Co-producing Future Earth: ambiguity and experimentation in the governance of global environmental change research

Eleanor Hadley Kershaw, MA (Cantab)

Thesis submitted to the University of Nottingham for the degree of Doctor of Philosophy

October, 2017

Abstract

The aim of this thesis is to investigate efforts to transform global environmental change research through co-design and co-production (involving non-academic actors in research governance and conduct). Social scientific work to date on this topic has largely taken an evaluative perspective, outlining challenges of and guidelines for co-production on the ground. By contrast, there is little work on how co-production is conceptualised and put into practice through (international) research governance. Yet institutions aiming to govern research are significant arbiters of meaning and power; their efforts to change research are worthy of investigation.

The thesis is based on a qualitative case study of Future Earth, a major international research initiative on global environmental change (GEC) and sustainability. Future Earth is unique in its ambition to internationally coordinate and co-design/co-produce new GEC/sustainability research at a global scale. The study is grounded in co-productionist, interpretive science and technology studies, drawing on ideas about political imaginaries of science and experimental approaches to engagement. It is based on thematic analysis of data from documents, interviews, focus groups and observation of Future Earth's emergence and development between 2010 and 2015.

The analysis suggests that visions of Future Earth were ambitious, diverse and sometimes ambiguous, evoking two potential institutional forms: a unified, cohesive 'flagship', or a 'rich tapestry' of varied initiatives. Ambiguity persisted in how co-production and related concepts were understood, with varying definitions motivated by different rationales for increased (or limited) involvement of non-academic stakeholders, from ensuring relevance to democratising expertise to preserving the objectivity or independence of science. These notions of appropriate engagement were underpinned by disparate conceptions of the value of research (as a service to society, site of democratic deliberation, or public good), reproducing (and challenging) established models of science and democracy.

The thesis argues that, from an experimental perspective, this ambiguity in visions of (co-production in) Future Earth can be seen to enable flexibility and allow differences to co-exist. This might require new, perhaps radical, thinking about how to organise, conduct and value research and its outcomes, with an increased emphasis on fostering, appreciating and productively working with diversity and institutional indeterminacy.

List of publications

Hadley Kershaw, E. (2018). Leviathan and the hybrid network: Future Earth, co-production and the experimental life of a global institution. In B. Nerlich, S. Hartley, S. Raman & A. Smith (Eds.), *Science and the politics of openness: Here be monsters*. Manchester: Manchester University Press.

Pearce, W., Grundmann, R., Hulme, M., Raman, S., Hadley Kershaw, E., & Tsouvalis, J. (2017). Beyond counting climate consensus. *Environmental Communication*, 1-8. doi: 10.1080/17524032.2017.1333965

Acknowledgements

Of course, the production of this thesis has been a process of many "co-'s", entailing countless people, institutions, resources, and more – too many to acknowledge adequately here. I am extremely grateful to all.

The research was funded by the Leverhulme Trust as part of the *Making Science Public* Research Programme (RP2011-SP-013). That backing is much appreciated.

This project would not have been possible without the support of Future Earth – sincere thanks to the committees, secretariats, and the research participants – all extremely busy and inspiring people who generously gave their time, input, and enthusiasm. It has been a great privilege to study Future Earth. Thank you.

Wholehearted thanks to my supervisors, Dr Sujatha Raman and Professor Brigitte Nerlich, who gave me this opportunity and have been unceasingly engaged, stimulating, imaginative, knowledgeable, supportive, encouraging, and present. They both have consistently gone above and beyond (even in retirement in Brigitte's case!), offering considerable expertise, insights, time, patience and kindness. I am extremely fortunate to have had the chance to work with and learn from them. Thank you both so much for everything.

Many thanks indeed to my examiners, Professor Alan Irwin and Dr Alison Mohr, for engaging so closely and enthusiastically with my work, and for providing such interesting, thought-provoking and helpful questions and suggestions for the future. It was an honour and a pleasure to be examined by you!

The Institute for Science and Society at the University of Nottingham has been a lovely home, and I've benefited a great deal from the friendships and interactions that have been nurtured within and between the PhD community, the academic staff, and the many visiting speakers and collaborators. Thank you in particular to PhD friends in A24 (past and present), who have supported and shaped me in lifelong ways.

My colleagues on the Making Science Public programme have been a source of inspiration, guidance and fun: thank you. Thanks in particular to Harinee Selvadurai for her administrative support, amiability, and excellent macaroons!

I am very grateful to the School of Sociology and Social Policy, especially Amal Treacher Kabesh and Andrew Yip for their dedication in training, developing and facilitating the PGR community, as well as the individual support they have given me (and Amal's great gluten free cakes!). Alison Haigh looked after me (and every single one of us!) administratively, practically, emotionally and nutritionally, with great empathy and warmth. Veronica Blake and Julie Bethell have offered seamless and good-natured administrative and moral support. Alison Mohr, Reiner Grundmann and Nick Stevenson have provided generous and insightful feedback on earlier drafts of chapters. Postgraduate, academic and administrative friends and colleagues across the School have given guidance, camaraderie, and encouragement. Thank you all.

I have had the good fortune to share aspects of this work at a range of conferences and seminars: thank you to all of the convenors and participants for the invitations, for listening, and for questions and feedback that have shaped this thesis in innumerable ways. Special thanks to Sheila Jasanoff, Shana Rabinowich Ashar and the Fellows of the Harvard STS Program for hosting me for five weeks in 2015, a formative experience that has been invaluable in developing the thesis. That trip was funded by the University of Nottingham Graduate School BESTS Award, for which I am very grateful.

Heartfelt thanks to my friends and family, who have helped me celebrate small successes, cheered me on, and been an infinite source of strength. I am looking forward to reciprocating every kindness. Baz and Gill have given me a world brimming with fantastic possibility and all the potions and pocket watches to find a path through it. Thank you for helping me along on this adventure (and all the others!) in so many ways. Thank you to Logan for the encouragement, jokes and happy times. Thanks to Emma, Rita, Frans and Martijn for some lovely breaks from the thesis.

Finally, thank you, Kristof, now and always. You have taken care of me and given me hope and happiness throughout. I hope I can do the same for you as we start the next chapter!

Contents

List of tables and figures

List of acronyms and abbreviations

Alliance, the: the Science and Technology Alliance for Global Sustainability

CGIAR: a global research partnership for a food-secure future

CNC-FE: Chinese National Committee for Future Earth

Co-'s: co-design, co-production and related terms (co-creation, co-delivery, co-dissemination, co-implementation, etc.)

DIVERSITAS: an international programme of biodiversity science

ESSP: Earth System Science Partnership

GEC: global environmental change

HEFCE: Higher Education Funding Council for England

ICSU: International Council for Science

(I)EC: (Interim) Engagement Committee

IGBP: International Geosphere-Biosphere Programme

IGFA: International Group of Funding Agencies for Global Change Research

IHDP: International Human Dimensions Programme on Global Environmental Change

IPBES: Intergovernmental Platform on Biodiversity and Ecosystem Services

IPCC: Intergovernmental Panel on Climate Change

ISSC: International Social Science Council

LWEC: Living with Environmental Change Programme

MSciP: Making Science Public research programme

OED: Oxford English Dictionary

RCUK: Research Councils United Kingdom

RGS: Royal Geographical Society

SDGs: Sustainable Development Goals

SC: Science Committee

STS: science and technology studies

STS Forum: Science, Technology and Society Forum

UN: United Nations

UNEP: United Nations Environment Programme

UNESCO: United Nations Educational, Scientific and Cultural Organization

UNU: United Nations University

WCRP: World Climate Research Programme

WMO: World Meteorological Organization

Chapter 1: Introduction

Co-design and co-production have increasingly been advocated as methods or frameworks for involving non-academic actors in research and governance in the UK and internationally. Proponents argue that when addressing grand challenges, such as climate change and biodiversity loss, co-produced research will better engage with societal needs and concerns. The aim of this thesis is to investigate efforts to transform global environmental change research through frameworks of co-design and co-production. The thesis is therefore situated at the intersection of two transnational developments: global environmental change on the one hand, and changing research and policy cultures on the other.

Processes of change in environments and in research and policy cultures can be considered to be occurring across multiple geographical and temporal scales and across national, political and sectoral boundaries. From the late 1980s, global warming and climate change began to be more widely discussed as global problems of science and politics requiring global solutions, against the backdrop of longstanding debates about environmental issues (Jasanoff & Martello, 2004; Jaspal & Nerlich, 2014). The transboundary nature of environmental phenomena has led to new configurations of politics and research along international lines, while research tools, concepts and representations have enabled environmental problems to be conceptualised as international and/or global (Miller & Edwards, 2001; Jasanoff & Wynne, 1998).

Some have argued that societal concern about problems such as environmental pollution and climate change has led to new ways (and sites) of producing knowledge, in which these concerns are permitted to shape research agendas and practice, increasingly outside of academic settings (Gibbons *et al.*, 1994; Nowotny *et al.*, 2001). Others have suggested that the ‘wicked’ or ‘post-normal’ nature of contemporary environmental challenges necessitates new approaches to science and politics. These problems are deemed to be ‘wicked’, as ‘they have no definitive formulation, and can be considered symptoms of yet other problems’ such that ‘a solution to one aspect of a wicked problem often reveals or creates other, even more complex, problems demanding further solutions’ (Hulme, 2009: 334); or ‘post-normal’ because both decision stakes and uncertainties are high, requiring a more pluralistic approach than Kuhnian ‘normal’ science (Funtowicz & Ravetz, 1993).

Since the 1980s and 1990s, shifts have occurred in science governance and conduct in the UK, other countries in Europe and beyond, and internationally. Concepts and approaches such as multi-, inter- and transdisciplinarity, public and stakeholder engagement in research (governance), and responsible research and innovation have been increasingly proposed by (social) scientists, research funders and policy makers. This is part of a wider trend towards initiatives of openness, transparency, accountability and participation in science and policy (Felt & Wynne, 2007; Irwin, 2006; Pallett, 2015b). These terms have gained currency in both research and broader public policy contexts, and are seen as key, in particular, to responding to grand societal challenges such as global environmental change, sustainability, health, poverty, and food security, among others.

In this context of changing research systems and increasing initiatives of open science and open policy making (in the UK and beyond), co-design and co-production have been advocated as approaches or frameworks for establishing and promoting relationships between research or policy and diverse actors, objects and concerns. The existing literature on co-production of knowledge (the involvement of non-academic actors in research) has largely taken an evaluative perspective, outlining challenges of and developing guidelines for co-production on the ground in local, national or regional contexts (e.g. Lemos & Morehouse, 2005; Bergmann *et al.*, 2012). There is also a significant body of literature on the latent processes of co-production in the sense of co-constitution of science and social order in a range of local, national and international contexts (Jasanoff, 2004c; Hilgartner *et al.*, 2015). By contrast, there is little work on how co-production is conceptualised and put into practice in and through research governance, particularly at the international level, and how this might or might not co- or re-constitute research governance itself.

This is the gap that this thesis intends to fill. It explores the adoption of co-design and co-production as principles or strategies for research governance and conduct, through a case study of Future Earth. Future Earth is particularly suited to exploring the issues indicated above for a variety of reasons. Future Earth is a major international research initiative on global environmental change (GEC) and sustainability, merging several existing international GEC research programmes into one initiative. This reorganisation is accompanied (and in part motivated) by ambitions for a 'new type of science' (Future Earth, 2014c: 5) and 'a new "social contract" between science and society' (Future Earth, 2013b: 11). To achieve these aims, Future Earth is unique in its intention to internationally coordinate and co-design/co-produce new research on GEC and sustainability at a global scale. Future Earth thus exemplifies calls for transformations in research systems, institutions, cultures, practices and knowledge-making communities, towards engagement with non-academic stakeholders. This push for change takes place in the context of Future Earth's research focus on GEC and sustainability, that is, transboundary, contested topics conceived of as global in nature and importance.

The following sections present a more detailed overview of the emergence of environmental change as a global matter of science and politics (1.1), and changes in research institutions and cultures as an emerging trend (1.2). The rationale for the research and the significance of this topic are then outlined (1.3), followed by a brief introduction to the case of Future Earth (1.4), a summary of the research questions, approach and scope (1.5), and an overview of the thesis structure (1.6).

1.1 Changing climates: environmental change as a global issue of science and politics

Environmental issues have been a matter of public concern and action since at least the 1960s, with the advent of environmental social movements within and across many nations. The centrality of science and technology in both causing environmental degradation (with unequal social impacts) and in identifying and defining these problems is apparent, for example in Rachel Carson's *Silent Spring* (1962), a biologist's critique of synthetic pesticide use in the US, widely credited for spurring the international environmental movement, in combination with other factors and catalysts (Jasanoff, 2001; McManus, 2009: 551). More than other social movements, the green movement and the politics of environmentalism have relied on scientific authority as a basis for their claims about the problems confronting society (Yearley, 1995).

Although environmental movements and environmental policies in nation states developed differently in different countries (Yearley, 1995), the convergence of a range of cultural, political and technoscientific shifts between the 1960s and the 1980s led to the emergence of an international or global environmentalism, and the conceptualisation of climate change and related environmental problems as global issues of science and politics (Jasanoff, 2001; Jasanoff & Martello, 2004; Miller & Edwards, 2001). For the most part politicians responded to this public concern with calls for more research, resulting in international efforts and investment in science, scientific monitoring and assessments (such as the establishment of the Intergovernmental Panel on Climate Change in 1988) with a view to ascertaining the best basis for policy responses to deal with ozone depletion, pollution, climate change, biodiversity loss and, more recently, extreme weather events; and the establishment of international institutions of environmental governance, such as the UN Framework Convention on Climate Change (UNFCCC) (Yearley, 2008).

While international policy and science institutions were built to address these concerns – and continue to be built, for example, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services (IPBES), established in 2012 (Turnhout *et al.*, 2012) – one of the most significant contributions of the social studies of science and technology, henceforth science and technology studies (STS), is to highlight how the political cultures and commitments of these institutions in turn shape the framings of the problems and the (type of) knowledge that is produced, therefore shaping how these phenomena are conceived and can be acted on (S. Beck *et al.*, 2017). As traced by many STS scholars (including but not limited to Miller & Edwards, 2001; Edwards, 2010; Yearley, 1996; S. Beck *et al.*, 2017), science, technology, and also political institutions thus have played a key role in articulating environmental issues and their publics as global in nature and significance.

This has entailed the globalisation – or internationalisation[1] – of research systems and agendas, whereby context specific, locally situated mechanisms of knowledge production (and knowledge itself), are standardised and harmonised in line with particular ways of defining and investigating the objects of research:

> Scientific internationalism is not simply a matter of cooperation across existing research agendas; in the context of climate change, there has been a reorientation of perspectives so as to reposition work in national investigative contexts as part of an emerging *Earth systems science*. Scientific practices in various countries are actively redesigned and linked together to define, in effect, problems and conceptual frameworks at what is construed as the international research front. Alternative concepts and approaches are thereby partially foreclosed as these alternatives also have to be marshalled and expressed at a fully international level.
>
> (Jasanoff & Wynne, 1998: 48-49; original emphasis)

The development of Earth system science therefore led to a transformation in research systems: the adoption of common approaches across disciplinary and national boundaries in order to model various "spheres" of major Earth systems, such as the atmosphere, the biosphere and the geosphere and the ways in which they interact (in which climate change is one particular phenomenon whose dynamics are to be investigated in relation to others across diverse systems, e.g. ecosystems, oceans, land use) (Jasanoff & Wynne, 1998). The multidisciplinary field of 'global environmental change' or 'global change' research also emerged in this context in the 1980s and early 1990s, aiming to examine 'anthropogenic impacts on the atmosphere, biosphere, cryosphere, hydrosphere and lithosphere', to 'describe, explain and predict these impacts at the planetary or regional scales, taking account of spatial-temporal variations and focusing on linkages between spheres', as well as investigating 'human dimensions' including responses (Castree, 2016: 329; Turner *et al.*, 1990).

[1] The distinction between globalisation and internationalisation is not always clarified in the literature. Jasanoff and Wynne (1998) use both terms – seemingly interchangeably – in relation to scientific systems, arguably with the implication that 'globalisation' refers to attempts to shift towards unitary cultures and systems through standardisation and homogenisation across – and despite – national boundaries, whereas 'internationalisation' refers to a process in which the significance of the nation state as a basic unit is preserved while activities become increasingly coordinated at a global level and communications and collaboration between states increases.

Recent policy developments have been heralded as landmarks in addressing climate change, for example, the Paris Agreement adopted by 195 parties to the UNFCCC in December 2015, which sets out a global action plan to limit global warming to below 2°C and entered into force in 2016 (European Commission, n.d.; UNFCCC, n.d.); and in linking environmental concerns with development and equity, for example in the Sustainable Development Goals adopted by the UN in 2015 (UN, n.d.). However, despite – or perhaps in part because – the discourse around these issues retains a sense of urgency and catastrophism (Hulme, 2009), there remains a perceived inertia in environmental politics and action, broadly attributed to a lack of public support for such policies and action rooted in ignorance or lack of understanding of science (Pearce *et al.*, 2017), or to a lack of power or willingness on the part of state actors given corporate interests, among other reasons.

In this context, the field of GEC research has recently seen calls for a greater influence on policy and action, driven by a concern that existing efforts to mitigate or adapt to GEC have been 'woefully inadequate' (Castree, 2016: 328). Future Earth can be seen as a significant example of this push towards solutions-oriented, policy relevant research, refocusing GEC or Earth system science towards global sustainability, in order to support timely responses to planetary change and enable 'people to thrive in sustainable and equitable world' (Future Earth, 2014c: 5). Co-production is a key aspect of this intended shift in research. The following section explores broader changes in science-society relations and the rise to prominence of co-production.

1.2 Changing science-society relations: co-production as a research and policy trend

Since the 1980s and 1990s the academic literature of research policy and STS has explored changes in research systems, institutions, cultures and practices that collectively appear to signal a new relationship between – or co-production of – science and society. The various conceptualisations of transformations in the dynamics between research and wider society include finalisation in science (Böhme *et al.*, 1983), post-normal science (Funtowicz & Ravetz, 1993), Mode 2 knowledge production (Gibbons *et al.*, 1994) and post-academic science (Ziman, 2000), among many others. While such concepts are diverse, they all describe, theorise or advocate a shift from the disciplinary organisation of research within the academy towards a greater recognition of socio-economic priorities and involvement of broader communities – particularly non-academic actors[2] – in the governance and conduct of research (or sometimes, more specifically, the natural sciences), whether at a local, national, regional or global level (Hessels & van Lente, 2008). These ideas and accounts of transformations in science-society relations are not uncontested, but some of them have also taken on a performative role, both suggesting that a new organisation of knowledge production is taking place or should take place, and simultaneously participating in its realisation (Godin, 1998).

