



# New science for global sustainability? The institutionalisation of knowledge co-production in Future Earth



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## ABSTRACT

In the context of complex and unprecedented issues of global change, calls for new modes of knowledge production that are better equipped to address urgent challenges of global sustainability are increasingly frequent. This paper presents a case study of the new major research programme “Future Earth”, which aims to bring ‘research for global sustainability’ to the mainstream of global change research. A core principle of Future Earth is the co-production of knowledge with extra-scientific actors. In studying how the principle of co-production becomes institutionalised in the emerging structure of Future Earth, this paper points to the existence of three distinct rationales (logics) on the purpose and practice of co-production. Co-production is understood as a way to enhance scientific accountability to society (‘logic of accountability’), to ensure the implementation of scientific knowledge in society (‘logic of impact’), and to include the knowledge, perspectives and experiences of extra-scientific actors in scientific knowledge production (‘logic of humility’). This heterogeneous conception of knowledge co-production provides helpful ambiguity allowing actors with different perspectives on science and its role in society to engage in Future Earth. However, in the process of designing an institutional structure for Future Earth tensions between the different logics of co-production become apparent. This research shows how logics of accountability and impact are prominent in shaping the development of Future Earth. The paper concludes by pointing to an essential tension between being inclusive and transformative when it comes to institutionalising new modes of knowledge production in large research programmes.

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## 1. Introduction

“The magnitude and urgency of the challenges facing humanity requires [...] a common coherent strategy of transdisciplinary research for global sustainability” (Belmont Forum, ICSU and ISSC, 2011; p. 1).

With the above statement, the International Council for Science (ICSU), the International Social Science Council (ISSC) and the funding agencies united in the Belmont Forum announced their ambition to fundamentally change the practice, content and organization of global change research.<sup>1</sup> These ambitions have materialized in the major new global change research programme “Future Earth: Research for Global

Sustainability”. Future Earth merges three international research programmes – the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP), and DIVERSITAS: a programme on biodiversity science – and their Earth System Science Partnership (ESSP), bringing together scientists from a wide variety of disciplines and organisations all over the world. The programme was launched at the United Nations Conference on Sustainable Development that took place in Rio de Janeiro, Brazil in June 2012 and intends to provide “the knowledge and support to accelerate our transformations to a sustainable world” (Future Earth, n.d.). In doing so, Future Earth questions and potentially reforms commonly held perceptions of science and its role in society. In particular, the programme advocates the co-production of knowledge with societal actors as a new mode of knowledge production that is essential to address the challenge of ‘global sustainability’.

The development of Future Earth can be placed in a larger discourse on the emergence of new modes of knowledge

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<sup>1</sup> Global change research, as addressed in this paper, is an international and interdisciplinary research domain focused on changes in the human environment. Research topics range from climate change, to land use change, biodiversity loss and urbanisation.

production<sup>2</sup> (e.g. Hessels and van Lente, 2008) and the changing role of science in society (e.g. Luks and Siebenhüner, 2007). Many authors have commented on a trend, at least in rhetoric, from curiosity-driven, mono-disciplinary modes of scientific knowledge production towards interdisciplinary, participatory and solution-oriented approaches (Funtowicz and Ravetz, 1993; Klein, 2001; Nowotny et al., 2001). New modes of knowledge production are proposed and advanced in a variety of contexts and settings, finding support as well as resistance among the scientific community. Yet, academic research on the practices, processes and particularities of this kind of 'epistemic work' is limited (Felt et al., 2012; p. 10). This study aims to make a contribution by investigating the process by which a new mode of 'research for global sustainability' is being negotiated and institutionalized in Future Earth.

The paper draws attention to one specific principle of Future Earth's 'research for global sustainability': the co-production of knowledge. Co-production<sup>3</sup> is presented (in documents and personal communication) as the most innovative aspect of Future Earth and a key feature distinguishing the new research programme from existing initiatives in global change research. In the next section, I discuss the principle of co-production in the context of related accounts of participatory knowledge production. Subsequently, I provide a brief review of the literature on intermediary organisations in science, and their role in supporting new modes of knowledge production. Then, I lay out my methods of data collection and analysis. The empirical section of the paper discusses, first, three co-existing logics that support a different interpretation and implementation of knowledge co-production in Future Earth and, subsequently, investigates how these different logics of knowledge co-production shape the process of developing an institutional structure for Future Earth. The paper concludes by pointing to the tensions between different logics of co-production that become apparent in Future Earth's re-orientation of global change research towards 'research for global sustainability'.

### 1.1. The principle of co-production

The term co-production was originally coined in the Science and Technology Studies (STS) literature to account for the relationship between science, technology and society. This notion of co-production draws attention to co-evolution and co-shaping of knowledge and social order, recognizing that knowledge is both "a product of social work and, at the same time, constitutive of forms of social life" (Jasanoff, 2004; p. 274). In the context of Future Earth, however, co-production is used in a practical rather than analytical sense, and refers to the intentional act of engaging extra-scientific actors in the process of scientific knowledge production.<sup>4</sup>

Co-production, in its practical orientation, is not a new idea. Similar ideas and objectives as captured by Future Earth's notion of co-production have been discussed in the academic literature under different terms, including participatory research (e.g. Lengwiller, 2007), interactive research (e.g. Lemos and Morehouse, 2005), civic

science (Bäckstrand, 2004), transdisciplinarity (e.g. Klein, 2001) and joint knowledge production (e.g. Hegger et al., 2012). These approaches share a focus on the participation of extra-scientific actors in academic knowledge production. Often, participation is proposed as a way to go beyond the linear relationship between science and society – in which science is communicated to society after its production – towards more interactive and productive arrangements between scientific and extra-scientific actors.

