamentary Group Climate Change that anchors scientific expertise also at the parliamentary level via lunch meetings with experts (ProClim- 4, 7, 10). Furthermore, ProClim- chaired the Swiss Advisory Body on Climate Change (OcCC) from 1997 until its end in 2012 (ProClim- 7, 8). Additionally, scientific climate advice is provided by a few universities, such as ETH Zurich or University of Bern, research centres at universities, like the Center for Climate Systems Modeling (C2SM) at the ETH Zurich, and universities of applied sciences, like the University of Applied Sciences Northwestern Switzerland (ProClim- 1, 2, 7, 8). From 2001 until 2013 the publicly funded scientific network NCCR Climate was concerned with both mitigation and adaptation issues and constituted a significant source of scientific advice.

The growing political importance of adaptation policy led to a growing pluralisation of the Swiss advisory landscape. Think tanks and consultancy agencies, such as ECOPLAN or INFRAS, gained in importance for scientific policy advice (ProClim- 1, 2, 7). Moreover, applied research projects and programmes serve as increasingly important providers of scientific expertise. For the Adaptation Strategy Switzerland climate researchers conducted scientific research as a basis for recommendations to be subsequently formulated in a joint action plan by the concerned federal departments. CC Hydro and its successor CC Hydro Plus represent instances of applied research programs with a distinct focus on climate change and water policy.

Overall, a small, but currently broadening, set of actors engages in Swiss climate policy advice that exhibits a “quite pronounced” (Steffen & Linder, 2006, 313) culture of expertise in which advice is still strongly dominated by interest groups (Vatter, 2008). Within this context, particularly among conservative Swiss political parties scientific climate sceptics’ propositions are very popular and often used for argumentation against climate-friendly measures (ProClim- 1, 4, 7). Outstanding features of the Swiss climate advisory landscape are the early institutionalization of the interface and the complex institutional nesting of ProClim-, the Parliamentary Group “Climate Change”, and OcCC. Furthermore, the Swiss climate policy interface exhibits an increasing orientation toward the demands of the users of scientific expertise which is reflected in the debates that surround the re-location and re-organization of the OcCC more closely at the Federal Government (ProClim- 4, 7).

7.2 ProClim- – Forum for Climate and Global Change of the Swiss Academy of Sciences

7.2.1 General description of ProClim-

ProClim-, the Forum for Climate and Global Change, is a Swiss platform for research and science-policy coordination on global and climate change. The forum aims to "[…] facilitate both integrated research activities and the necessary linkages among scientists, policy-makers and the public at home and abroad" and "[…] to enhance communication between science, public, administration, politics, economy and public"[105]. More precisely, the platform aims to foster knowledge exchange and networking among scientists, to enhance international cooperation and the integration of Swiss researchers into the international climate research community, to provide information to decision-makers, economy, and the public as well as to support these actor groups with recommendations on relevant questions.

ProClim- was founded in 1988 on the initiative of the Swiss climate research community via and at the Swiss Academy of Sciences (SCNAT) as an interdisciplinary national climate research program, the Programme Climatologique Suisse (ProClim-). In 1991 the body was re(de)fined by the Academy's Board as Swiss Institute for Climate and Global Change in terms of organization and tasks. Since 1993 it is called Forum for Climate and Global Change (Arquit Niederberger, 2005, Lehmann & Rieder, 2002).

Two different sources grant the ProClim- funding: The SCNAT allocates about 50% of the annual budget from public means. The academy's budget for its Climate theme amounts to about 950.000 Swiss Francs (~ 750.000 euros) per annum and is mainly implemented by ProClim-. The other half of the ProClim- budget bases on project funding from various sources, like the Federal Office for the Environment (FOEN), the insurance company Swiss Re, MeteoSwiss, international research programs or service fees for business workshops etc. (ProClim, 2011a, Swiss Academies of Arts and Sciences, 2011).

7.2.2 Institutionalization

The *ProClim- Office* carries out the platform's work as regards administration and content. It is located at the SCNAT in Bern and is led by the ProClim- *Executive Director* (Dr. Christoph Ritz). The core staff currently consists of five scientists, three student assistants, and occasional observers or guest researchers. ProClim- exhibits a nested organizational structure: The Office run the secretariat of the independent *Advisory Body on Climate Change OcCC* until 2012 and is responsible for the administrative and topical organization of the meetings of the *Parliamentary Group "Climate Change"* (see Figure 10). Furthermore, ProClim- hosts the secretariat of the Interacademic Commission on Energy (a+ Energy Commission) on behalf of the Swiss Academies and serves as an interface to the International Human Dimensions of Global Change Program (IHDP Switzerland) [106].

ProClim-'s efforts are supervised by a *Steering Committee* that consists of eleven independent members from public and private research institutes and administration as well as one ex-officio member. The committee, which is chaired by its director Prof. Heinz Gutscher, oversees and discusses ProClim-'s annual programmes and new ideas with regard to scientific priorities and strategic advisory aspects.

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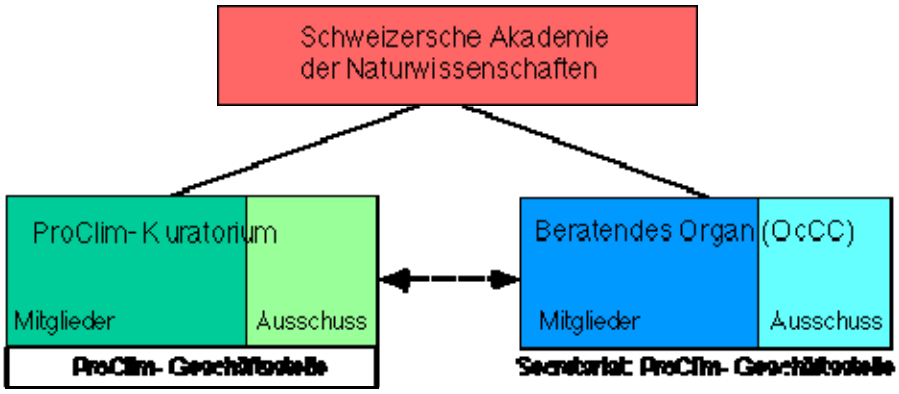
105 http://www.proclim.ch/4dcgi/proclim/de/home?1589.

106 http://www.proclim.ch/4dcgi/proclim/de/home?1589; http://www.proclim.ch/4dcgi/proclim/de/event?934; http://www.occc.ch/.

Figure 10: Organizational Structure of ProClim



Source: http://www.occc.ch/about_d.html

ProClim- is formally accountable to the SCNAT. However, this does not encompass special reporting requirements or evaluations. The forum accounts for its activities by the development, discussion, and publication of its Annual Programs. The Steering Committee's recommendations on the Annual Programme and further ideas do not have binding character (ProClim, 2011a, ProClim, 2012).

7.2.3 Activities

ProClim- and its subsidiary bodies broker scientific expertise in various ways which are closely related to the forum's self-conception as platform and independent advisor. The most important activities encompass coordination and networking, the compilation and translation of knowledge as well as public outreach. ProClim- conceives *coordination and the support of networking* (*KBA2*) among various actor groups as one of its core tasks (ProClim- 4, 7, 10). On the one hand, the forum brings together Swiss and international scientific peers. ProClim- organizes scientific events like the Swiss Global Change Day[107], it selects and delegates the Swiss authors and reviewers to the IPCC reports, and the forum participates in international research programs, like International Geosphere-Biosphere Programme IGBP or World Climate Research Programme WCRP. On the other hand, ProClim- supports the matchmaking between national and international scientific experts as well as socio-political actors, including administration, media, and businesses. The openly accessible research database "InfoSystem"[108] enables scientists and non-scientists to search a list of more than 10.000 researchers and about 2.500 research projects on climate and global change. The corresponding online help desk links media, administrative or private inquires with suitable experts for guest lectures or events. The forum and the OcCC also host specific networking events, like the Annual Symposium on Climate Change Adaptation, which particularly addresses scientists and ministry officials (ProClim, 2011a, ProClim, 2012). At the regional level ProClim- organizes Regional Climate Dialogues where climate scientists, regional and municipal decision makers, and economy come together.

Furthermore, ProClim- provides policy advice by *compiling and translating scientific knowledge* (*KBA3*). The forum provides personal, user-tailored expertise in response to inquiries on climate questions, for instance on the IPCC. Assessment reports of ProClim- and OcCC, like the Swiss Climate Scenarios (OcCC/ProClim, 2007), position papers or climate science synopses, such as the Global Change Ab-

107 http://events.scnat.ch/proclim/index_en.php?id=15221.

108 http://4dweb.proclim.ch/4dcgi/proclim/de/index.html.

stracts[109], are primarily directed at policy makers. At the same time, they serve as support and information for Swiss scientists (ProClim- 4, 7). ProClim- co-organizes the events of the Parliamentary Group "Climate Change" which aim at providing tailored scientific and practice expertise to Swiss parliamentarians, such as Climate Change – Facts and Consequences for Switzerland or Tourism: Challenge Climate Change[110]. ProClim- also passes on researchers' expertise in formats with broader user range: Instances are fact sheets, like Climate Press[111] for journalists, newsletters, and specifically tailored education material. The latter are sometimes produced and published on demand of administration, media or businesses.

A third important pillar of ProClim-'s knowledge brokerage activities constitutes the efforts for *public outreach* (*KBA7*). ProClim- manages the web-based "KlimaPortal"[112] that provides scientific knowledge tailored to the needs of pupils and the broader public. Furthermore, the forum organizes popular scientific exhibitions, for instance for schools, and facilitates public forums and media conferences on emerging mitigation and adaptation topics. Instances for these endeavours are IPCC information events or the Klimaforum Thun (ProClim, 2011a, ProClim, 2012).

In particular through its supporting role for the OcCC, ProClim- is involved in the *analysis and evaluation of policies* (*KBA5*), for instance statements on current climate policy issues, like the OcCC Statement on Revision of the CO_2 Law[113]. Additionally, assessments on Swiss climate policy issues, such as the study ProClima: Climate Goals and Emission Reduction (OcCC, 2012b) (see exemplary activity below) or the report Climate Change and Switzerland 2050: Expected Impacts on Environment, Society and Economy (OcCC/ProClim, 2007), serve as preparatory policy analysis with recommendations for government, administration, and economy (OcCC, 2012b). Besides ProClim- staff is also involved in *personal policy advice (KBA6)* by participating in several national and international committees and boards, like the a+ Energy Committee which represents the energy commission of the Swiss Academies of Science and tackles issues of future Swiss energy supply[114].

Exemplary activity 1: OcCC – Organe Consultatif sur les Changements Climatiques

Until 2012, ProClim- provided the secretariat for the independent *Advisory Body on Climate Change OcCC* for the federal Swiss government and administration. OcCC was an independent advisory council that aimed at constituting an interface between research, economy, and administration in order to foster evidence-based policy advice (OcCC, 2012a)[115]. In 1996 the Federal Department of Home Affairs (FDHA) and the Federal Department of the Environment, Transport, Energy and Communication (UVEK) mandated the SCNAT to establish the OcCC (Arquit Niederberger, 2005, Lehmann & Rieder, 2002, ProClim, 2011a)[116]. Due to expected synergy effects the *OcCC Executive Secretariat* was located at and managed by ProClim- (Dr. Christoph Kull). The eleven OcCC members from the realms of science, politics, federal administration, and the private sector were selected by ProClim- and met regularly

109 http://www.proclim.ch/4dcgi/proclim/en/Media?1135.

110 http://www.proclim.ch/4dcgi/proclim/all/event?934.

111 http://www.proclim.ch/4dcgi/proclim/all/Media?665.

112 http://www.climate-change.ch/4dcgi/index_de.html.

113 http://www.proclim.ch/4dcgi/occc/de/Stellungnahme?1352.

114 http://4dweb.proclim.ch/4dcgi/proclim/all/Detail_Program?a%2benergy-commission.

115 http://www.occc.ch/about_d.html.

116 http://www.proclim.ch/4dcgi/proclim/de/home?1589; http://www.proclim.ch/4dcgi/proclim/de/event?934; http://www.occc.ch/.

(ProClim- 7, 8). From ministerial side, the Federal Office for the Environment (FOEN) accompanied the body's work.

The council is an example for ProClim-'s activities which aim at the *compilation and translation of scientific knowledge* (*KBA3*) and at *policy analysis and evaluation* (*KBA6*). ProClim- was not only concerned with the administrative issues, i.e. organization and the host of the OcCC meetings, but ProClim- staff members also identified and proposed relevant authors for the reports and coordinated the projects. Additionally, in most cases ProClim- staff members served as co-authors of the reports themselves. One of ProClim-'s employees position encompasses 30% funding which is dedicated to scientific research for OcCC (ProClim- 7). A prominent instance of such a report is the Climate Change and Switzerland 2050 study (OcCC/ProClim, 2007). Within this context ProClim- selected the appropriate researchers and coordinated the meetings in which the researchers and committee members jointly defined the research question. Afterwards, different working groups of scientists collated and analysed the existing scientific state of knowledge on sectoral impacts of climate change for Switzerland and, then, handed over the report to the OcCC. The OcCC members derived concrete policy-recommendations from these findings within small working groups on specific sub-topics which were also hosted and coordinated by ProClim- (ProClim- 7). The resulting project report fed into OcCC statements on current policy making – like the OcCC Statement on the Revision of the CO_2 Law (2009)[117] –, a specific event where the report was presented, and fact sheets that summarize the results for policy makers and further important stakeholders. Besides the provision of studies, the council delegated members to parliamentary hearings or the environment commission of the Swiss parliament and provided the scientific representation of the Swiss delegation for international climate negotiations at the suggestion of ProClim- (ProClim- 7, OcCC, 2012b).

Overall, in the interviewees' perception the scientific information provided by the OcCC considerably contributed to increased awareness in Swiss political and societal debates surrounding climate issues (ProClim- 7, 8). Furthermore, policy makers and associations used the generated knowledge as basis for their statements, for instance, within the context of the ultimate Revision of the Swiss CO_2 Law and the initiative For a Healthy Climate in 2012. OcCC's work and information also led to an increased integration of adaptation policy into the FOEN's agenda (ProClim- 7). The council's mandate expired in 2012. Over the next few months a considerable personnel and organizational restructuring shall take place: Prospectively, solely researchers will fill the body's positions and it shall be located 'more closely' to the Swiss Federal Council, i.e. at the UVEK (ProClim- 7, 8, 9).

Exemplary activity 2: Parliamentary Group "Climate Change"

One main activity of ProClim- is the organizational and content-wise support of the *Parliamentary Group "Climate Change"*. In 1996 eight members of the Swiss parliament and the ProClim- Executive Director Dr. Christoph Ritz founded the parliamentary group in order to offer scientific policy advice and actively stimulate debate on climate change-related questions among researchers, practice experts, and members of the Swiss parliament (ProClim- 8, 10).

The group organizes presentations on current climate-related issues in combination with working lunches once each parliamentary session. At each meeting two short presentations are given on current mitigation and adaptation questions in order to provide targeted information to parliamentarians; in most cases one speech is delivered by a scientist and one by a practice expert. Scientific speakers are mostly natural scientists or economists[118]. Afterwards, the lunch meetings provide the opportunity for plenary

117 http://proclimweb.scnat.ch/portal/ressources/1352.pdf.

118 http://www.proclim.ch/4dcgi/proclim/de/home?1589; http://www.proclim.ch/4dcgi/proclim/all/event?934.

discussion as well as informal contacts. Up to today the Parliamentary Group has arranged more than 50 lunch meetings on climate change-related issues. Some of the more recent topics encompassed Energy Production from Underground – Potentials, Chances, and Hazards, Climate Change and Global Change – Ramifications for World Agriculture, and Climate Change – Facts and Consequences for Switzerland[119]. The ProClim- Executive Director (Dr. Christoph Ritz) simultaneously serves as *Executive Secretary* of the group. In cooperation with two members of the Swiss parliament, the group's President and Vice-President, he schedules the meetings in administrative and content terms, i.e. coordinates the dates for the events as well as selects the topics and presenters. Afterwards, they invite all members of the Swiss parliament. Furthermore, ProClim- supports the speakers' preparations in terms of structure, language, and content in order to assure that their presentations are tailored to the specific audience (ProClim- 10).

According to the interviewees, scientific expertise brokered via these lunch meetings most frequently serves as background knowledge. At the same time, it is also directly used by parliamentarians: For instance, the meetings have motivated members of the parliaments to initiate parliamentary interpellations, such as the Interpellation on the Attainment of Climate Targets in 2012[120], and motions or formed the basis for legislative proposals. Furthermore, the information served as a basis for discussions in the Parliamentary Energy Committee (ProClim- 8, 10). In some cases, the events of the Parliamentary Group "Climate Change" lead also to further knowledge brokerage activities, when experts on climate change issues are requested to provide their expertise to parliamentary commissions (ProClim- 8).

7.2.4 Strategies to achieve knowledge brokerage effectiveness

ProClim-'s main priorities in terms of ensuring the effectiveness of the provided scientific expertise are their perceived relevance and scientific credibility. However, the perceived fairness of the process of generating knowledge and advice seems to be less important.

Salience

ProClim- strongly strives for assuring the relevance of expertise for its stakeholders. One focus of the forum is the coordination of science with particularly political, but also some societal actors. We, furthermore, find a broad spectrum of ProClim- outputs that are clearly tailored to the user's needs in terms of content and presentation. In its function as secretariat for OcCC and the Parliamentary Group "Climate Change" the forum fosters its strong, institutional links to government and parliament, but also to the private sector. Additionally, some members of the ProClim- Steering Committee are linked to practice, like the FOEN or Swiss Re, and, thus, have a say in the forum's agenda (ProClim, 2011a, ProClim, 2012)[121].