These changes potentially challenge existing arrangements, 'calling into question the adequacy of familiar knowledge producing institutions, whether universities, government research establishments, or corporate laboratories' (Gibbons *et al.*, 1994: 1). For the most part, these ideas suggest that what were once considered to be distinct boundaries between different social institutions and actors (policy, science/research, civil society, public and private) are becoming increasingly blurred and intertwined. While STS has demonstrated that these boundaries were perhaps always permeable, contingent, contextually situated and socially constructed (Gieryn, 1995; Latour, 1987), recent years have seen shifts in the active configuration of research, politics and publics alongside changes in the perceived authority of science and the nation state. This has entailed movement towards more decentred assemblages of knowledge, politics and economics, with increased influence of the private sector, increasingly 'internationalised' or 'globalised' forms of governance – or governmentality, and increasing significance of localism (Jasanoff, 2005; Irwin & Michael, 2003; Irwin, 2016).

In response to (perceived) crises in the legitimacy of science, in the adequacy of existing governance and research arrangements, and the seemingly impenetrable complexity of challenges facing contemporary societies, there have been increasing calls within national and international research (funding) communities for multi-,

[2] Such as "users" of research, "decision makers", "policy makers", "business", "industry", "civil society", "local communities", "the public", or other "stakeholders".

inter- and transdisciplinarity, public and stakeholder engagement, and responsible research and innovation (RRI).

These initiatives can be considered to be part of a broader trend of efforts (or gestures) towards openness, transparency, accountability and public/stakeholder participation in research and broader governance and policy contexts in the UK, Europe and perhaps beyond (Felt & Wynne, 2007; Irwin, 2006; Pallett, 2015b). In the context of this trend, co-design and co-production have been advocated as research and/or governance approaches, for example, in the UK by research councils and academics (H. Campbell & Vanderhoven, 2016) and in public policy contexts (Durose & Richardson, 2015). Co-production has not only been advocated from the top down: researchers working on environment and sustainability, health, community and development studies, public policy, and the arts and humanities have adopted co-production and related approaches in projects in a range of contexts and at a range of geographical scales (Lemos & Morehouse, 2005; Wehrens, 2013; Gillard *et al.*, 2012; Beebeejaun *et al.*, 2014; Durose *et al.*, n.d.; RCUK, n.d.-a).

However, while initiatives of co-production, transdisciplinarity, engagement and RRI aim to move beyond the traditional disciplinary organisation of research and open up research and policy processes to a wider range of actors, the concepts underpinning them retain a high degree of interpretive flexibility (Ribeiro *et al.*, 2017). They also sometimes serve as 'buzzwords' that mobilise people and resources (Bensaude Vincent, 2014), or as 'boundary objects' that enable diverse parties with different perspectives to work together (Star & Griesemer, 1989). In particular, co-production and related concepts such as co-design and transdisciplinarity have various meanings in different theory and practice contexts.

In practice, broadly, co-production refers – beyond the everyday meaning of multiple financers in film, television, theatre or other arts production (OED, n.d.-a) – to the participation or collaboration of non-academic actors in research (whether defining questions, gathering or analysing data, or engagement in other aspects of the research process) (e.g. Pohl *et al.*, 2010), or the involvement of communities and/or other non-governmental actors in policy processes or public service provision (Bovaird, 2007) (Nerlich, 2015 usefully explores these two strands).

‘Co-design’ has similar meanings, sometimes with a greater focus on the earlier (design) stages of a research or policy/service provision process, but is also used in a range of other contexts, for example the collaborative design of products or built environments for user-friendliness (e.g. computer programmes, household items) and better fit with human needs and behaviours (e.g. urban development plans, architecture) (Moser, 2016).

‘Transdisciplinarity’ can mean the involvement of non-academic actors in research and/or the integration of academic and non-academic knowledge and expertise, particularly in sustainability science contexts (Popa *et al.*, 2015; Klein, 2004), but also can be understood as solutions-oriented research spanning disciplinary expertise with a view to solving societal problems (e.g. Masterman, 2017).

Further satellite concepts circulate around these terms, for example, ‘co-creation’, ‘co-dissemination’, and ‘co-delivery’, as explored in relation to public policy by Koskela-Huotari *et al.* (2013) in the brilliantly titled paper ‘Jungle of “Co”’.

Co-production is also adopted in various theoretical contexts from which some of the practice meanings above originate. For example, in governance and economics research, Elinor Ostrom used the term to describe the reliance of professional (state) service providers on the activities of service ‘users’ (Ostrom *et al.*, 1978) or ‘the process through which inputs used to produce a good or service are contributed by individuals who are not “in” the same organization’ (Ostrom, 1996: 1073), so that divides between public and private or state and civil society become blurred; this was later interpreted in more instrumental participatory terms in policy and service provision practice contexts as noted above. In STS, co-production is used by Sheila Jasanoff (2004b) and other scholars as an analytical idiom to explore the latent co-constitution of science (knowledge) and social (political) order, and the multiple descriptive and normative uses of the term in this field have been noted by Lövbrand (2011), among others.

While the language of STS and cognate fields (e.g. ‘dialogue’, ‘engagement’, ‘co-production’, ‘RRI’) is adopted in research governance, practice and broader policy contexts, the motivations for using these approaches in these contexts do not always follow the original logics espoused by scholars, and implementing the concepts can be challenging (Irwin, 2006; Stirling, 2008). The reasons for proposing and adopting these approaches to reconfiguring epistemic practices, knowledge domains, and science-society relations are as – if not more – diverse than the range of interpretations of the concepts themselves. STS researchers continue to argue for social agency, for opening up or democratising science and governance, and ensuring accountability of science/scientists and policy-makers to broader society. But they also suggest that, despite the proliferation of the language of STS, deficit and linear models persist that assume one-way relationships between experts and other stakeholders, and between knowledge and socially beneficial outcomes via policy, failing to acknowledge the uncertainties and limits of knowledge and governance (Irwin, 2006; Stirling, 2008; Jasanoff, 2003).

Overall then, for the purposes of this study, co-production has, as Jon Turney pointed out in a blog post for Future Earth, ‘a range of meanings - under two main headings, an organizational one and a more social-philosophical one’; or as Sheila Jasanoff pointed out in an interview quoted in that piece, co-production can be seen either ‘as a strategic move to get a robust result’ or as ‘something that is going on in the world, like it or not’ (Turney, 2014).

The existing academic literature in research policy studies and STS on co-production can therefore, for the most part, be separated into two strands that focus on intentional co-production and on analytical co-production. The former comprises papers by researchers doing co-production (and/or co-design, transdisciplinarity, etc.) themselves and/or studying those doing co-production, where co-design and co-production are methods or frameworks for collaboration across disciplines and sectors, involving non-academic actors in research conduct. These papers tend to focus on individual projects and organisations and/or comparisons between more than one project or organisation, usually in local, national or regional contexts, and for the most part they focus on research conduct on the ground and/or propose forward-looking frameworks for those wishing to undertake co-production (e.g. Lemos & Morehouse, 2005; Pohl *et al.*, 2010).

The latter, analytical co-production strand comprises papers by researchers employing co-production as a theoretical, conceptual or analytical idiom, tool, framework or lens to explore, characterise and describe processes of co-constitution of science/knowledge and social/political order. This strand focuses on cases of the intertwining of epistemic and political order in a range of contexts, for example, exploring how notions of objective or relevant knowledge were integral to the constitution or performance of a strengthened and integrated Europe in the case of the European Environment Agency (Waterton & Wynne, 2004).

1.3 Rationale for the thesis: the significance of international science governance and co-production

Having briefly reviewed some of the literatures on co-production in STS and cognate disciplines above, it becomes clear that there is little work on how co-production is conceptualised and put into practice in and through research governance, particularly at the international level, nor on the relationship between co-production as analytical concept and its translation into a notion or practice of knowing actors. Institutions aiming to govern research play a significant role as sites of co-production understood as the co-constitution of science/knowledge and social/political order; the latent intertwining of the epistemic (ways of knowing the world) and the normative (ways of living in it). They are therefore important creators, mediators and arbiters of meaning, action, participation, and, consequently, power.

As noted in section 1.1, the significance of international research institutions and programmes in defining, framing, and addressing environmental and sustainability issues and concerns at a global level has been explored in the STS literature, for example, through analyses of the role of iconic images (such as photographs of Earth from space) in giving rise to global environmentalist movements (Jasanoff, 2001), or of scientific and economic systems modelling in framing environmental risks (Cutcliffe, 2000: 5). On the other hand, STS has examined the internationalisation of research and political systems, arguing that the scale and complexity of phenomena such as climate change has led to the organisation of research (and politics) beyond disciplinary and national boundaries (for example, around concepts such as ‘global warming’, ‘the Earth system’, or more recently ‘the Anthropocene’) (Jasanoff & Wynne, 1998; Lövbrand *et al.*, 2015). These types of interrelations between research and society, where knowledge creates or shapes – and is shaped by – ways of living, can be considered to be constitutive or interactional co-production of science and social order, in the sense developed in STS (Jasanoff, 2004b, 2005; Hilgartner *et al.*, 2015).

International science programmes, aiming to govern and coordinate new research (and in some cases synthesise existing research) are considered to be of particular interest as sites of this type of co-production. In the international relations literature, for the most part international institutions[3] ‘are not depicted as purposive actors with an autonomy, power or culture of their own’ (Elzinga, 2001: 13635) and are ‘ordinarily seen as agents whose primary purpose is to compensate for the lack of evenness on the playing fields of multilateral action’ whose main contributions include facilitating negotiation and disseminating knowledge (Jasanoff & Wynne, 1998: 53-54).

However, according to more constructivist international relations literature, and the co-productionist STS approach, international institutions should be considered to take on a much more active role in generating knowledge and ways of living:

> They […] should be seen as additional sites for the production of new forms of knowledge, beliefs, and political action – not merely as cognitively passive agents that facilitate convergence toward some independently ordained, optimal end-point of international bargaining. [Their power] flows […] from their ability to reframe problems for collective solution, and to redefine the boundaries and parameters of relevant knowledge (and thus of imaginable policy action), and to determine the rules of participation in knowledge creation.
>
> (Jasanoff & Wynne, 1998: 54)

[3] ‘Institution’ and ‘organisation’ are often used interchangeably in the literature. In both cases I understand the term to mean an entity, structure, asssemblage or collectivity to varying extents ‘established for a particular purpose’ and to a lesser extent ‘governed by rules, with clear authority relations, a division of labour and firm boundaries’ (Bruce & Yearley, 2006: 221). Section 1.5 below discusses the boundedness (or otherwise) of institutions. I use ‘social institution’ to refer to the broader sociological concept of established aspects of society (as opposed to an institution in the sense of organisation) (J. Scott & Marshall, 2009).

This power in articulating problems, shaping (what counts as relevant) knowledge, and determining who counts as legitimate epistemic and political participants, suggests that such organisations can be considered to 'take on a life of their own':

> New actors are seen to be created, responsibilities specified, and authority delineated, defining and binding the roles of both old and new actors, giving them meaning and normative values. In this model, culture, imagery, and rhetoric are held to be forceful ingredients in the life of international organizations, especially in the way these play out their roles in constructing social worlds with a global reach […].
>
> (Elzinga, 2001: 13636)

Institutions that aim to govern research (e.g. through agenda setting, co-ordination, funding schemes, capacity building) thus have consequences for how science (and also politics) are framed, who can participate, in which ways; their cultures, imageries and rhetoric are powerful in constructing and representing social and natural worlds. Jasanoff (2004b) argues that, alongside identities, discourses and representations, institutions are one of the four most common instruments of constitutive and interactional co-production, operating at the nexus of social and natural order and stabilising what we know and how we know it:

> […] co-production could hardly be conceived in the absence of institutions, partaking of their resilience as well as their plasticity. When environmental knowledge changes, for example, new institutions emerge to provide the web of social and normative understandings within which such characterisations of nature – whether climate change, endangered elephants or agricultural science […] – can be recognised and given political effect. In other policy settings, institutions are required to interpret evidence, make law, standardise methods, disseminate knowledge or ratify new identities.
>
> (Jasanoff, 2004b: 40)

Such institutions and their initiatives of science governance (particularly those aiming to effect change in scientific cultures or systems) can be considered to be reflective, indicative, symptomatic (Irwin, 2006) and constitutive of broader trends in research, politics and science-society relations.

So how does this latent constitutive or interactional co-production relate to the intentional co-design and co-production of knowledge or policy as introduced in the previous section, in which non-academic actors are involved in research, or non-governmental actors are involved in policy and service provision? As suggested by Jason Chilvers and colleagues in a panel abstract for the Royal Geographical Society 2014 Annual International Conference: Geographies of Co-Production, the notion of co-production as collaboratively 'making things together' might be usefully informed by the 'reflexive-relational' co-production elaborated in STS:

> This drive to do 'coproduction' can eschew the alternative more reflexive-relational meaning of coproduction championed in science and technology studies (STS) and cognate disciplines, which emphasises the mutual constitution of epistemic, social and political orders and draws attention to how "the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it" (Jasanoff, 2004: 2). This perspective forces us to consider how the emergent practices, technologies and spaces for doing 'coproduction' are themselves relationally shaped by – and recursively produce/perform – forms of epistemic, social and political order.
>
> (Chilvers *et al.*, 2014)

From this perspective, as also argued by Irwin (2006), investigations into empirical examples of 'doing co-production' need not take an evaluative or dismissive stance, calling out failings against pre-determined democratic ideals, but rather could explore the ways in which co-production (and its practices, technologies, and spaces, for example) are understood, constructed, performed – and how they in turn are shaped by, shape and perform particular social orders, such as forms of democracy – in particular contexts. This is the spirit in which this thesis investigates an empirical example of co-production in the context of global environmental change and sustainability research, as further outlined below.

1.4 Co-producing Future Earth?

This thesis aims to contribute towards filling the gap in literature on how co-production is conceptualised and put into practice in and through research governance, particularly at the international level. It intends to do so by adopting an approach informed by ideas about co-constitution outlined above, in a qualitative empirical study of Future Earth, a major international research initiative on global environmental change and sustainability.

As noted in the previous section, international scientific institutions have played a key role in formulating conceptual and cognitive categories, around which particular types of research have been organised and particular framings of global problems have arisen. Between the late 1980s and 2010, the internationalisation and harmonisation of research on global environmental change and the field of Earth system science was facilitated by the international networks of four research programmes and their Earth System Science Partnership (ESSP):

- the World Climate Research Programme (WCRP);
- the International Geosphere-Biosphere Programme (IGBP);
- the International Human Dimensions Programme on Global Environmental Change Programme (IHDP); and
- DIVERSITAS, an international programme of biodiversity science.

Between 2006 and 2009 the co-sponsors of these international programmes reviewed the programmes and decided to merge them into one: Future Earth (ICSU, 2009).[4]

Future Earth is a 10-year international initiative on GEC and sustainability, announced in 2012 by an Alliance of the co-sponsors of the existing programmes (comprising international science councils, United Nations agencies and the Belmont Forum group of global change research funders) (Future Earth, n.d.-d). Features planned for the fully operational phase of Future Earth (2015 onwards) included

- producing integrated research across disciplines spanning natural and social science, the humanities and engineering;
- the co-design and co-production of research with stakeholder groups including funders, policy makers, civil society, business, and the media;
- a global scope, encompassing all regions but also “bottom up” input from the research community and beyond;
- the accelerated delivery of solutions-oriented, policy-relevant research. (Future Earth, 2013b; ICSU, n.d.)

[4] Further background on the emergence of Future Earth is provided in Chapter 4. At the time of writing (September 2017), IGBP, IHDP and DIVERSITAS have closed, while WCRP retains its status as an independent programme contributing to Future Earth (Future Earth, 2014b).

The co-design and co-production of relevant knowledge in particular were billed as 'one of the most innovative aspects' of the initiative (Future Earth, n.d.-e). Future Earth therefore exemplifies calls for transformations in research systems and knowledge-making communities towards engagement with non-academic stakeholders. Its mission as expressed today (2017) is based on the need for 'contributions from a new type of science link[ing] disciplines, knowledge systems and societal partners to support a more agile global innovation system' (Future Earth, n.d.-g).

Future Earth aims to provide a global framework for and international coordination of new research on GEC and sustainability. This is different from the large-scale synthesis of existing research in assessments undertaken by the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES); both of which have been the focus of STS literature in recent years (Hulme & Mahony, 2010; Turnhout *et al.*, 2012; Montana, 2017). Future Earth intends to feed into these assessments, as well as undertaking smaller scale ad hoc syntheses of its own (Future Earth, 2014c).

The thesis explores visions for the identity and remit of the new initiative as it emerged, and how co-design and co-production were imagined, practiced and institutionalised in this context between 2010 and early 2015. While there is a growing body of literature around Future Earth[5] (van der Hel, 2016; Lahsen, 2016; Lövbrand *et al.*, 2015; Castree, 2016; De Pryck & Wanneau, 2017) and emerging from it (Moser, 2016 among others), this literature has either focused specifically on the challenges of involving social sciences given the existing framings (Lahsen, 2016; Lövbrand *et al.*, 2015), or on the actual practice of co-design on the ground in affiliated projects (Moser, 2016). One study has explored the institutionalisation of co-production in Future Earth (van der Hel, 2016), taking a more evaluative approach to the tensions between different understandings of the concept. However, none of these studies have explored the broader implications of co-design and co-production for research governance and organisation, nor how this relates to the translation of

[5] While I have been writing the thesis and presenting initial findings at conferences and seminars, interest in this topic has been increasing. In Chapter 2, I explore in more detail how these studies overlap with and differ from mine.

co-production as an analytical STS concept into a notion or practice of knowing actors.

Aside from Future Earth, there have been few (if any) attempts to adopt co-design and co-production as principles or strategies for the governance and production of new research at global scale; Future Earth can therefore be seen as an experiment in doing so (this view on Future Earth is explored in more detail in section 1.5). Hence, Future Earth presents a unique opportunity to study this process, as well as the relationship between co-production as analytical or normative concept originating in academia (specifically STS) and its translation into a practice or policy. This study takes up this opportunity by exploring how co-design and co-production are understood, imagined, and implemented in Future Earth, including how they relate to broader questions of institutional identity and function, and to broader social and natural orders.

This interest is also fuelled by my professional experience in this context: between 2010 and 2012 I worked as a project manager for the International Social Science Council (ISSC), which was a co-sponsor of the International Human Dimensions Programme on Global Environmental Change (IHDP; one of the existing GEC programmes). During that time, the ISSC co-led (with the International Council for Science) a Visioning Process that developed the initial research agenda and proposals for Future Earth, and it also joined the Alliance that championed the development of Future Earth (and eventually formed its Governing Council). I thus participated in several activities that fed into the early development of the initiative.