However, as the literature points out, different ideas about the purpose and practices of engaging extra-scientific actors in scientific knowledge production prevail. Bäckstrand (2004), for example, distinguishes between participation pursued with the aim to restore public trust in science, to address the complexity of global environmental problems, or to extend the principle of democracy to scientific knowledge production. These perspectives build on different epistemic and normative understandings of science and its role in society, and are not necessarily compatible. The first perspective retains the traditional model of top-down scientific expert knowledge, whereas the latter two perspectives suggest reforms of scientific norms, institutions and procedures, albeit in different ways (Bäckstrand, 2004). Similarly, Lövbrand's (2011) study of co-production in European climate science reveals a tension between narratives of usefulness, according to which science is expected to respond to the needs of decision-makers, and an emancipatory, critical and reflexive objective of participation in scientific knowledge production. Multiple authors have observed that participatory knowledge production tends to remain rooted in traditional structures and assumptions of science, providing an attractive label and legitimacy for scientific knowledge production while actual practices remain unchanged (e.g. Felt et al., 2012; Turnhout et al., 2013).

### 1.2. The role of research programmes

Academic reflections on new modes of knowledge production often point to the importance of the institutional context of science in supporting and encouraging new research practices (e.g. Dedeurwaerdere, 2013; Kueffer et al., 2012; Yarime et al., 2012). Historically developed institutional structures of modern science – such as the academic publishing system, career trajectories, department structures and criteria for evaluation and funding – are often unsupportive of new modes of knowledge production (Rip, 2011). Increasingly, though, research programmes, at national, regional and international level bring new modes of knowledge production to the core of their research strategies. Hessels (2013) identifies research programmes as 'intermediary organizations with a coordinating mission', that is, organisations that aim to coordinate research practices in a specific research domain, possibly steering research in new directions. These programmes operate between the macro structures of the science system and the micro level of daily research practices, thus providing a context for institutional support of new modes of knowledge production within a research system that is organized based on traditional values of science. Studies of existing research programmes and formal research networks have pointed out that, to support the engagement of extra-scientific actors in scientific knowledge production, it is important to "purposefully put into place structures and process" (Klenk and Hickey, 2012; p. 370). Engagement of extra-scientific actors in the early stages of programme design is considered particularly promising (Garrett-Jones et al., 2005; Hessels, 2013; Klenk and Hickey, 2013), since these early stages provide the opportunity to engage multiple actors in shaping the research programme and structure, and tend to give an indication of the way in which these actors participate in the coordination of research during later stages of the programme's development (Hessels et al., 2014). Moreover, funding agencies are identified as important actors in stimulating and supporting research

<sup>2</sup> I use the phrase 'new modes of knowledge production' to refer to a set of ideas and approaches that divert from disciplinary and curiosity-driven science, and are discussed in the literature in terms of mode-2 knowledge production, post-normal science, triple-helix, etc.

<sup>3</sup> A distinction is sometimes made between the 'co-design of research agendas', the 'co-production of knowledge' and the 'co-dissemination of findings'. In this paper, the term co-production is used to refer to the underlying principle of including extra-scientific actors in the process of scientific knowledge production, this may include co-design, co-production and co-dissemination.

<sup>4</sup> On the difference between the analytical understanding of co-production, and the more utilitarian interpretation of co-production in practical terms, see Kerkhoff and Lebel, 2015; Lövbrand, 2011.

programmes based on new modes of knowledge production (Lyall et al., 2013). Intermediary organisations thus provide an opportunity to support new modes of knowledge production in the context of institutionalized macro-level structures of science. At the same time, these research programmes face the challenge of fitting organisational structures and governance models to the wide diversity of objectives and expectations that exist in a research community (Turpin et al., 2011).

### 1.3. Institutionalizing co-production in Future Earth

It seems plausible to assume that the principle of co-production gained prominence in the international institutional domain of global change research precisely because it allows for multiple interpretations, including more traditional perception of science-society relations and scientific practices (Turnhout et al., 2013). A flexible concept like knowledge co-production can provide a possibility to overcome conflict between different value positions as it is adaptable to multiple contexts, visions and perspectives (Bensaude Vincent, 2014). In the process of institutional change, however, such multiple understandings might prove problematic as different notions of the purpose and practice of participation in scientific knowledge production may link to different ideas on the preferred form of institutionalisation (Turnhout et al., 2013). Institutional settings are not neutral instruments, but “embody certain intentions, aspirations and purposes” (Pinheiro and Stensaker, 2013). This raises the question why institutional arrangements are established in a particular way, and how particular organisational structures and institutional rules are promoted and legitimised (ibid.). Moreover, we can expect that changes in the institutional structure of research will be “the subject of considerable debate and negotiation” (Turpin, 1997; p. 265), as particular knowledge producing practices may become supported at the expense of others.

Studies on the institutional aspects of new modes of knowledge production have mainly focussed on institutions at the national or sub-national level; global networks of knowledge production – although promoted as appropriate institutional arrangements to support new modes of knowledge production in research for sustainability (e.g. Yarime et al., 2012) – have yet to be investigated sufficiently. This study asks how the principle of knowledge co-production becomes institutionalised in the new research programme Future Earth. Studying a research programme ‘in the making’ allows for explicit consideration on the vision, aims and purposes that guide the development of a new research programme, the tensions between different positions that become apparent in negotiating new institutional arrangements, and the processes through which new organisational structures and institutional rules are eventually established.

## 2. Data collection and analysis

The empirical part of this paper presents a qualitative case study of the emergence and development of the new major research programme Future Earth. The results presented reflect events from early 2009 (with the start of the ICSU-ISSC Visioning

Process, see below) until December 2015. I base my analysis on documentary material and interviews. The documentary material consists of 1) key documents of the organizations involved in global change research, including vision documents, strategic plans, annual reports, review documents, meeting minutes and newsletters; and 2) academic publications reflecting on epistemic and institutional developments in global change research, and often advocating particular future directions (listed in supplementary material). Together, this documentary material provides and overview of the main events in global change research leading up to the development of Future Earth, as well as insights in the visions and rationales that shaped these developments.