Credibility

The scientific credibility of ProClim-'s advice is another important aspect in order to foster the effectiveness of its activities. Right from the beginning independence and impartiality were important for the forum. It was established by and located at the Swiss Academy of Sciences in order to avoid partisanship, in both scientific and political terms (ProClim- 1, 4, 7). Furthermore, although the subsidiary bodies OcCC and the Parliamentary Group are institutionally connected to the forum, they are practically independent in order to assure ProClim-'s autonomy.

119 http://www.proclim.ch/4dcgi/proclim/de/event?934.

120 http://www.parlament.ch/d/suche/seiten/geschaefte.aspx?gesch_id=20124054.

121 http://4dweb.proclim.ch/4dcgi/proclim/de/persinprog?proclim-&person=steering-committee.

Regarding the overall orientation and quality of ProClim-'s scientific work, the Steering Committee, which is partly composed of prestigious scientists, discusses and supervises new topics to be approached by ProClim- (ProClim- 4, 5). The Forum follows the Swiss academies of sciences' criteria for research and bases its research on international state-of-the-art research (ProClim, 2012, Arquit Niederberger, 2005).

Legitimacy

The most important effort in order to assure the legitimacy of ProClim-'s work constitutes the broad dissemination strategy. The forum distributes scientific expertise by a diverse portfolio of products, ranging from highly scientific to popular ones. All documents are open to the public via the online platforms and users of these are able to pursue direct inquiries. However, ProClim-'s internal processes, institutional affiliations, and responsibilities are not very transparent. Only scattered information is available in this regard via the Swiss Academies of Arts and Sciences (Swiss Academies of Arts and Sciences, 2011). With regard to inclusiveness we found that ProClim- pays attention that researchers from all Swiss language groups are represented in the forum's committees and work (ProClim- 1, 7). A broad stakeholder involvement beyond selected researchers, ministry officials, and business representatives, however, is not very important for ProClim-'s work.

8 United Kingdom

8.1 Overview on climate policy advice in the UK

The UK is a relatively active country, in both climate change mitigation and adaptation policies. The UK has started early to formulate a comprehensive domestic mitigation policy when it introduced first statutory measures to reduce GHG emissions already in 1989 through the Non-Fossil Fuel Obligation (NFFO). Also in international climate negotiations, the UK government has always been "an active protagonist of a global deal to limit human-induced climate change" (Bowen & Rydge, 2011), even against the background of recent fiscal pressures.

Corresponding to the high activity level in climate policy the UK climate advisory landscape is one of the most diverse in Europe (Thunert, 2006). This is reflected, among others in the three analysed UK cases (UKCIP, CCC/ASC, and CXC) that represent important KB institutions with quite different approaches and are operating at different political levels. From the early 1970s onwards university research centres, such as the Climatic Research Unit (CRU) at the University of East Anglia or the Centre for Social and Economic Research on the Global Environment (CSERGE) at the University of East Anglia and University College London (UCL), have started to focus on climate change research (Hulme & Turnpenny, 2004). This academic expertise has been complemented by departmental research institutes, particularly by the MetOffice Hadley Centre for Climate Prediction and Research and the Environment Agency (UKCIP 5, CCC/ASC 1, 2, Hulme & Turnpenny, 2004, Hoppe *et al.*, 2012). Besides, a variety of independent think tanks and consultancy agencies, such as Alexander Ballard Ltd or Collingwood Environmental Planning, have increasingly gained in importance in climate policy advice (Thunert, 2006, Turnpenny *et al.*, 2005).

Earlier than most other OECD countries the UK started to focus on adaptation policy alongside mitigation issues (Bauer *et al.*, 2012). Already in 1997 the UK Climate Impact Programme (UKCIP) (see chapter 8.2) was established in order to coordinate research on impacts of climate change and provide support for decision makers by applying a stakeholder-based approach (Hulme & Turnpenny, 2004, Hoppe *et al.*, 2012). In 2000, the idea of stronger action- or solution-oriented research further manifested in the foundation of the research network Tyndall Centre for Climate Change Research that conducts transdisciplinary climate change research (Hulme & Turnpenny, 2004, Turnpenny *et al.*, 2005). In 2008, the Climate Change Act introduced a range of institutions to support the UK Government in climate change policies which increased the comprehensiveness of the already existing advisory architecture: An independent expert advisory body, the Committee on Climate Change (CCC) with its Adaptation Sub-Committee (ASC) (see chapter 8.3), was established that counsels the government on mitigation issues and preparing for adaptation (Bauer *et al.*, 2012). The Act also institutionalized the Climate Change Risk Assessment (CCRA), which aims at regularly evaluating the risks and opportunities of climate change in order to inform the National Adaptation Programme (NAP) (CCC/ASC 1, 2, UKCIP 5, Bauer *et al.*, 2012). Such statutory assessment is a quite unique approach among European countries and indicates the UK's strong reliance on evidence-based policy making. In order to contribute to the development of the NAP the Adapting to Climate Change Programme (ACC) was set up within Defra which represents a highly evidence-based governmental programme that compiles scientific information and builds capacity for adaptation action. Besides the Act further formats for policy advice were introduced: The Living with Environmental Change Programme (LWEC, since 2008) allows different public sector organizations to fund, conduct, and use environmental research (Swart *et al.*, 2009). In 2011 Chief Scientific Advisors for

the Ministries DECC and Defra were introduced as personal advisors, which are directly accountable to the respective Secretaries of State and provide immediate on-demand-policy advice (CCC/ASC 2, UKCIP 3, Reinecke *et al.*, 2013, Thunert, 2006).

The national structures are paralleled by advisory initiatives at the sub-national level which appear to rather prefer "an action network approach to addressing climate change than at the national level" (Turnpenny *et al.*, 2005, 10). An instance of scientific advice that is directed at devolved authorities is the Scottish ClimateXChange (CXC) centre of expertise (see chapter 8.4), a research collaboration on mitigation and adaptation issues. Moreover, the Regional Climate Change Partnerships are collaborative networks between regional public, private, and third sector actors which have supported coordinated action on adaptation issues at local and regional level since 2000 (Bauer *et al.*, 2012).

Overall, the UK exhibits a highly evidence-based style of policy making in which scientific expertise plays an important role for both, political and public debates, primarily in the form of natural-science-based climate models and assessments (Jasanoff, 2005, Hulme & Dessai, 2008). For instance, the Stern Review (Stern *et al.*, 2007) was commissioned by the former Blair Government as an instrument for communicating climate policy. However, the established role of science was challenged in 2009 when during the so-called Climategate emails of the University of East Anglia were leaked which suggested that researchers had manipulated findings for the IPCC report. Climate scepticism or at least doubts in the seriousness of climate change are an issue among political and societal actors in the UK, although in public discourse a broad consensus on the notion of anthropogenic climate change exists (Hoppe *et al.*, 2012, 14). Additionally, we observe an increasing diversity of advisory forms, particularly against the background of adaptation policy. The current landscape features a high degree of stakeholder integration and practice-orientation. This goes hand in hand with an increased opening of internal advisory structures of UK government to external scientific experts.

8.2 UK Climate Impacts Programme (UKCIP)

8.2.1 General description of UKCIP

The UK Climate Impacts Programme (UKCIP) is an advisory service that coordinates research on impacts of climate change in the UK and provides support and advice for public and private decision makers to assess and adapt to these impacts at local, regional and national levels. UKCIP is an independent unit at the Environmental Change Institute at the University of Oxford which was established in 1997 by the UK Government Department of the Environment, Transport and the Regions (DETR) (UKCIP, 2011). Its operations are based on contracts with DETR and its successor Defra (Department for Environment, Food and Rural Affairs) for 3 programming periods (1997-2002, 2002-2005, 2005-2010, see UKCIP, 2011, McKenzie Hedger *et al.*, 2006). Since October 2011, with the end of the last programming period, many of UKCIP's agendas and tasks have been transferred to the Environment Agency that is delivering the work on adaptation for Defra "in house" (UKCIP 3, 4). UKCIP remains working as a research unit of the Environmental Change Institute at the University of Oxford.

UKCIP's objectives and activities for each respective contracting period responded to Defra's demands and stakeholder requirements (Whitelaw *et al.*, 2006). With the 2005 contract period UKCIP's operational scope and objectives were substantially expanded to also include the facilitation of adaptation practices by helping organizations develop and implement adaptation strategies and actions, and supporting new legislative requirements associated with adaptation. While this thematic shift was mainly pursued by UKCIP, the Climate Change Act of 2008 has created an increased demand for advice and

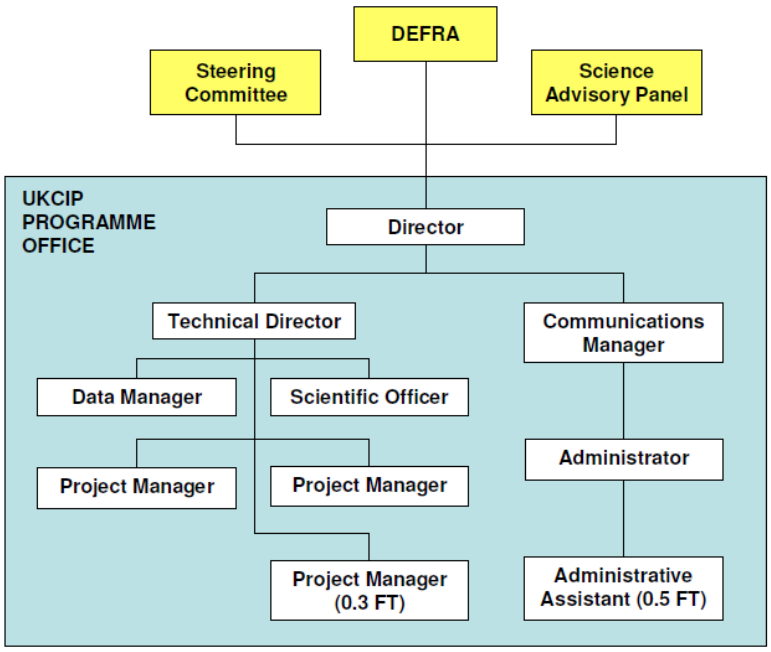
support to stakeholders regarding adaptation assessments and actions (UKCIP 1, 2, UKCIP, 2011). Since the end of the contract with Defra UKCIP engages in a reduced set of activities around fostering and coordinating stakeholder inclusive research on the impacts of CC in the UK and the provision of and training on integration tools (UKCIP 4, 5, UKCIP, 2011).

Throughout the programming periods UKCIP was funded by the UK Government, DETR/Defra, from 2007 onwards mainly via its Adaptation to Climate Change Programme (ACC). The overall budget in the period 2002-2005 was 1.8 million pound (ca. 2.2 million euros, see Whitelaw *et al.*, 2006), and added up to 1 million pounds (ca.1.2 million euro) annually for the contracting period 2005-2010 (UKCIP, 2011). In addition, the Devolved Administrations, the Environmental Change Institute (Oxford University) as well as the Government's Knowledge Transfer Partnership scheme contributed to the overall budget. Increasingly, the research that UKCIP facilitates and coordinates is funded by various public and private stakeholders (e.g. research councils, regional authorities, statutory providers, see McKenzie Hedger *et al.*, 2006).

8.2.2 Institutionalization

The UKCIP Programme Office is based at the University of Oxford's Environmental Change Institute and was staffed with up to 17 researchers and communication experts in 2010, which has been reduced to currently 9 (director: Roger Street).[122] Before 2011 an Advisory Panel encompassing key stakeholders from government departments and other agencies, local, regional and devolved administration, research, and the private sector (initially called Steering Committee) advised on the overall work and direction of the programme (UKCIP 4, McKenzie Hedger *et al.*, 2006, Whitelaw *et al.*, 2006). A Science Advisory Group (initially Science Panel) with six senior experts from research oversaw the scientific integrity of the work and tools (see Figure 11).

Figure 11: Organizational chart of UKCIP until 2011



Source: (Whitelaw *et al.*, 2006)

[122] http://www.ukcip.org.uk/.

In the User Forum stakeholders (local to national public and private decision makers) exchanged on their adaptation experiences biannually and advised UKCIP on their needs (McKenzie Hedger *et al.*, 2006). Until 2011, UKCIP reported twice a year to Defra as major funder. Moreover, external evaluations were conducted at the completion of each of the first two contracting periods as well as a self-evaluation report in 2011 (UKCIP, 2011, Whitelaw *et al.*, 2006).

8.2.3 Activities

In line with the working mission as explicated in its contracts with Defra, UKCIP's major activities have been about raising the awareness for climate change and its impacts, vulnerabilities and adaptation needs and target adaptation actions (UKCIP, 2011, Swart *et al.*, 2009). This continues to be a main activity also after the contract's ending and is pursued by UKCIP mainly by means of *coordinating (KBA 2)*, assisting and fostering stakeholder-led research studies in England, Scotland and Wales. Especially today UKCIP takes the role of a communication service provider (broker) supporting and informing on-going research programmes and networks, like the ARCC CN within the Living with Environmental Change programme (see separate description, ARCC CN, 2012).

Already in the late 1990 and early 2000s when climate change adaptation was hardly on the political agenda UKCIP contributed to building the knowledge base and raising awareness by initiating and supporting *regional scoping studies on climate change impacts (KBA3)*. UKCIP collaborated closely with regional stakeholders in organizing workshops and compiling the reports and therewith strongly *facilitated the establishment of the Regional Climate Change Partnerships* (RCCPs*, KBA2*) (UKCIP, 2011, Whitelaw *et al.*, 2006). The RCCPs are stakeholder-led partnerships that cover all nine English regions and continue to facilitate knowledge exchange and build capacities for climate change adaptation. UKCIP has worked closely with the partnerships regarding the *development and testing of its several tools*, the *organization of trainings and workshops (KBA4)* and the *compilation of information* (KBA3). UKCIP has further supported the RCCPs by sending *representatives to the steering or advisory bodies (KBA6)* and providing the Secretariat for the umbrella organization for the RCCPs until 2011, which now autonomously operates as Climate UK.[123] Moreover, UKCIP set up a so called UKCIP/RCCP Business and Climate Change Adaptation Forum, an online community for exchange on best practice experiences, knowledge, publications etc. (UKCIP 6).

Especially between 2005 and 2011 UKCIP has been heavily engaged in the development of a whole set of *decision support tools and guidance (KBA4)* helping public and private organisations to identify how they might be affected by CC and what they can do to minimise their risks or exploit the opportunities (UKCIP, 2011). UKCIP heavily engages stakeholders in the development process of various tools in order to secure their applicability. UKCIP has also offered trainings and workshops as well as remote training techniques or online learning modules on the use of projections and its core tools, e.g. on the UKCP09, UKCIP Adaptation Wizard; Local Climate Impacts Profile, but also on related topics such as National Indicator 188; SMEs and businesses; Adaptation Reporting Power; Departmental Adaptation Plans (UKCIP 1, 4, 5, UKCIP, 2011).[124]

Moreover, UKCIP provides summary reports that synthesize on-going and completed research on climate change impacts (KBA 3). UKCIP also supports the compilation of (sectoral) adaptation studies as well as case studies on how businesses, local authorities and others adapt to climate change, e.g. Modelling Natural Resource Responses to Climate Change (Monarch) or "build knowledge for a changing climate" (BKCC) (UKCIP 1, 5, UKCIP, 2011, McKenzie Hedger *et al.*, 2006).

123 http://climateuk.net/home.

124 http://www.ukcip.org.uk/.

Because of UKCIPs expertise in stakeholder engagement as well as knowledge communication and transfer more generally it was approached by the Government to *compile, translate and disseminate* information on climate change adaptation *to users (KBA3)*. Most prominently, UKCIP developed the communication strategy for the national climate projections UKCIP02 and UKCP09 (see separate description; UKCIP 3, 4, 5).

Although a strong focus of UKCIP is on informing and helping public and private stakeholders (government departments and agencies, local governments, regional partnerships, business or statutory companies) to adapt to climate change, it also explicitly *reaches out to the general public* and the media (*KBA7*). Through the database on its webpage, for instance, it provides access to all sorts of relevant and easy to digest information on on-going research, adaptation actions, impacts of climate or news about adaptation activities, e.g. BRAIN: Base for Research, Adaptation, Impacts and News (UKCIP, 2011). Notification about activities is provided via the e-news, Twitter or Facebook, the Climate Digests, monthly synthesizing 4–6 adaptation-relevant academic papers, or other popular scientific publications (UKCIP, 2011, McKenzie Hedger *et al.*, 2006).

Exemplary activity 1: ARCC Coordination Network

Since the Environment Agency took over major responsibilities on adaptation services, UKCIP mainly focuses on coordinating and fostering research in the area of climate change adaptation. Inter alia, UKCIP provides support services to the so called, Adaptation and Resilience to a Changing Climate coordination Network (ARCC CN).[125] ARCC CN is a collaborative research network comprising of researchers and stakeholders that conduct joint research projects with a particular focus on the implications for the built environment and infrastructure sectors looking for instance at urban environments, transport networks, water resources or energy systems.

ARCC CN was established by the Engineering and Physical Sciences Research Council (EPSRC) in 2009 and is an accredited activity within the Living with Environmental Change (LWEC) programme contributing to its "Infrastructure Challenge" (ARCC CN, 2012). The central idea and aim of ARCC CN is to facilitate that knowledge and evidence from the research community is made available to policy and practice more effectively (UKCIP 4). Through the joint activities between research and end-user communities, the ARCC CN provides more socially robust evidence enabling the design of more resilient urban systems. In concrete ARCC CN integrates 18 individual research projects across 35 research institutions as well as various different stakeholders from research, policy (central and local governments), economy (industry and business) (ARCC CN, 2012).