Furthermore, my work contributed to the development of a GEC agenda for the social sciences, comprising a framework 'The Transformative Cornerstones of Social Science Research for Global Change' (Hackmann & St Clair, 2012), a design for a social science research funding programme that would contribute to Future Earth (the Transformations to Sustainability Programme), and the initial work towards the *World Social Science Report 2013: Changing Global Environments*. This alerted me to the changes occurring in this international context, including an increased focus on disciplinary and institutional integration and co-production with non-academic stakeholders. I also became aware of the existing knowledge hierarchies at play in these settings, where it was necessary to assert the importance of social science in addressing issues traditionally defined by the natural sciences, and where the role of the arts and humanities was often an afterthought.

With an academic background in English literature and several years' professional experience in the arts and subsequently in sustainable development, this was not a shock, but it sparked a range of questions to which I could not see easy answers. I wondered why and how certain types, forms or aspects of knowledge, research, experience and skills (for example, formally validated natural science) had come to be valued over others (for example, social science or informal experiential knowledge and expertise). How is it justifiable that a small number of people are able to determine the framing of issues that could or should be of collective or common concern, while others are unaware that these discussions are even happening? But also, what is the alternative? With increasing talk of integration and co-design/co-production, I wondered what the implications of these approaches would be for such knowledge hierarchies and power relations; how might these approaches challenge existing ideas about how to do and value research?

Even the briefest dip into the literature of STS provides answers to some of the questions above, and much of that literature can be seen to be motivated by a similar normative bent or 'democratic impulse' (Edge, 1995). However, it also reveals the complexity of contemporary knowledge politics (the naivety of the perspective above) and throws up many more difficult, recursive questions about the nature of knowledge, science and democracy. This thesis represents my initial, clumsy steps in understanding and navigating these troubling questions.

1.5 Research questions, approach and scope

Given this interest in knowledge hierarchies and the ways in which research and other types of knowledge and experience are valued (as outlined above), this thesis is conceptually grounded in co-productionist, interpretive science and technology studies, drawing on ideas about political imaginaries of science and experiments in science and democracy. The ‘experimental’ approach is outlined in more detail below.

Methodologically, the case study comprises thematic and interpretive analysis of data from documents, interviews, focus groups and participant observation in and around the emergence and development of Future Earth between 2010 and early 2015.

Using these conceptual and methodological lenses, the following aim and research questions will be addressed:

> **Thesis aim**: To investigate attempts to transform global environmental change (GEC) research systems, practices and cultures through the adoption and institutionalisation of co-design and co-production, using a major new international research initiative, Future Earth, as a case study.
>
> **Research questions**:

1. What is Future Earth? What are the visions of its identity and remit?
2. What do co-design and co-production mean in the context of Future Earth? Why are they advocated and adopted; what are the rationales underpinning these concepts?
3. Who is imagined or expected to be involved in co-design and co-production? What are the underlying models or imaginaries of science and society?
4. How are these ideas being – and how will they be – implemented in practice to govern, coordinate and conduct research?
5. So what? How can findings from this case contribute to the literatures on co-production and international research governance, on experiments in science and democracy, and what are the implications for research governance in practice?

These questions will be addressed using an approach that foregrounds experimentality, as outlined in the following section.

The 'experimental' approach

As noted above, Future Earth can be seen as an experiment in adopting co-design and co-production as principles or strategies for the governance and production of new research at global scale (and more broadly as an experiment in institutional transformation). Co-production within Future Earth can also be seen as an experiment (or series of experiments) in itself. Experimentation can therefore be seen to characterise the empirical context that is being studied.

Experimentality is also adopted in this thesis as a heuristic or analytical lens. The conceptual and analytical approach adopted in this thesis draws on previous work calling for less dismissive and evaluative accounts of experiments in science governance and public participation (Irwin, 2006; Chilvers & Kearnes, 2016a), shifting focus from whether initiatives succeed or fail against pre-determined ideals (e.g. democratic norms), but rather exploring the ways in which initiatives constitute and are constitutive of such ideals and norms. From this perspective, the actors, objects and concerns of science governance – and broader social and political orders – are emergent from science governance practice, rather than pre-existing entities.

This approach enables an analytically generous stance towards an emerging initiative such as Future Earth and co-production within it, calling attention to its generative, performative and productive capacities, exploring what co-production means and opens up in this context, rather than its impacts or whether or not it is successful in particular ways. The 'experimental' approach also emphasises the ontological variability or indeterminacy of such settings (Marres, 2012, 2013).

This analytical perspective is based on an understanding of democracy, science and their institutions as fluid, unbounded (Pallett & Chilvers, 2015), intertwined and co-produced (Jasanoff, 2004c; Pallett & Chilvers, 2015). The notion of 'ecologies of participation' usefully characterises diverse, distributed participatory experiments as co-constitutive of broader political and epistemic cultures and regimes (Chilvers & Kearnes, 2016b).

Scope and boundaries of the study

Future Earth's development was in its early stages at the time of this study: although the notion of a new, overarching framework, programme or initiative for GEC research dates back to at least 2008 (ICSU, 2009), and much activity towards its formation occurred in the intervening period, according to official Future Earth sources the initiative did not become "fully operational" until the end of 2015 when the permanent Secretariat was in place (Future Earth, n.d.-d). The data collection for this thesis for the most part took place between late 2013 and early 2015, with the bulk of the fieldwork (interviews and meeting observation/focus groups) conducted between March and July 2014 – that is, during what could be considered to be Future Earth's formative period. This provides significant advantages in terms of studying the meanings and practices of co-production (and indeed processes of co-constitution) as they emerged and before any type of (temporary) stabilisation was achieved:

> […] supranational science programs present distinctive sites for observing the coproduction of scientific and political order because their authority is still emergent and the processes through which order is being created are less thoroughly naturalized or socialized than in most national programs.
>
> (Jasanoff & Wynne, 1998: 48)

However, it also posed challenges, particularly in terms of the complexity and indeterminacy of the 'object' of study, and, concomitantly, the breadth and nature of the data collected (although, of course, this is arguably the case in any empirical research into ongoing situations or phenomena). For this reason, and owing to more mundane constraints (financial, temporal and personal capacity), the study focuses in particular on the activity and discourse around Future Earth's emergence, design and development as undertaken within and around its co-sponsoring organisations and the teams and committees working on its design, development and implementation before and during the period of study (comprising, for example, the Transition Team that designed it, the Science Committee, Interim Engagement Committee, Interim Secretariat, etc.).

For the most part, this is activity at the ‘global’ or ‘central’ level around what could, from one perspective, be considered to be the main locus of Future Earth decision making. However, it should be noted that, even during the study, Future Earth comprised much broader networks of actors, objects and practices, including (but not limited to) the existing GEC programmes and projects, new Future Earth Fast-Track Initiatives, staff of the international co-sponsors and other organisations who supported or contributed to Future Earth’s development and operations, as well as broader environmental research and policy communities, organisations and actors.

Therefore, the focus of this study is, broadly speaking, on the governance of Future Earth, and relatedly, on the governance and institutionalisation of co-production. The term ‘governance’ can be seen as problematic, given its interpretive flexibility or imprecision, the potentially limitless scope of what might be included, and its associations with obfuscation of state responsibility (via ‘globalisation’ or devolution/outsourcing to non-state or non-governmental actors) (Irwin, 2008). In this thesis, governance is used in a dual way. On the one hand, when used to refer to the institutional or organisational structure and apparatus of Future Earth, it mirrors (many of) the actors’ use of the term, to suggest the (supposed) central coordinating and decision-making authority of these structures. On the other hand, analytically I subscribe to a distributed, decentred view on governance (and indeed on science, politics and other social institutions more broadly). As outlined by Irwin (2008) in summary of STS understandings of this term, this view suggests that the development and control of science and technology includes the activities of a range of actors beyond the state (e.g. industry, scientific organisations, public and pressure groups, consumers, the market, etc.):

> “Governance” encompasses the range of organizational mechanisms, operational assumptions, modes of thought, and consequential activities involved in governing a particular area of social action— in this case, relating to the development and control of science and technology. Viewed in this way, governance is not simply about a defined set of bureaucratic and scientific institutions but also the wider activities of governing and, indeed, self-governing (Barry, 2001; Dean, 1999). The implication is that national

> governments no longer have the ability to direct society toward specific goals. Instead, they must play a part within de-centered networks and shifting assemblages of power.
>
> (Irwin, 2008: 584)

However, this is accompanied by a further point that potentially challenges the focus of this study:

> The key point about "scientific governance" therefore is that it cannot be squeezed into a single institutional or processual definition. […] the study of scientific governance is broadly concerned with the relationship between science, technology, and political power— with special emphasis on democratic engagement, the relationship between "scientific" and wider social concerns, and the resolution of political conflict and controversy.
>
> (Irwin, 2008: 584)

The risk in undertaking a single organisational 'case study' is the reification of that institution and the assumption that it forms a central, rational, bounded locus of power (Pallett & Chilvers, 2015). I have attempted to avoid this danger in my analysis by focusing on the ways in which Future Earth's identity as an institution is constructed, multiple and open to interpretation (in Chapter 4), and how co-production and governance are constructed, understood, practiced and institutionalised in and by Future Earth (in Chapters 5-7). The aim is to explore Future Earth – in its role as an international institution – as an important creator and arbiter of meaning, knowledge, participation and problem-framing (as outlined in section 1.3 above), while at the same time acknowledging that Future Earth constitutes and is constituted by wider networks, assemblages and social orders (e.g. 'ecologies of participation' (Chilvers & Kearnes, 2016a)). This is attempted by exploring how visions in Future Earth reproduce, challenge or perform existing models of science and democracy, and how particular understandings, tools or mechanisms of co-production (or participation) are adopted in this context.

1.6 Structure of the thesis

While some of the literature relevant to this thesis has been reviewed in this introduction, *Chapter 2* reviews in more detail five important strands of academic literature in which the thesis is situated and on which the analysis in the data chapters is based.

- Firstly, STS approaches to scientific governance and the social organisation of science, transformations in research systems, the performativity of these accounts, and the translation of STS ideas into science policy.
- Secondly, literature on the governance and organisation of GEC research, locating the existing GEC programmes in the global and disciplinary landscape, and reviewing existing work on Future Earth.
- Thirdly, literature on co-production, which can broadly be categorised into two strands: on the one hand, work employing co-production as an analytical idiom to signify the co-constitution of science or knowledge and social order; and on the other hand, work on co-production as a method for research design and process. This comprises studies of co-production in practice, or guidelines for future research of this type.
- Fourthly, an overview of the notion of political imaginaries of science which is key to co-production and which encapsulates the performativity of visions of science-society relations.
- Finally, literature relating to the concepts of experiment and the experimental as relevant to the study of the relationship between science, technology, democracy, publics, and environment, covering the multiple facets and uses of ‘experiment’ in the STS and related literature.

Chapter 3 discusses the research design, methods and process, beginning with an outline of the study’s epistemological grounding in co-productionist, interpretive STS, and its ‘experimental stance’. It describes the research process, including data collection and generation, ethics and access, an outline of each method adopted (document analysis, interviews, ethnographic observation and focus groups) and thematic analysis. It concludes with a reflexive consideration of the role of the researcher.

Chapters 4 to 7 address research questions 1-4 respectively, and *Chapter 8* concludes the thesis by addressing question 5.

Chapter 4 addresses the question of what Future Earth is (supposed to be) by presenting background on the emergence of Future Earth, and an analysis of its imagined identity and remit. It describes the institutional landscape and context in which efforts on the part of both funding and research communities to create a new programme aligned, and it highlights the significance of two related goals in Future Earth: integration and co-design (of both institutions and knowledge). This forms the background for a detailed thematic analysis of visions of Future Earth's institutional identity and remit, suggesting that some visions align with a 'flagship' model and others with a 'rich tapestry' model. The chapter then outlines several ambiguities, dilemmas or tensions in different visions or goals for Future Earth, some of which echo the flagship model, and others evoke the rich tapestry one.

Chapter 5 begins to explore what co-production and related concepts mean in Future Earth, and what the rationales for adopting these approaches seem to be. Given the wide range of actors involved and large scale of ambition, it is unsurprising that co-production and related terms are multiple, ambiguous and contested. The chapter argues that although the discussions and activities around co-production were messy in the sense that there was little consensus on co-production and related terms, it is possible to identify common themes and features that coalesce around particular views on what co-production is about. Three understandings of the "co-'s"[6] are outlined.

Chapter 6 explores who is supposed to be involved in co-production (and in Future Earth more broadly) according to the documents and actors leading on its development. Although involving societal stakeholders is key to all understandings of the co-'s in Future Earth, who these stakeholders might be is not always clear, and what this might mean in practice is not often expounded. This chapter presents an analysis of who is (imagined/supposed to be) involved in Future Earth, focusing on constructions of society, stakeholders, the public and other potential partners, and

[6] "Co-'s" is adopted as a catch-all term to refer to the various "co-" words in Future Earth, predominantly co-design and co-production but also related concepts such as co-delivery, co-dissemination, co-creation, co-implementation, co-intervention, etc. Sometimes these words are used interchangeably by the actors. The thesis attempts to disentangle some of these meanings.

thereby elucidating the underlying science-society imaginaries and models (e.g. of democracy) that inform the different views of co-production explored in the previous chapter.

Chapter 7 looks at how the implementation of co-production in Future Earth is imagined and undertaken. It outlines several emergent themes significant to co-production: temporality and institutional levels; organisational structure and process; principles and practice; scale and substance; and evaluation and learning. These elements comprise key questions that are (or will need to be) negotiated in the implementation of co-'s in Future Earth: when co-design/co-production might happen; in which institutional configuration; at which institutional, geographical and communicative scales and levels; and around and through which processes, principles, practices and problems. It argues that these interlinked elements are underpinned and shaped by the models of co-production identified in Chapters 5 and 6, and thus the broader tensions in Future Earth's remit identified in Chapter 4.

Chapter 8 pulls together the findings from the preceding four chapters to consider the broader implications for the existing research, and for the governance of co-production in practice. It argues that while Future Earth actors do occasionally conceptualise co-'s or Future Earth more broadly as an experiment, or experimental, this view is not always foregrounded. However, this is a potentially productive way of considering the initiative and co-production within it. From this perspective, tensions and ambiguities are not necessarily problematic, as ambiguity can make space for openness, flexibility and ontological variability. The implications of these arguments for the literature are then outlined, followed by the implications for governance and practice of co-production, and some tentative suggestions are proposed for Future Earth. The chapter concludes by acknowledging the limitations of the study and proposing avenues for future research.

Chapter 2: Literature review

To conceptualise the study of Future Earth, this chapter reviews relevant strands of the STS and broader social scientific literature relating to scientific governance and the social organisation of research (2.1); the governance and organisation of global environmental change research (2.2); co-production (2.3); political imaginaries of science (2.4); and experimentality (2.5). These literatures cover the landscape in which the thesis is situated, namely scientific governance. They also deal with the specific domain that it concerns (GEC), the specific topic of interest (co-production), and the concepts and approaches adopted in this work (co-production; political imaginaries of science; experimentality). The chapter reviews existing trends and debates, and identifies gaps in this literature, with a view to locating the contribution of this thesis.

Section **2.1** builds on the scene-setting in Chapter 1 by outlining STS approaches to scientific governance and the social organisation of science, transformations in research systems, the performativity of these accounts, and the translation of STS ideas into science policy.

Section **2.2** looks more specifically at the governance and organisation of GEC research. It builds on the literature presented in Chapter 1, locating the existing GEC programmes in the global and disciplinary landscape, and reviewing existing work on Future Earth.

Section **2.3** reviews literature on co-production, and informs the epistemological underpinnings of the research. The literature can be categorised into two strands: on the one hand, work employing co-production as an analytical idiom to signify the co-constitution of science or knowledge and social order; on the other hand, work on co-production as a method for research design and process. This comprises studies of co-production in practice and guidelines for future research of this type.

Section **2.4** outlines the notion of political imaginaries of science which is key to co-production and which encapsulates the performativity of visions of science-society relations. This concept structures the analysis presented in Chapter 6.

Finally, the analytical stance of this research foregrounds ‘experimentality’, so section **2.5** reviews literature relating to the concepts of experiment and the experimental as relevant to the study of the relationship between science, technology, democracy, publics, and environment, covering the multiple facets and uses of ‘experiment’ in the STS and related literature. This includes work on experiments as scientific methodology and instrument of democracy; on experiments in participation; on technology as social experiment; and on policy experiments and experimental governance.

Section **2.6** concludes the chapter by briefly summarising the key gaps in literature and debates to which this thesis intends to contribute.

2.1 Scientific governance, the organisation of science, and STS in policy

As introduced in Chapter 1, scientific governance and the social organisation of science – the relationship and boundaries between science and politics, and between science and its organisation and control – have been, and continue to be, core concerns of STS (Irwin, 2008; Hackett *et al.*, 2017). Whether thinking specifically about science (advice) in policy making (Jasanoff, 1990; Hilgartner, 2000; Wilsdon & Doubleday, 2013), policy for directing and regulating science and technology (Jasanoff, 2003; Stirling, 2008; Macnaghten & Chilvers, 2014; Garforth & Stöckelová, 2011), or more broadly about the relationship between science and democracy (Irwin & Michael, 2003; Latour, 2004; Jasanoff, 2004c; Brown, 2009; Hilgartner *et al.*, 2015), STS has developed a wealth of empirical investigations and conceptual contributions.

A diverse range of complementary concepts has been established to account for the socio-technical formations of knowledge and power, and the interrelations between the scientific and the political. To name just a few, such ideas include actor-network theory (Latour, 1987) and associated concepts such as sociotechnical networks (Wetmore, 2004) and ethno-epistemic assemblages (Irwin & Michael, 2003); boundary work[7] (Gieryn, 1995); epistemic cultures (Knorr Cetina, 1999); epistemic communities (Haas, 1992); civic epistemologies (Jasanoff, 2005); and the co-production of science and social order (Jasanoff, 2004c). While each of these terms does its own conceptual work, broadly they all explore the ways in which the scientific and the political (and the social and the natural, the cognitive and the material) are not essential categories, but rather are socially negotiated, contextually contingent and mutually produced through various configurations of social and natural actors (whether individuals, institutions, non-humans, artefacts, environments, etc.).