The documentary material is complemented with 18 in-depth expert interviews with senior scientists and managers affiliated with different organizations involved in the global change community (see Appendix A). A first set of questions in these semi-structured interviews concentrated on the interviewees’ perceptions of the new ‘science for global sustainability’ proposed by Future Earth, and specifically the principle of co-production. Interviewees were asked about their understanding of the principles, purposes and practices of this ‘mode of knowledge production’, and the way it differs from ‘traditional’ modes of knowledge production in global change research. A second set of questions was directed at the process of negotiating and establishing a new institutional structure for global change research. Here I invited interviewees to reflect on their participation in this process, the challenges they encountered, and the eventual decisions that were made. Interviews were conducted in person or via Skype and lasted between 45 min and 2 h. All interviews were recorded and transcribed.

In my analysis of documentary materials and transcribed interviews, I draw on the concept of ‘logics’ as an analytical tool (Barry and Born, 2013; Barry et al., 2008). Barry and colleagues employ the concept of logics to point to “a set of contemporary rationales about what the purposes of interdisciplinarity are and how it should be guided and justified” (Barry et al., 2008; p. 24).<sup>5</sup> Here, I direct this analytical tool to the principle of co-production, focussing on different understandings of the purpose and practices of knowledge co-production as they are expressed in the context of Future Earth. The focus on logics allows me to disentangle different rationales of knowledge co-production in Future Earth, and assess how these logics shape the process of institutional design.

My analysis proceeded in two steps. First, I coded the empirical material focussing on the different understandings of the principle of knowledge co-production, based on the attributes listed in Table 1 (‘Coding scheme’). Subsequently, I categorized the interview quotes and texts fragments according to the different interpretations of these five attributes of co-production. This allowed me to distinguish three rationales for knowledge co-

**Table 1**  
Coding scheme.

Attribute	Description
Why co-produce?	Reasons given for co-producing scientific knowledge with extra-scientific actors
How to co-produce?	Description of co-producing practices
With whom to co-produce?	Actors, institutions, categories or sectors mentioned as potential partners in the co-producing process
Roles of scientists	Roles and responsibilities attributed to scientists in knowledge co-production
Roles of non-scientists	Roles and responsibilities attributed to extra-scientific actors in knowledge co-production

<sup>5</sup> Barry et al., (2008) and Barry and Born (2013) distinguish three logics for the pursuit of interdisciplinarity, namely the logic of accountability, the logic of innovation and the logic of ontology. Although related, the logics identified by Barry et al. are not directly transferable to the case of knowledge co-production and the specific context of Future Earth. Instead, through an inductive process, I distinguish three logics that feature prominently in the text and talk on knowledge co-production in the context of Future Earth.

production in Future Earth which provide different interpretations with respect to the purpose and practice of co-production. I refer to these three rationales as 'logics of co-production'. This part of the analysis is presented in section 3 ('Logics of co-production in Future Earth').

Second, I used this framework of three logics to analyse the institutionalisation of the principle of co-production in Future Earth. Based on the collected documents and interview material, I examined the process by which the institutional design for Future Earth came into being, focussing in particular on the rationales and justifications given for particular decisions and events, as well as the tensions between positions that surfaced during several moments in this process. The framework of three logics was used to identify different rationales shaping the process of institutional design, and to assess which understandings of science and its role in society find support in the emerging institutional structure of Future Earth. I distinguish four phases in the development of Future Earth's institutional structure, where different combinations of logics are at play. This part of the analysis is presented in section 4 ('Institutionalising co-production in Future Earth').

### 3. Logics of co-production in Future Earth

In the following, I introduce the three logics of knowledge co-production that I distinguish in the text and talk on co-production in Future Earth. All three logics support Future Earth's central aim of a science that is firmly rooted in society and contributes to societal goals, yet differ in understanding of the purpose and

practices of knowledge co-production, the type of societal actors that scientists are expected to engage with, and the roles attributed to societal actors as well as scientists themselves in the process of knowledge co-production (see also Table 2). These three logics of knowledge co-production are not mutually exclusive; they are sometimes combined in a single storyline and can be seen as interdependent. Nevertheless, it is useful to make a distinction between the logics of co-production as they represent different underlying motivations for knowledge co-production, imply different modes of practicing co-production, and potentially lead to different institutionalisations of co-production in Future Earth.

#### 3.1. Logic of accountability

The first logic of co-production that I distinguish is centred on the objective for science to be relevant and responsive to the needs of society. This 'logic of accountability'<sup>6</sup>; builds on the narrative of a social contract between science and society: science provides useful knowledge to society in return for the resources it receives. In contrast with earlier interpretations of the science-society contract in which science was expected to deliver societal returns through self-governance, the accountability logic of co-production

<sup>6</sup> Accountability in science can take many different forms, ranging from mere legitimization of existing scientific practices to radical reorientation of science (Barry et al., 2008). Here, I focus on the way accountability is expressed and institutionalized in the context of Future Earth, which is shaped by the central role of funding agencies in the development of the programme (see also Section 4).

**Table 2**  
Logics of co-production.

	Logic of accountability	Logic of impact	Logic of humility
Purpose of co-production	To be <i>responsive</i> to the needs of society	To ensure <i>implementation</i> of scientific knowledge in society	To be humble and reflexive about the role of science in society
Motivation to engage in co-production	Living up to societal needs and demands; to justify public spending on research (and possibly increase funding by demonstrating utility of research)	Having an impact in society; supporting transformations towards global sustainability	Acknowledging different ways of knowing; taking into account different values, norms, understandings in dealing with uncertain and complex issues
How to co-produce	Engaging extra-scientific actors in the research process, particularly in deciding on research priorities, to ensure that research responds to societal needs	Engaging extra-scientific actors throughout the research process to increase legitimacy, reduce scepticism and create ownership.	Recognising extra-scientific actors as legitimate knowledge holders; creating knowledge together
With whom to co-produce	Those that provide funding for scientific knowledge production (directly: funding agencies; indirectly: governments and tax payers; possibly private sector)	Actors that can make a difference in society (often interpreted as private sector and high-level decision-makers)	Actors who bring in different knowledges, perspectives and experiences than scientific actors
Role and responsibility of science	Providing the knowledge that society needs; providing useful knowledge	Inform and guide transition to global sustainability; co-producing sustainable futures	Facilitating knowledge production and stakeholder cooperation; engage in reflexive learning process
Roles and responsibility of societal actors	Informing research directions and research agendas	Implementing scientific knowledge in society	Epistemic partner in knowledge production process
Illustrative quotes	"... governments and society want a bigger say in the formulation of the research questions and issues that they want science to investigate and explore. Because governments are making the investment, they want to have more say in what the science priorities are and look like" [4] <sup>a</sup> "[Answering to major societal concerns] is the only way to justify the money we have, and if we want to get some more into our science, this is the only way to go." [11]	"... you have to give [stakeholders] a role in the beginning so that your questions are framed in the right way. But also during the research, you actually have to check if their needs aren't changing, if your insights aren't changing. And in the end the big advantage is that, if you have still their buy in, they will actually communicate your results." [1] "There is [ . . . ] a greater chance of creating durable, effective interventions if decision makers and other users of the research are appropriately involved in the process of designing and producing knowledge." (ISSC and Belmont Forum, 2011, p. 21)	"... like academics, non-academics are knowledge producers as well as users, [and] they hold valid knowledge that has to be part of framing the agenda and of research" [6] [Co-production of knowledge is a process] . . . by which scientific and societal actors negotiate how different sources of knowledge can be brought together into new and mutual understandings. Sustainable development requires knowledge that is integrated in appropriate ways with scientific and other forms of knowledge." (ISSC and UNESCO, 2013, p. 607)