The network aims at fostering information exchange and synergies among different research projects on adaptation and with that avoids duplication and promotes a greater impact on policies, respectively. UKCIP has a central facilitating role within the network and is concerned with management, coordination and promotion tasks. Building on existing links to regional and local stakeholders, e.g. the RCCPs and Climate UK, UKCIP promotes and facilitates the exchange with stakeholders from business administration and government as well as researchers *(KBA2)*. For instance forums, coordination meetings or workshops are held at different stages of the research: initially to identify emerging research needs of user-communities and ways how the ARCC CN researchers could address these, in between, to collaborate on research (e.g. on joint issues across projects) or to address potential discrepancies as well as to assure that research results are effectively transferred to potential users and beneficiaries (dissemination and launching events). Generally, the research approach is that of co-production, where stakeholders contribute as regional experts rather than mere recipients of ready-made evidence. Moreover,

[125] http://www.arcc-cn.org.uk/.

the stakeholder networks ought to play a strong role in furthering the dissemination and availability of outputs across the different projects also after the projects end (UKCIP 4, 5, ARCC CN, 2012).[126]

One example of UKCIP's facilitating role is the support of the project SNACC "Suburban neighbourhood adaptation for a changing climate".[127] The project is oriented at the adaptation of the built environment in ways that are both, less carbon intensive as well as socially acceptable. UKCIP *supports* the respective *partnership* of the universities of the West of England, Oxford Brookes and Heriot-Watt with practice partners from the City Councils of Bristol, Oxford and Stockport as well as from business (ARCC CN, 2012). UKCIP, for instance, organized workshops with residents and local authority representatives in six piloting neighbourhoods in Bristol, Stockport and Oxford aimed at identifying the potential for action and inaction as well as to create ownership. In addition UKCIP organized the project's final dissemination conference in London in October 2012 (ARCC CN, 2012).

In terms of the actual effect of UKCIP's activities, e.g. on the uptake of the research results in adaptation policies at the respective government levels, the current contentious framing of the climate change issue in the UK has diminished the scope for triggering corresponding decisions in broader policy and business sectors. However, the inclusive science approach pursued esp. by UKCIP within ARCC CN as well as the focus on issues that actually concern stakeholders (local health, wellbeing etc.) helped to further the acceptance of the research products and their implementation in municipal or local policy planning and practical solutions, like urban design (e.g. SNACC) (UKCIP 4). At a national level, UKCIP plays a major role in communicating the research results under the ARCC CN to inform on-going policy developments, like the National Adaptation Programme or the government's flagship energy efficiency scheme ("Green Deal"). The explicit reference in the National Adaptation Programme to the "significant research" that is undertaken within the ARCC CN (esp. SNACC) is telling of UKCIP's success in exerting its designated role to disseminate the evidence, e.g. on overheating risks, to policy (UKCIP 5).

Exemplary activity 2: Local Climate Impact Profile - LCLIP

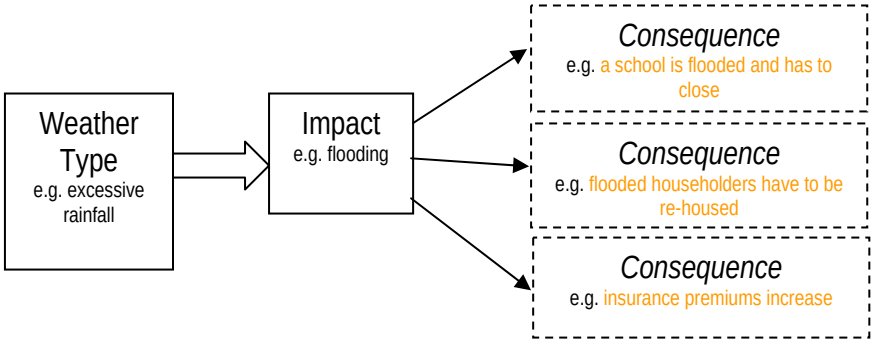
UKCIP provides a quite extensive set of *user-tailored decision support tools (KBA4)* through its website, e.g. the Business Areas Climate Assessment Tool (BACLIAT), the Local Climate Impacts Profile (LCLIP) for local authorities, or the Adaptation Wizard (UKCIP 5, UKCIP, 2011).

LCLIP is a very prominent tool that was jointly developed with and piloted in the County of Oxfordshire. Additional guidance and support material on how to do the LCLIP was jointly developed with local users and is provided online (UKCIP 1, UKCIP, 2009) encompassing for instance, a Gantt chart, template spread sheets for data collection, interview templates and transcripts, sample reports, emails, websites or press releases and so forth. Eventually, the LCLIP is no ready-made tool and looks differently for each organisation which shall follow its own approach of doing and framing the work in line with its respective purpose. The LCLIP, thus, rather only guides local authorities on how to self-assess "their localized" vulnerability to current and future climate change impacts highlighting their context specific concerns, requirements and resources (UKCIP 1, 2, 4). It is easy to apply, mainly concerned with collecting accessible data about how weather events have impacted the authority's delivery of services apply and could thus principally be done "on the back of an envelope in one afternoon" (UKCIP 4, see Figure 12 for a data collection example)

126 http://www.arcc-cn.org.uk/.

127 http://snacc-research.org.

Figure 12: Local Climate Impacts Profile Data Collection



Source: UKCIP's LCLIP pack; retrieved from: http://www.ukcip.org.uk/lclip/how-to-do-an-lclip/tools/

Therefore local authorities are, for instance, guided to scan the media or their internal records for past weather events and elaborate on how exactly the authority has reacted to the incidents, e.g. including the costs which the events induced in different departments, for instance for emergency provisions, insurance claims or road repairs (UKCIP 2, UKCIP, 2006, UKCIP, 2009). With that local authorities not only identify and economically assess potential future impacts of climate change but also reveal ways in which the authority (typically community, but potentially also private organization) is already prepared or not. Through this, the LCLIP indirectly fosters the capacities of local governments to respond to climate change in the future.

Concerning the actual use of the LCLIP it is noteworthy to say, that the tool served hundreds of local authorities in fulfilling their national reporting requirements under the National Indicator 188 until it was abolished in 2011[128] (UKCIP 2, 4, UKCIP, 2011). Outputs range from (internal) reports and briefs or singular charts over (series of) presentation events to websites or newspaper articles, which are in effect limited to raising awareness in the local governments about adaptation needs. Whether local action is triggered heavily relies on the (political) willingness and capacity of the local authorities (UKCIP 1). Concerning the overall contentious framing of the climate change issue, the focus of LCLIP on local weather events as well as on the localized costs and benefits of adaptive actions has promoted the broad application of the tool (UKCIP 4). Despite the persisting climate scepticism and local budget shortages, local authorities have now even begun to develop their own version of the tool (called SWIM: Severe Weather Impact Monitoring) within the so called Regional Climate Change Partnerships (RCCPs), where they jointly monitor local severe weather incidents on an interactive online platform hosted by the MET office (UKCIP 2, 4).

Exemplary activity 3: Communicating the United Kingdom Climate Projections - UKCP09

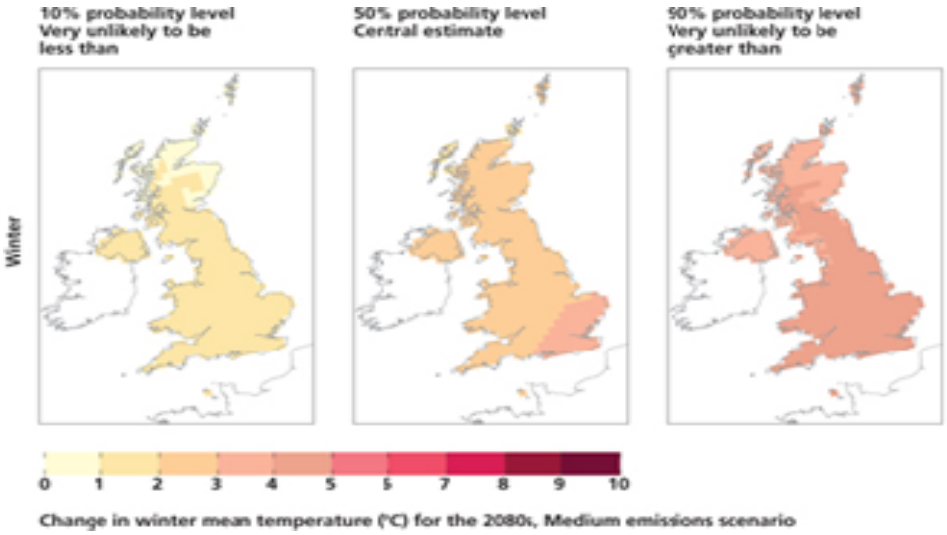
UKCIP was heavily involved in the development of the UK Climate Projections (UKCP09) and in particular engaged with securing user input as well as the development of the communication strategy. The UKCP09 are nation-wide scenarios of plausible future climate change in the UK for different time periods and different scenarios of greenhouse gas emissions. The projections are meant to inform and help decision makers in their adaptation planning. UKCIP facilitated the work of the so called UKCP09 Users' Panel (now called User Advisory Panel) which is one out of 3 Management groups and was formed in

[128] In the UK, the National Indicator 188 measured the "progress on assessing and managing climate risks and opportunities, and incorporating appropriate action into local authority and partners' strategic planning" between 2008 and 2011 (Local and Regional Partnership Board, 2010). Afterwards, Defra used the indicator to support local authorities on a voluntary basis.

January 2007 to oversee and inform the process. Based on the experiences with the UKCP02, the Panel was installed to inform the development of the UKCP09 as well as guidance and training services with a user perspective and with that enhance their practical applicability. The Panel encompasses representatives from different communities and sectors and convened at various stages of the development of the UKCP09 (via emails, face-to-face or conference calls) exchanging especially on relevant parameters as well as the testing and enhancement of the user interface (UKCIP 3, 4, 5).[129] UKCIP would then bring in the concrete demands and views by users in the actual technical development of the climate projections, e.g. rectifying and challenging the use of an overly technical language or the lack of practically usable parameters in the projections (UKCIP 3).

Correspondingly, UKCIP developed different information formats and guidance on the projections which are openly accessible on the UKCIP and UKCP09[130] websites. For example, UKCIP has developed the "Before you start" section where interested users are prepared on how to make use of the UKCP09. Once on the website users are guided through different online tutorials before datasets and products are displayed for different levels of details (UKCIP 4). These information formats are not only aimed at raising awareness and fostering the consideration of climate change at national or regional level but also at clarifying the probabilistic nature of climate projections and with that building users' confidence and capacities. For instance, several colourful UK maps are displayed that illustrate the projected changes in temperature and precipitation across the UK until the 2080s for the 'medium' emissions scenario (see Figure 12).[131] Using data from UKCP09, different maps are given for the 10, 50 and 90% probability levels. With that, users are explicitly encouraged to consider and by that sensitize for the wide range of outcomes of all emissions scenarios deriving from the remaining uncertainties of the models in use. Moreover, key findings and graphs are provided on the web pages for different probabilistic changes in key parameters for each region, again with the wide range of possible values being explicated. The UKCP09 maps and key findings may be used by professional users at their discretion and are freely downloadable at a high resolution.

Figure 13: Example of UKCP09 map



Source: http://www.ukcip.org.uk/essentials/uk-impacts/

129 http://www.ukcip.org.uk/.

130 http://ukclimateprojections.defra.gov.uk/, technically the user interface was realized by the British Atmospheric Data Centre (UKCIP 3).

131 http://www.ukcip.org.uk/, http://ukclimateprojections.defra.gov.uk/.

The scenarios are widely used throughout the UK serving as common frameworks for activities on climate change impacts and adaptation (UKCIP 3, 6, UKCIP, 2011), e.g. for the National Adaptation Programme (UKCIP 5). To enable a broad and context tailored application of its information, UKCIP has developed different information layers with increasing level of details responding to different levels of professional knowledge of potential users (UKCIP 4). Furthermore, maps and graphs are linked to an interactive UKCP09 User Interface (Outputs page) where users can create customized versions of these images by changing the parameters in line with their information needs (UKCIP 4). The user functionality is further promoted with a FAQ section on the webpage providing additional explanations of the use of multiple maps.

8.2.4 Strategies to achieve knowledge brokerage effectiveness

UKCIP strives for the effectiveness of its advice activities in various ways highlighting in particular the practical relevance and usability of climate change knowledge. While the scientific credibility of its advice is generally important it is less essential in cases where the engagement of stakeholders is actively sought for, e.g. to improve the acceptance (legitimacy) and applicability of research.

Saliency

Stakeholders and their needs are a key concern that is strongly guiding almost all past and on-going operations at UKCIP. Accordingly, all work plans as well as research studies are stakeholder-led. Therefore constant user dialogue and interaction takes place in stakeholder workshops, user forums and other set-ups for receiving feedback for developing different service products, such as tools, and to test their utility, respectively (UKCIP, 2011, McKenzie Hedger *et al.*, 2006). Through its Advisory Panel and particularly the user forums users' views and needs are captured to broadly inform and direct the overall work of UKCIP, for instance of its clients (like Defra). Research studies are typically commissioned by and jointly developed (agenda setting but often also production) with user groups (national and devolved administrations, local authorities, business etc.) thus ensuring that research meets user needs (UKCIP 1, 5, UKCIP, 2011, McKenzie Hedger *et al.*, 2006). Likewise, the tools that have been developed are not only informed by academic research but also build upon substantial practitioners input (UKCIP 1, 2). In line with its credo of sharing research "outputs in ways that are useful to stakeholders" it offers a whole range of easily accessible information formats to users, whereas it pursues the practice of "learning through doing culture" (UKCIP 6, UKCIP, 2011).

Credibility

The scientific accuracy of UKCIP's activities is important. Its products, such as the tools, are typically also informed by and based on academic research (UKCIP 4, 5, UKCIP, 2011). Studies and products are based on scientific information, for instance on the UKCP09 scenarios which are seen as the most authoritative scenarios available for the UK (UKCIP 3). UKCIP has been evaluated in 2004/5 among others regarding the scientific and technical dimensions of its operations (Whitelaw *et al.*, 2006). Overall the institute is seen as independent from policy which has allowed UKCIP to play better the 'honest broker' or 'critical friend' role (UKCIP, 2011).

Legitimacy

With its active dissemination strategy offering open access to a plethora of different information formats, e.g. through its webpage, UKCIP assures a high degree of transparency about research activities and outputs, though slightly less on internal processes and organization, a situation that has probably also been nourished with the institutional restructuring and transfer of responsibilities to the EA past 2011

(UKCIP 3).[132] Moreover, the legitimacy of its operations builds upon the involvement of stakeholders in research and process. Although typically more explicitly targeted at increasing the research utility, stakeholder-led research is also serving the social acceptability of results and with that fostering adaptation action (UKCIP 1, 2). Moreover, its activities build upon a broad client and partner base (e.g. the Users Forum) representative of a whole range of different public and private decision makers and institutions (UKCIP 4, UKCIP, 2011, McKenzie Hedger *et al.*, 2006).

[132] http://www.ukcip.org.uk/.

8.3 Climate Change Committee (CCC)

8.3.1 General description of CCC

The Climate Change Committee (CCC) with its Adaptation Sub-committee (ASC) is a statutory, but independent, advisory body to the UK Government and Devolved Administrations that – qua objectives – aims at providing an authoritative body of evidence that influences "UK Government and devolved administration strategy in the areas of carbon budgets and preparedness for climate change in the UK" (Committee on Climate Change, 2012).

The CCC was established based on the requirements of the Climate Change Act 2008 which also sets out its general responsibilities as an independent, non-departmental advisory body (HM Government *et al.*, 2010). Formally, the CCC and its Adaptation Sub-Committee fall under the responsibility of and are funded by the Secretaries of State of the UK Government (Department of Energy and Climate Change (DECC) and Department for Environment, Food and Rural Affairs (Defra)) as well as the relevant Northern Ireland Department, the Welsh and Scottish Ministers (ibid). The role, governance and accountability, management and financial responsibilities of the CCC/ASC are captured in its Framework Document (HM Government *et al.*, 2010). The working programmes and plans of the CCC are coordinated with the respective funding parties, in particular the current and future work priorities of the CCC are set out in 3-year Corporate Plans (e.g. 2012-2015, Committee on Climate Change, 2012). The objectives, tasks and outputs of the ASC are detailed in a separate Work Programme (Committee on Climate Change, 2009). In addition, CCC and ASC provide advice to national and Devolved Administrations on demand.