In addition to investigating these diverse relations, STS has frequently taken a particular normative angle on these issues, advocating the 'democratisation' of science, technology, expertise and their relationship to policy and governance (Liberatore & Funtowicz, 2003; Edge, 1995). This work seeks to acknowledge the limitations of technocratic, scientistic approaches to governance, and open up political and knowledge making processes to those that would not normally have access to them, and/or to a broader range of expertise (Wynne, 1996; Jasanoff, 2003; Stirling, 2008; Stilgoe *et al.*, 2014). This work has itself limitations, some of which are discussed below in section 2.5.2.

STS has also explored modes of social and epistemic organisation of science. These can be seen to span patterns of aggregation across scales (e.g. from individual researchers, teams, laboratories, disciplines, to the institution/community of science, through arrangements such as thought collectives, paradigms and big science); specialisation (e.g. in disciplines, fields and specialities with particular practices, instruments, resources, questions, and thought styles); and integration (e.g. through multi-, inter-, transdisciplinarity and synthesis towards holistic explanations) (Hackett *et al.*, 2017). The political implications of the organisation of science are apparent when considering its purpose and its relationship to other societal sectors

[7] Also the related concepts of boundary objects (Star & Griesemer, 1989) and boundary organisations (Guston, 1999).

(Hackett *et al.*, 2017), for example, in the literature on changing science-society relations (discussed in Chapter 1).

As noted in Chapter 1, since at least the 1980s, the academic literature of research policy studies and STS has considered changes in the organisation of research (or ‘research systems’), including institutional and economic configurations, the contexts and processes of knowledge practices, the types of problems considered and knowledge generated, the stakeholders involved and the dynamics between them. In addition to notions of finalisation in science, post-normal science, Mode 2 knowledge production and post-academic science (Chapter 1), other concepts aiming to characterise these changes include strategic research (Irvine & Martin, 1984), innovation systems (Edquist, 1997), academic capitalism (Slaughter & Leslie, 1997), the “Triple Helix” model of industry, university and government (Etzkowitz & Leydesdorff, 1998), and the commercialisation of university research (Jacob & Hellström, 2000). These accounts call into question notions of “pure” or “ivory tower” research through their explorations and theorisations of the increasing engagement and complex partnerships between research (or in some cases, more specifically, the natural sciences) and non-academic actors or organisations.

The New Production of Knowledge (NPK) is among the most influential of these accounts, in which Gibbons *et al.* (1994) describe a shift from autonomous, homogenous, discipline-based research systems – ‘Mode 1’ knowledge production – to an increasing prevalence of ‘Mode 2’ knowledge production. Mode 2 is heterogeneous in its participants, practices and organisations, producing knowledge in the ‘context of application’ through transdisciplinary collaborations with a much greater degree of reflexivity and social accountability, taking into account a broader range of values and interests, and utilising new forms of quality control beyond traditional academic peer review. Gibbons *et al.* (1994) explicitly frame knowledge production as a problem-solving endeavour: Mode 1 is occupied with finding solutions to intellectual, academic problems defined within a disciplinary context; Mode 2 tries to solve problems of concern to broader society. These ideas are elaborated by Nowotny *et al.* (2001) in *Re-Thinking Science*, which argues that, given contemporary conditions of uncertainty and complexity, science should be more embedded in its social contexts, leading to more ‘socially robust knowledge’.

While these concepts have been influential, they are not without critique. Hessels & van Lente (2008) suggest that in the case of NPK, this in part stems from uncertainty as to whether it should be read as a descriptive account of current transformations or a prescriptive or normative call to bring such changes about. Those that read it as a ‘descriptive theory’ suggest that ‘there is a lack of empirical evidence for the rising importance of attributes of Mode 2’ and that ‘the claims lack a theoretical underpinning and references to sociological theory’ (Hessels & van Lente, 2008: 755-6).[8] On the other hand, those that read it as a ‘normative programme’ either disagree with the supposed normative stance, or accept the normative stance whilst questioning the possibility of its implementation (Hessels & van Lente, 2008: 754).

In a review of NPK for *Social Studies of Science*, Godin (1998: 480) argues that the model ‘has all the characteristics of a performative discourse’; ‘suggesting a new organisation of knowledge and [simultaneously] participating in its realisation’ (1998: 465). Hessels & van Lente conclude that the NPK model has been ‘successful as a manifesto’: ‘with its broad scope and evocative claims it has raised considerable attention in the area of science policy’ (2008: 758). Indeed, the language of Mode 1 and Mode 2 was used in the context of the Visioning Process from which Future Earth emerged.[9] Similarly, the notion of ‘a new “social contract” between science and society’ was key to the formulation of Future Earth (Future Earth, 2013b: 11). While attributed in that context to Lubchenco (1998), this notion also evokes Gibbons’s (1999) *Nature* article ‘Science’s new social contract with society’ which outlines the ideas of NPK and *Re-Thinking Science.* (Castree (2016) describes the history of this phrase and its use in global change research in more detail.)

So, conceptualisations, descriptions or visions of (transformations in) research systems, such as NPK, inform, shape and perform research cultures, practice and

---

8 Related critiques include that these changes apply only to a particular section of science (that is, policy-related fields) and that Mode 2 does not add anything beyond earlier characterisations of shifts in science systems, such as that of “finalization” (Weingart, 1997).

9 Personal observation, 3rd Visioning Meeting, 10-11 February, 2011.

policy. More broadly, work in sociology and STS on the performativity of social science has explored the constitutive or reality-making effects of social science concepts and methods, collapsing the distinction between knowledge making practices and a reality that they reflect or represent (e.g. Law & Urry, 2004).

Focusing on scientific governance in particular, STS literature has considered ways in which STS ideas (e.g. public engagement with science, dialogue, and RRI) – many associated with the normative project of democratisation – have informed policy and practice (Irwin, 2006; Stilgoe *et al.*, 2014; de Saille, 2015b). This literature finds that while aspects of STS concepts (e.g. from 'deficit to dialogue') make their way into policy contexts, the underlying pathologies of deficit model assumptions, and technocratic, linear model notions of the relationship between science, technology and socially beneficial outcomes via policy, both remain deeply entrenched.

Others see hopeful avenues for actively influencing policy and practice and/or continuing to try (Webster, 2007; Felt *et al.*, 2013; Downey & Zuiderent-Jerak, 2017). Noting Irwin's (2006: 299) finding that science policy currently rests on 'an uneasy blend of "old" and "new" assumptions', Stilgoe (2012: 203) argues that the uncertainty resulting from the lack of clearly defined alternatives to conventional science policy assumptions 'has opened up a space in which new forms of experiment have become legitimate.' Section 2.5 further explores notions of experiment, and how they might be mobilised or investigated through research on the 'broader project of dialogic governance' (Stilgoe *et al*., 2014: 6). Section 2.4 explores one significant conceptualisation of performative ways of thinking about science and society: the notion of 'political imaginaries' of science. In the meantime, the following section reviews a select set of literature on the organisation and governance of GEC research.

2.2 The governance and organisation of global environmental change research

Having explored scientific governance in general, I now move on to consider literature on the organisation and governance of GEC research, and an emerging literature on Future Earth.

The domains of environmental change and sustainability research can be seen as exemplary in terms of the types of transformation in science-society relations discussed in the previous section and Chapter 1. Nowotny *et al.* (2001: 132-134) suggest that the environmental sciences show evidence of ‘strong contextualisation’, for example in the ‘“integration” of research and public debate’ in arenas such as international conferences on climate change and sustainability (e.g. the 1992 UN Conference on the Environment and Development and subsequent UN conferences), where ‘government scientists mingle with other policy-makers, university scientists and representatives from non-governmental organisations’. Societal concerns about environmental challenges are seen by scientists as legitimate and are therefore allowed to ‘enter into the research that is being undertaken’, ‘propel[ling] another kind of research agenda: one that seeks to integrate also the natural and social world and explore how the two might live together – sustainably’ (Nowotny *et al*., 2001: 133-134). Similarly, the notion of post-normal science was originally developed in relation to issues of environmental risk, where both uncertainty and decision stakes are high (Funtowicz & Ravetz, 1993).

As explored in Chapter 1, STS has considered the ways in which global environmental concerns, knowledge and international institutions are co-constituted (e.g. Miller & Edwards, 2001). International research organisations and programmes have played a significant role in the internationalisation or globalisation of research fields through standardisation and cognitive harmonisation. This means that locally produced, contingent scientific knowledge can be stabilised, transported and reproduced across different times and places, and hence attains a sort of ‘pragmatic universalism’ (Jasanoff & Wynne, 1998: 20). It also brings about harmonisation of ‘the ways in which the objects of research are defined, as well as the choice and detailed implementation of preferred methodologies, basic models, and concepts’ (Jasanoff & Wynne, 1998: 47).

Particularly in relation to Earth system science, international scientific organisations have played a key role in formulating conceptual and cognitive categories, around which particular types of research have been organised and particular framings of global problems have arisen. As introduced in Chapter 1, the harmonisation of the field of Earth system science and global (environmental) change research has been facilitated by the international networks of four research programmes and their Earth System Science Partnership (ESSP): the International Geosphere-Biosphere Programme (IGBP), the World Climate Research Programme (WCRP), the International Human Dimensions Programme on Global Environmental Change (IHDP), and DIVERSITAS, an international programme of biodiversity science.

Miller (2001) considers a range of international institutions, including research programmes such as the IGBP, to be ‘boundary organisations’, in that they mix elements of science and politics through processes of ‘hybrid management’, as part of a broader climate regime[10] (illustrated in Figure 1 below). As noted in Chapter 1, a broad range of literature has explored the ways in which these institutions have power in the framing of and responses to environmental and societal challenges; they are important creators of meaning and knowledge, arbiters of inclusion and deliberation, rather than simply mechanisms for knowledge dissemination, facilitators of multilateral collaboration, etc. A significant challenge faced by these institutions is the need to balance the credibility, legitimacy and relevance/salience of their knowledge and knowledge making processes, often portrayed as a trade-off between each imperative (Cash *et al.*, 2003). While this is seen as a complicated task, Miller (2007: 238) paints a hopeful picture, imagining international knowledge institutions (e.g. the IPCC, but presumably also the likes of IGBP and others) as holding the potential to be ‘proto-democratic experiments in international governance’ through their processes of setting international knowledge standards, making global kinds, and constructing new deliberative spaces (and thus also in their ability to constrain the exercise of coercive power in world affairs). However, others have argued that the democratic implications of such institutions need to be made more transparent and open to governance (S. Beck & Forsyth, 2015).

[10] Climate regime being ‘the suite of social, political, scientific, and economic networks and institutions (both formal and informal) that have emerged in response to human threats to the earth’s climate system’ (Miller, 2001: 497, note 3).

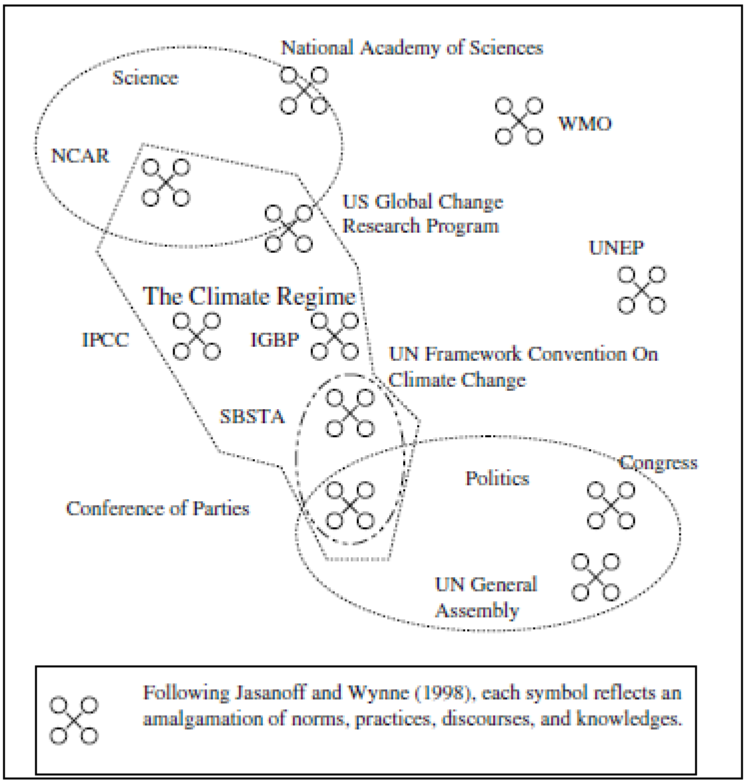


Figure 1: The institutional landscape of the climate regime[11] (Miller, 2001: 485)[12]

Others still have more specifically explored the ways in which programmes of the ESSP (particularly the IGBP and IHDP) have constituted particular problematisations of the Earth system and global change (Uhrqvist & Lövbrand, 2014; Uhrqvist, 2014; Lövbrand *et al.*, 2009).

A significant body of literature has developed around the politics of the knowledge-making processes of the IPCC, IPBES, and other international assessment institutions, which I will not explore in detail here. While many of the debates are relevant to Future Earth and its precursors, it is important to note that Future Earth faces similar but also different challenges, in that it intends to organise and co-

[11] NCAR=National Center for Atmospheric Research; WMO=World Meteorological Organization; UNEP=UN Environment Programme; IPCC= Intergovernmental Panel on Climate Change; IGBP=International Geosphere-Biosphere Programme; SBSTA=UN Framework Convention on Climate Change's Subsidiary Body for Scientific and Technological Advice.

[12] Miller, C., Science, Technology, & Human Values, Vol. 26, No. 4, Autumn 2001, pp. 478-500, copyright © 2001 by Sage Publications. Reprinted by Permission of SAGE Publications, Inc.

ordinate new research in addition to the synthesis of existing research, as typically undertaken by the assessment bodies.

Key arguments emerging from that literature (and broader literature on global environmental knowledge and governance) include a concern about ‘how the term *global* might contain assumptions about what is considered *universal*’, which social orders are enforced by global knowledge and which might be excluded (Beck & Forsyth, 2015: 113), how globalising knowledge might (through aggregation and universalism) erase peculiarities of place and context, cultural diversity and differentiation, and plural representations of Earth’s present and futures, leading to reductive conceptualisations of the ‘problem’ and the (ease of finding) potential ‘solutions’ (Hulme, 2010; Castree *et al.*, 2014).

This literature is particularly concerned with carving out adequate space for the (interpretive) social sciences and humanities to respond to the calls for increased involvement of their disciplines. However, many scholars suggest that the existing problem and knowledge framings (often universalist, reductionist and undifferentiated) are not conducive to this type of knowledge, and that ambitions towards ‘integration’ pose significant challenges, whether political or epistemological (Rayner & Malone, 1998). These concerns are raised in relation to Future Earth by scholars including Lovbrand *et al.* (2015); Lahsen (2015); Castree (2016); De Pryck and Wanneau (2017). Other work on Future Earth has primarily comprised forward looking considerations from those involved in the existing projects and programmes (e.g. Mauser *et al.*, 2013; Suni *et al.*, 2016; Leemans, 2016). Section 2.3 includes an overview of existing work on co-production in Future Earth in particular.

Further concerns in relation to these global knowledges include the excess of phenomena and elements tied into all-encompassing concepts such as ‘climate change’, ‘global environmental change’ and ‘Earth system’, and the alarmist language commonly deployed to conceive of these problems as ‘mega-challenges’ (Hulme, 2009). The semantic field has become very crowded, and in the meantime these phenomena and their associated challenges have turned into ‘wicked problems’ in that ‘they have no definitive formulation, and can be considered symptoms of yet other problems’, with the result that ‘a solution to one aspect of a wicked problem often reveals or creates other, even more complex, problems demanding further solutions’ (Hulme, 2009: 334).

Hulme, and others including Rayner (2012), suggest that the adoption of ‘clumsy solutions’ and pursuing contradictory goals are a better way of addressing ‘wicked problems’ than insisting on singular definitions (Hulme, 2009: 338). Hulme also proposes an alternative: rather than framing climate change as a problem requiring solutions, we could consider the idea of climate change as an opportunity in its capacity as an ‘imaginative resource’ and mobiliser of diverse myths (2009: 340), enabling a reflexive consideration of our ‘social goals about how and why we live on this planet’ (2009: 361).

This echoes the optimistic arguments of Jasanoff (2001) and Sarewitz (1996) around the notion of “sustainability”, whether a ‘globally articulated ethical concept’ embodied in the iconic image of the Earth seen from space (Jasanoff, 2001: 334), or ‘an alternative framework – a new mythology – for evaluating the contribution of science and technology to human development and welfare’ (Sarewitz, 1996: 194). These hopeful analyses highlight the significance and potency of collective imaginations and shared cultural meanings. However, a tension is also revealed in relation to their capacity to allow space for heterogeneity, plurality and diversity (perhaps beyond the standardised meta-narratives of economic and scientific globalisation): when these imaginations and meanings, concepts and myths themselves become articulated – and mobilised – at a global level, how can heterogeneity be maintained?

Yet, if, as argued by STS scholars including Gibbons *et al.* (1994) and Nowotny *et al.* (2001), research systems are becoming heterogeneous and science is beginning to make more space for local and contingent narratives even within international and globalised systems, perhaps there is space for the development of overarching imaginaries and myths that may still permit a multitude of meanings to flourish. How this might be achieved in practice and whether research policy and international institutions might have a role in doing so requires further investigation, building on existing explorations of these challenges and their (temporary) resolution (e.g. Montana, 2017).

2.3 Co-production: 'theory' and practice

As discussed in Chapter 1, the notion of 'co-production' and related concepts such as 'co-design' and 'transdisciplinarity' have multiple meanings in different theoretical and practice contexts. This section provides an overview of understandings of co-production in STS (touching on co-production in other fields), beginning with Jasanoff's (2004; 2005) articulation of the concept, then exploring its uses in practice.

2.3.1 Co-production of science and social order

The premise of Jasanoff's (2004a: 2) conceptualisation of co-production is that 'the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it' so that 'knowledge and its material embodiments are at once products of social work and constitutive of forms of social life.' Knowledge (science) and social orders (or worlds) are produced together. In order for a particular (aspect of) reality to be thought of, spoken about, acted on, or governed we need to have the knowledge that makes it thinkable, sayable, doable, or governable, and this knowledge – and related material artefacts – are embedded with particular normative visions of how the world 'ought to be' in addition to how it 'is'. Hence, Jasanoff argues, we need to understand how different actors make sense of and engage with apparently universal scientific/natural (e.g. the gene) and political/social entities (e.g. the state).