<sup>a</sup> The numbers between brackets refer to the number of the interview. Experts interviewed for this study are listed in Appendix A.

assumes that active involvement of 'users' is required for science to provide useful insights and products for society. Co-production is thus proposed as a way to ensure societal benefits of science. Public funding agencies are perceived as forming the link between societal demands and scientific knowledge production, and their involvement in science governance is expected to steer science towards improved accountability. In extension, the business community is identified as potential beneficiary of science and partner in co-production, with the expectation that a better response to the needs of the business community might increase private sector funding for science. Based on this logic, scientists are expected to be responsive to the needs of societal actors in setting research agendas and formulating research questions, yet remain in control of scientific knowledge production and in this respect maintain a certain level of separation from society, which is considered essential to safeguard scientific credibility.

### 3.2. Logic of impact

A second logic that shapes the discourse of knowledge co-production in Future Earth proposes co-production as a practice to remedy the perceived gap between scientific knowledge and its implementation in society. This logic stresses that co-production is important "... to ensure that proposed and established solutions are acceptable in actual societal contexts" (Future Earth, 2013, p. 51). The assumption is that engaging 'users' or 'stakeholders' throughout the research process will increase legitimacy of and reduce scepticism towards research and research results, thus enhancing the likelihood that scientific knowledge will contribute to societal change. The societal actors identified as possible partner in knowledge co-production are those actors that are in a position to 'make a difference in society'. The private sector in particular is often recognised as an engagement partner that has the potential to implement science-based solutions for a transition to global sustainability. Similar to the logic of accountability, the roles of scientific and extra-scientific actors in the various stages of scientific knowledge production are clearly differentiated. Scientists take the lead in the production of scientific knowledge, whereas the role of 'stakeholders' is to ensure that research questions are relevant to societal needs and that scientific knowledge finds implementation in society.

### 3.3. Logic of humility

A third logic that shapes the discourse of knowledge co-production in Future Earth builds on the position that scientists need "to be humble and reflective about their own positions, recognizing that their own views of the world and of what kinds of science and knowledge are appropriate are always positioned and partial" (Prof. Melissa Leach, Vice-Chair of the Future Earth Science Committee, as quoted in Sayer, 2014). This 'logic of humility'<sup>7</sup>; emphasizes the relevance of societal norms, values and concerns in addressing issues of sustainability, and maintains that scientific knowledge production should not close down questions of meaning and value, but rather allow for inclusive and open deliberation of issues of societal concern. The assumption is that taking societal complexities into account in producing scientific knowledge for global sustainability will enhance the value of research in addressing issues of global change. Hence, co-production of knowledge is called for as an approach that includes

the knowledge, perspectives and experiences of extra-scientific actors in scientific knowledge production. Extra-scientific actors are perceived as legitimate knowledge holders and partners in the full process of scientific knowledge production. This means that the boundaries between science and other societal subsystems are blurred in the common pursuit of knowledge for global sustainability.

## 4. Institutionalising co-production in Future Earth

The three logics that shape the discourse on co-production in Future Earth imply different forms of institutionalising this principle in the structures, rules and procedures of the programme. In this section, I discuss the development of Future Earth and analyse which logics we see 'at work' in the process of designing and negotiating a new institutional context of 'research for global sustainability'. The section is structured along four phases in the development of Future Earth in which different combinations of logics shape the process of designing an institutional structure for the programme.

### 4.1. The formation of an alliance

Early 2009, following reviews of existing international research programmes in the global change community which pointed out that these programmes, although generally successful in their scientific objectives, had limited societal impact (ICSU and IGFA, 2008, 2009), the International Council for Science (ICSU) and the International Social Science Council (ISSC) engaged in a 'Visioning Process' to explore research priorities and new institutional frameworks for the next decade of global change research. The report that resulted from this process stresses that:

There is an "urgent need for the international scientific community to develop the knowledge that can inform and shape effective responses to ... threats [resulting from human-induced global environmental change]" (ICSU, 2010, p. 5)

This statement illustrates the strong emphasis in the ICSU-ISSC Visioning Process on the societal role of global change research community. It is argued that, while the global change community has already played an important role in understanding the functioning of the Earth system, it now needs to step up to the challenges of 'informing and shaping' the societal response to global change. The report continues by stating that:

"Research will often be most useful, and the results most readily accepted by users, if priorities are shaped with the active involvement of potential users of research results and if the research is carried out in the context of a bi-directional flow of information between scientists and users. An effective response to global environmental change will be aided by the co-creation of new knowledge with a broad range of stakeholders through participatory practices" (ICSU, 2010, p. 6)

Here, again, the focus is on an *effective* response to global environmental change requiring *effective* interactions with stakeholders. Illustrating that, in this initial visioning process, objectives of scientific impact in society were central to the developments towards a new type of research and a new institutional framework.