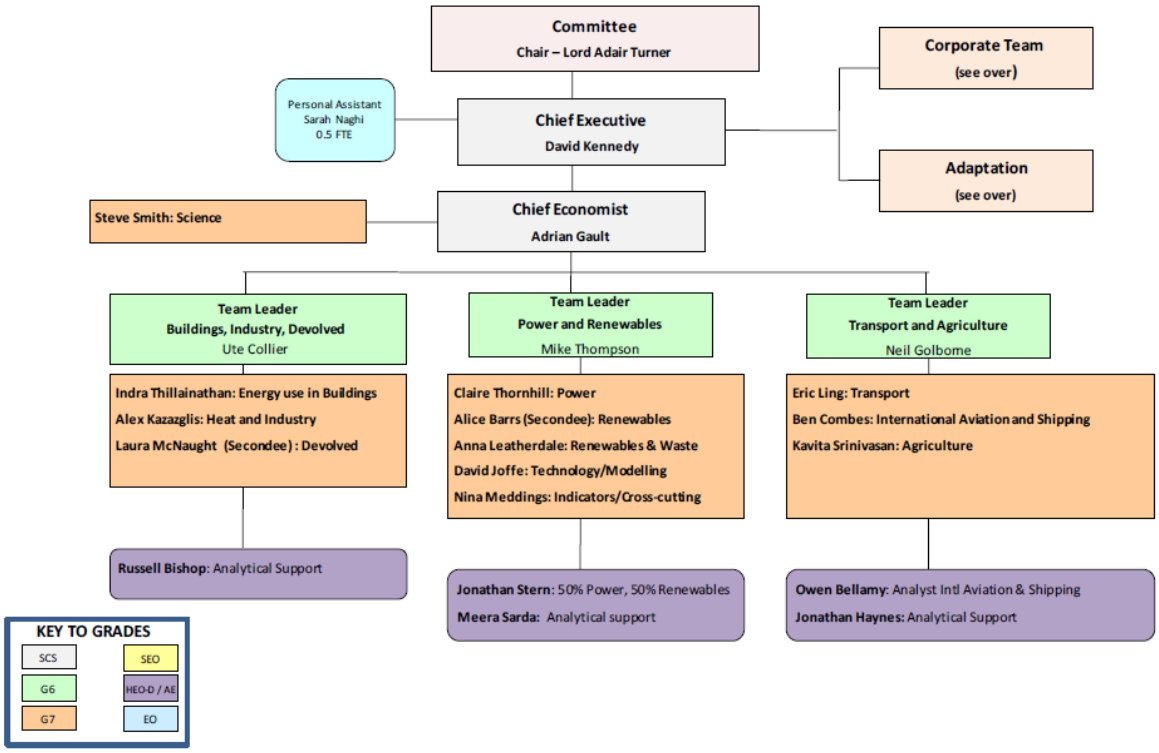
The overall annual budget of approx. 3 million pounds sterling (ca. 4 million euros) of the CCC is jointly covered by DECC (84%), the Scottish Government (8%), the Welsh Assembly Government (5%) and the Department of the Environment Northern Ireland (3%). The ASC in contrast, is jointly sponsored by Defra, the Scottish Government, the Welsh Assembly Government and the Department of the Environment Northern Ireland; with ca. 0.8million pounds sterling (ca. 1million euros) per year in total (HM Government *et al.*, 2010, Committee on Climate Change, 2012).

8.3.2 Institutionalization

The UK Committee on Climate Change comprises eight academic experts from the fields of climate change science and economics and is chaired by Lord Deben, who is also a member to it. The ASC, chaired by Lord Krebs, consists of six independent members senior experts in the area of climate change adaptation. Chairs and members of both committees are jointly appointed for a period of 5 years by the responsible ministers (HM Government *et al.*, 2010). David Kennedy is the chief executive responsible for safeguarding the public funds and for the day-to-day operations and management of both, the CCC and ASC (CCC 5, HM Government *et al.*, 2010). The Committee is supported by a secretariat with a mainly scientific staff of 33 people (for details see Figure 14). It provides the major analytical research input as well as corporate support on which the advice of the committees is built (CCC 2, 5) The Adaptation Sub-Committee utilizes the CCC's secretariat staff (Committee on Climate Change, 2012).[133]

[133] http://www.theccc.org.uk/.

Figure 14: Organizational Chart for Committee on Climate Change
(without Corporate Team and Adaptation Committee)



Source: Adaptation Sub-Committee (2010).

The operations of the CCC and ASC are overseen by a so called Sponsor Group (chair: DECC) which is composed of senior representatives from DECC, Defra, Communities and Local Government, HM Treasury, Department for Transport, Business Innovation and Skills, the Devolved Administrations, the CCC and the ASC. The Sponsor group is concerned and agrees upon the business plan and key performance targets, informs the committees about their indicative budgets for the following year and revises performance and results for the previous financial year.

The CCC and ASC have strict reporting and accountability requirements on the use of (financial) resources, providing monthly forecasts and monitoring information on performance and finance to the funding parties (DECC, Defra, Devolved Administrations) and the National Audit Office, whereas the funding parties report to the respective parliaments. An audit committee oversees the financial and corporate governance, internal controls, risk management systems and its compliance with relevant legal and regulatory requirements. Annual reports are produced on all activities together with the audited accounts each financial year (HM Government *et al.*, 2010).

8.3.3 Activities

In line with a more strategic focus of the mandates of CCC and ASC to support the transition to a low carbon economy and a resilient society, the major scientific advice activities that the Committees engages in may be best described as scientific analysis for policies (CCC 5). It *compiles and translates science to its major users (KBA3)* by producing studies and different information formats on various topics that concern the on-going policy processes in the UK and its regions. For instance, the CCC synthesizes state-of-the-art research or international action on climate change in the sectors of energy (renew-

able), transport, buildings and industry (low carbon innovation). The ASC additionally advices on the Climate Change Risk Assessment regarding the methodology and Synthesis report (CCC 2, HM Government *et al.*, 2010, Committee on Climate Change, 2009).

A further major activity of both the CCC and ASC is advising the national and devolved authorities on the on-going *development of mitigation and adaptation* strategies and *policies (KBA5).* The most prominent example is the CCC's advice on and setting of the UK Carbon budgets and the progress reports that regularly evaluate their achievement (see separate description).[134] Beyond the UK Government, the CCC also provides comparable advice on mitigation policies for the devolved administrations. For instance for Northern Ireland with the report "The Appropriateness of a Northern Ireland Climate Change Act" which assesses the current emission trends as well as the regulatory framework in place vis-à-vis the legally binding emission reduction targets also elaborating on the opportunities and remaining challenges (Committee on Climate Change, 2011). The ASC is mainly concerned with the assessment of progress on and preparedness for adapting the UK to climate change impacts (Committee on Climate Change, 2009, Adaptation Sub-Committee, 2011). Therefore it evaluates how well the country meets and implements the objectives, proposals and policies of the national Adapting to Climate Change Programme – mainly through assessment reports, e.g. 'How well prepared is the UK for climate change' (Adaptation Sub-Committee, 2010). It offers similar assessments to devolved regions upon request, e.g. of the Scottish Government (CCC 6).

On the basis of their assessment and evaluating activities the CCC and ASC also *prepare advisory letters (KBA6)* to individual parliamentarians or Ministers on demand and *attend public hearings* (KBA6) and provide so called "evidence," to the Parliament and other public authorities.

Beyond the activities targeted at national and devolved authorities (esp. status and progress reports, carbon budgets) or the Parliament and single MPs, the Committee also *reaches out (KBA7)* to the general public and interested stakeholders, however rather as an add on to its advice to policy. Supported by an own PR section the CCC provides podcasts and videos, blog, press releases, or even social media (Twitter, Facebook, etc.) entries to inform about its activities and products.

Exemplary activity 1: Setting and monitoring the UK carbon budgets (CCC)

The Climate Change Act 2008 ('the Act') is the national regulatory framework for mitigation and adaption to climate change. For example, it encompasses ambitious emission reduction and adaptation targets as well as the regular accountability to Parliament regarding meeting these targets. Among others the Act requires the Government to set legally binding 'carbon budgets,' i.e. a cap on the amount of greenhouse gases emitted in the UK over a five-year period in reference to an overall long-term target (e.g. recommended 80% cut by 2050). Qua regulatory requirement, the Committee on Climate Change advises the responsible Department for Energy and Climate Change (DECC) on the appropriate level of each carbon budget. The proposed carbon budgets ought to reflect the most cost effective pathway of achieving the respective long term objective (CCC 5).[135]

Supported by the secretariat and backed by externally commissioned studies the Committee determines appropriate budgets in line with a set of different emissions reduction scenarios. Based thereon, the Committee also derives at conclusions about the different alternative emission pathways the Government may take. Thought as practice-oriented advice to DECC, the Committee also conducts an economic assessment for the different relevant sectors and technological options in order to identify the most cost effective ways to meet the carbon budgets (CCC 5).

134 http://www.legislation.gov.uk/ukpga/2008/27/contents.

135 http://www.legislation.gov.uk/ukpga/2008/27/contents (esp. Part 2), also: http://www.theccc.org.uk/.

The carbon budgets are officially launched and tabled to the Parliament. It has to agree to the budgets as set by the CCC, which the Government has to implement accordingly. So far, all four carbon budgets have been put into legislation and will run up to 2027. [136] The last Carbon Budget (2023-2027), presented in May 2011, caps the allowed emissions at 1950 million tonnes of carbon dioxide equivalent ($MtCO_2e$). In its concomitantly published Policy Statement, the government promises to "make every possible effort to meet the fourth carbon budget through domestic action" (Department of Energy and Climate Change, 2011). Qua own claim, Government has reacted to the advice by the CCC by installing various policy measures such as the Electricity Market Reform or the Renewable Heat Incentive to green the UK economy stimulating necessary investments into suitable low-carbon technologies (e.g. CCS) and infrastructure (Department of Energy and Climate Change, 2011). However, despite the statutory role that the CCC has regarding setting the legally binding emission reduction targets, the Government retains considerable discretion in terms of how to implement the respective targets (CCC 5).

Exemplary activity 2: Progress reports on adaptation policies (ASC)

Qua statutory role, as set by the Climate Change Act, the Adaptation Sub Committee provides the government with the progress reports on adaptation which assess how the Government's adaptation policy succeeds in responding to the risks as identified in the Climate Change Risk Assessment.[137] The Adaptation Sub-Committee drafts various progress reports on the basis of a range of indicators against which the UK's progress is monitored (see Adaptation Sub-Committee, 2011).

The first national progress report titled 'How well prepared is the UK for climate change', for instance, acknowledges the progress of the UK regarding raising awareness, but laments lacking action on the ground (Adaptation Sub-Committee, 2010). The government is encouraged to further enhance practical implementation in the priority areas of land use planning, infrastructure, buildings, natural resources and emergency planning stressing in particular the co-benefits that adaptation measures would have for business actors. As legally required, the report was launched and tabled to the Parliament on 16 September 2010 (Adaptation Sub-Committee, 2010). The second progress report "Adapting to climate chance in the UK – Measuring Progress" (Adaptation Sub-Committee, 2011) similarly stresses land-use planning, managing water resources, and buildings as adaptation priority areas. In future, a major purpose of the progress reports will be to monitor and evaluate the progress of the Government's National Adaptation Programme (adopted in 2013) and to provide recommendations for its revision every 5 years (CCC 1, 2, 3).

The progress reports provide the Government's Adaptation Programme with sector specific recommendations on where exactly and how to further its adaptation efforts. Moreover, they are an important scrutiny to keep the Government accountable to its commitments in the Climate Change Act (CCC 1, 2). At the launch of the first assessment the Secretary of State for Environment, Food and Rural Affairs, Caroline Spelman, has officially acknowledged the report as a "wake-up call". [138] Moreover, Defra has prepared a strategic statement "Adapting to Climate Change: A new approach" (defra, 2010) in immediate reaction to the ASC progress report underlining the ASC's role for adaptation policy in the UK. In the statement Defra outlines the way in which it seeks to derive at a greener and more resilient economy

136 http://www.theccc.org.uk/.

137 http://www.legislation.gov.uk/ukpga/2008/27/contents (esp. Part 4: section 95 & schedule 1). The ASC exerts a similar role for the devolved administrations and as set out in their climate change regulations, e.g. Climate Change (Scotland) Act 2009 (CCC 2, 6).

138 https://www.gov.uk/government/news/urgent-action-on-climate-change-caroline-spelman-issues-wake-up-call.

stressing the role for decision makers in businesses for climate change adaptation action. At least rhetorically, Defra thus re-affirms the ASC recommendations.

Despite the statutory role of the ASC and the formal accountability (especially from 2013 onwards), the Government is, nonetheless, not legally bound to take up concrete recommendations by the ASC in the national adaptation policies (CCC 1, 2), in particular if these have severe implications for government budgets (CCC 3). Nonetheless, with its progress reports, but also in regular personal interaction, especially through the secretariat, the ASC provides Defra with highly valued evidence that the department employs, for instance, to identify priority areas for as well as monitoring methodologies of different policy measures to be considered in the Adaptation Programme and its regular revisions (CCC 3).

8.3.4 Strategies to achieve knowledge brokerage effectiveness

Both saliency and credibility mark central concerns of the Committee on Climate Change and its Adaptation Sub-Committee. In contrast to other cases the political relevance of the Committees derives from its statutory rather than from stakeholder inclusiveness or orientation. Legitimacy in contrast is important to achieve overall effectiveness in its policy advice.

Saliency

Already qua statutory role, the relevance of the work of CCC and its sub-committee are guaranteed for the overall climate change mitigation and adaptation policies in the UK and devolved administrations. The Climate Change Act 2008, which builds upon concrete demands by national and devolved authorities, gives the Committee a strong mandate and major responsibilities for advising different climate change policy drafting processes (HM Government *et al.*, 2010). In line with the use-orientation of its research, the CCC and its sub-committee regularly interact with its major sponsors: DECC, Defra and respective Devolved Administration, accordingly. A common working group as well as a "Memorandum of Understanding on Economic Modelling" have been installed to further facilitate a shared understanding and information exchange between the CCC and government officials (ibid.). Overall stakeholder consultations are applied to increase the practice-orientation and usability especially of the (progress and policy) reports produced (CCC 1).

Credibility

The authoritativeness of its advice is a key concern for the CCC and its sub-committee. Correspondingly, all members are renowned and senior experts ("eminent scientists") with a long-standing experience and high reputation in their field of expertise (CCC 1, 3, 5). Typically members also remain affiliated with their academic host institution which furthers their independence from political influence (CCC 1). Furthermore, the Committee closely cooperates with several leading research centres in the UK such as the Met Office, Hadley Centre, UKCIP or Walker Institute. A strong emphasis is set on evidence-based advice which builds upon robust and state-of-the-art scientific evidence and rests upon the organizational and practical independence of the Committee (CCC 1, 3, 5, HM Government *et al.*, 2010). Considering the authoritativeness of its research, the CCC has been shortlisted as a finalist in the Climate Week Awards in recognition of the innovative analysis which informed the 4th carbon budget report (Committee on Climate Change, 2012).

Legitimacy

In line with the general UK disclosure policy concerning public spending and regulation, also the CCC features a high transparency regarding its general organization and responsibilities (including salaries and procurement processes) as well as regarding the methodologies it applies and outputs it produces.

Generally all reports are made available free of charge through the website. [139] A strong media profile and coverage accompanies this disclosure policy which enhances the overall legitimacy of the institution. Moreover yet less of predominant importance as compares to the credibility and relevance of its advice, are measures to increase the social acceptance of its activities. Yet when its progress or assessment reports cover highly contested issues, stakeholders are consulted to have their views reflected appropriately and with that increase the acceptance of the evidence (CCC 1).

139 http://www.theccc.org.uk/.

8.4 ClimateXChange Scotland, CXC

8.4.1 General description of CXC

ClimateXChange (CXC) is one of two Centres of Expertise in Scotland. The CXC was established in April 2011 by the Scottish Government with the aim to provide a sound evidence base for Scotland's climate policy, thematically highlighting especially the area of climate change mitigation (CXC 1). Qua founding mission it seeks to connect "climate change research and policy" and "to provide responsive research to Scottish Government policy teams and other public agencies on climate change and the transition to a low carbon economy" (ClimateXChange). CXC comprises 16 research and higher education institutions that conduct (joint) research on different natural, physical and socio-economic aspects of climate change (so called work strands). Membership is the result of competitive tender where interested research institutions could apply to. Research proposals have been peer reviewed by scientific and policy experts regarding their contribution to the overall portfolio of Strategic Research in Scotland. The overall research priorities for this portfolio were derived in a collaborative process involving policy makers, industry, academics and representatives from the Major Research Providers (MRP) (CXC 1).[140]

CXC is exclusively funded by the Scottish Government that provides a core budget of currently ca. 3 million pound (ca. 4 million euros). The government also funds a so called 'call down' pot of roughly 1 million pounds (ca. 1.2 million euros), which has been installed to further the possibilities of commissioning targeted research which is also open to institutions outside the member network (CXC 1).

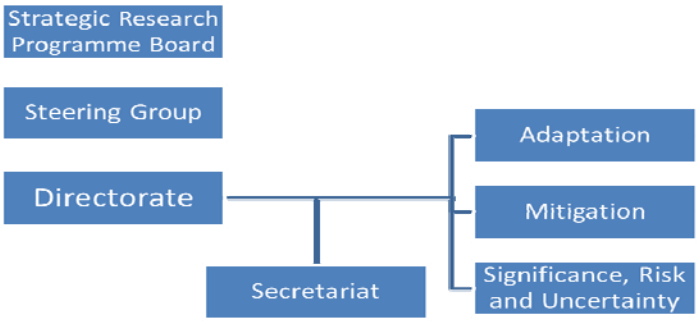
8.4.2 Institutionalization

The centre covers 16 research and higher education institutions from all over Scotland, including the universities of Edinburgh, Aberdeen, Dundee, St. Andrews, Strathclyde (Glasgow), Glasgow and the Harriot Watt University as well as other research institutions such as Scotland's Rural College, the Moredun Research Institute, Forest Research or Biomathematics & Statistics Scotland, the Royal Botanic Garden Edinburgh, Sniffer (knowledge brokers) and the Crichton Carbon Centre. Through the participating institutions the centre can draw on roughly 110 researchers. The centre's joint research initially circled around 3 broader themes, so called Work Streams: "Adaptation", "Mitigation", "Significance, Risk and Uncertainty" (ClimateXChange, no year) that recently have been restructured with 'risks and uncertainties' now being cross cutting issues in all research (CXC 2, see Figure 15). Research under these work streams covers eight topics (so called work strands): agriculture, natural environment, forestry, water, health, economy, the built environment and energy.[141]

[140] http://www.scotland.gov.uk/Topics/Research/About/EBAR/StrategicResearch, www.climatexchange.org.uk.