Pre-empting the criticism that co-production has the same unifying or totalising ambitions of natural scientific theories, Jasanoff considers it to be an idiom rather than a theory, extolling its interpretive and 'explanatory power' rather than its consistency or predictive ability (2004a: 2). Through an examination of the 'intertwining of the cognitive, material, social and normative', co-production makes sense of the complex interactions between knowledge and social order (2004a: 6). This allows STS analyses to move beyond binaries of science and politics, nature and culture, objective and subjective, that lead to social or natural determinism (including the black-boxing of concepts within social and natural science), and beyond standard linear models of the research-society interface: 'our methods of understanding and manipulating the world curve back and reorder our collective experience along unforeseen pathways' (2004b: 13). Importantly, it does not make artificial distinctions between "micro" and "macro", but rather enables the analysis of the (re)making of national or global constitutional order through localised engagements ('without [which] perpetual reperformance they might as well cease to exist') (2004b: 43). Four instruments, or pathways, of coproduction are outlined: making identities; making institutions; making discourses; making representations (Jasanoff, 2004b).

Jasanoff (2004b) traces the origins of the analytical idiom of co-production to two precursory strands in STS and broader social science literature: a *constitutive* strand and an *interactionist* strand. The former theorised how stability is created and maintained in the emergence of new socio-technical formations and systems of thought (through the translation of experiences into a "reality" that is seen as immutable); the latter strand focused on conflicts within existing socio-technical formations, asking how people organise and reorganise their ideas about reality, particularly when the accepted demarcations between what counts as nature/science or social/cultural are challenged (2004b: 18-19).

The work of Bruno Latour is cited as key within the constitutive strand – Latour (1993) being the first to introduce the term 'co-production' – although Jasanoff argues that actor-network theory's focus on the place of the non-human and material in accounts of power is at the detriment of analyses of human agency, values, beliefs, imagination, and political conflicts, failing to account for 'significant economic, technological and social disparities in the practices of world-making' (2004b: 28).

This understanding of co-production has been empirically applied to make sense of the IPCC (Miller, 2004) and the European Environment Agency (Waterton &

Wynne, 2004), among many other institutions, representations, discourses, and identities. It has taken root as a central analytical concept or ontological/ epistemological framing in STS literature and beyond, with studies across a broad range of fields adopting the term to signal processes of co-constitution, mutual production and entanglement (e.g. Cutts *et al.*, 2011; Pickersgill, 2012; Muñoz-Erickson, 2014). The extent to which all of these are true to the interpretation proposed by Jasanoff and her colleagues is questionable: it is a very useful shorthand for dynamic and processual interrelations of domains usually (traditionally) considered distinct, but the broader project of identifying the world-making/-maintaining, state-making/-maintaining, constitutional effects of co-production perhaps receives less attention in some strands of the literature.

2.3.2 Co- (joint) production of knowledge

Lövbrand (2011) distinguishes between two uses of co-production in the STS literature: the descriptive dimension of the co-production idiom (as explored in the previous section), and 'prescriptive interpretations of the term that have gained ground in the science studies literature in recent years' in which co-production becomes a 'normative framework for engaging non-scientists as active partners in the funding, making and use of such knowledge' (Lövbrand, 2011: 226-227).

Among the first (if not the first) to use the term in this way is Callon (1999). Here co-production is used to label a model of knowledge production in which lay people are actively involved in the creation of knowledge concerning them. This could be considered as a precursor to the strand of literature on co-production as active, deliberate collaboration, though it is rarely cited there. Earlier models arising in the social sciences (and other fields) that have much in common with these collaborative, normative and instrumental versions of co-production include the multiple variations of action research, originating in feminist social studies of the 1970s (Levin & Greenwood, 2011: 70), participatory methods in health, development and agricultural studies, and the project of 'engaged' or 'interactive' social science:

> a style of activity where researchers, funding agencies and "user groups" interact throughout the entire research process, including the definition of the

> research agenda, project selection, project execution and the application of research insights.
>
> (A. Scott *et al.*, 1999; quoted in Caswill & Shove, 2000: 154)

The prescriptive or normative strand of co-production in STS as identified by Lövbrand (2011) can be further divided into two types, to categorise which Lövbrand draws on Barry *et al.*'s (2008) logics of ontology and accountability. The first is interested in effecting ontological change, in that 'knowledge co-produced with non-scientists holds the promise of more open-ended and inclusive deliberations over questions of common purpose' (as well as the nature of the objects, phenomena, etc. at hand), as part of a broader reflexive and emancipatory agenda (Lövbrand, 2011: 227).

The second is utilitarian and follows a 'logic of accountability': rather than seeking to transform existing ways of thinking, it hopes to adjust research agendas to allow for a knowledge supply more appropriate to societal demand, assuming that involvement of non-academic stakeholders in research governance and practice 'will both compel scientists to justify the social benefits of their research and empower diverse publics to shape research portfolios in accordance with their needs' (Lövbrand, 2011: 227).

Lövbrand mobilises these different understandings of co-production in her examination of 'how knowledge-making practices are incorporated into European climate policy-making, and more importantly, how EU climate policy has shaped the funding, making and interpretation of useful European climate policy research' through a case study of the FP6-funded research project ADAM (Adaptation and Mitigation Strategies; Supporting European Climate Policy) (Lövbrand, 2011: 225). She finds that although the project aspired to both types of normative co-production, it could not deliver reflexive policy appraisals because the policy-framings had been so fully adopted that it was not possible to reconsider their ontological assumptions. However, the project was more successful in delivering "useful" knowledge: although the researchers had to adapt their agenda to the needs of the policy-makers, the knowledge produced contributed to the discourse of international climate policy. Lövbrand (2011: 234) argues that this latter observation reveals a process of co-production in the descriptive sense, but that the overall picture 'paints a less rosy picture' for prescriptive co-production, since the requests for outputs adhering to the policy community's interpretations of useful knowledge did not allow space for policy re-examination. Lövbrand (2011) suggests that this might have been different if the ADAM research project had taken place at an earlier point in the policy process, if a broader spectrum of actors had been involved in the research, or if the project had been more careful about its promises to deliver "useful" knowledge; perhaps in some cases "usefulness" is not an appropriate standard of success.

Other empirical papers on "co-production" tend to cite Jasanoff (2004c) while outlining the research background, but present retrospective and/or comparative analyses of local or national-level research projects involving non-academic actors – or present forward-looking frameworks or guidelines for conducting co-production – without linking the observations closely to the (descriptive) idiom of co-production as summarised above (e.g. Pohl *et al.*, 2010; Robinson & Tansey, 2006; Kemp & Rotmans, 2009; Edelenbos *et al.*, 2011; Polk, 2015). These papers consider a range of conceptual and practical issues and challenges that arise in relation to these local processes of the co-production of research (through collaboration). In a paper presenting an assessment framework for analysing the merits and limitations of co-produced projects, Hegger *et al.* (2012: 54) prefer to use the term 'joint knowledge production', meaning 'direct collaboration between scientists, policymakers and other societal actors in specific projects', arguing that 'knowledge co-production' in Jasanoff's sense is hard to discern precisely because of its indirect and latent character (woven into – and weaving – social and natural orders).

The literature on transdisciplinarity and co-design follows a very similar pattern to that of co-production, primarily either enumerating the challenges involved or providing frameworks and guidelines for those wishing to adopt such approaches (see Moser, 2016 for a useful review). These papers do not tend to foreground broader issues of knowledge politics and the relationship of these practices to scientific governance. Exceptions include Klenk and Meehan (2015) who explore the limitations and exclusions imposed by stipulating 'integration' as a necessary element of co-production, and Polk (2014) who critically interrogates the assumption that transdiciplinary, co-produced research inherently leads to beneficial social solutions and outcomes (among others such as Felt *et al.* (2016) and Daly (2016)).

Two significant publications have explored co-design and co-production in Future Earth. Firstly, van der Hel (2016) has explored the institutionalisation of co-production in Future Earth, taking an evaluative approach to the tensions between different understandings of the concept. Drawing on Barry *et al.* (2008), van der Hel identifies three distinct rationales for co-production: it is seen 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”)’ (2016: 165). As we shall see, similar (and additional) rationales were identified in the present study and will be discussed in Chapter 5.

Secondly, the contributions to the special issue of *Current Opinion in Environmental Sustainability* edited by Moser (2016) consider how co-design played out on the ground in the research projects affiliated with the Transformations to Sustainability programme, which contributes to Future Earth.

However, none of these studies have explored in detail the broader implications of co-design and co-production (and associated political imaginaries, see section 2.4 below) for research governance and organisation, nor how this relates to the translation of co-production as an analytical STS concept into a notion or practice of knowing actors.

In summary, the existing STS and science policy literature on co-production for the most part can be separated into two strands that focus respectively on analytical or descriptive co-production and on intentional co-production. The former (analytical co-production strand) comprises papers by researchers employing co-production as a theoretical, conceptual or analytical idiom, tool or framework to explore processes of co-constitution of science/knowledge and social/political order in cases in local, national, and international contexts. The latter (intentional co-production strand) comprises papers by researchers doing co-production (and/or co-design, transdisciplinarity, etc.) themselves and/or studying those doing co-production, and/or wishing to create forward-looking frameworks for co-production, where co-production means involving non-academic actors in research governance and conduct. These papers tend to focus on individual projects and organisations and/or comparisons between more than one project or organisation, usually in local, national or regional contexts, and for the most part they focus on research production rather than research governance. Few studies have examined the adoption of co-design and co-production as principles or strategies for the governance and production of new research at global scale, and the relationship between co-production as analytical concept and its translation into research policy and governance.

While co-production broadly informs the epistemological and analytical approach of this study, and also acts as the ‘object’ or subject of the research, the following section turns to a specific concept used to frame the analysis: that of political imaginaries of science.

2.4 Political imaginaries of science

The notion of ‘imaginaries’ has roots in sociology, STS, political theory, human geography and related fields, with iterations including technoscientific imaginaries (Marcus, 1994), social imaginaries (Taylor, 2004), sociotechnical imaginaries (Jasanoff & Kim, 2009), genetic or biomedical imaginaries (Franklin, 2000; Waldby, 2000), political imaginaries (Ezrahi, 2012), (institutional) imaginaries of publics (Stephens *et al.*, 2013; I. Welsh & Wynne, 2013), and spatial imaginaries (Watkins, 2015). Although diverse, these concepts broadly share two features: imaginaries are visions, myths or stories that are collectively held by social groups (whether scientific communities, whole societies, nation states or other powerful institutions such as foundations, corporations, expert bodies, professional societies, or social movements), and they are considered to be performative in that they not only conceive of these visions but also enact, enable and produce the social, technical, material and spatial relations, worlds and futures envisioned therein (whether that be particular configurations of the social and the political, the social and the technoscientific, or the social and the materio-spatial). In STS the term is considered to have particular value due to its ability to account for the visions of the social that are embedded in particular technoscientific regimes or developments (McNeil *et al.*, 2017); thus imaginaries (particularly sociotechnical imaginaries) are considered to be instruments of the co-production of science and social order (Jasanoff & Kim, 2015).

In an argument that mobilises Ezrahi's (2012) notion of 'political imaginaries' (which suggests that democracy and other political regimes must be collectively imagined and performed in order to exist), Nowotny (2014: 17) asserts that STS work on public understanding of science has failed to consider political institutions, policy-makers and politicians as part of the public sphere and thus to acknowledge and research how changes in politics and modes of governance impact on public engagement and science-society relations.

Given the power that policy-makers have to distribute or redirect funding, articulate policies, and build organisational structures and procedures, Nowotny calls for attention to be paid to the political imaginaries which shape and emerge from policy-makers' understanding of and engagement with science, in which citizens are invoked as 'ultimate and fictitious beneficiaries of all scientific and technological activities undertaken in the public and private sphere' (Nowotny, 2014: 17). According to Nowotny, such 'necessary fictions' have causative and performative power, shaping individual and collective minds and institutions.

Three such political imaginaries are outlined in Nowotny's account. The first is tied to notions of economic competitiveness, and is seen as manifest in the current fixation on short-term impact of every unit of scientific activity. Public-private partnerships pervade this imaginary, where citizens are abstract or individualised voters and consumers, beneficiaries of greater efficiency in knowledge production, maximum research impact, innovation and job creation. Any gaps between benefits and risks of technologies are plugged with promises of further innovation.

The second is a counter-imaginary – 'dear to scientists' – that sees science as 'a public good which is non-rivalrous in use' and which calls for autonomous space and funding (2014: 18). Key to this imaginary is the idea of great societal transformation brought about by unpredictable advances in science and technology, requiring the suspension of belief in immediate use, impact or returns; therefore science is incompatible with the aims of the private sector, and must take place in the public sector.

If the first imaginary is most closely associated with a neoliberal political economy, the notion of autonomy in the second perhaps reflects norms encapsulated in Polanyi's *Republic of Science* (1962), in which Polanyi compares the workings of science to economic markets, arguing that science operates best as a republic in which individual scientists all contribute to the advancement of knowledge by being free to work independently towards this shared endeavour without centralised (governmental), hierarchical coordination; in this way scientific discoveries are maximised. He argues that guiding science towards socially beneficial channels is impossible due to the unpredictability of scientific progress and the incidental nature of practical benefits. While their conception of the public interest in science is different, this imaginary is perhaps also reminiscent of Vannevar Bush's *Science: The Endless Frontier* (1945), in which Bush advocates the role of basic research, funded by the US government but independent of its political control, essential to national progress and public good (through innovations such as penicillin, radar etc., which will follow if basic research is supported).

Finally, Nowotny identifies one further political imaginary, this time within STS, motivated by a desire to pursue Enlightenment ideals through participation and inclusiveness. This imaginary comprises the aim to improve outcomes of scientific and technological activity by incorporating diverse views, but perhaps was flawed in its assumption that 'an all-inclusive participation was possible, unquestioned and unquestionable' (2014: 18) (as also argued by Raman (2015) in considering an alternative mode of inclusion). Nowotny notes that Mode 2 was informed by this imaginary rather than one rooted in neoliberal ideology.

These imaginaries entail diverse conceptualisations of the public value of science: value for individual tax payers'/consumers' money; unquantifiable, non-rivalrous public good; object – and more importantly, site – of democratic deliberation. They can also entail conceptualisations of social, geopolitical orders that may have consequences for which publics are envisaged as – and engaged with as – 'beneficiaries': for example, Nowotny contrasts science as an international public good (which could be imagined to be of benefit to all publics across national boundaries) with science as a source of national economic competitiveness (perhaps benefiting only citizens of the nation states concerned).

This conceptualisation of 'political imaginaries of science' and the three particular imaginaries outlined above are used as a heuristic to structure the analysis in Chapter 6. The following section explores another aspect of the analytical toolkit of the thesis: the notion of 'experimentality'.

2.5 Experimentality

The following sections explore the concepts of experiment and the experimental as relevant to the study of the relationship between science, technology, democracy, publics, and environment. I first briefly introduce the multiple facets and uses of 'experiment' in the STS and related literature (2.5.1), before presenting a more detailed overview of the relevant strands of the STS literature on experiments (2.5.2): experiments as scientific methodology and instrument of democracy; experiments in participation; technology as social experiment; policy experiments and experimental governance. The final section (2.5.3) focuses on key aspects and qualities of experiments, with a view to informing a notion of experiment or experimentality[13] for the purposes of this study. These themes and approaches are picked up again in Chapter 3, which outlines how the concept of experiment informs the analytical stance of the present study.

[13] 'Experimentality' here is intended in the sense of 'the quality of being experimental'(Wiktionary, n.d.-a). 'Experimentality' was the name of a year-long collaborative programme of events in 2009-2010 initiated by the University of Lancaster exploring ideas and practices of experimentation in science and technology, the arts, commerce, politics, popular culture, everyday life, and the natural world (University of Lancaster, n.d.).

2.5.1 Experiment as multifaceted concept

There has been a recent proliferation of work in STS and other fields (including human geography, environmental social science and humanities, etc.) featuring experiments or the experimental. This section introduces the multiple facets of these terms in the literature.

While the study of experiments was formative for STS as a discipline in the late 1970s and 1980s, there has been a recent increase in interest in experiments and ‘the experimental’ in STS and cognate fields, whether as an object of research, analytical lens, method and/or normative approach. This more recent work builds on the STS tradition of studying the (scientific) experiment as methodology but also as integral to democracy and political culture, first in natural science (Shapin & Schaffer, 1985; Ezrahi, 1990), subsequently in social science (Gross & Krohn, 2005) and, more recently, in more broadly conceived experiments, for example, domestic experiments in ways of living (Marres, 2012).

A growing body of work on ‘experiments in participation’ explores the relationships between science, technology, democracy and publics (also, environment, non-/more-than-humans, the material, etc.), both by studying such experiments as *‘objects’ of research*, but also by proposing or adopting experiment as a *method, resource or device* for participation or other intervention or action in (scientific) governance, public engagement in technoscience and democracy, and STS (Lezaun *et al*., 2017; Horst, 2011). In addition, the language (or ‘vocabulary’) of experiment has been increasingly used as a *heuristic, analytical or theoretical lens* to ‘account for political actions and practices’ and to explore processes of democratic ordering around public participation, social activism, public administration (Laurent, 2016: 773) and material/object-oriented participation in science and democracy (Latour, 2004; Marres, 2012, 2013).

In addition to (and in some cases informing) this work on experiments in participation, another strand of work has explored the blurring of boundaries between (particularly technological) experiment and society (Krohn & Weyer, 1994), and the ambiguity of where/when experiments end (Davies, 2010), suggesting that experimentalism is an inherent *aspect, quality or condition of contemporary societies* (U. Beck, 1992). Building on notions that the whole world has become a laboratory (U. Beck, 2009; Latour, 1998, 2004), increasing acknowledgement of the limits of technoscientific prediction and control, and awareness of the (often unevenly distributed) detrimental environmental and social impacts of human activity (more recently conceptualised in terms of the 'Anthropocene' (Lövbrand *et al.*, 2015)), experimentation has also been proposed as a *normative approach to – or mode of – governance* (of technoscience and more broadly). These approaches frequently take their inspiration from John Dewey's pragmatist political philosophy in which policy- and state-making is seen as an ongoing experimental process of trial, error and revision (and democracy as participatory) (Dewey, 1991 [1927]). This can be seen in calls for shifts from a regime of "technoscientific promises" to one of "collective experimentation", where development and governance of emerging technologies is distributed between many participants and direction is ascertained collectively in the process of development (e.g. open source software development) (Felt & Wynne, 2007; Stilgoe, 2015), or in proposals for and conduct of experimental approaches to environmental science and governance at various scales (Bulkeley & Castán Broto, 2013; Klenk & Meehan, 2015; Kivimaa *et al.*, 2017).