Parallel to the ICSU-ISSC Visioning Process, some of the major funders of global change research, among them the US' National Science Foundation (NSF) and the UK's Environmental Research Council (NERC), created a new platform for international cooperation among national funding agencies: the Belmont Forum. The Belmont Forum intends to coordinate across national funding agencies in the domain of global change with the overarching aim

<sup>7</sup> The name is inspired by Jasanoff's (2003) work on 'technologies of humility', in which she argues that coming to grips with the limits of scientific knowledge requires an "intellectual environment in which citizens are encouraged to bring their knowledge and skills to bear on the resolution of common problems" (p.227).

“[t]o deliver knowledge needed for action” (Belmont Forum, 2011, p. 7). Here, again, we find that the objective of societal impact is strongly represented. The constitutional White Paper of the Belmont Forum states the following:

“To maximise benefit to policy and business, provision of this information [i.e. the information that society needs to respond to the challenges of global environmental change] will need to be co-designed in partnership with influential societal decision-making systems, internationally and at regional scales.” (Belmont Forum, 2011, p. 4)

The above statement emphasizes the benefit of research for particular societal actors (policy and business) rather than societal effectiveness in general, and, to maximize benefit, the need to engage ‘influential societal decision-making systems’ in processes of co-design. Within the Belmont Forum and its constitutional White Paper there is a strong sense that the global change community needs to increase its accountability to its societal sponsors by stepping up to the challenge of providing the knowledge needed by governments and businesses.

Finding similarities in their missions, ICSU, ISSC and the Belmont Forum decided to join forces in the process of initiating a new research programme for global change research. In a joint statement of intent, the science councils and funders of global change research stated that:

“A step change in coordination and collaboration is required that will . . . [e]ndeavour to collectively identify priorities, co-design research strategies and co-produce knowledge with users and key drivers of innovation and change, including the policy and business communities.” (Belmont Forum, ICSU and ISSC, 2011; p.1)

Whereas the notion of engagement and participation had been mentioned in both the ICSU/ISSC and Belmont Forum process, co-production now took centre stage as the principle where the science councils and funding agencies found common ground. Co-production was made a core objective of the new research initiative, as well as a principle for the design of the initiative itself (ICSU, 2011a).

Together with the other institutional sponsors of global change research (UNESCO, UNU and UNEP), ICSU, ISSC and the Belmont Forum formed an alliance which was formalized as the Science and Technology Alliance for Global Sustainability (in short: ‘The Alliance’). This alliance is identified as a ‘strategic alliance’, bringing together the relevant partners to co-produce the new research programme and to encourage and facilitate the co-production of knowledge in Future Earth [4,11,13]. Within this strategic alliance, the international science councils (ICSU and ISSC) represent the scientific community. A strong link to national funders of global change research is provided by the Belmont Forum, which is expected to ensure that Future Earth responds to the knowledge needs of its sponsors. This central role of the funding agencies with respect to co-production in Future Earth reflects the logic of accountability, with the funding agencies identified as key actors in ensuring the accountability of the new research programme to society. The presence of UN bodies in the Alliance (UNESCO, UNU and UNEP) is also justified through the logic of accountability, with these international agencies (indirectly) representing the ‘users’ of Future Earth. At the same time, including UN organizations as institutional sponsors is anticipated to provide the initiative with “political convening power” and to “build visibility and capacity for Future Earth at a global level [and] directly with governments” [13], thus supporting the societal influence of Future Earth and reflecting the logic of impact. The Alliance became the initiator and interim-Governing Council of Future Earth, taking responsibility for setting-up

governance structures, appointing committees and running the secretariat in the early stages of Future Earth’s development.

In sum, in this initial phase in the development of Future Earth, the principle of co-production acts as a bridging concept bringing together multiple actors in a common alliance to develop a new research initiative. Shared logics of impact and accountability shape and justify the establishment of the Alliance and the role of its members in co-producing Future Earth. The objective to enhance the effectiveness of global change knowledge in society features prominently in both the ICSU-ISSC Visioning Process and the Belmont Forum White Paper, and the formation of a strategic alliance between science councils, funding agencies and UN organizations, co-producing the new initiative Future Earth, is expected to contribute to this objective (logic of impact). At the same time, the funding agencies bring in a focus on the ‘users’ of global change research (at this stage mostly simplified as policy and business communities) and the responsibility to respond to their needs (logic of accountability).

#### 4.2. Negotiating Future Earth’s initial design

The Alliance established a “Transition Team” tasked with the development of an initial research strategy and organisational design for Future Earth. Members of the Transition Team were selected to represent different scientific communities as well as the science councils, funders and ‘users’ of global change research (ICSU, 2011b), reflecting the objective to build the new initiative through a process of co-production.<sup>8</sup> The Transition Team agreed that an institutional innovation was necessary to support the principle of knowledge co-production in Future Earth. Yet, *how* to internalize the principles of co-production in the institutional design of Future Earth proved to be a point of disagreement.

One way in which the Transition Team decided to incorporate the principle of co-production in the institutional design of Future Earth was by complementing the Science Committee – an established component of the governance structure of international research programmes – with an Engagement Committee. Where the Science Committee traditionally consists of respected members of the scientific community tasked with steering the research directions of a research programme, an Engagement Committee was considered an appropriate way to include extra-scientific actors in shaping and steering research for global sustainability. However, perspectives differed with respect to the desired position of the Engagement Committee in the organisation structure of Future Earth. Discussions within the Transition Team centred on the question whether priority should be given to the Science Committee (representing the scientific community) or the Engagement Committee (representing the ‘stakeholders’ or ‘users’ of Future Earth). This discussion reflects different positions with respect to the appropriate and desired relationship between scientific and non-scientific actors. Whereas some members argued that the new research programme should be driven directly by the needs of society and therefore the Engagement Committee should have priority in the organizational design, other members, while recognising the role of non-academic actors in advising on scientific priorities, pointed to the importance of scientific autonomy which would be safeguarded by the primacy of the Science Committee in Future Earth’s organisational design.