[141] www.climatexchange.org.uk.

Figure 15: Organizational chart of ClimateXChange (before restructuring)



Source: Kerr 2011 launching presentation retrieved from:
http://www.crew.ac.uk/sites/www.crew.ac.uk/files/documents/CXC%20Launch_Andy%20Kerr.pptx

The directorate encompasses three Directors with different topical responsibilities: Policy, Science, Main Research Providers. The Directorate represents the CXC externally and serves as node between the research network and Government commissioning also research outside the CXC (CXC 2). The Directorate is supported by a small Secretariat (staff of 3-4; full time). The secretariat also manages the call-down enquiry service and supports the work streams and the work strands thereunder (CXC 2, Sniffer). The Secretariat team is also responsible for the communication and promotion of the major research outputs (CXC 1, 2, 3). The CXC Secretariat is managed by Sniffer (Knowledge Brokers for a Resilient Scotland, a registered charity) and ECCI (Edinburgh Centre for Carbon Innovation, a collaborative public private partnership) in Edinburgh, Scotland's capital city, and with that situated close to government and its agencies. Moreover, the secretariat consists of communication professionals rather than senior researchers (CXC 2).

Seven members from government, research and society form the Strategic Research Programme Board which is a government body accountable for the overall Scottish strategic research budget. [142] The CXC reports on on-going activities annually (in financial years) to the funding Scottish Government (ClimateXChange). Operations are, moreover, overseen by a Steering Group that consist of 5 representatives of the Scottish Government and 4 representatives of other key institutions and gives strategic advice, direction and recommendations.[143]

8.4.3 Activities

Research in CXC takes place in topical work strands under the different work streams in the issue areas (sectors) agriculture, built environment, economy, energy forestry, health, the natural environment and water (CXC 2, 3). Typically applied and integrated research projects (incl. experiments) are conducted in 3 to 5 year project terms across the work strands. With these integrated research projects the CXC investigates different aspects of climate change mitigation and adaptation in the different covered sectors to identify potentials to reduce greenhouse gas emissions as well as to adapt to climate change, respectively (CXC 1).

Apart from this more classical applied research approach CXC seeks to inform government policy development and implementation. In order to respond to governmental information needs in a timely and

142 http://www.scotland.gov.uk/Topics/Research/About/EBAR/StrategicResearch.

143 www.climatexchange.org.uk.

targeted manner, CXC has established the so called "Call Down Service" (see separate description). The Call Down Service collects, translates and distributes advisory demands from the government and provides a range of products that translate relevant research of the network into various user-benign formats (KBA3). Exemplary are the academic briefs that give concise and concrete answers to different explicit enquiries by the Scottish Government (CXC 1, 2, 3). In order to respond to the information needs of the Scottish Government in "near term" (CXC 2, 3), CXC also conducts shorter studies (3-12 months). Especially with this planned research and the Call Down Service the CXC contributes to discussing and investigating potential mitigation policy options in the agriculture, forestry or building sectors, and, for instance, develops indicators of climate change adaptation for Scotland as basis to *identify* appropriate *adaptation or mitigation strategies* for the country *(KBA5).*[144] With that, the CXC actively supports the Scottish Government sectoral teams in identifying mitigation and adaptation policy options, for instance, for inclusion in the second Report on Proposals and Policies (RPP2 under the Climate Change (Scotland) Act) or for the drafting of the Adaptation Programme of the country (ClimateXChange). Accordingly, officials from the Scottish government (policy teams) mark the major target group of the CXC operations, but also the Scottish Environmental Protection Agency or Scottish Natural Heritage have benefited from CXCs support (Sniffer, CXC 1).

Exemplary activity 1: Call Down Service

An important service of ClimateXChange is the so called 'Call Down Service' which seeks to provide policy makers with robust scientific evidence and professional opinion in response to their specific policy questions.[145]

The service is facilitated by the small independent secretariat and the Policy Director (Kerr), which have a strong orientation towards the policy relevance of CXC and a broad overview over the network's research (CXC 2). They heavily engage and discuss knowledge needs with the policy team officers in the Scottish Government (and its agencies) as major clients in both more formalized and informal exchange contexts. The secretariat translates concrete knowledge demands into relevant and accurate research questions. In a subsequent call for tender, CXC's researchers may apply to answer these commissioned questions (CXC 1).

Because the CXC network mainly includes institutions concerned with natural resources and has a respective bias towards land-use issues, tenders are now also open to external experts. The government has redirected a substantial part of the overall network funding (1 million pounds) into a respective call-down pot to also attract this outside expertise (CXC 1). This set-up, however, also slightly reduces the secretariat's steering power to better align this research to policy needs (CXC 2).

The typical call-down products are simple short reports, presentations or briefs answering precisely the initial question. They are reviewed for clarity, quality and accuracy by and partly jointly authored with the CXC Directorate and secretariat (CXC 2). Examples are a "Brief on Blue Carbon" (i.e. coastal ecosystems' ability to capture carbon), the "Review of Strategies for Adapting to Climate Change" or the "Potential Emissions Abatement from Peatland Restoration" (Sniffer). Because of the strong linkage of the research with concrete policies the call down service is broadly perceived as an "innovative way of research for policy" and a "very successful measure" (CXC 1, 2, 3). The high spatial and organizational vicinity further supports that the service is effective: the secretariat can already anticipate the kind of questions that will arise and with that better prepare its members to respond appropriately (CXC 2).

144 www.climatexchange.org.uk.

145 www.climatexchange.org.uk. See also: (ClimateXChange)

Exemplary activity 2: Informing the Scottish Adaptation Programme

Following the Climate Change (Scotland) Act (2009), the government has to develop the Scottish Adaptation Programme which details the objectives, policies and proposals to be taken in response to the risks as identified by the UK Climate Change Risk Assessment.[146] The CXC is the major scientific advisory body to the process (CXC 1, 3). The CXC is exerting this role either by conducting planned research, i.e. "near term" (3-12 months) studies underneath the Work Streams or through the call down service described before.[147]

An example that was explicitly thought to inform the Scottish Adaptation Programme, is a research study on potential adaptation actions and on the respective "on the ground" experiences in Scotland (Martin, 2013). Basically it denotes a policy brief comprising 12 pages reviewing research on and synthesizing different adaptation policies and practical actions to respond to the most likely and severe climate impacts in different sectors, such as water resource management, health, land use planning, forestry, agriculture and buildings. It further identifies possible measures to reduce impacts from flooding, heavy rains, droughts or air pollution and gives examples of 'no-regret', 'low-regret' and 'win-win' adaptation actions. The brief, for example, highlights green roofs and walls as possible win-win solutions. The final document displays a whole range of possible practical options and highlights also some Scottish "on the ground cases" to be potentially included in the Scottish Adaptation Programme as inspiration for similar actions in the country (Martin, 2013).

Regarding the actual use of the product in policies, it is noteworthy to say, that the brief is officially laid in the Scottish Parliament. However, since it has just been published it is impossible to trace whether and how the policy brief eventually exerts an effect on Scottish adaptation policies. However, despite the discretion of government to ignore CXC policy advice, the products of the Centre of Expertise on Climate Change are genuinely perceived as an important ingredient for policy development under the 'Climate Change Adaptation Programme' (CXC 1, 3).

Exemplary activity 3: Policy Milestones

It is a central role of the CXC Secretariat to have a close eye on and understand the policy agenda of the government in order to have the CXC deliver research that is usable for actual policy. Therefore it has cultivated a tight relationship with the policy teams in the Scottish government to ensure that policy is informed about all on-going research (results and methods) that fits current problems of the policy teams.

In reverse direction, the so called Policy Milestones are another means of keeping the overall research targeted at actual policies. Basically they are a simple internal communication tool which was designed together with government officials to inform the researchers in CXC about upcoming key policy issues on the Scottish policy agenda. It simply displays the policy timeline in various climate related policy areas. For instance, it informs about when the land use strategy will be revised and when there will be a new spatial planning framework for Scotland. It easily links policy and research agendas reminding researchers of where the government policies are headed to and with that assures that CXC research feeds policy with relevant insights on time (CXC 2).

While it is targeted mainly at the researchers in CXC, quite a few officers in the policy team of the government have actually found the tool a useful and handy "memory joker". It is less clear in how far re-

146 http://www.scotland.gov.uk/Topics/Environment/climatechange/scotlands-action/adaptation/AdaptationProgramme.

147 CXC 2, 3, cf. also: Kerr 2011 launching presentation, retrieved from: http://www.crew.ac.uk/sites/www.crew.ac.uk/files/documents/CXC%20Launch_Andy%20Kerr.pptx .

searchers have actually been using them regularly and the Secretariat recently decided to do away with the tool. The human resource (in a secretariat of 3) to keep them continuously updated were not outbalancing their unclear benefits. While the milestones are, thus, a neat and handy visual aid to understand the policy side, they are actually no suitable substitute for an essential continuous (informal) personal dialogue and exchange between academics and policy teams (through the secretariat or directly) – be it via email and telephone or in more institutionalized settings such as departmental meetings, conferences and workshops (CXC 2).

8.4.4 Strategies to achieve knowledge brokerage effectiveness

In line with the guiding principle that the government should benefit from the research, CXC pursues both robust science and orientation at actual policies (CXC 1). In contrast, CXC is less concerned about the legitimacy of its scientific advice beyond the open accessibility of its publicly financed research.

Saliency

In particular with its Call-Down service CXC addresses specific questions that the government currently has. Also the general research plans under the work streams are jointly developed with Scottish Government policy teams. Likewise also the research deliverable formats (indicators, policy briefs, workshops) follow this idea. (CXC 1, 2, 3)

In order to improve the use orientation of its research and services, CXC regularly seeks the feedback from policy teams on their practical suitability (esp. call-down service) and on the actual uses (CXC 2). Also organizationally, the spatial vicinity to the major addressee, the Scottish Government, is conducive: Both, the directorate and secretariat (Sniffer) are located in Edinburgh and with that very close to government. Benefitting from the comparably small size of the capital city, CXC staff is actively seeking contact with government officials at various occasions (CXC 2, 3).

Also practically, research outputs inform Scottish Government sectoral policy teams in identifying mitigation and adaptation policy options, for instance, for inclusion in the second Report on Proposals and Policies (RPP2 under the Climate Change (Scotland) Act) or for the writing of the Adaptation Programme of the country ((ClimateXChange), CXC 1). Also with the policy milestones, but even more with personal exchange, a constant link of research with the policy timelines is secured (CXC 2).

Credibility

The production of credible research results and of conclusions that build upon objective, independent, integrated and authoritative evidence is a core concern for CXC (CXC 2, 3). Accordingly, all policy advice draws on peer-reviewed research results of the applied research projects undertaken at its partner universities. CXC also closely cooperates with the UK CCC, UKCIP, Living With Environmental Change (LWEC), the UK Energy Research Centre (UKERC) and the Met Office to be able to always build upon the latest research insights and best data available. The fact that internal expertise is partly restricted with a slight bias on agriculture and natural resources is addressed with the possibility to commission research to external institutions (CXC 1, 3).

Overall despite the spatial and organizational vicinity to policy the CXC is a formally independent organization and the intermediary structures (translation services by directorate, secretariat and government policy team) assure the distance of projects and researchers from politics (CXC 3).

Legitimacy

As publicly funded network information about and results of all work of the CXC is made accessible through the website (ClimateXChange). Information about internal organizational and procedural affairs is less easily accessible. Also because societal acceptance is of minor importance for the research institute which provides services to the government as major (or even only) client, the CXC is less concerned with ensuring the legitimacy of its research results towards the whole of society (CXC 2). In terms of representing relevant positions and views, the steering group simply includes 5 members from government as the main stakeholder of the centre.[148]

[148] www.climatexchange.org.uk.

Part C: Synthesis

9 Overview of organisational features

In Part B, we have presented nine outstanding KBIs and we have featured exemplary brokerage activities of those institutions. In Part C, we synthesise key findings of the nine case studies. In this first chapter, we characterize and compare the nine KBIs along some basic organisational features. Chapter 10 provides a synthesis and comparison of the specific knowledge brokerage activities found in the nine cases, while chapter 11 compiles and discusses common challenges and tensions in science-policy interaction; in chapter 12 we draw some general conclusions.

The analysed cases all strive to provide and translate scientific expertise for decision-making in politics and society in the area of climate change. However, they present different approaches of doing so. They differ, among others, in terms of institutionalisation, duration, availability of financial and human resources, funding sources and thematic foci (see Table 3).

Table 3: General features of the analysed KBIs

Name	Type	Foundation/ Duration	Funding	Funded by (main sources)	Staff	Thematic focus
PIK	Non-university research institute	1992	€ 28 million (2011)	BMBF (Federal Ministry of Science) State Brandenburg Research programmes	Ca. 320	Adaptation Mitigation
KLIM-ZUG	Research programme	2008-2013	€ 83 million (whole period)	BMBF Practice partners	n/s	Predominantly adaptation Partly mitigation
CSC	Climate service provider	2009	ca. € 20 million (2009-2014 in total)	BMBF	33	Predominantly adaptation Partly mitigation
PBL	State agency	1996, 2008 major restructuring	€ 33,8 million (2012)	Ministry of Infrastructure and Environment (IenM)	270 (200 permanent; ca. 40 in climate department)	Mitigation, esp. energy transition Adaptation
KfC	Research programme	2008-2014	€ 100 million (whole period)	IenM Local and regional stakeholders	n/s	Adaptation
ProClim-	Information platform	1988	ca. € 1,5 million (2011)	Swiss Academy of Science (SNAT) Other sources (ministries, businesses etc.)	5 scientists, 3 student assistants	Mitigation, Adaptation
UKCIP	Climate service provider	1997-2011 as programme financed by government, since 2011 research unit	€ 1,2 million / a. 2005-2011, drastically reduced thereafter	until 2011: Defra	2010: 17 staff members (programme office) Currently: 9	Adaptation
CCC/ ASC	Governmental advisory body	2008	CCC - ca. € 4 million /a ASC - ca. € 0.8 million /a	DECC, Defra, devolved governments	Committee members: CCC – 8; ASC – 6 Secretariat staff: 33	Mitigation Adaptation (ASC)
CXC	Research network	2011	€ 5.2 million / a	Scottish government	Network:110 researchers Secretariat+Directorate: 7	Mitigation, Adaptation

As the nine cases show, knowledge brokerage in climate policy is institutionalised in varied forms. Among our cases, we find quite classical formats ranging from non-university research institutions (like the Potsdam Institute for Climate Impact Research) over state agencies (like the Netherlands Environmental Assessment Agency) to standard advisory bodies (like the Committee on Climate Change). Other cases also represent quite common forms of knowledge generation, like research programmes. However, our specific cases KLIMZUG and KfC stand for a new generation of research programmes that to a larger degree rely on joint knowledge production between researchers and stakeholders and follow a more focussed regional approach. CXC is a research network with a secretariat that serves as a direct link to the Scottish government and administration. A last category of cases shows a more hybrid type: ProClim-, UKCIP and CSC are all institutionally linked to established scientific institutions; however, they are not primarily oriented towards advancing science but rather towards serving as information platforms, networking hubs or climate service providers.

The analysed KBIs further differ in age and their period of existence. Some are long established institutions, like the Swiss ProClim-, the Dutch PBL or the German PIK. The results of our survey (Reinecke *et al.*, 2013) but also our in-depth case analyses in this report point to the fact that with the emergence of adaptation on the political agenda also the climate advisory landscapes diversified. In our in-depth cases this development is reflected in the two research programmes KLIMZUG and KfC as well as in the establishment of UKCIP, the ASC and the CSC. In particular UKCIP is widely perceived as a pioneer in advancing knowledge brokerage in climate change adaptation. Also in the area of climate change mitigation new institutions, like the CCC and CXC, have emerged in recent years.

When looking at the actors that established the respective KBIs the dominance of government becomes apparent: With the exception of ProClim- that was initiated by the Swiss Academy of Science the initiation of the analysed KBIs has been mainly driven by governmental actors, in some cases however guided by impulses and input of the scientific community (e.g. PIK, CSC, KfC, KLIMZUG).

Also in the funding of the KBIs, governments are central. They provide a substantial part of the institutional core, seed, or project funding. It is mainly two types of ministries that fund scientific climate advice: On the one hand ministries of science and on the other hand ministries in charge of climate change policy (e.g. IenM, Defra, DECC). When KBIs are financed by the latter they generally show a much stronger orientation towards the knowledge and advisory needs of their funders. This consideration, in contrast, is not so important when they are financed by the science ministries. Besides governmental funding KBIs increasingly search for other sources of funding, for example fees for membership or for research products as well as donations.

The analysed KBIs also receive quite different annual amounts of funding and consequently differ considerably in the size of their staff. PBL and PIK have by far the highest amount of financial and human resources at their disposal. Also the research programmes KfC and KLIMZUG are equipped with a comparatively high annual budget. This budget is, however, distributed across a number of research institutions in the respective regions. The range of financial and human resources strongly corresponds with the capacities of the KBIs to conduct own research which has a noticeable impact on the implementation of distinctive approaches of knowledge brokerage. PBL, PIK and the research programmes devote considerable time and resources to own research activities. Other KBIs, such as UKCIP and ProClim- more or less solely concentrate on knowledge brokerage activities and feed their own knowledge needs mostly by drawing on outside research.