However, as noted by Stilgoe (2015: 41) with reference to experiments in geoengineering, the term 'experiment' itself has (the potential to) become somewhat of a buzzword used to sell new activities while not being 'completely sure about the outcome' (Stilgoe, 2015: 41). Although this suggests the term may be employed strategically to garner interest and capital without unduly raising expectations about particular results, the use of this concept by scholars of science and technology is interesting in its ambiguity (Lorimer & Driessen, 2014), ambivalence (Laurent, 2009) or multivalence (Lezaun *et al.*, 2017). Of particular interest is its flexibility to operate both (and often simultaneously) as, on the one hand, an analytical lens or object of research (i.e. studying experiments, whether framed as such by actors and/or analysts, in order to acquire knowledge about the natural and/or social world), and, on the other, as an opening, instrument or 'resource' for reflexive actors to intervene in and change the world (Lezaun *et al*., 2017: 201; Chilvers and Kearnes, 2016).

The following section will explore the STS literature on experiments in more detail, with a view to ascertaining different understandings and uses of the term.

2.5.2 Experiments in the STS literature (and beyond)

History of science and STS have considered experiments in various ways (as usefully summarised by Stilgoe (2015, ch. 2), Marres (2012, ch. 5), and Lezaun *et al.* (2017), among others). This work can be broadly categorised into four themes: 1) the emergence and significance of experiments as scientific methodology and instrument of democracy; 2) experiments in participation; 3) technology as social experiment; and 4) policy experiments and experimental governance. Each of these strands of literature is examined below.

<u>Experiments as scientific methodology and instrument of democracy</u>

The conventional understanding of a scientific experiment in the sense associated with natural science and positivist social science is as a means or method of discovering, testing and demonstrating truths or facts about the world: 'an action or operation undertaken in order to discover something unknown, to test a hypothesis, or establish or illustrate some known truth', rather than the more general understanding of 'a tentative procedure; a method, system of things, or course of action, adopted in uncertainty whether it will answer the purpose' (OED, n.d.-c). As noted by Stilgoe (2015: 42), an experiment in the formal scientific sense might involve 'the deliberate use or observation of a system in which certain things are controlled in order to measure effects.' This requires various materials and technologies of experiment, such as protocols, record keeping, equipment, artefacts and inscription devices, and relies on notions of the experimental system as bounded, ordered, secluded and subject to control (Latour, 1987; Rheinberger, 1997; Marres, 2012).

However, as noted by Lorimer and Driessen (2014: 170), the modern idea of 'Experiment' in the sense above (as a formalised part of scientific enquiry) is an (albeit strongly held) ideal, or 'a theoretical caricature; a powerful rhetorical device' that does not exist in practice. Building on Rheinberger's work on the 'experimental systems' of laboratories (1997), Lorimer and Driessen argue that 'a multitude of laboratory ethnographies have demonstrated that labs are much like field sites comprising experiments that are tentative, local and uncertain' (2013: 170).

Rheinberger's (1997) work is also useful for its conceptualisation of experiments as designed to generate surprises and to generate and detect difference rather than confirming what is known. This generative and interventionist view – along with the idea that experiments are a particular instance of formalised intervention in the world rather than (solely) representation of the world (Hacking, 1983) – is adopted and further developed in various strands of STS and environmental social science/humanities (e.g. Lane *et al.*, 2011; Chilvers & Kearnes, 2016b).

Social and historical studies of science and technology have a long tradition of exploring the role of experiments in both science and democracy. Shapin and Schaffer's (1985) canonical historical study examines the emergence and institutionalisation of experiment as the preferred means of generating scientific knowledge in the seventeenth century. Through an analysis of the disputes arising from Hobbes' scepticism (rooted in his natural philosophy) towards Boyle's experimentalism, this study provides several key insights that have been carried forward in STS work. One such is the significance of the authority or credibility of the experimenter to the establishment of the authority or credibility of (experimental) knowledge, and the role of the experiment itself in performing reliability and credibility (Dear, 2004). Experiments are not only about knowledge production. As argued by Jasanoff (2004b), Shapin and Schaffer's exploration of how this controversy over the credibility of different forms of knowledge related to the broader political conflicts of the era is a key early example of co-productionist study: it found that 'the problem of generating and protecting knowledge is a problem of politics, and, conversely, that the problem of political order always involves solutions to the problem of knowledge' (Shapin and Schaffer, 1985: 21).

Building on this aspect of Shapin and Schaffer's work, Ezrahi (1990) considers how it is possible – in the context of the rise of liberalism – to justify the rule by the few, highlighting the significance of the public experiment as a template for the development of modern liberal democracy. As Jasanoff summarises:

> Politics after the scientific revolution became, [Ezrahi] argues, an extended "experimental space", in which the modern, liberal state could use science and technology for instrumental ends to gain the assent of its witnessing ("attestive") publics.
>
> (Jasanoff, 2004: 32)

From this perspective, public experiments are 'a defining genre or literary form of public politics in liberal democracies' (Marres, 2012: 85-86), and the central role accorded to science, and particularly the empirical (for example, in notions of political transparency as suggested above, and in the preference for making decisions on the basis of facts), in contemporary Euro-American political culture can be traced back to this co-development of experimental science, political cultures, and the role of publics in relation to them.

These ideas have been taken up in co-productionist work on the relationship between science and democracy (Jasanoff, 2004c; Hilgartner *et al.*, 2015), which has recently branched into the study of public participation, whether exploring participation as co-produced, emergent and experimental (Chilvers and Kearnes, 2016; Laurent, 2016), or in efforts to foreground and conceptualise the material aspects of participation initiatives (Marres, 2012). These works draw on the earlier analyses of the enrolment of publics as witnesses of public experiments and democratic transparency (Shapin and Schaffer, 1985; Ezrahi, 1990) to explore the constitutive effects of public participation endeavours, and the relationship between the ontological, the empirical and the performative therein. The following section explores this literature on experiments in participation in more detail.

Experiments in participation

Recent STS work on the relationship between science, publics and democracy has suggested that it may be productive to consider (public) participation in science and democracy as experimental or as an experiment (Irwin, 2006; Laurent, 2011, 2016; Marres, 2012; Chilvers & Kearnes, 2016b; Lezaun *et al.*, 2017). This work adopts a broad understanding of experiment, as argued by Laurent (2016: 774), ‘not limiting it to tests of pre-given hypotheses in controlled conditions, but allowing it to apply to situations where tentative practices are undertaken before potential extension or replication’. In these contexts, the experimental implies this tentativeness and the potential for variability in outcomes of participatory interventions; ‘it is not possible to predetermine or prejudge the productions or qualities of participation’ (Chilvers and Kearnes, 2016: 37). Emphasis is shifted from ‘considering experimentation as a procedural activity in which actors take part to exploring how the condition of experimentality enables the enactment of actors and their relationships in specific ways’ (Lezaun et al., 2017: 204); participation is experimental in the sense that situations, actors, objects and issues are emergent, (re)configured and co-constituted in the process.

This approach is driven by three related arguments. First, there is a sense among some scholars that existing work on public engagement has tended to focus too heavily on (and/or over-determine) the procedural aspects of participatory activities, developing frameworks to evaluate whether such tools are democratic or not and/or to enable more democratic tools. Second, it has been argued that the democratic ideals of STS/Public Engagement with Science could perhaps be better grounded and interrogated more thoroughly. Finally, some suggest that while great effort has been invested in exploring the construction of science and technology, there is a need for a symmetrical investigation of how ‘participation’ is constructed, including how notions of democratic legitimacy emerge through participatory processes, and the significant role of the technical and material in shaping these activities. This has led to proposals for a reinvigorated study of the politics of engagement in science and democracy, and specifically the emergent and co-constitutive nature of ‘experiments’ in participation and engagement. The three aforementioned arguments (procedural focus and overdetermination; ‘ready-made’ ideals; and the need for symmetrical co-productionist accounts) are outlined in more detail below, followed by a consideration of experiment as theoretical concept and experimental traditions.

Procedural focus and overdetermination

Some scholars advocating and adopting this shift towards a symmetrical or co-productionist approach to the study of participation (e.g. Chilvers and Kearnes, 2016; Marres, 2012) have suggested that much of the literature on public engagement either adopts an evaluative stance in which engagement practices are critiqued for failing to adhere to normative ideals, such as particular notions of (deliberative) democracy, or attempts to categorise particular devices or approaches as democratic or not (e.g. Fiorino, 1990; Rowe & Frewer, 2000). Marres (2012: 130) describes this as the ‘investment of social and political theory in fixing and over-determining participation in terms of its necessary or sufficient features’, going on to suggest that indetermination (Gomart, 2002) is a valuable feature of experiments in participation (Marres, 2013: 436).

The proposal to view participation as experimental and to study such efforts in a symmetrical way dates back to at least 2006. Irwin (2006) explores the adoption of the language of STS (e.g. dialogue and transparency) in governance settings, suggesting that this ‘new’ approach to scientific governance actually replicates and blends with many of the problems of the ‘old’ model (based on the deficit theory, according to which lay ‘publics’ are empty vessels waiting to be filled with knowledge, upon receipt of which they will unquestioningly support science and technology). However, he suggests that, even if this is the case, these attempts are still significant and worthy of study ‘in an open, empirical and symmetrical fashion’, considering them ‘as social experiments in themselves’ (Irwin, 2006: 317).

Since that paper was published many studies of public participation have explored the ways in which publics and participation are imagined, convened, constituted, constructed, created, and emergent (e.g. Mohr *et al.*, 2013; Mahony *et al.*, 2010; I. Welsh & Wynne, 2013). However, Chilvers and Kearnes (2016) argue that there remains a ‘residual realist’ approach in two strands of the literature: ‘affirmative’ literature that focuses on methodologies of participation with a view to improving practice (Fiorino, 1990; Renn *et al.*, 1995; Rowe & Frewer, 2000; Fung & Wright, 2001), and ‘critical’ literature rooted in cultural theories of hegemony, focusing on the exclusive, disempowering and oppressive potential of participation (e.g. Cooke &

Kothari, 2001; Swyngedouw, 2005; Mouffe, 2005). Chilvers and Kearnes suggest that these literatures still make (realist, externalist) assumptions about the pre-existence of publics and of democracy, with the former literature subscribing to a deliberative model of democracy and the latter to an agonistic one.

The notion of democracy as 'ready-made' which, according to Chilvers and Kearnes (2016), still pervades both models, speaks to another, related critique of existing work on participation.

'Ready-made' ideals

A tension between deliberative and agonistic models within ideals of democracy in STS has been highlighted by Lövbrand *et al.* (2011). Using Felt and Wynne's (2007) European Commission report as a key illustrative example, they argue that while STS has pursued a normative commitment to deliberative democratisation of science and technology, its emphasis on diversity and dissensus is more in line with an agonistic model (rather than political theories of deliberative democracy that rest on rational communication to arrive at consensus and truths of the common good). This leads the authors to question on what basis the legitimacy of calls for deliberative democracy is established (if not on deliberative political theory, then empirically, or in another theory of democracy?).

This chimes with Marres' (2012) suggestion that STS work has 'relied on 'off-the-shelf' ideals of public participation, derived mainly from deliberative and post-Marxist political theory' (ix) and has 'tended to uphold participation and democracy as theoretical ideals, while leaving these ideals themselves relatively un-interrogated' (154) (but see Jasanoff, 2003, 2005). Both Marres' (2012) and Lövbrand *et al.*'s (2011) critiques suggest that (the basis and articulation of) normative ambitions in STS around democratisation and deliberation require further thought. Together with Chilvers and Kearnes (2016), Marres (2012) also aims to re-think the theoretical conceptualisation of democracy and participation from static and pre-determined to co-constitutive and deeply intertwined with objects, environments, science and technology, etc.

A symmetrical, co-productionist approach

Some of those using experimentality as an analytical frame are prompted by a sense that, while STS has investigated the construction of science and technology, criticised failures in science and technology to meet the standards of democracy, and called for the democratisation of science and technology, this has not been accompanied by an equivalent and simultaneous exploration of the construction of 'participation' and 'democracy' themselves. According to these scholars, STS is lacking 'a sustained attempt to utilise the tools of symmetrical and co-productionist analysis […] to understand how 'participation' itself is also actively constructed and in the making' (Chilvers and Kearnes, 2016: xiv).

To counter the residual realism described above, Chilvers and Kearnes propose the adoption of a co-productionist approach to the study of participation. Imagining engagement exercises as emergent social experiments implies that rather than (or as well as) aiming for a fixed ideal form of intervention or participation, the intervention itself is constitutive of such norms. This approach views these initiatives and their objects, publics and practices as emergent and co-produced with particular social orders and notions of democracy (including notions of democratic legitimacy): 'Questions and judgements of democratic legitimacy, in this sense, emerge within the practices and projects of democratization and participation' (25) across a range of scales, from individual experiments, through spaces and technologies of participation, to broader political and epistemic regimes and cultures.

Experiment as heuristic, analytical or theoretical concept

It is worth noting that in the work described above, 'experiments' in participation are often framed as such both by the actors involved in undertaking the intervention, and the analysts involved in studying it. For example, Laurent (2011) explores how three participatory endeavours in France were framed in the language of – and with features of – experiments by those establishing them, and Mohr (2011) further describes similar experiments in the UK.

Beyond this use of the terminology, devices, and/or technologies of experiment (whether for interventionist or analytical purposes – or both – as far as it is possible to distinguish), scholars in STS have also adopted experimentality as a theoretical concept to characterise the changing relationships between objects and actors through science and democracy. Latour (2004) conceives of 'collective experimentation' as a process by which new actors are admitted into the collective (for example, the introduction of the genome). Building on this, Marres (2012) develops a notion of 'experimental ontology', in which public demonstrations and experiments perform ontological and normative variability.

Experimental traditions

In addition to these key strands of literature, taking cue from Marres (2012), it is also worth considering certain experimental traditions, whether scientific, technical, moral, political or aesthetic. This draws attention to conceptualisations and practices of experiment beyond those associated with natural science. Examples comprise experiments in social science such as Garfinkel's (1967) 'breaching' experiments in which social conventions were intentionally violated in everyday settings in order to expose the tacit, shared norms in those contexts; and 'experiments in living' as proposed by Mill (2002 [1859]) (explored below in 'Policy experiments and experimental governance'), and carried forward by natural philosophers such as Thoreau (2008 [1854]) retreating to live alone in 'wild' or 'natural' settings in the 19th century.

Another important source or locale of experimentation is the arts. For example, the *Oxford Dictionary of Literary Terms* defines 'experimentalism' as 'the commitment to exploring new concepts and representations of the world through methods that go beyond the established conventions of literary tradition' (Oxford Dictionary of Literary Terms, 2015). These elements of novelty, creativity, and moving beyond existing frameworks, points of reference or convention often play a part in – and can usefully inform notions of – experiment as seen in and applied to other domains, for example art-science as collective experimentation and public experiment (Gabrys & Yusoff, 2012; Born & Barry, 2010).

Technology as social experiment

Another strand of literature in STS has explored technology as a social experiment. Much of this work draws on earlier social theory and STS ideas about the blurring of scientific and social spaces, the overspill of 'the laboratory' into broader society (U. Beck, 1992: 69; Krohn & Weyer, 1994), and the notion that the whole world has become a laboratory (or always was because experiments were never as bounded or controlled as the experimenters would claim) (U. Beck, 2009: 36; Latour, 1999: 43). These works suggest that risk in sociotechnical systems (such as those that comprise nuclear power plants) is impossible to determine due to the complexity of those systems. This systemic complexity (along with the interdependence of elements of the system) is a factor in the inevitability and unpredictability of 'normal accidents' (Perrow, 1984), in which the interaction of multiple failures in a sociotechnical system deemed to be "safe" leads to a catastrophic accident, such as that of Three Mile Island, Chernobyl or Fukushima.

Given this modern condition of 'existential experimentalism' (U. Beck 2009: 5) in which humankind's uncertainty and ignorance about the potential harmful impacts of new technologies is ever present (but perhaps not sufficiently acknowledged – although increasingly so in recent times), the lens of 'technology as social experiment' has been adopted by some researchers in order to shift governance and scholarly focus from risk (and associated assumptions about the possibility of prediction and control) to 'the conditions for legitimate experimentation' (Stilgoe, 2015: 45) and 'the conditions under which such experiments are morally justified' (Doorn *et al.*, 2016: 607).

Policy experiments and experimental governance

Beyond the literatures outlined above (but in many cases inspired by the conditions theorised/characterised therein), there has recently been a proliferation of literature proposing and exploring experimental approaches to policy and governance, across a range of areas, including education (Stoker & John, 2009), health and social care (Ettelt *et al.*, 2015), and – of particular interest for the purposes of this study –

environmental and sustainability governance challenges such as climate change (Kivimaa *et al.*, 2017).

The idea of thinking about policy and governance in experimental terms is not new: a tradition of policy experiments from the 1960s onwards has attempted to import the concepts and techniques of natural scientific and psychological experiments into the practice of policy making and governance in order to test, evaluate and improve policy; though the lack of control over variables has led to the framing of such efforts as 'quasi-experimental' (D. T. Campbell, 1969: 410), and their effectiveness in influencing policy direction has been questioned (D. T. Campbell, 1969; Greenberg & Robins, 1986).

In the UK this approach to policy has in recent years taken the form of increased calls for and use of randomised control trials in public policy contexts (Haynes *et al.*, 2012). This trend has faced criticism from STS and policy scholars, who argue that RCTs are often presented hegemonically as the gold standard method for generating 'neutral' and unsituated ('context free') evidence of what policy interventions work (Pearce & Raman, 2014), and that 'policy experiments [have] aimed at demonstrating the effectiveness of policies rather than investigating whether they "worked"' (Ettelt *et al.*, 2015: 294).

Beyond these conceptualisations of policy experiment that retain (at least some elements of) a scientific, positivist conceptualisation of experiment, another strand of literature has viewed society itself as an experiment, and therefore the best way to advance policy and other social action is through experimentation in the sense of trying things out and valuation in practice (Gross and Krohn, 2005; Mill, 2002 [1859]). Exploring how the work of early American sociologists of the Chicago School understood society as undergoing a process of self-experimentation in order to cope with the insecurity and uncertainty of the modern world, Gross and Krohn (2005: 79) note that this perspective is informed by 'the observation that in modern societies, social practices increasingly present themselves as experiments via a willingness to remain open to new forms of experience'. Similarly, Marres (2012) considers John Stuart Mill as the original proponent of 'experiments in living' as moral experimentation, i.e. a way of valuating different modes of living by trying them out: ‘the worth of different modes of life should be proved practically, when any one thinks fit to try them’ (Mill, 2002 (1859): 58, cited in Marres, 2012: 90).