<sup>8</sup> However, the executive team consisted of scientists only. Illustrating that, as in other stages of Future Earth’s development, ambitions of co-production were not always reflected in reality.

“... there was lots of discussion [within the Transition Team] as to which one [i.e. which committee] would be on top—to put it crudely ... in the end we concluded that they had to be equal ... I can remember a meeting where we actually beat this ... we said, this is stupid! This whole discussion is really pointless. We've got to have both. And they need to be on the same level and they've got to interact with due respect for each other, they've got to interact properly. It says all that in the text [i.e. the Initial Design Report of Future Earth]. We spend ages getting this text right.” [11]

Thus, in the organisational design that the Transition Team eventually settled with, the Science Committee and the Engagement Committee have “the same status and priority” (*Future Earth*, 2013; p82). Members of the Transition Team explain that this dual structure was developed to give stakeholders a strong voice in the governance of Future Earth and to avoid ‘getting the science right first and doing the engagement later’ [1, 11, 16]. Including extra-scientific actors from the start was considered important to ensure that Future Earth produces the knowledge that society needs (logic of accountability) while building relationships of trust and legitimacy and increasing the likelihood of implementation of scientific knowledge in society (logic of impact). At the same time, the dual structure is argued to be safe-guarding scientific autonomy:

“You want to have a certain independence of your science, in order to have your freedom and quality and all of that. And at the same time, you want to have policy relevance. It is difficult to do both at once. [The dual structure] was the solution that was found to both have a place where you have your policy-relevance and you have your stakeholders, and then at the same time scientists also have some space to meet separately.” [6]

Thus, whereas the governance structure of Future Earth, with its dual structure of a Science Committee and Engagement Committee, was meant to bring the principles of co-production at the core of the research programme, it also accommodates principles of scientific independence and autonomy.

The next step was to decide on the appropriate membership of the Engagement Committee. The profile for Engagement Committee members stresses the desirability of “[s]trong experience in addressing environmental change and sustainability issues at different scales, from the local to the global scale” (*Future Earth*, 2014a), thus encouraging engagement of actors who, based on their experience in addressing environmental change and sustainability issues, have the potential ‘to make a difference in society’. Indeed, members of the Engagement Committee represent high-level positions in various sectors of society, from international political bodies to multinational organisations. Here, again, we see the logic of impact at work, where co-production is proposed to ensure that scientific findings translate into societal change.

With the establishment of the Science and Engagement Committees, as well as various subcommittees at the regional and national scale, new actors and voices were brought into Future Earth. In this context, the dual structure of Science Committee and Engagement Committee became a point of discussion, not in the least by members of these committees themselves. The separation of ‘science’ from ‘engagement’ through the two distinct committees became strongly questioned based on the reasoning that both scientific and extra-scientific actors hold relevant knowledge as well as value positions with respect to research for global sustainability (logic of humility), making a separation of committees unnecessary and undesirable. Voices went up to reconsider this aspect of the governance structure of Future Earth and, rather than two committees with different mandates, establish a single

committee in which scientists and stakeholders would work together in shaping research for global sustainability. Indeed, during this phase, most meetings of the Science Committee and Engagement Committee were held jointly and tasks were carried out under common responsibility, diminishing the structural separation between the two committees.

In sum, during this second phase in the development of Future Earth, debates on the appropriate governance structure for the new research programmes expose tensions between different logics of co-production. The establishment of a dual structure of a Science and Engagement Committee institutionalizes the co-production principle in the governance structure of Future Earth by allowing ‘stakeholders’ or ‘users’ to shape research directions (logic of accountability) and increasing the likelihood of implementation of knowledge in society (logic of impact), while also accommodation values of scientific independence and autonomy. At the same time, opening up the programme and its development to new actors with the establishment of the Science Committee and Engagement Committee strengthened the understanding of co-production based on the logic of humility, as reflected in internal criticism on Future Earth’s dual governance structure.

#### 4.3. Developing institutional rules and procedures

Future Earth was officially launched at the Planet under Pressure conference (London, March 2012) and the Rio+20 United Nations Conference on Sustainable Development (Rio de Janeiro, June 2012), reflecting its dual commitment to the scientific community and decision-making audiences. Future Earth’s vision document (*Future Earth*, 2014b) and Strategic Research Agenda (*Future Earth*, 2014c), both again stress co-production as a central principle of Future Earth. The vision document states that, by 2025, Future Earth will have:

“Pioneered approaches to co-design and co-produce solutions-oriented science, knowledge and innovation for global sustainable development” (*Future Earth*, 2014b, p.5), and “Enabled and mobilised capacities to co-produce knowledge, across cultural and social differences, geographies and generations.” (*Future Earth*, 2014b, p.6)

These statements, rather than focussing on the design of Future Earth itself, stress the role of the programme in supporting co-production of knowledge in the research projects and initiatives operating under Future Earth’s umbrella. Next to the governance structure discussed in the previous section, institutional rules and procedures were developed with the intention to contribute towards this objective. One of these is the ‘Memorandum of Understanding’ that existing research projects are expected to sign when becoming part of Future Earth. In a statement addressed to the Science Committee of Future Earth, research projects are requested to describe how they meet, or will seek to meet the principle of co-production in their research strategy and practices. Co-production has also been made a key criterion for the establishment of new initiatives under the umbrella of Future Earth and the assessment of funding proposals by the Belmont Forum.

Particularly in the early stages of Future Earth’s development, the design of assessment criteria and the actual assessment of the project and project proposals was taken up by academic actors represented in the Science Committee (partly because the Engagement Committee was not fully established yet at this point). More recently, the Engagement Committee has acquired an official role in the process of reviewing global change research projects that intend to become part of Future Earth, indicating that judging the value of science is no longer considered the exclusive task of the scientific community.

To aid a common vision and strategy on the principle of co-production, members of the Science Committee and Engagement Committee have been working on an 'Engagement Strategy'. Initially, this document was developed as a white paper – an authoritative document on engagement in Future Earth – yet, over time the document got the status of a green paper, intended to stimulate discussion on the topic of engagement, rather than an authoritative statement on the principles and practices of knowledge co-production in Future Earth [18]. Various drafts of the document point to the diversity of meanings associate with the principle of co-production. Indeed, the document acknowledges 'multiple interrelated objectives' and stresses that there is 'no one type fits all' when it comes to engagement. Instead, all initiatives within Future Earth are expected to develop their own tailored engagement strategy.