10 Knowledge brokerage activities: overview and comparison

Knowledge brokerage takes on a variety of institutional forms and it draws on an even greater variety of specific activities. This is also reflected in the analysed cases, which offer a whole portfolio of different, partly more classical but sometimes also quite innovative knowledge brokerage. In the first empirical phase of the ReSciPI project, i.e. the international stock-taking survey, we identified seven functionally distinct types of how advisory institutions integrate science and policy-making (see Table 1 above). All of those activities (indexed as KBA1-7) could also be found and fleshed out in greater detail in the nine in-depth case studies (as described in Part B of this report). In this chapter, we summarise and compare the seven types of knowledge brokerage activities across the nine cases and carve out particularly innovative approaches.

A dominant perception of science is that research questions are formulated out of scientific curiosity and meant to develop and empirically validate theories. As soon as science leaves the proverbial 'laboratory' and seeks to inform policy-making research questions have to be oriented towards societal values as well. Effective knowledge brokerage, therefore, not only focuses on transferring existing knowledge to users, but already starts with efforts to capture prevailing knowledge needs on the side of potential users. All analysed KBIs, at least to some degree, involve stakeholders in their agenda setting. However, only a few KBIs employ ***systematic procedures to identify research needs or knowledge gaps (KBA1).*** In the first phase of the Dutch research programme Knowledge for Climate (KfC) short-term research needs of the eight Hotspots were identified in a bottom-up manner including relevant local and regional stakeholders who had a considerable say in the process. Also the German Climate Service Center (CSC) and the Scottish ClimateXChange (CXC) make active use of more or less formalized dialogue formats to identify concrete research questions of their clients, however, in a less extensive and coherent way. This does not mean that knowledge needs remain unaddressed in other cases, but rather that the respective way of how research agendas are set is generally less interactive or user-inclusive: Either it occurs only occasionally and is based on personal dialogue, or it follows a more 'traditional' science-driven approach of identifying remaining research gaps.

A common challenge for successful scientific advice to politics and society is that knowledge is scattered across a variety of sometimes quite specialized research institutions and that, in consequence, targeted and comprehensive information may be missing. In addition, societal and political stakeholders often lack the contacts and links to research institutions or particular experts and vice versa. To respond to these challenges many KBIs engage or even specialize in ***coordination and networking activities (KBA2),*** i.e. they aim at promoting and strengthening interactions and dialogue between different actors. With the exception of institutions that are close to government, namely the CCC and PBL, all analysed KBIs are quite active in this respect. One variant of networking activities addresses mainly *peers from the science domain* (incl. R&D in industry). The rationale is that connecting different knowledge providers allows more integrated and, thus potentially, more appropriate and usable knowledge. Examples include PIK's coordinating role for developing chapters for the IPCC Assessment Reports and CSC's coordination of climate science institutions in Germany (e.g. under the *Klimanavigator*).

Another more policy-oriented variant of networking aims at the exchange between scientific organizations and *stakeholders from policy, economy and society*. The CSC, for instance, manages an actor network that includes both, climate knowledge providers and major addressees. UKCIP has strongly focused its KB activities on linking science and practice and has, for example, been quite active in arranging the User Forum for the UKCP09 that informed the scenarios' development and communication. Moreover, UKCIP has in many instances coordinated stakeholder-led research in particular on regional and local impacts of climate change and, among others, fostered the establishment of the Regional Cli-

mate Change Partnerships that aim at long-term cooperation in the field of climate change adaptation in the respective regions. Similarly, the analysed research programmes (KfC and KLIMZUG) engage in extensive networking between actors from science and practice in the regions to increase the relevance and social robustness of the research. The programmes therewith also aim at establishing new or strengthening existing institutional and interpersonal ties to nourish cooperation on adaptation and mitigation also beyond the ending of the projects.

In a third variant, KBIs follow a strategy of '*match making*' (Michaels, 2009), that means, they serve as pure intermediaries who make sure that knowledge seekers are connected to the relevant providers of scientific information. The online help desks offered by ProClim- or CSC provide a way through which a 'question' can be linked with the 'right person' or the 'right information'. In contrast to this rather remote approach the so called Call-Down Service offered by CXC presents a quite dialogic format. The CXC Secretariat supports the policy teams of the Scottish Government in developing use-tailored research questions. For these questions tenders are invited from scientists inside and outside the CXC network and their efforts are financially compensated through a call down pot. Likewise, ProClim- supports the Parliamentary Group "Climate Change" by identifying and coaching suitable guest speakers from the research and practice community for their lunch-break events.

All analysed cases heavily engage in ***compiling and translating climate science into usable formats*** *(KBA3).* The compilation of climate science in some instances takes on quite common formats. Some KBIs regularly publish disciplinary studies, meta-analyses of existing research and, quite often in our cases, integrated assessments (partly based on own scenario and model building). These activities are quite similar to classical research with the exception that they are always conducted with an eye towards societal problem solving, in our context climate change mitigation and adaptation.

In climate policy advice, *scenario and modelling activities* play an especially prominent role. In our cases we could see that the intensity and sophistication of scenario-building and modelling is strongly correlated with the resources and capacities of the respective KBIs. Consequently, it is not surprising that these activities are especially prominent in the work of PIK, PBL and the research programmes KfC and KLIMZUG. An own context-tailored local current model (GETM) has, for instance, been developed for the western Baltic Sea within the KLIMZUG region RADOST. Especially PIK and PBL are very well known for their models and continuously refine them. But also the comparatively smaller CSC builds its advisory activities on own scenario and model building. The smaller KBIs, in contrast, typically cannot afford own modelling and, therefore, mostly rely on outside sources, which they can draw on through *networking activities (KBA2)*, be it via a personal affiliation of their staff with respective high profile institutions or the participation in joint research projects (e.g. EU-FP 7) or even the commissioning of respective input (e.g. contributing to the CCC and ASC reports).

While the compilation of climate science, and in particular modelling and scenario building, is still often perceived as a playground for researchers, we found a range of innovative, more *collaborative* approaches. For instance, the scenario building in PIK's ENCI-LowCarb project includes economic and societal stakeholders in all major research phases as well as in the project consortium. Stakeholders have been involved in identifying the parameters of the scenarios ("reality check") and were consulted about the acceptance of different low carbon policy measures. These views, including those of potential blockers, eventually informed the selection of effective policies to be included in the PIK model which was again presented to and discussed with the same stakeholders. Yet, while ENCI-LowCarb is a rather exceptional project for PIK, collaborative science is a frequent, though not a universal, approach taken in the two research programmes KfC and KLIMZUG. Oriented at supporting concrete adaptation action and low carbon pathways for the involved regions, decision-makers and stakeholders are not passive recipients of policy advice, but actively co-produce or broker knowledge themselves.

All analysed KBIs are not confined to merely compiling climate research but equally or even predominantly aim at *translating* climate information into user-benign forms. Common formats include executive summaries, fact sheets or policy briefs, newsletter, or pamphlets, but also more innovative and highly use-tailored information formats. CSC's climate fact sheets, for instance, are highly individualized and client-tailored information products that CSC has produced together with the development bank KfW. These fact sheets inform investors in industry and finance, or their 'multipliers,' on 4-6 pages about potential climate change in the respective countries or regions of interest. Another case of a client-oriented product is the PIK-report "Turning down the heat: Climate Extremes, Regional Impacts, and the Case for Resilience." The review study targets at the world regions of interest to the major addressee and was jointly produced with Climate Analytics involving also senior researchers from the World Bank.

Translating and transferring scientific climate information alone often does not suffice because political and societal stakeholders in many instances lack the capacities to understand the information or apply it to their concrete decision situations. Therefore, KBIs also engage in ***capacity building and decision support** (KBA4).* More uni-directional tools of decision-support encompass guidelines, user manuals or visualisations of scientific results. In some more interactive cases guidance has been developed by including users, as in the case of CSCs practitioners' manual on statistical methods (Bülow *et al.*, 2012), which builds on practical experiences in the KLIMZUG projects.

A quite common instrument is the production of maps that visualise the impacts of climate change in particular regions. These tools aim at raising awareness for climate change issues and provide a rough guidance to address related challenges. In many cases, these decision support tools are designed for a rather anonymous audience and consequently may still miss the actual needs of particular user groups. In contrast to that, some KBIs employ more innovative approaches where users are involved in developing or shaping decision support tools in line with their demands. CSC and PIK, for example, give users a direct say on climate change parameters or respective thresholds to be displayed in maps or graphs (e.g. CSC's climate signal maps, PIK's Climate Impacts Online). Through UKCIP's Users' Forum practitioners even had a noticeable influence on contents and the overall functionality of the user-interface for the UKCP09 projections. Front-runner KBIs frequently also test the actual use and usability of their tools in pilot studies. UKCIP is a pioneer in developing decision support tools in an interactive and highly emancipating way. Tools like BACLIAT and LCLIP are not only easy to employ by users, but have been developed *in situ* in different professional contexts (e.g. businesses or local authorities). The LCLIP, for instance, enables local authorities to conduct climate impact assessments themselves and to autonomously identify the most suitable policy responses, respectively.

In some cases, decision support tools are complemented with trainings, workshops or online guidance. While some events and workshops may rather serve the purpose of providing information and raising awareness for the necessity to act (*know what*), these trainings increasingly aim at enabling political and societal actors to apply information and tools on their own in order to derive at informed decisions (*know how and why*). The CSC, for instance, offered trainings on climate science and methodologies for stakeholders in the KLIMZUG regions with the objective to make them climate science 'literate' (CSC 1, 4). Consequently, stakeholders have become 'emancipated' and enabled to autonomously conduct further workshops including discussions on climate change science methodologies and uncertainties.

A core activity of scientific policy advice is the ***analysis, development and evaluation of policies** (KBA5).* More or less directly tied to *actual* decision-making processes a range of KBIs engage in the assessment of policy proposals or the evaluation of existing policies. Prominent examples include the progress reports of the CCC and ASC on the UK government's mitigation and adaptation policies. Also the assessments of the CXC are meant to inform specific policies, namely the second Report on Proposals and Policies (RPP2) under the Climate Change (Scotland) Act as well as the Adaptation Programme. In some instances, policy assessments and evaluations also develop specific policy options or

strategies. The CCC, for instance, is not only mandated to set appropriate carbon budgets but also to identify the most cost effective pathway of how to achieve them. Slightly less oriented at concrete legislation but still targeted at policy, are the efforts by PIK and PBL to identify low GHG pathways for Germany and the Netherlands, respectively. A more intense and also more interactive variation is when researchers and decision makers jointly draft concrete policies, often in the form of strategies, rather than laws. Here, the two analysed research programmes (KfC and KLIMZUG) provide good examples; both have been deeply involved in the development of regional adaptation (and partly mitigation) strategies.

Besides written analysis and evaluations, ***policy advice*** also occurs ***in person*** (KBA6), yet it hardly notes a core brokerage activity. Particularly researchers at PIK, PBL, ProClim-, CXC and CCC engage in personal advice at least at a notable level. A well-known and iconic example is the role of PIK's director Schellnhuber as chief scientific advisor of the German chancellor during the German EC presidency in 2007 and beyond. Another form is the membership in standing advisory committees of governments. Again, Prof. Schellnhuber is a case in point: He is a member and longstanding chairman of the German Advisory Council on Global Change (WBGU). Other less institutionalized variations of personal policy advice can be observed particularly in the cases of CXC, PBL and CCC. Members of the respective organizations often present their scientific findings in person at more or less official events such as parliamentary hearings or face-to-face advice to sub-councils or government departments. A distinct personal advice activity of the state agency PBL is the quasi-political representation by senior scientists, most notably as members of the Dutch delegation to UNFCCC.

Finally, the analysed KBIs do not stop at providing information, guidance and advice solely to political and societal stakeholders, but also engage in ***public outreach*** (KBA7), i.e. activities that target a broader audience. All KBIs draw on three major channels of communication: the internet (website), classical media (e.g. via press releases), and enacted forms (e.g. exchange events, like public science conferences and lectures). All our cases increasingly employ "web 2.0" formats of online communication, most notably social media (like blogs, Facebook, apps, podcasts etc.). In the KLIMZUG region Nord, for instance, a whole sub-process was dedicated to the development and dissemination of comic books on climate change (so called *Klimanovellen*). A gadget going in a similar direction are the board games developed by PIK. Other examples of more enacted and interactive forms of public outreach are the climate museum at PIK or the exhibitions that KfC, KLIMZUG and ProClim- have organized. Evidently, in these cases public outreach is not understood as a mere by-product of advice to decision makers in policy and society. Instead, institutions pay special attention to the different information needs and employ alternative communication approaches in order to effectively raise the interest of the general public (i.e. pupils, lay persons etc.) or media for the topic of climate change mitigation and adaptation.

To sum up, in some of our cases we still find more classical and/or linear forms of scientific policy advice, such as scientific assessments in form of a written report or classical personal advice; however, most KBIs also apply more interactive formats. We found a wide range of innovative knowledge brokerage activities and processes that involve decision-makers and stakeholders beyond their role as mere addressees.

11 Effective climate policy advice between saliency, credibility and legitimacy

The analysed KBIs all strive for contributing to decision-making in the area of climate change. The question of how successful or effective they are in informing and influencing politics and society is therefore central for their work. Influence can be evidenced directly in the uptake of recommendations and policy options and hence changes in policies. More often, however, influence occurs indirectly as subtle changes in an issue domain, i.e. changes in the goals, interests, beliefs, strategies and resources of actors, changes in (problem) framings, discourses and agendas and hence problem perceptions (Clark *et al.*, 2006). Such influence generally occurs over a longer time and is, thus, not straightforwardly observable (Pregernig, 2006). Consequently, the main focus of our analysis was on the strategies and mechanisms that the nine KBIs deliberately employ to enact and ensure their political and societal influence. Hence the case descriptions and analyses in part B followed the three attributions saliency, credibility and legitimacy (SCL) as introduced in chapter 3.

Our analyses demonstrate that effectiveness is not passively experienced but deliberately created (though not fully controlled) by the KBIs, which employ three distinct types of strategies to support SCL: (i) KBIs put in place specific *organizational* designs or set-ups, (ii) they employ particular *procedural* strategies and (iii) they also highlight their policy-relevance by means of elaborated *rhetorical* mechanisms. As graphically depicted in Figure 16 the three strategies are often enacted in a cascade-like form: Organizational or procedural strategies and mechanisms become transmission belts for SCL only – or at least primarily – if they are openly conveyed to a KBI's external audiences, i.e. if they are 'boosted' rhetorically. Rhetorical in this context does not imply that the underlying structures and procedures are 'faked', but rather that particular organizational and procedural features are framed in a specific way and are possibly highlighted and enhanced.

Figure 16: Strategies to support saliency, credibility and legitimacy

In our nine case studies, we could find a wide range of strategies and mechanisms that KBIs employ to enhance SCL of their advice (see Table 4). Frequent organizational strategies include institutionalized steering or advisory bodies with (renowned) scientific members and/or societal stakeholders, funding provisions or liaison offices. Among the manifold procedural strategies and mechanisms the consultation and involvement of non-scientific actors, the provision of use-tailored products, the adherence to scientific standards, including the publication in peer reviewed journals and the disclosure of uncertainties are the most common ones. For many KBIs, the overt declaration of independence is a particularly important rhetorical strategy.

Table 4: Strategies and mechanisms in support of saliency, credibility and legitimacy

	Strategy	Mechanism
Saliency	Programmatic problem- and decision-orientation	• Orientation at societal problems and their solutions in objectives and mission statements • Targeting concrete decisions or political addressees • Scaling to regional or local levels
	Demand-driven approach	• Political initiation of KBI • Research strategy and priorities in consultation with users • Single projects user-initiated or formulated with the involvement of users
	Participation in KB activities	• Consultation • Collaborative research
	Institutionalized societal steering, advice or evaluation	• Societal advisory or steering bodies • Mixed advisory or steering bodies (scientific and societal) • Evaluation of societal relevance and impact
	Policy vicinity	• Liaison offices • Frequent personal contacts and in-house stays • KBI staff speaking on behalf of principals
	Provision of use-tailored products	• Policy summaries, briefs etc. • User-tailored maps and tools
Credibility	Competence and reputation of staff and KBI as a whole	• Academic qualifications and experiences • Leading and renowned scientists • Reputation of organization
	Scientific collaboration	• Networking with other scientific organizations • Collaboration with renowned scientists
	Organizational independence	• Organizational and financial autonomy • Self-initiated KB activities • Presentation as 'honest broker'
	Scientific quality standards and procedures	• Guidelines of good scientific practice • State of the art research • Disclosure of uncertainties • Use of authoritative sources
	Product quality	• Publication record in peer reviewed journals
	Scientific advice, steering, evaluation	• Scientific advisory or steering bodies • Mixed advisory or steering bodies (scientific and societal) • Evaluation of scientific quality
Legitimacy	Transparency	• Transparency in organization and processes • Transparency in outputs and products
	Inclusiveness	• Stakeholder participation (but mostly just as a 'by-product') • Involvement of different (partly: opposing) views and interests

The analysis of the strategies and mechanisms to enact SCL suggests that KBIs put **different emphasis** on the single attributions. Showing and ensuring their relevance for political and societal decision-making ranks top for all analysed KBIs and is prominently reflected in the mission statements or objectives of all cases. Credibility is also strongly invoked by some KBIs, in particular research organizations such as PIK and PBL. Yet, others do not promote the attribution as visibly as they do so for their political and societal relevance. Legitimacy, i.e. the perceived fairness, clearly stands back behind saliency and credibility. This does not mean that the analysed KBIs and their activities are not perceived as legitimate but rather that the KBIs themselves put less emphasis in ensuring and publicly 'proving' their fairness.