This chimes with more recent calls for experimentation as a response to the challenges of climate change. For example, Clark (2010) argues, on the basis that predictive models may have underestimated the extremity and abruptness of future climate change (see also Wynne, 2010), we should adapt as our ancestors did through flexibility and improvisation, to avoid responding to anticipated catastrophes in catastrophic ways. This argument suggests that an experimental approach is necessary for survival; prediction and control are not adequate or even possible in ‘conditions of inherent uncertainty’. This aligns well with STS normative ambitions regarding the acknowledgement of uncertainty and pursuit of alternative modes of knowing and being beyond prediction and control (whether for survival or for less urgent but still important goals).

This understanding of experimentality is also adopted in the notion of ‘experimental goverance’ or ‘experimentalist governance’ in relation to EU (or other collaborative) decision-making under conditions of uncertainty in policy areas such as climate change, forestry and urban water management policy (e.g. Bulkeley & Castán Broto, 2012). As argued by Ettelt et al. (2015), ‘these studies approach experimentation as an issue of the power and governance structures that emerge and shift in the process of collaborative policy development’ (Ettelt et al., 2015: 294). Experimentation in the governance of climate change and other complex environmental problems is increasingly advocated and adopted (Kivimaa *et al.*, 2017), whether as a means to facilitate quick adaptive responses to surprises, the testing of competing approaches, and the building of experiential knowledge (Klenk and Meehan, 2015), or in order to ‘challenge the status quo and enable the exploration of governance innovations, technologies and services in a temporary space’, for example in the field of sustainability transitions, where experiments are ‘often seen as a way of establishing niches, i.e. fringe spaces for emerging technologies or alternatives to current methods of governance’ (Kivimaa *et al.*, 2017: 1).

Finally, building on Latour's (1998, 2004) concept of 'collective experimentation' (as mentioned above) there have been calls for collective experimentation as a mode of governance to open up deliberation around scientific and technological development to a broader range of actors, as opposed to a 'regime of technoscientific promises' (Felt & Wynne, 2007: 24). In the alternative 'regime of collective experimentation' (of which the authors see several emerging examples, such as open source software development or patient associations), experimentation is conceptualised as happening when 'situations emerge or are created which allow to try out things and to learn from them [sic]' (27). Such experimentation centres around emergent 'matters of concern', bringing together selective and concerned groups (not "the public") (sometimes working independently of each other) to achieve collective goals (Felt & Wynne, 2007: 27-28).

This normative approach to governance of science and emerging technologies has been broadly adopted by scholars working in STS and cognate fields (e.g. Pallett, 2015a; Stilgoe, 2015; Felt *et al.*, 2016), and informs more distributed notions of governance, democracy and their relation to science and technology, such as Chilvers and Kearnes (2016) 'ecologies of participation'.

2.5.3 Key aspects and qualities of experiments

From the literature reviewed above, it is clear that experiment can indeed be interpreted in a broad range of ways, incorporating a variety of concepts, actors, objects and practices. In this section I outline some of the key aspects, elements, qualities and features of experiment or experimentality for the purposes of this study.

In this context, experiment refers primarily to 'a *tentative* procedure; a method, system of things, or course of action, *adopted in uncertainty whether it will answer the purpose*', rather than 'an action or operation undertaken in order *to discover something unknown, to test a hypothesis, or establish or illustrate some known truth*' (OED, n.d.-c; my emphasis). It is perhaps usefully elaborated in relation to the concept of improvisation:

> The action or fact of doing anything spontaneously, without preparation, or on the spur of the moment; the action of responding to circumstances or making do with what is available; an instance of this. Also: the result of this; something produced or created in this manner.
>
> (OED, n.d.-d)

Responding to circumstances is the more relevant aspect of improvisation in institutional cases such as Future Earth, rather than spontaneity or lack of preparation, although responsiveness and flexibility might demand spontaneity and quick thinking particularly when circumstances have not allowed preparation.

The definition above blurs the distinction between process and result in a way that might enable a view of experimentation – and indeed of co-design and co-production – whereby the process is valuable in itself, not only in its capacity to produce results or outputs. This sits well with the constructivist lens adopted in the studies of experiments in participation outlined above, in which what might – from a realist perspective – be considered to be the pre-existing inputs of participation exercises (participants, interests, etc.) instead are seen as constructed, constituted and/or shaped by/during such experimentation, whose 'outputs' are also not fully-formed or stable, but instead contingent, emergent and changeable. Instead of a linear model with inputs, process and outputs, it is possible to reimagine such endeavours and their components as constantly 'in the making' (Chilvers and Kearnes, 2016).

The key elements of experimentality for the purposes of this study, then, might comprise: the tentative pursuit of a course of action; the ambition to learn from this endeavour (in this sense it may adopt some features of the latter OED definition – 'to discover something unknown, to test a hypothesis' (OED, n.d.-c) – for example, the use of protocols and record keeping); some element of adaptability or responsiveness to circumstances; a condition of uncertainty in the context of the experiment and/or as to its potential outcomes; a sense that some aspect of the situation or course of action is novel and/or an openness to new experience; the opportunity for ontological indeterminacy or variability (sometimes through disruption), and, linked to that, the opportunity for normative intervention and performativity/generativity.

2.6 Conclusion

Having presented an overview of the diverse literatures on scientific governance, the governance and organisation of GEC research, co-production, political imaginaries, and experimentality, I now conclude by briefly summarising the key gaps and debates the thesis aims to fill and participate in with a view to situating the contribution of the thesis.

First, the thesis contributes to literatures on the (international) governance of GEC research and intentional co-production, filling a gap on the meanings and implementation of co-production in that context, and the ways in which ideas (possibly) originating in STS are adopted and translated there.

Second, the thesis responds to Nowotny's (2014) call to consider the political imaginaries of science: it does so by exploring the political imaginaries of science shared by those responsible for governing and organising science through Future Earth.

Finally, the thesis extends the approach developed in the literature on experiments in participation. I argue that this approach could be broadened beyond 'participation' (in all its various interpretations and permutations) towards a broader range of epistemic and political activities. While Chilvers and Kearnes offer a co-productionist account of public participation linked to their ongoing work on 'Critical Public Engagement', building on the 'Public Understanding of Science' and 'Public Engagement' literatures (Pallett, 2012), this lens can also usefully be applied to other forms of engagement and science-society interaction (for example, initiatives at the science-policy interface). Indeed, the co-productionist idiom adopted by Chilvers and Kearnes was originally developed in relation to science, democracy, and broader public reason (in the sense of civic epistemologies[14] and other aspects of reasoning in, by, for, and with public(s) and/or in the name of the public good) (Jasanoff, 2004; Jasanoff, 2005; Jasanoff, 2012: 5).

[14] '[T]he social and institutional practices by which political communities construct, review, validate, and deliberate politically relevant knowledge. […] includ[ing] the styles of reasoning, modes of argumentation, standards of evidence, and norms of expertise that characterize public deliberation and political institutions.' (Miller, 2008: 1896).

The following chapter explores the ways in which these ideas, concepts and approaches are operationalised in this study through the research design and methods.

Chapter 3: Research design and methods

This chapter discusses how the approaches and ideas identified in the literatures reviewed in Chapter 2 were operationalised in the research design, methods and process. Section **3.1** begins with an overview of how the project developed, an outline of the co-productionist, interpretive epistemological underpinnings, and the experimental analytical stance. Section **3.2** describes the research process, including data collection and generation, ethics and access, and an outline of each method adopted: document analysis, interviews, ethnographic observation and focus groups. Section **3.3** concludes with a reflexive consideration of the role of the researcher. It should be noted that – as with any writing – decisions have been made about which details to foreground and which to omit.

3.1 Development and methodology of the research

The doctoral studentship and associated PhD project on which this thesis is based were part of a larger research programme funded by the Leverhulme Trust, 'Making Science Public: Challenges and Opportunities' (2012-2017), which explored the changing relationships between science, politics and publics (MSciP, n.d.).

From very early on it was clear that meanings of co-production are broad and sometimes contentious, as illustrated during a Making Science Public multidisciplinary team meeting at which each participant introduced concepts central to their interests or field. I presented Jasanoff's idiom of co-production (2004b), which led to an animated discussion on what the idiom of co-production achieves that other constructivist approaches do not (for example, avoiding the black-boxing of both natural and social concepts), how it relates to more instrumental understandings of the term, and whether, in characterising constitutive processes as 'co-' something, it might unintentionally reinforce the very dichotomies it is attempting to challenge (e.g. science and society, social and natural, epistemic and political, cognitive and material, etc.) (Nerlich, 2012). Given this focus on meaning, and the study's roots in STS, a qualitative, interpretive methodology was adopted, based on a constructivist, co-productionist epistemology.

Constructivism, originating in the sociology of knowledge, suggests that social properties and our understandings of the world (meanings and knowledge) are constructed through social interaction (Berger & Luckmann, 1967); there is no unmediated access to an essential reality, or God's eye view (Haraway, 1988). In examining how science and technology are constructed, STS has focused on the specificities of particular contexts and practices of knowledge production, showing the ways in which knowledge (and its artefacts) are shaped by the political, moral, social and institutional cultures, assumptions, and commitments of those making it, and reciprocally, how societies are shaped by and through science and technology (Jasanoff, 2004c). The field has thus predominantly used the conceptual and methodological tools of the interpretive social sciences and humanities, with their emphasis on understanding meanings as opposed to explaining causes; indeed, it is founded in the deconstruction and critique of the universalising and predictive aspirations of natural science and positivist social science (Benton & Craib, 2011).

As Sismondo (2010: 200) suggests, 'much of the success of the field [of STS] has stemmed from an insistent localism and materialism, seeing macro-level structures as constituted by and having their effects in micro-level actions'. For this reason, case studies are central to STS, to the extent that (at least in 2007) 'the guidelines to reviewers provided by *Science, Technology, & Human Values,* […] more or less imply that case studies are the expected form of contribution' (Wyatt & Balmer, 2007: 626, footnote 2).

While there is no single definition of 'case study' (Flyvbjerg, 2011) and research across a range of traditions (including positivism (Yin, 2009)) adopts some version of this method, the possibility for 'more detail, richness, completeness, and variance – that is, depth' (Flyvbjerg, 2011: 301) afforded by a focused study of one particular 'unit' or context (or comparison between several 'units' or contexts) seems particularly suited to a constructivist epistemology, given its emphasis on the contextually situated, socially constructed nature of meaning and knowledge. As argued by Beaulieu *et al.* (2007), case studies have been particularly useful to STS in illustrating the diversity and disunity of science and technology, thereby 'de-essentialis[ing]' them (675).

However, the prevalence of case studies in STS has also been seen as problematic, linked to a broader issue of a perceived gap in STS scholarship between grand theories (e.g. ANT or social construction of technology – to the extent that they can be characterised as theories) and detailed, descriptive case studies, sometimes prompting difficult questions about what such case studies can contribute to the progression of STS knowledge (Wyatt & Balmer, 2007). Adopting a case study approach entails (epistemological and therefore also political) decisions and claims about what the subject of a particular study is a case *of*, and where the boundary lies between case and context (Flyvbjerg, 2011: 301) or between 'action (to be analyzed) and scenery (to be black-boxed)' (Wyatt & Balmer, 2007: 623). As I have already discussed in Chapter 1 (section 5), all research places artificial boundaries around its subject of study; I have attempted to account for (some of) the ways I have done that in this study there.

Related to the question of 'a case of what?', case studies raise the problem of the extent to which they are generalisable. In some ways, Future Earth could be seen to be an 'extreme/unique' (Yin, 2009: 47) or 'intrinsic' (Stake, 1995: 3) case, in that it is unlike any preceding initiative, and it is of interest in itself without the need to generalise to other cases: it is the first international initiative to attempt the explicit institutionalisation of co-design and co-production of GEC research (at least as far as I am aware). However, antithetically, it could also be seen as an 'exemplifying' case (Bryman, 2012: 70), in that it calls for changes in research cultures, practices and communities, and increased impact, so could be seen to be emblematic of broader efforts or gestures towards open science and open policymaking, increased policy-relevance and solutions-orientation. Following Irwin (2006), I would suggest that Future Earth's efforts are 'symptomatic' of broader science-society relations, and in line with an STS epistemology/ontology, I would argue that they are also constitutive of them. Therefore, this study aims to explore Future Earth's constitutive and generative effects in relation to broader epistemic and political regimes or cultures. It thus can potentially tell us something about broader trends and other initiatives that might share some similar features; however, any such claims should be couched in acknowledgement of the significance of context-specificity and contingency.

Qualitative research is broadly associated with constructivist and interpretive traditions and could be considered to be the most appropriate method for considering questions of meaning and process, given the richness and detail of data it provides and generates (Bryman, 2012). Qualitative analysis can be seen to bring together and constitute multiple perspectives and meanings, considering actors' meanings – and meanings co-produced between researcher and actors – through the lens of the concepts and theories used to shape the study. Rather than adhering to the positivist norms and criteria of objectivity, replicability, generalisability, and validity, its quality or credibility can be considered in relation to characteristics such as trustworthiness, authenticity, reflexivity, transparency, and participant validation (Bryman, 2012; Denzin & Lincoln, 2018). This chapter aims to meet some of these criteria (and demonstrate how others were met) by accounting for the research process, including key details on what was done and reflections on the role of the researcher.

3.1.1 Analytical stance

Building on the STS literature on experimentality reviewed in Chapter 2, I now turn to how this concept informs the analytical stance of the present study. Studying an emerging initiative such as Future Earth poses a range of challenges, amongst which balancing a critical outlook with humility and generosity towards the actors, organisation and work studied, is of particular importance. As explored in Chapter 2 Chilvers and Kearnes (2016), and, before them, Irwin (2006), argue that it is necessary to move beyond the evaluative approach of some STS work on participation initiatives (e.g. Fiorino, 1990; Rowe & Frewer, 2000), and the associated idea that public participation practices can and should be judged against pre-established democratic norms and ideals (Chilvers & Kearnes, 2016). Instead, such initiatives can be viewed as emergent, open-ended social experiments. This shifts the question from 'is this democratic?' to 'what notions or forms of democracy are enacted here?'. Similarly, rather than asking 'is Future Earth co-producing?' or ‘has Future Earth succeeded in co-producing?’, the question is ‘what does co-production mean in this context?’.

In forgoing the presumption that a central, coordinating agency (the state or institutions such as Future Earth) is the (only) locus of power and capability (Chilvers & Kearnes 2016: 34; Irwin, 2008), what might otherwise be considered to be institutional, collective or individual failings against a pre-ordained ideal interaction or activity can be (re-)interpreted as negotiations with more readily acknowledged challenges, constraints and conditions forming part of an assemblage in which particular forms and visions of democracy – and science – are enacted. What might – from a realist perspective – be considered to be the pre-existing inputs of participation and governance exercises (participants, interests, etc.) instead are seen as constructed and/or shaped by/during such experimentation – and they in turn shape the governance or participation experiment.

Chilvers and Kearnes’ (2016) co-productionist approach to understanding public participation suggests that actors, objects/issues of concern, practices, and broader social/political orders – including democratic (or other) norms – are co-constituted emergent aspects, properties and/or qualities of ongoing interactions, configurations and collectives. In their view, such interactions might include routine and institutionalised participation practices, as well as more organic, ad hoc, and ephemeral forms of engagement and ‘entanglement’. This lens can also usefully be applied to the form of science-society engagement represented by Future Earth.

Future Earth may not strictly be an experiment in ‘public participation’ in the sense implied by Chilvers and Kearnes (2016), Laurent (2016), or Irwin (2006; 2013) – in that it does not explicitly intend to engage ‘the public’ and is not directly an instrument of (particular) nation state(s) or their mechanisms for framing, mediating and governing public issues. However, it is perhaps all the more interesting for this: convened by the ‘scientific community’ and science funders and policy makers at the international level, it represents an attempt to effect change in existing social and epistemic orders of science at multiple scales, whether through participatory means or in other ways.

The approach taken in this thesis thus aims to a) explore how Future Earth and/or co-production in Future Earth are framed by those involved as (an) experiment(s), b) view Future Earth through the analytical lens of 'experimentality' to consider the ways in which Future Earth is ontologically variable and generative; for example, by exploring how 'co-production', 'participation', 'democracy' and Future Earth itself are constructed and emerge from (experimental) activities and discourse around (what some label as) Future Earth. This second step potentially opens the path for c), a normative or interventionist re-thinking or 're-making' of Future Earth and its concepts (or an opening for others to do this) (Chilvers & Kearnes, 2016).

3.2 Research design and process

Having explored the broad project development and methodological, epistemological and analytical stance of the work, I now move on to discuss specific decisions about the research design and execution and an account of how the research was undertaken.

3.2.1 Data collection and generation

While the decision to use qualitative methods was in some ways pre-determined by the type of questions and issues I was interested in and the field of study in which I intended to situate myself and my work (STS), the range of particular methods was more open. The existing STS literature on co-production and international governance of research tends to (chronologically) trace the development of particular institutions, programmes, projects, or processes through a combination of qualitative research methods, including document analysis, interviews with key stakeholders, and ethnographic observation of meetings and events (or participant observation and reflexive auto-analysis in the case of research projects employing joint knowledge production in which the author(s) was/were directly involved) (e.g. Pohl *et al.*, 2010; Lövbrand, 2011; Robinson & Tansey, 2006). For example, Granjou e*t al.* argue that:

> retracing the different projects and hopes in which the institutionalisation process is anchored at its early stage can enable us not to be fooled by the

> mainstream narrative which is being constructed by leading actors and could quickly become the sole official foundation narrative of this institution.
>
> (Granjou *et al.*, 2013: 23)

Although this highlights the significance of gathering various perspectives before official narratives have stabilised, it perhaps also makes an unfounded assumption that there will in fact be one overarching official narrative at some stage in the institution's emergence. However, it does prompt a consideration of the best sources of official and unofficial discourses, and the rhetorical work they may intend to perform.

For example, Shove and Rip (2000) turn to four sources to ascertain how "users" of research are rhetorically or symbolically constructed and how research "use" works in practice. They analyse the "official" narratives of ESRC annual reports, the (less official) descriptions of potential research users and use in research funding applications submitted to ESRC calls for proposals, and material generated from interviews with supposed research "users" and with researchers on their experience of research "use". A key point to arise from this analysis (which is not fully addressed in the article) is what type of access to "practice", actual use, or "reality", interviews can give. While Shove and Rip (2000) acknowledge the rhetorical work undertaken by the ESRC documents and application forms, they take a less nuanced approach to the interview material, seemingly assuming that the accounts relayed during interview offer a straightforward or direct representation of actual research use.

Hammersley (1992: 53) suggests that there are two sorts of interest we can take in interview accounts: on the one hand we can treat them as social phenomena that we are seeking to explain and/or as an indication of the cultural perspectives of those producing them. On the other hand, we can see them as a source of information about phenomena to which they refer. Although I do not believe that interviews can offer unproblematic access to actual practice or a "reality" exterior to the conversation, according to a constructivist epistemology interviews allow narratives, meanings and representations to be jointly produced – or co-produced – between the interviewer (researcher) and interviewee (participant) (Harding, 2006). The meanings co-produced can be considered to be relational and constitutive of reality/ies (Denzin, 2001).