Yet, a form of engagement supported by Future Earth in particular is that through Knowledge Action Networks (KANs). Knowledge Action Networks are new initiatives intended to bringing together researchers and extra-scientific actors in responding to key societal challenges (as defined in [Future Earth, 2014b](#)). A core objective of Knowledge Action Networks is to strengthen the link between scientific knowledge and societal change. Knowledge Action Networks are expected to support the production of 'actionable scientific knowledge' and 'inform solutions for global sustainability' ([Future Earth, 2016](#)), reflecting a perspective on co-production based on the logic of impact.

Thus, the principle of co-production has been made a precondition for evaluation and funding of research under the umbrella of Future Earth. Early experiences with co-production as assessment criterion expose that what co-production exactly means in this context, how it can be evaluated and by whom, is open for debate and interpretation by both the scientists submitting a proposal and the actors conducting the review and assessment. An exception is formed by Knowledge Action Networks, the new flagship initiatives of Future Earth, which display a rationale of impact in their framing and operationalisation.

#### 4.4. Formalizing structures and responsibilities

In 2015, Future Earth appointed its first Executive Director, established a permanent secretariat, and decided on the final governance structure of the programme. According to the initial design of Future Earth developed by the Transition Team, the Alliance partners were expected to hand over their role as interim-Governing Council to an independent multi-stakeholder body. Although attempts were made to establish such a multi-stakeholder body, it was eventually decided that the Alliance would continue its role as Governing Council of Future Earth.<sup>9</sup> This means that members of the Alliance form the "main decision-making body of Future Earth on all aspects of the Programme, including its strategic direction" ([Future Earth, 2013](#), p. 44). As such, the position of funding agencies and UN organisations in steering the development and future direction of scientific knowledge production is further strengthened. The Governing Council is the ultimate decision-making body of Future Earth, responsible for the programme's strategic directions and the appointment of members of the Science Committee and Engagement Committee. The Science Committee and Engagement Committee have a primarily advisory role, with some

<sup>9</sup> The Alliance was expanded with two new organizational members, the Sustainable Development Solutions Network (SDSN) and the Science and Technology in Society (STS) Forum, as well as one member of the Funders Consortium sponsoring Future Earth's secretariat.

implementing commitments.<sup>10</sup> The separate mandates of the two advisory committees have been reconfirmed in the final governance structure approved by the Governing Council. Within this formalized structure, the Science Committee advises and reports to the Governing Council on scientific matters, whereas the Engagement Committee advises on engagement, communication and fundraising strategies, and is responsible for developing a network of social partners willing to participate in the co-production of knowledge. Monitoring, supporting and evaluating research initiatives is the responsibility of the two committees together.

Thus, in this final stage of the development of Future Earth discussed here, with the Alliance partners reclaiming their central role in Future Earth as members of the Governing Council, and by formalizing the dual structure of the Science Committee and Engagement Committee (albeit in an advising role), the logics of accountability and impact are reinforced. However, it should be remembered that Future Earth is "a work in progress whose functioning and structure may evolve over time" ([Future Earth, 2013](#); p81).

#### 5. Discussion: co-producing research for global sustainability

The three logics of knowledge co-production identified in this paper represent different normative positions on the appropriate relationship between science and society and the role of extra-scientific actors in scientific knowledge production. This heterogeneous conception of knowledge co-production within Future Earth may, on the one hand, be understood as providing helpful ambiguity allowing actors with different perspectives on science and its role in society to engage in Future Earth. On the other hand, certain tensions exist between the different logics of co-production. These tensions and their 'resolution' in the institutional structure of Future Earth reflect the politics of reorienting global change research to 'research for global sustainability'.

As the above analysis has shown, tensions between logics of co-production surface at several moments in the development of Future Earth. A first set of tensions relates to the role of extra-scientific actors in (the governance of) research for global sustainability. Based on divergent objectives (see [Table 2](#)), different roles of extra-scientific actors are regarded as most desirable, ranging from a primarily advisory role towards active engagement in processes of knowledge production. These tensions shaped discussions on the appropriate governance structure of Future Earth, particularly with respect to the dual structure of the Science Committee and Engagement Committee, and the appropriate role of the Alliance partners in the governance of research through Future Earth.

A second set of tensions between logics of co-production relates to the type of extra-scientific actors perceived as most relevant and legitimate to engage with. Priorities range from engaging influential societal actors, to engaging actors that bring different knowledge and values into the process of knowledge production. This tension is important with respect to the composition of Future Earth's governance bodies, particularly the Governing Council and the Engagement Committee. Yet, it also speaks to the rules and procedures for monitoring, supporting and evaluating co-production in the research projects that operate under the umbrella of Future Earth, as these rules and procedure are meant to facilitate and encourage the engagement of extra-scientific actors in co-production of knowledge.

The current institutional structure of Future Earth is primarily

<sup>10</sup> This is different from the governance structure of the earlier global change programmes, where the Scientific Committee was the main decision-making body.

shaped by logics of accountability and impact. The importance of these logics in shaping the governance structure of Future Earth is evident in the institutionalized role of funding agencies and high-level political actors in the governance structure of Future Earth, the composition of the Engagement Committee with actors ‘that can make a difference in society’, the dual structure of Science Committee and Engagement Committee which allows for engagement of extra-scientific while safeguarding scientific autonomy, and the establishment of impact-driven Knowledge Action Networks as Future Earth’s flagship initiatives. The institutionalisation of the logics of accountability and impact in Future Earth’s institutional structure can be explained by the centrality of these logics in early stages of Future Earth’s development, when ICSU, ISSC and the Belmont Forum took a leading role. Moreover, both logics of co-production are accommodative of ideas and values of scientific independence and autonomy, thus resonating with ‘traditional’ perceptions of science and its role in society. Hence, these logics of co-production find less resistance within the scientific community, advancing their institutionalisation in Future Earth.