Moreover, there are **interdependencies, synergies and trade-offs** between the three attributions (Sarkki *et al.*, 2013, Mitchell *et al.*, 2006). Societal relevance, for example, can decrease when the technical credibility is not given and hence the authoritativeness is lost. Similarly, legitimacy also depends on the credibility and the overall societal usefulness of advice. But besides these synergetic relations the

single strategies to ensure SCL may also take opposite directions and hence lead to trade-offs or areas of tensions. For example, striving for saliency and credibility at the same time can sometimes be difficult because it requires the balancing of partly opposing demands, namely that of policy makers and that of the scientific community. In the following, we describe five specific areas of synergies and tensions between saliency, credibility and legitimacy in more detail, which we paraphrase as follows:

- Institutional ties: Between political vicinity and independence
- Identification of research questions: Between stakeholder demands and scientific curiosity
- Participation: Between relevance and inclusivity
- Policy Advice: Between impartiality and advocacy
- Communicating research: Between understandability and scientific accuracy.

Institutional ties: Between political vicinity and independence

As already described in the relevant literature, KBIs have a hard time to work close to the political and societal sphere to ensure their relevance, while at the same time following strict scientific rules and procedures to maintain their independence and credibility (Mitchell *et al.*, 2006). In many instances, the relevance of policy advice suffers if KBIs are – for the sake of ensuring their credibility – too distant from political agendas, however, they risk their independence if they get too close to political struggles (Pregernig, 2004). Also in our cases, finding the 'right distance' between politics and science is a big challenge that becomes already apparent in the different organizational set-ups of the KBIs and the institutional links that they keep to different political or societal institutions. In almost all cases the question on how close KBIs would position themselves to political actors and processes was already decided at the time of the KBIs' initiation. With the exception of ProClim- that was initiated by the scientific community, all analysed KBIs were put in place on the initiative of policy makers or at least in a joint effort of science and politics. Policy-initiated KBIs are often built on governmental or parliamentary decree and frequently accompanied by a political mandate that sets the overall thematic orientation and responsibilities of the organisation. For example, the CCC was established through the UK Climate Change Act 2008 that gives the Committee a strong mandate and major responsibilities for advising different climate change policy drafting processes (HM Government *et al.*, 2010). The political initiative and mandate thus signal a concrete political need and hence imply saliency of the KBI from the start.

Despite the fact that almost all our KBIs have been politically initiated, they still differ in their organisational setup and in relation to how they position themselves via-à-vis the scientific and political sphere. Some KBIs are institutionalized as classical research organisations (such as PIK), designed as a research programme (e.g. KfC and KLIMZUG) or institutionally linked to science (such as ProClim- at the Swiss Academy of Science or CSC at the Helmholtz-Society). With that, the KBIs exhibit a rather large degree of political and scientific independence. This is often accompanied by a self-portrayal as a primarily scientific institution (for example in the case of PIK). Other KBIs such as the CSC are institutionally linked to science but already span the boundary to society and politics in their profiles as a service provider. Still other KBIs have a more hybrid status. Scientific advisory bodies (like CCC) or governmental agencies (like PBL) are almost by nature structurally tied closer to politics. PBL, for example, has an organizational principal-agent relationship with (mostly) ministries that as a consequence enhances its saliency. Via funding provisions or a formalized say on the agenda, principals can have a strong influence on the KBIs' knowledge production and, with that, on the saliency of their advice.

While a KBI's institutional vicinity to politics obviously can contribute immensely to saliency it also jeopardizes its credibility and legitimacy, especially when the institutional ties are limited to a few political institutions or actors such as a specific ministry. Easily the accusation of a politically (or in the case of

company or industry ties: commercially) entrenched institution may emerge. In order to ensure credibility and legitimacy despite strong institutional ties, KBIs often emphasise their independence from politics, interest groups and sometimes also commercial influences. Interestingly, we found that often exactly those KBIs that are characterised by strong ties to politics (such as PBL or CCC) are particularly vocal in stressing their independency, neutrality and objectivity. As the case of PBL illustrates the independence is not only highlighted by representatives of the KBI (PBL 1, 4, 7) but also confirmed by ministry representatives: *"but they're independent, we have no way of influencing them actually at all. So they're even more independent than they realize*" (PBL 2). The aura of independence is established by blunt declarations, the disclosure of organizational structures and financial information (in particular the ratio of government funding to third party funding). Funding is an interesting example of how a credibility argument can be played out in different directions, depending on the context. Some KBIs stress their broad base of public core funding, which is seen to enhance their credibility because it signals independence from clients with particular interests. Other KBIs point to their large proportion of external funding as a source of credibility because the KBI is independent from the governmental 'drip-feed'. Another strategy to ensure independency despite political vicinity is to complement close institutional links to politics with close ties to science. The scientific members of the CCC, for example, are not only seniors but remain affiliated with their academic host institution in order to further their independence from political influence (CCC 1).

On the other side KBIs also deliberately come closer to politics and society. Organizational strategies to establish institutional ties with politics and stakeholders include the involvement of representatives from politics and from societal groups in the KBIs' organizational bodies, most notably steering and advisory committees. Vicinity may also be established spatially. Thus, PBL as well as PIK maintain offices in the respective capital cities, The Hague and Berlin, despite being located elsewhere. This allows for a closer interaction between the KBIs and relevant political actors.

Building on the organizational strategies described above the KBIs also employ a range of procedural strategies to ensure their independence and/or position themselves close to political and societal needs. These strategies are discussed in the following section when looking at how research questions and advisory projects are formulate, who is involved in consultation and collaboration and how policy advice is given and communicated.

Identification of research questions: Between user needs and scientific curiosity

The challenge to balance societal relevance and scientific standards becomes also apparent in the advancement of research themes, the formulation of research questions and the design of projects. Scientific research questions are often perceived as too abstract or far away from the needs of political and societal decision-makers. Cash and Clarke (2001) observe that a classical *"pitfall [for policy advice] is the identification of interesting and tractable questions within a scientific community that have little relevance outside of it, including no bearing on a decision maker's real-world situation".* In order to avoid this pitfall all analysed KBIs have structures or procedures in place to capture the demands of non-scientific actors in their agenda-setting. With the exception of PIK all analysed KBIs formulate their periodic work programs or research strategies in a participatory way with political actors and other stakeholders with the aim to align their general research orientation towards user needs. The degree and form of involvement and the decision-making power of political and societal stakeholders in defining the general research strategies, however, vary considerably, including (one-time) consultations, surveys, joint developments and the approval of full research strategies. Besides strategic agenda-setting all analysed KBIs, occasionally or habitually, respond to concrete needs of non-scientific actors when starting new projects or KB activities and involve stakeholders in the formulation of research questions.

While these procedural strategies and mechanisms to capture the demand of politics and society aim at ensuring saliency, they at least partly conflict with the requirements of scientific inquiry. As outlined above several KBIs are located in and identify with science and conduct research mainly to advance the scientific state of the art. This applies in particular to the research institution PIK, the two research programs KfC and KLIMZUG but also the departmental research institute PBL and for single institutions in the CXC. In these institutions scientists are not only asked to produce societal relevant information but also, and in some cases primarily, to generate new research insights that are publishable in international peer reviewed journals. The standards for 'good' research questions thus do not predominantly include their societal relevance but rather (mainly) their scientific novelty and their contribution to theory development and empirical validation. Engaging mainly in demand-driven research involves the danger of "narrowing the scope of the scientific agenda" (Sarkki *et al.*, 2013, 9). An interviewee describes the ideal of 'detached' science as follows: *"Science is driven by pure scientific interest, curiosity and reputation [...] science must not be driven by [political/societal] interest. It doesn't matter whether I want to engage for the environment or not"* (PIK 3).

The KfC research programme is a particularly illustrative example of how these, partly contradicting, standards are sought to be reconciled but also how challenging this task proves to be. A major concern of the programme is to meet criteria of scientific excellence while being responsive to "real life problems." Consequently, the research questions and research projects for the eight Hotspots are highly demand-driven and were developed in a participatory and iterative manner with local and regional stakeholders in a process that lasted more than a year. Yet, for many scientists the resulting questions proved to be unsuitable to advance the science basis. Therefore, after 1-2 years of the programme's duration the Themes were introduced with the intention to answer overarching research questions from a scientific angle (KfC 4). Again, stakeholders could bring in their knowledge needs and priorities which the researchers translated into scientifically relevant research themes and questions. Partly the research questions of the themes and the practical needs of the Hotspots fit very well, yet in other cases interviewees reported that the themes' research was too abstract to apply them in the regional or local context.

Keeping at least partial definitional power over research questions is not only a strategy to ensure the scientific usefulness but it also serves as a mechanism for political independence and hence credibility. As outlined above, PBL as a departmental agency is in a principal-agent relationship with the IenM and policy-relevance is a core value. Yet, they "feel independent" (PBL 1). Both, at the strategic level of the working programme as well as the level of single research projects PBL closely consults with the ministry (PBL 1, 2, 4, 5). The working programme is based on proposals from and discussions with several ministries (most notably IenM), the PBL departments and the PBL Advisory Board. The final decision on the content of the Work Program, however, resides with the PBL director (PBL Netherlands Environmental Assessment Agency, 2012a). Similarly, also single PBL researchers reserve the right to redirect or reformulate the research questions as they see fit or even to decline a commission (PBL 1). Overall, this example illustrates nicely how KBIs keep their work demand-driven by simultaneously maintaining authority over the final questions and hence ensuring independency but also scientific quality. Other KBIs such as the Climate Service Center combine both demand-driven projects and self-initiated research or product development when they think that they are needed and useful (CSC 2).

Participation: Between relevance and inclusivity

Consultation and collaboration does not only take place during the agenda-setting but occurs throughout the whole knowledge brokerage process. Participation of stakeholders and/or citizens has become a core principle of many knowledge brokerage institutions and activities. Drawing on the concepts of Mode 2 or transdisciplinary research, post-normal science or co-production, it is widely assumed that by involving non-scientific actors the relevance as well as societal robustness of research is strengthened

(Nowotny *et al.*, 2001, Funtowicz & Ravetz, 1993, Pohl, 2008, Dilling & Lemos, 2011). All analysed cases in one way or another rely on the consultation and involvement of non-scientific actors. As outlined above political or societal stakeholders already play a prominent role in the identification and formulation of research needs. Beyond agenda-setting, all analysed KBIs have institutionalized stakeholder advice or steering at the organizational level. Further, KBIs incorporates consultation and participation in concrete research projects and knowledge brokerage activities in some capacity. However, the significance, intensity and form of participation differ widely. For some KBIs, like ProClim-, CCC, CXC or CSC participation is of minor relevance and not an integral and systematic part of all activities. Stakeholder inclusion is then typically restricted to membership in steering or advisory bodies or only occurs in form of ad hoc consultation. PBL and PIK rely on participation in some projects when they see it fit while other projects resemble 'classical' research projects. On the other side of the spectrum, for UKCIP and the research programmes KfC and KLIMZUG participation marks a core principle of their activities yet with varying intensity. Interaction with target groups often occurs in workshops or other types of events as well as in personal contacts. In most cases, stakeholders are consulted to obtain feedback, while scientists still maintain the authority over the process as a whole. In a few other cases, stakeholders are equal partners in fully fledged collaborative or transdisciplinary research processes and knowledge brokerage activities. In these cases, participation is continuous, iterative and with considerable sway over the processes. In the KfC research programme scientists and stakeholders (including municipalities, water boards, regional authorities and companies) of the Hotspots are actively engaged in collaborative action research. Non-scientific stakeholders are the leaders of the hotspots and hence have a considerable say in the design of the processes (see above). For example, PhD students and civil servants jointly conduct research, including interviews, joint publications and presentations not only for practitioners but also in scientific contexts (KfC 7). Such a design is demanding for both stakeholders and scientists. The whole process may be challenged by a lack of continued interest and resources of stakeholders to participate.

Consultation and participation can be geared towards all three attributions of saliency, credibility and legitimacy and thus provide synergetic effects. Which attribution is actually invoked very much depends on the actor groups that are invited to participate. In the majority of the analysed cases consultation and participation are primarily used to increase the practice-orientation and usability of KB activities. Saliency is strengthened not through the involvement of the broader citizenry but rather through consultation of the relevant stakeholders. Stakeholders are actors with genuine decision-making power over the issue concerned, i.e. the 'classical' target or user groups. UKCIP seeks constant user dialogue and feedback in stakeholder workshops, user forums and other set-ups (UKCIP, 2011). Through its Advisory Panel and particularly the user forums the views of its clients (like Defra) and users are captured to guide the overall work. For the "UKCP09 Users' Panel", that informs the development and delivery of the UKCP09 scenarios, members were selected based on their expertise and ability to represent the needs of their respective communities or sectors (UKCIP 3, 5). Credibility is fostered when actors are brought in because of their local or regional knowledge, "because they have knowledge you need" (PBL 1). The people addressed may be identical with the concerned stakeholders, but in this case they are not so much consulted for their input of relevant political questions or societal perspectives but rather for their factual knowledge, which scientists may use in generating research findings. By involving stakeholders researchers can gain knowledge "that hasn't been published anywhere else" (PBL 1).

Participation seems to be geared towards legitimacy concerns if and whenever KBIs strive to establish a broad representation of different societal perspectives and values. This is the case when KBIs explicitly try to include climate change sceptics or address the citizenry at large. In the analysed cases legitimacy seems to be more of a welcomed 'by-product' of participation rather than a top priority in knowledge brokerage activities. A few KBIs, however, deliberately build on and foster the legitimizing effects of participation. Legitimacy is invoked by securing and rhetorically emphasizing the openness to different

stakeholder groups and hence the inclusiveness of the processes. KBIs actively search for collaborators from a wide variety of societal domains, including NGOs with a critical perspective to politics, administration or business with the intention to ensure and show that they "consider appropriate values, interests, concerns, and specific circumstances from multiple perspectives" (Mitchell *et al.*, 2006, 320). The search for legitimacy through participation is particularly pronounced in the activities of PBL: Drawing on the concept of post-normal science, PBL builds on the incorporation of a diversity of views and approaches to increase the robustness of the findings and recommendations (Petersen *et al.*, 2011). PBL has, for example, initiated online deliberations on the IPCC and possible errors in its reports and explicitly aims at entering into dialogue with climate sceptic views.

While the examples given so far mainly point to the synergetic effects of participation, it may also lead to contradictions between the three attributions of saliency, credibility and legitimacy. The broad and open inclusion of differing views, which is often sought to build consensus and with that legitimacy, may slow and prolong knowledge brokerage activities and hence undermine the relevance of results for target audiences. In addition, the results of such a process may be compromise-driven and not compatible with important addressees. Limiting inclusion to the most important addressees for the sake of saliency, in turn, may lead to a loss in legitimacy because other actors or views are excluded and the KBI may, in consequence, be seen as serving only the interests of established elites. Yet, in the case of ProClim- we could also observe the opposite strategy of deliberately excluding specific actors in order to keep credibility and legitimacy. The parliamentary lunches that serve the information and dialogue with parliamentarians, for instance, leave out administrative representatives as far as possible in order to be able to provide direct and unfiltered scientific information to elected representatives (ProClim- 4). In addition, participation may jeopardize the credibility of the technical dimension when assumingly 'unknowledgeable' participants are involved. In some of the mote technically oriented workshops in KLIMZUG, for example, citizens were not regarded as 'trustworthy' informants because they were "emotional" while stakeholders proved to be "more objective" (KLIMZUG 4).

Policy Advice: Between impartiality and advocacy

The challenge of the 'right distance' between science and policy making does not only arise in organizational terms, as discussed above, but also and especially when KBIs are confronted with the question of what kind of policy advice they should, could or have to give. For many KBIs (in particular the CCC, KLIMZUG, KfC, PBL and ProClim-'s OcCC) giving concrete policy advice to on-going political debates and decisions is one of their core activity. Policy advice takes very different forms, be it a study assessing economic, political and societal pathways, a rather technical calculation of carbon budgets, an assessment of policy proposals, an evaluation of the implementation and effectiveness of particular policies, a presentation in a parliamentary commission or a telephone call in which a scientist provides information to a ministerial official. KBIs' policy advice may also differ in how prescriptive, reserved or open the advice appears. In this context, scientists are challenged by different demands from politics and society but also from their peers. In general terms, our case studies have illustrated that there is (still) a strong conviction that science has to be impartial and disinterested and act as kind of an 'honest broker' in providing neutral and objective advice. In some instances this goes so far that policy-makers ask for a concrete answer to a particular question but scientists are reluctant to provide this answer (PIK 3). Scientific advisors seem to fear and avoid the accusation of lobbying or advocating particular policy options because they know that this might damage their credibility and legitimacy. From the perspective of policy makers or stakeholders this stance may sometimes be unsatisfactory. As soon as scientists restrict their advice to pure factual questions they risk losing saliency because their answers are too detached from political questions and options. Some KBIs or individual scientists head for a middle-ground in that they feel the moral obligation and task to provide at least "orientation knowledge" for society and politics (PIK 3). Consequently, they may frame their advice in accordance with current societal

debates (e.g. on the 'great transformation') or explicitly act as a societal 'warner' (e.g. when making reference to 'tipping points'). Balancing between advocating particular policy options and providing impartial factual information is challenging not only because policy-makers may ask for clear answers but also because the interpretation of what counts as advocacy depends on the respective political position. Especially with regard to climate change many interviews problematized the danger that their KBI is or might be associated with the "green movement" (PBL 1), as a "green NGO" (CCC 2) or as a "climate change alarmist" (Storch & Krauß, 2013). Consequently KBIs employ a range of strategies to avoid such accusation and take on different roles and functions of policy advice.