The logic of humility became a more central component of the discourse on co-production in Future Earth only after the initial foundations of Future Earth was established by the alliance between science councils, funding agencies and UN organisations. Although particularly the ISSC had been pointing to the value of a humble and reflexive perspective on the role of science in society in early talks on the principle of co-production, the logic of humility gained ground in the institutional process with Future Earth opening up to new actors through, for example, the establishment of the Science and Engagement Committees. The increased questioning of the institutional separation of ‘science’ and ‘engagement’ in the dual governance structure of Future Earth reflects the presence of this logic of co-production in discussions on the appropriate institutional design. Moreover, the flexibility of Future Earth’s rules and procedures accommodates co-production based on the logic of humility, although no particular mechanisms for encouraging new knowledge traditions and communities to engage in Future Earth exist at this stage. In the final design of the governance structure of Future Earth, with the formalization of the Alliance partners as Governing Council, the initial dominance of the logic of accountability and impact is reinforced. An explanation for the marginal role of the humility logic in shaping the governance structure of Future Earth could be that this logic of co-production is less accommodative of the traditional values of scientific independence and autonomy. As such, co-production based on the logic of humility is met with misunderstanding and resistance by some members of the scientific community, hindering the institutionalisation of this logic in Future Earth. Ironically, this defiance from traditional ideas about science and its role in society also makes that co-production based on a logic of humility, to flourish, requires strong institutional support.

In sum, tensions in the process of institutionalising co-production in Future Earth centre on the question who is allowed and able to shape ‘research for global sustainability’ and thus engage in “conversations about the future of Earth” (Löfbrand *et al.*, 2015; p. 216). Future Earth institutionalises the role of funding agencies, high-level policy bodies and prominent public and private sector actors in the governance of ‘research for global sustainability’. The programme’s institutional rules and procedures open up possibilities for engaging extra-scientific actors in knowledge production in various types and forms. Yet, Future Earth’s flexible rules and procedures – which allow multiple logics of co-production to co-exist – may also hold the programme from encouraging scientists to change their research practices towards a new ‘science for global sustainability’, allowing the gap between principles and practices of co-production to go unchallenged.

## 6. Conclusion

The process of designing a new research programme opens up discussions on values and beliefs which are otherwise taken for granted. This research has illustrated how the existence of multiple rationales on the principle of co-production shapes the process of institutional design, leading, in some cases, to the manifestation of tensions and intense negotiations about appropriate governance structures and institutional rules in support of ‘research for global sustainability’. A final tension which shapes the institutionalization of new modes of knowledge production in research programmes resides in the need to accommodate the diversity of values and perspectives on science and its role in society, while also encouraging and advancing a new mode of knowledge production. In navigating this tension between being inclusive and transformative, research programmes operate on a precarious balance between doing more of the same under a different name, and supporting and steering research communities towards new modes of knowledge production.

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## Appendix A. Interview respondents

Interviews were conducted between April 2014 and March 2015. All interviewees agreed to be named in this paper. Directed quotes used in the article were verified with the respective respondents. For each respondent, current (at the time of the interview) and previous positions at international programmes and organizations in global change research are provided.

1. Prof. Dr Rik Leemans. Executive Member, Transition Team for Future Earth; Former Chair, Earth System Science Partnership. Wageningen, The Netherlands, 24 April 2014

2. Dr Martin Rice. Former Executive Officer, Earth System Science Partnership (ESSP). Skype, 13 May 2014

3. Prof. Dr Sybil Seitzinger. Executive Director, International Geosphere-Biosphere Programme (IGBP); Former Member, Scientific Committee, International Geosphere-Biosphere Programme (IGBP). Skype, 19 May 2014

4. Dr Albert van Jaarsveld. Chief Executive Officer, South African National Research Foundation; Co-Chair, Belmont Forum. Skype, 29 May 2014

5. Prof. Dr Thomas Rosswall. Former Executive Director, International Council for Science (ICSU); Former Executive Director, International Geosphere-Biosphere Programme (IGBP); Former Executive Director Global Change System for Analysis, Research and Training (START). Skype, 29 May 2014

6. Prof. Dr Anne Larigauderie. Former Executive Director, DIVERSITAS. Skype, 10 June 2014

7. Prof. Dr Sander van der Leeuw. Former Member, Scientific Committee, International Human Dimensions Programme (IHDP). Utrecht, The Netherlands, 11 June 2014

8. Prof. Dr Jill Jäger. Former Executive Director, International Human Dimensions Programme (IHDP). Skype, 20 June 2014

9. Prof. Dr Oran Young. Former Chair, Scientific Committee, International Human Dimensions Programme (IHDP). Norwich, United Kingdom, 30 June 2014
10. Prof. Dr Corinne le Quééré. Member, Science Committee, Future Earth. United Kingdom, 4 July 2014
11. Prof. Dr Peter Liss. Executive Member, Transition Team for Future Earth; Former Chair, Scientific Committee, International Geosphere-Biosphere Programme (IGBP). Norwich, United Kingdom, 4 July 2014
12. Prof. Dr Will Steffen. Former Executive Director, International Geosphere-Biosphere Programme (IGBP). Skype, 22 July 2014
13. Dr Heide Hackmann. Executive Director, International Social Science Council (ISSC). Skype, 24 July 2014
14. Dr John Ingram. Former Executive Officer, Global Environmental Change and Food Systems (GECAFS) project. Skype, 14 October 2014
15. Dr Carthage Smith. Deputy-Director, International Council for Science (ICSU). Skype, 17 October 2014
16. Prof. Dr Diana Liverman. Co-Chair, Transition Team for Future Earth. Skype, 28 October 2014
17. Dr John Marks. Former Chair, International Group of Funding Agencies (IGFA); Former Executive Director, International Geosphere-Biosphere Programme (IGBP). Leiden, The Netherlands, 28 November 2014
18. Mr Farooq Ullah. Member, Engagement Committee, Future Earth. Skype, 2 March 2015

## Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.envsci.2016.03.012>.

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