A frequent rhetorical strategy that KBIs use is the reference to the ideal of the 'honest broker'. Following Pielke Jr. (2007, 17) "[t]he honest broker of policy alternatives engages in decision-making by clarifying and, at times, seeking to expand the scope of choices available to decision-makers" and "seeks explicitly to integrate scientific knowledge with stakeholder concerns in the form of alternative possible courses of actions". Thus PBL sees its role as an independent adviser, neither favouring strong climate policies nor advancing sceptic positions (PBL 1).

Particularly interesting is the CCC's role for setting the carbon budgets. Because of its statutory role deriving from the Climate Change Act 2008 the CCC has a rather strong handle on the Government's Carbon Plan, especially by pre-defining permissible emissions caps. Although the final decision resides with the government and parliament, they have to justify their deviation from the CCC's proposal (CCC 2). Hence, the CCC rather closes than opens policy options, yet its statutory role in the Climate Change Act as well as the rather technical character of the carbon budgets obviate accusations of undue advocacy.

In the case of KfC the political implications of the research and advice on actual adaptation planning were rhetorically attenuated in order to avoid that decision-makers feel patronized. Besides a few exceptions (e.g. Rotterdam) many of the final results were re-framed not as real adaptation strategies (i.e. clear policies) as originally intended, but were called somewhat differently (e.g. 'visions') to downgrade their political importance (KfC 1). Thus local and regional decision makers could still see room for their own strategies and measures. This example shows that saliency might not only be challenged by too vague or open answers but also by too strict, prescriptive advice. At times a clear answer is demanded by political decision-makers in order to advance policies, at other times political decision-makers prefer to have some leeway.

UKCIP draws on a specific strategy to position itself in the 'uncontested' area between science and policy-making. Instead of providing concrete advice on climate change adaptation measures, UKCIP rather provides stakeholders with tools to assess their own vulnerability and develop corresponding strategies. Consequently, UKCIP perceives itself more as a 'facilitator': "*It is not about imposing the solution, but rather about trying to work with the people*" (UKCIP 4). Interestingly, users partly voiced that they have had their issues with the facilitating and participatory approach, because they wanted usable ('hard') facts and numbers, i.e. when and where exactly the climate change impacts will show, and what it will cost. In the case of the LCLIPs, local authorities were irritated that the support they received was more of a ('soft') kind, like capacity building and training as well as feedback of how they could – themselves – identify what they desired or wanted with regard to a future changing climate. Consequently, for some local authorities the tool lost its saliency because it did not provide the clear answers that were expected. For others, in contrast, the saliency was advanced, because by engaging in learning processes they became experts themselves and hence developed capacities to develop adaptation strategies (UKCIP 2).

Another role and function is advertised by the Adaptation Sub-Committee, namely scrutiny. The ASC as part of the CCC is institutionally close to the government and has a statutory advisory role in the Climate Change Act. Interviewees emphasize that this advisory role is filled by scrutinising the work of the gov-

ernment: "*It is mainly Defra that is our customer. They are the people we scrutinise. They are also the people that fund us, so it is quite a strange set-up (laughing). The people who are paying us, we are telling them what they are doing wrong"* (CCC 2). This quote also shows how the committee maintains distance despite close institutional ties and thus assures credibility and legitimacy. By being openly critical to the work of the principal the ASC blocks the impression of a partial body that only favours government policy. These strategies to ensure impartiality and independence are particularly pronounced in the case of the CCC/ASC because it is exposed to frequent critique of "acting as a green NGO" (CCC 2) and hence being biased towards climate change action instead of being impartial and neutral against a variety of options. This framing obviously challenges its credibility as a scientific advisory body and its legitimacy for their privileged ways to inform government policies.

The discussion of the different roles and strategies in immediate climate policy advice has shown how KBIs constantly balance between their saliency, credibility and legitimacy. The relevance of scientific policy advice might be reduced by both, a too reserved or open position concerning concrete guidance or directions as well as a too narrow constriction of the political scope of action. A too prescriptive advice may lessen saliency from the beginning, because it leaves no room for political considerations and hence the advice is ignored (see KfC). However, prescriptive advice may in some instances also enhance saliency because clear answers are given (see the CCC's carbon budgets) while a policy advice that provides a range of options may be ignored because it lacks clear guidance. Credibility and legitimacy may also be lost when KBIs provide clear political recommendations and hence become politicised.

Communicating research: Between understandability and scientific accuracy

A related and widely recognised challenge concerns the communication of research results to decision-makers and the broader public that ideally should be understandable for a non-expert audience on the one side without losing scientific accuracy on the other side. KBIs produce a wide variety of services and products that take different formats and are targeted at different audiences. Most analysed KBIs produce scientific publications, including peer reviewed articles, PhD theses, scientific books, conference presentations, assessments and research reports. By this the KBIs mainly address the scholarly community and prove their scientific quality and hence promote the trustworthiness of their results, i.e. their credibility. This type of publication is especially important for and pronounced by KBIs that are firmly integrated in the scientific sphere, like PIK, PBL, KfC or KLIMZUG. Besides scientific publications, the analysed KBIs offer a wide portfolio of services and products tailored to socio-political actors, including policy-makers, stakeholders, media and the general public. These include traditionally policy briefs, government reports, popular scientific articles, practical guides and handbooks. More recent and innovative formats include interactive and visual interfaces, comic books, tools or enacting ways such as exhibitions and games, Web 2.0 applications such as Wikis, blogs, podcasts, webinars, apps and the like. These formats aim at informing actors with varying degrees of knowledge (up to hardly any knowledge) about the research and potential options for action.

The importance of the translation of climate science in usable format differs between the single KBIs. For several KBIs dissemination or knowledge transfer has become an important aspect of their work. This is for example reflected organizationally in the establishment of a communication office (UKCIP, PBL, KfC). In addition scientists are often asked to present their information to practitioners, be it in formal settings like parliamentary hearings, in workshops, or in informal personal contacts. As interviewees suggests this would be a *"torture"* (PIK 3) or at least *"a walk on the eggshells"* (KLIMZUG 4) for the 'classical' scientist and, therefore, scientists are often reluctant to communicate with practitioners even though collaborative programmes such as KfC or KLIMZUG exactly aim at this interaction. Thus, in some instances the scientific standards of the individual researcher may collide with the KBI's claim to transfer and mediate knowledge and develop societal relevance. However, most scientists within the

analysed KBIs are already quite aware and willing to communicate beyond the scientific community. Still they are challenged by combining scientific standards with the demand for understandable information.

Non-scientific publications and presentations generally ought to be catchier, shorter, reduced in complexity, and more concise in order to raise interest and ensure their understandability. Ultimately this should foster the applicability and relevance of information for non-scientific actors and hence their uptake. However, while it is often already difficult for scientists to condense their research in an understandable format, this task is complicated by the danger of losing scientific accuracy and hence credibility. Scientific publications generally follow clearly defined standards and in particular disclose in detail theoretical premises, methodological approaches (in climate science this often includes complex model descriptions) and uncertainties in the findings. All these aspects are rather impeding the understandability for socio-political actors and hence are often omitted, reduced or transformed in non-scientific publications.

The dealing with and communication of uncertainties is a particular illustrative example for the trade-offs between relevance and credibility in communicating results to non-scientific audiences. Almost all interviewees named the addressing of uncertainties as a central issue in communicating climate change information and often talked about the many struggles involved. One interviewee puts it very dramatic: *"Communicating the uncertainty was just a nightmare!"* (UKCIP 4). Scientists struggle, in particular, with the media's demand for easy and clear statements *"in black and white"* (ProClim- 4) and their open dislike for uncertainties (ProClim- 4). Uncertainties, for example regarding the regional or local impacts of climate change in terms of precipitation patterns, are generally widely discussed in scientific articles; yet when KBIs such as the CSC produce user-benign climate maps to illustrate these impacts they can hardly communicate these uncertainties in detail. This would make the maps overly complex, the clear message of expected impacts would be lost and hence the maps would become less applicable for the users. However, omitting uncertainties in favour of clear messages and understandable statements makes the KBI vulnerable in terms of their scientific credibility. Easily the accusation may be raised of unscientific procedures, biased information and ultimately a political agenda.

In order to avoid such accusations some KBIs provide ample access to their data and models and openly communicate uncertainties. PBL stands out in this regard: The agency maintains websites dedicated to their main models (i.e. IMAGE, Fair, Edgar, or Hyde). On the websites the model frameworks and details are introduced, results and publications are provided and an overview over uncertainties and sensitivities is given. In addition, PBL has explicit guidelines on how to deal with and communicate uncertainties. Built on a guiding document elaborated in 2003/2004, the agency has developed a number of tools, such as mini-checklists, a quick-scan questionnaire or a tool catalogue for uncertainty assessments (Petersen *et al.*, 2011).

Another strategy to enhance understandability of scientific information and information is to educate and train users in reading the information (UKCIP 4). UKCIP and CSC in particular engage in workshops, trainings or only tutorials that inform the stakeholders and users on how to use scenarios and projections, how to read probabilistic statements, etc. In this strategy saliency and credibility go hand in hand: By enhancing the scientific literacy of users they become more capable of actually using the information and by understanding the basic behind it are also more prone to accept them as credible.

12 Conclusions

Science and policy are intricately interlinked in climate change mitigation and adaptation (Jasanoff & Wynne, 1998, Miller & Edwards, 2001). Be it the setting of emission reduction targets and the respective implementation of mitigation measures, be it the assessment of the costs of climate change and the ensuing need for prioritizing different fields of action, or be it the identification of vulnerabilities to the effects of climate change and the realisation of necessary adaptation measures, political decisions strongly, and to a growing extent, rely on scientific results and argumentations (NATIONAL RESEARCH COUNCIL, 2010).

As a consequence of the growing pervasiveness of science-related issues in climate policy there has been a corresponding increase in the use of expert scientific advice to inform decision-making and, by implication, a mounting differentiation of the advisory landscape. Scientific policy advice does not only take place in classical formats, like IPCC-like expert panels or advisory committees, but takes many and much more diverse forms. The case studies have demonstrated that venues of scientific policy advice range from classical research institutions and governmental agencies, over collaborative research programmes to climate services to information and networking hubs. Similarly, we observe diverse knowledge brokerage activities which increasingly build on a dynamic understanding of the science-policy interface. In the following, we summarize the main innovative approaches in KB models and activities that we identified in our case studies.

Regional and collaborative research programmes

Climate change policy, in particular in the area of adaptation, often entails the development and implementation of policies and measures at regional and local levels. Accordingly, KBIs increasingly scale their activities to regions in order to provide research that is more responsive to the expectations and knowledge needs of specific users. The German research programme *KLIMZUG*, for instance, analyses regional vulnerabilities and develops approaches to deal with the consequences of climate change in seven regions. A key concern is the build-up of institutional capacities, inter alia, by activating and strengthening regional cooperative networks, which encompass actors from science, policy, industry, business and civil society. Similarly, the Dutch research programme *Knowledge for Climate* (KfC) organizes research around so called 'Hotspots,' i.e. eight regional areas across the country in which partners from science and practice collaborate in all phases of the research and implementation process. An outstanding design element of KfC is that the localized research in Hotspots is intertwined with and complemented by more overarching and disciplinary work in the so called 'Themes'.

Climate Service Centres – no „one-size-fits-all"

While regionalisation allows KBIs to be close to their 'customers,' it hardly addresses the strong fragmentation of climate expertise, which often makes it difficult for potential users to draw on the knowledge they need. One approach to counter fragmentation is the establishment of climate service centres. In ReSciPI, we identified two different models: first, the „full service centre" and, second, cases that only fulfil specific service functions. The German *CSC* and the British Climate Impacts Programme *UKCIP* are examples for the first approach, which offers a broad spectrum of user-tailored climate information products and services.

More focused types, in contrast, confine their services to networking or pure match-making, i.e. linking information providers with knowledge demands. The Swiss *ProClim-*, for instance, links actors from government, administration, business or media with climate science by means of an online data base (*InfoSystem*) and by the organisation of different dialogue events. With the so called *Call Down Service CXC* actively explores the knowledge needs of the Scottish administration and translates these into

meaningful research questions; researchers may apply to provide concise responses – typically policy briefs – on short call.

Hybrids between advisory bodies and departmental research

The British *Committee on Climate Change* (CCC) and its *Adaptation Sub-Committee* (ASC) are characterised by a remarkable vicinity to political decisions and can be classified as a kind of hybrid institution between departmental research and expert body. In contrast to many classical departmental research institutions, which perform more routine environmental reporting tasks, CCC and ASC have a stronger focus on concrete policies (e.g. setting and monitoring sector specific *carbon budgets*); while, at the same time, they differ substantially from specialized advisory bodies because they are equipped with (more) own research capacities. The committees hardly conduct primary research, but draw on a huge body of expertise either through commissioned studies, or through their own assessment and synthesis work. The high political relevance of the CCC and ASC substantially builds upon their strong political mandate (esp. qua *Climate Change Act 2008*) and their ties to government administration.

Research institutions heading for Mode 2 research

Despite vocal calls for more 'evidence-based policy-making,' scientific expertise often remains unconsidered in actual decisions. One reason is found in the classical form of knowledge production, known as Mode 1 science, that rests upon overly academic, disciplinary and hierarchical research. In contrast, Mode 2 science strongly relies on interdisciplinarity and a close collaboration with non-scientific actors. The *Potsdam Institute for Climate Impact Research* (PIK) explicitly follows this new approach and ties sophisticated natural scientific and economic modelling together with practical knowledge. This new orientation is also manifested in the organizational structure of the institute: two out of four research domains („Sustainable Solutions" and „Transdisciplinary Concepts & Methods") are specifically dedicated to this research approach.

Decision support – tools and beyond

The effectiveness of scientific policy advice is eventually measured against its ability to influence political, economic and societal actors and decisions. Accordingly, a number of advisory institutions build on the use of interactive decision support tools. Prominent examples include web-based platforms, like *Klimanavigator* (www.klimanavigator.de), that has been initiated and coordinated by CSC, or *KlimafolgenOnline* (www.klimafolgenonline.com), a service jointly developed by PIK and WetterOnline.de. While all those instruments allow for use-specified queries and analyses, *UKCIP's* approach goes one step further: In order to ensure its applicability to actual decision making, UKCIP has involved relevant stakeholders already in the development of the tools. In the design of the Business Areas Climate Assessment Tool (BACLIAT) and the Local Climate Impacts Profiles (LCLIP), for instance, future users were invited to bring in their local knowledge, e.g. as regards potential climate impacts. In addition, UKCIP has put great efforts into building capacities (e.g. through trainings and workshops) in order to allow local and regional decision makers to use the new tools in a competent way.

Search for questions, not only for answers

The design and implementation of a decision support system can mark the end point of a successful project of scientific policy advice. However, it is important not to forget that the foundations for successful knowledge brokerage are already laid at the very beginning of an advisory process, namely when knowledge needs are identified. An innovative example for a systematic agenda setting approach is the Dutch *KfC* programme: In a first step, stakeholders in the eight Hotspots defined specific regional knowledge needs, which scientists, subsequently, translated into concrete research questions. Some of those research questions were converted into applied research projects in which scientists and stake-

holders worked closely together in a transdisciplinary way. In the last step, the partners will implement the research results, primarily in the context of the elaboration of regional adaptation strategies. With this ambitious integration strategy, which spans all phases of an applied research project, KfC's Hotspots can be characterised as 'real-world laboratories', even though – as our ReSciPI results suggest – the integration of the perspectives of scientists and decision-makers is far from easy.

Targeting (new) addressees

Successful policy advice is often characterised by a strong orientation towards particular user groups. Most of the KBIs in this report address more than one target group. Across all countries and types of KB institutions political decision makers, and in particular representatives of ministerial administrations, mark the most frequently targeted group. In contrast, parliaments and their members tend to be sidelined. A remarkable exception is the *Parliamentary Group "Climate Change"* in Switzerland which organizes lunch events. ProClim- facilitates these regular events that aim at presenting and discussing recent insights in climate science with parliamentarians.

In many cases advisory institutions also target the media and the broader public. However, KB institutions often see that more as a by-product of their advisory activities rather than a primary purpose. Nonetheless, informing the public and media often takes quite innovative forms: *KLIMZUG-NORD*, for instance, uses catchy comics to convey its central messages on climate change and adaptation to the younger; PIK hosts a climate museum and developed a board game. In addition, many institutions make heavy use of the internet and increasingly employ "advice 2.0" formats, such as webinars, Wikis, blogs, podcasts.

The innovative models and approaches of knowledge brokerage presented in this report can serve as inspiring examples for a more productive interaction of climate science and politics in the featured countries, but also beyond. However, successful formats are no blue prints and should not be copied in an overly schematic way. Our analysis demonstrates that venues, modes and design of scientific climate policy advice differ across countries. Germany and the UK, for example, exhibit a diversified advisory landscape and a long tradition in involving university and non-university research institutions in science-policy networks and advisory bodies. As a consequence, knowledge may be more scattered and hence calls for stronger networking activities as provided, for example, by UKCIP and the CSC. In other countries, like the Netherlands and Switzerland, the advisory landscape is considerably smaller. A limited number of KBIs play a key advisory role and partly have a privileged access to policy makers and political processes. PBL, as one of three Dutch assessment agencies, for instance, exhibits such a special standing in Dutch climate policy. Also in Switzerland the advisory landscape revolves to a large degree around one institution, i.e. ProClim- as a central hub. Against the background of these differences the reshaping science policy interactions, thus, needs to be highly responsive to the respective politico-cultural context.

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