Finally, ethnographic (participant) observation equally does not provide unproblematic access to the “reality” of research and research policy practices, given the subjective and situated nature of observation, and the ethical issues that can arise (see below for a consideration of ethics across the research methods in this project). However, given that this is the case for all methods, observation offers some advantages, such as the possibility of gaining valuable insights into interactions, negotiations and processes unavailable through other methods (Bryman, 2012).

Given these considerations, the decision was made to analyse publicly available Future Earth documents (web pages, reports, etc.), particularly to learn about ‘official’ meanings. Documents internal to the organisation would be analysed if access could be obtained. Secondly, I would try to undertake interviews with key Future Earth actors, adopting a dual approach to the interview data generated: firstly analysing how the interviewees use and construct significant concepts such as co-production, given that this talk is constitutive or performative; secondly using the interviews as one source of information about (the implementation of) Future Earth, given that the interviewees may produce relational interpretations or representations of practice. Finally, in order to gain an insight into the challenges and opportunities encountered during the establishment of Future Earth, the observation of negotiations during committee and other agenda-setting meetings could provide invaluable insights about processes or discussion of co-production unavailable through other methods.

3.2.2 Ethics and access

The research was approved by the Research Ethics Officer of the School of Sociology and Social Policy, University of Nottingham. Key considerations within the framework of the formal ethics approval process comprised:

- ensuring that interview participants would receive full information on the project (via an information sheet; see Appendix 2) and give their informed consent to participate (see consent form in Appendix 3), including the option to withdraw at any stage of the research;

- ensuring that participants in any meetings observed would be aware of my presence and have access to further details of the study via an information sheet circulated in advance, and that, at the time of observation, I would be introduced or my presence would be made known by the meeting chair(s);
- protecting the anonymity of interview participants to the extent that is possible given that some occupy unique positions within the initiative.

In relation to this last point, the ethics framework and consent form of the School adopts an ‘anonymity by default’ position (Saunders *et al.*, 2014: 618), in line with the majority of national ethical guidelines for social research (e.g. Social Research Foundation, 2003; British Sociological Association, 2002). However, the ability to truly guarantee anonymity, particularly between ‘insiders’ of a particular group or organisation, has been questioned (Tolich, 2004). Therefore, the standard consent form template provided by the School was adapted (Appendix 3) to note that every effort would be made to maximise the anonymity of participants, but that in some cases the participant may be identifiable to Future Earth colleagues (or others) from the use of quotes or descriptors in publications or reports. This was discussed with all research participants, none of whom expressed concern about being identified, and many of whom suggested that they would be happy to be identified by name. For consistency, I have attempted to anonymise all participants as far as possible, as further discussed below.

Efforts towards anonymisation tread a line between the imperative to protect participants’ identities to avoid intrusion and harm, while maintaining the richness and integrity of the data (provided by contextual details, for example) (Saunders *et al.*, 2014). In this case, anonymising the data has led to the loss of some analytically significant details (e.g. as indicated in footnote 45, p. 237). In retrospect, I would have taken a more flexible approach to anonymisation, offering anonymity as an option rather than as the default position (The Research Ethics Guidebook, n.d.). Participants may have felt less free to openly discuss politically sensitive aspects of Future Earth’s development, but as this was not the major focus of the research, this would have been unlikely to significantly influence the quality of the data. Since ‘elite’ research actors (those in senior, expert and influential positions) are for the most part very familiar with (social) research processes and ethics protocols, the chances of harm as a result of identification could be seen to be minimal (Future Earth as an initiative or institution could be considered to be more at stake than the individuals involved). However, power and vulnerability of research participants, including so-called ‘elite’ actors, is fluid, dynamic and relational, therefore any approach taken would need to engage in ongoing reflexivity and sensitivity (Lancaster, 2017).

My existing contacts were key to facilitating access, (I believe) lending me legitimacy with other actors involved, and offering advice on the best approach. Having provided a document outlining my proposed project to the Future Earth Executive Group (EG) (comprising the Chair and Co-Vice Chairs of the Science Committee and the Interim Director), I was informed that I was one of several PhD students interested in studying different aspects of the initiative, so the EG would consult the rest of the Science Committee and the Interim Engagement Committee (once it had been appointed) on the issue of access. The response to this consultation was reported to be generally positive and the value of research on Future Earth was appreciated, but some concerns were raised about access to sensitive meetings and minutes. The committees therefore developed a ‘Research on Future Earth’ policy and accompanying formal approval process in order to ensure that the research would not be disruptive; i.e. that it would respect people’s time and that it would not conflict with the goals of Future Earth.

I submitted the required documents for this second approval process and agreed with the conditions outlined in the policy. Further reflection on this aspect of my interaction with Future Earth is provided in section 3.3 below. Once Future Earth had approved my project, I was granted access to internal documents (including meeting minutes, papers, etc.) and recordings of committee and projects teleconferences, with some limitations (for example, funding bids were not shared due to concerns about confidentiality). I was also granted access to the June 2014 joint meetings of the Science Committee and Interim Engagement Committee in Beijing.

Given this unique and privileged access, in consultation with my supervisors and my contacts at Future Earth, the decision was made to undertake some focus groups during these meetings. This would enable me to see what sort of interaction might happen around co-production, and to maximise the number of participants' perspectives contributed to the study while respecting their time. Formal ethics approval was again granted by the School, and approval was also granted by Future Earth. Rather than a standalone, formal event at the beginning of the fieldwork period, obtaining access was an ongoing interaction and negotiation with the Interim Secretariat and Executive Group, who were extremely generous in offering their support, time and resources.

3.2.3 Document analysis

Alongside the process of obtaining ethical and Future Earth approval for the project, I conducted an initial analysis of Future Earth documents in the public domain. For many actors outside of Future Earth and its broader networks, its websites and documents might be the first point of contact with the initiative; rather than seeing these sources as representations of Future Earth, they can be considered to constitute Future Earth. Starting with the Future Earth section of the ICSU website, and subsequently the Future Earth website once it was established (in mid-2013), I collected all meeting reports, position papers and other documents available to download, as well as the web pages themselves. These documents dated back to 2010 until early 2014 for the initial analysis (and up to early 2015 for the subsequent analysis) (see Appendix 1 for a summary of the documents collected). Once access was provided to internal documents (in February 2014 onwards) these were added to the dataset.

The primary functions of the external documents seem to be a) to record the activities and decisions of the ICSU-ISSC Visioning Process and subsequent work of the Transition Team that designed the new initiative, then of the (Interim) Secretariat, Science Committee and (Interim) Engagement Committee, and b) to communicate this activity and the identity, vision and research agenda of Future Earth to the existing global environmental change research community (those involved in the existing programmes and sub-projects) as well as a broader interested (and new) audience, including potential funders of the initiative. As such, the documents are performative in the sense that they argue for the need for a new initiative, and elaborate what this might comprise. They are also points of reference that inform and contribute (among other factors) to shaping the performance of actions by Future Earth actors (and beyond), including setting up institutional structures, inclusion and exclusion of other actors, research agendas and so on.

The documents (and the subsequent interview, focus group and observation data) were analysed thematically. Thematic analysis is used widely in social science research, although it is not well demarcated and its protocols are not strictly codified (as opposed to, for example, conversation analysis or particular types of discourse analysis) (Bryman, 2012; Braun & Clarke, 2006). However, as a method for identifying, analysing and reporting patterns (i.e. themes) within data, it offers the opportunity to present a 'rich and detailed, yet complex, account of data' (Braun & Clarke, 2006: 78).

Due to the volume of data collected, I decided to use NVivo for the initial analysis (to facilitate a faster analysis process (Bryman, 2012)), coding the documents in relation to broad questions on the nature, purpose and meanings of Future Earth and co-production within it. I then explored the content in detail and began to categorise the data into more nuanced codes or themes. For example, within 'why establish Future Earth', the themes of 'convergence of thinking between research and funding communities' and 'addressing and responding to societal needs' recurred and seemed to be significant.

This analysis shaped my view of potential areas of interest (feeding into the design of the interview schedule, as discussed below), and was subsequently continued manually at a later stage in the process once the fieldwork data had been collected. A combination of electronic and manual data analysis can be considered to compensate for some of the limitations of each method, such as the potential for electronic techniques to lead to excessive multiplication of codes lacking in subtlety or meaning, or the inability to quickly search for key terms or phrases across large datasets if only hard copies are used (E. Welsh, 2002; Basit, 2003).

3.2.4 Interviews

The interviews, observation and focus groups were conducted between March and July 2014, after the Science Committee's first face-to-face meeting (in South Africa, December 2013) and the Interim Engagement Committee's first face-to-face meeting (in the US, January 2014), in the run up to, during and after their first joint face-to-face meeting in Beijing, June 2014. At this stage, Future Earth was operating with an Interim Secretariat (hosted at the International Council for Science (ICSU)'s offices in Paris). In its capacity as institutional co-sponsor in partnership with the other Alliance members (the ISSC, the Belmont Forum, UNESCO, UNEP, UNU, WMO), ICSU was still playing an active role in the appointment of the committees and the selection of the permanent Secretariat.

<u>Sampling</u>

Before fieldwork began, a long list of potential interview participants was drawn up including:

- Members of the Transition Team that worked on the initial design of the initiative (which comprised 31 researchers, research policy makers, representatives of international intergovernmental organisations, representatives of the four GEC research programmes and other stakeholder institutions);
- Members of the Science Committee (which comprised 18 researchers across natural and social science and the humanities), Interim Engagement Committee (which comprised seven members 'from a range of stakeholder groups' (Future Earth, n.d.-b)) including people working at the science-policy interface, local/national government, the UN, private foundations, NGOs and the media), and Interim Secretariat (which comprised an Interim Director, two Science Officers, a Communications Coordinator, an Administrative Officer, and one Science and Engagement Officer);

- Members of the Alliance (which comprised representatives of ICSU, the ISSC, the Belmont Forum, UNEP, UNESCO, UNU, and WMO);
- People involved in the existing GEC programmes and projects;
- People not formally affiliated with, but aware of and interested in, Future Earth and/or whose work is relevant to transdisciplinary GEC research.

Based on this initial list, participants were sampled purposively and opportunistically (Bryman, 2012), with a view to achieving maximum variety across and within the categories above, with consideration of disciplinary, sectoral and institutional affiliation, geographical location, and gender.

Once the project had been formally approved by Future Earth, I began to approach potential participants by email to request interviews, attaching an information sheet outlining the project and what participation would involve (Appendix 2). 15 people were approached for individual interviews, all of whom responded. Ten suggested a potential date and were interviewed. Five suggested resuming contact at a later date due to being particularly busy at that time; three of these were later approached to participate in focus groups and accepted.

The ten one-on-one interview participants comprised three Alliance members, three Science Committee members, one Interim Engagement Committee member, one Interim Secretariat member, one person engaged to work freelance for Future Earth, and one person uninvolved but aware of Future Earth. Of these participants, three had participated in the Transition Team. Most had engaged in interdisciplinary work or had worked across several disciplines through their careers, so there are different ways to describe their disciplinary affiliations. Indeed, many of their day-to-day roles (beyond Future Earth) could be considered to span sectors, including research and policy for example. Broadly, five had backgrounds in or were currently engaged in natural science research; six had backgrounds in or were currently engaged in social science/humanities research. One described themselves as being one of the few non-scientists/non-researchers involved. Three were working as research administrators/managers in a funding or policy making capacity. Three worked for NGOs, one for a national research funding agency. The gender split was eight male and two female. Eight were based in Europe, one in North America and one in Asia-Pacific.

While in some ways the participants were extremely diverse (in terms of day-to-day roles, disciplinary backgrounds, institutional affiliations, and extent/duration/nature of involvement in Future Earth), the male and European weighting was a result of several factors. The sampling and recruitment strategy started from the assumption that face-to-face interviews were preferable to Skype or telephone interviews (a common norm in qualitative research (Deakin & Wakefield, 2014)), meaning that initial interviews were scheduled with those within reasonable travelling distance of Nottingham or who happened to be attending the same events as me. Two of those that were unable to participate during the requested period (suggesting resuming contact at a later date) were female, and two of them were based in Africa. This imbalance was addressed to some extent in the sampling for the focus groups (discussed further below), although balancing all of the potential characteristics to be taken into account there proved challenging, and the primary aim for those groups was to ensure diversity within the group, followed secondarily by a consideration of diversity across all participants in the study.

Another attempt to increase the diversity of participants was made in undertaking six short on-the-spot unrecorded interviews with participants in the joint meetings of the Science Committee and Interim Engagement Committee in June 2014 (although there was an overall gender imbalance in participants at the meetings, given that the full Engagement Committee had not yet been appointed; also it should be noted that several committee members had recently relocated from developing countries to Europe, which indicates that using country of work/residence is perhaps too reductive an indicator when considering diversity). These were conducted opportunistically with five female and two male participants based in Latin America, Africa, and Europe (Science Committee and Interim Secretariat members). My notes taken during and after those discussions have been included in the material analysed. Furthermore, I was also given access to six video interviews with committee members about co-design and co-production, conducted and recorded by Interim Secretariat members in the context of the Beijing meeting. The video interview participants comprise two women, four men – one Interim Engagement Committee member and five Science Committee members – based in Latin America, Africa, Europe and North America. The focus group, observation and video data is discussed in more detail below.

Interview process and treatment of the data

Of the one-on-one interviews, six were conducted in advance of the Beijing meetings (four face-to-face, comprising two in the participant's office, one in a café and one in a seminar room at a conference; and two by Skype). One of the interviews conducted by Skype was cut short by an interruption on the side of the participant, so it was resumed a fortnight later; for the purposes of analysis I have counted this as one interview as it represents one participant's (albeit changing and co-constituted, interactional) perspective. Three interviews were conducted in the context of the joint meetings in Beijing (two pre-arranged and one ad hoc) in the conference hotel restaurant, on the terrace, and in a side room off the main meeting room. One was conducted by Skype after the meetings. Several of the interviews over Skype began with both parties using video, but due to the instability of the connection, video was turned off early in the conversations (before recording began).

While Skype interviews have several perceived deficiencies as opposed to face-to-face interviews, such as absence of visual cues, loss of non-verbal and contextual (ethnographic) data, and difficulty in establishing rapport (Novick, 2008; Deakin & Wakefield, 2014), I did not find that Skype interviewing detracted from the quality of the data. The loss of certain contextual details was, in my opinion, compensated for by the requirement to listen carefully and take turns in speaking with a heightened sensitivity that is not always possible face-to-face due to excessive sensory input or stimuli.

At the beginning of every exchange, I thanked the participants for their time, checked how long they would be available, and talked through the information sheet and consent form (Appendices 2 and 3). Once I was confident that they were satisfied with the project and interview arrangements, and they had signed the consent form (or, in the case of Skype interviews, given their verbal consent by confirming each of the statements read out from the form, and agreeing to sign and return the consent form electronically following the interview), with their permission I started recording the conversation. Recordings of in person interviews were made with a digital recording device and Skype interviews were recorded (audio only) using the software package ‘ecamm Call Recorder for Skype’.

The interview recordings range in length from 30 minutes to 59 minutes (though the combined recordings of the interview conducted over two dates total 72 minutes), with a mean duration of 41 minutes (if the combined recordings are counted separately) or 46 minutes (if they are counted as one).

The interviews took a semi-structured format, with a prepared list of questions (example provided in Appendix 4; this was adapted according to each participant’s role or involvement in Future Earth), which was not adhered to rigidly. This allowed me to pursue interesting avenues that arose in the conversation, while ensuring that questions from each section were covered. The sections broadly comprised:

- The participant’s background, current role and involvement in Future Earth (to break the ice and consider their positionality and relationship to Future Earth);
- What they consider Future Earth to be, what its aims are;
- Who was (expected) to be involved and how; what Future Earth’s activities were/would be;
- What the impacts of Future Earth might be and how it was playing out so far;
- What challenges and opportunities might be encountered;
- What co-production means (if this had not already arisen earlier in the conversation).

An effort was made not to explicitly mention co-design, co-production and transdisciplinarity initially in the majority of the interviews, to see the ways in which the participant would raise and frame these concepts. However, it is worth noting that the information sheet included the project’s focus on these concepts, so this already framed the interaction to some degree.

I transcribed the six interviews conducted in advance of the Beijing meetings (except the second half of the interview conducted over two dates) immediately after the interview or within a few days. Given personal challenges faced after the meetings, the remaining interviews and focus groups were transcribed by a professional transcriber (who signed a confidentiality agreement, securely stored, password protected and subsequently destroyed her copies of the data). No particular transcription convention was followed, given that the analysis does not rely on a high level of interactional detail (length of pauses etc.) as in conversation or some types of discourse analysis (Bryman, 2012). I listened back to the recordings – or segments of them – at various stages in the analysis to ascertain further meaning from tone of voice, pace, etc. and to check details in the transcripts.

In the thesis, to increase the chances of anonymity, verbal tics and potentially distinguishing linguistic features have been removed, interview numbers have been assigned in a different order to the sequence in which they were conducted, gendered pronouns have been removed, interview participants have been labelled 'I[number]' (or 'Interview [number]') and focus group participants have been labelled 'FGP[number]'. For the purposes of analysis and argument, phrases pertinent to the themes have been italicised. In quotes from documents, original emphasis is indicated; other emphasis is mine.

The interview data was analysed together with the focus group and observation data, as discussed in section 3.2.7 below.

3.2.5 Ethnographic (participant) observation

As outlined above, the decision to observe the joint meeting of the SC and IEC was made to gain an insight into the decision making, negotiation and framing processes of Future Earth in its early stages. This particular meeting was the first that occurred following approval of my project by Future Earth. The meetings comprised a one-day symposium organised by the Chinese National Committee for Future Earth as a showcase of Chinese GEC research, attended by some SC, IEC and Interim

Secretariat members, the CNC-FE, other Chinese researchers and professionals, and Chinese press covering the event. This was followed by three days of SC and IEC meetings, mostly joint, with one session where the SC and IEC met separately. Some members of the Alliance were present for parts of the meetings (and held their own meeting, which I did not observe, the day after the SC/IEC meetings concluded).

The observation and focus groups were deeply intertwined (along with the document analysis and interviews conducted beforehand, during and afterwards), but for the purposes of clarity I here deal with them in turn. In terms of observation, my role was as a 'partially participating observer' or 'minimally participating observer' (Bryman, 2012: 443), that is, I did not participate in the group's activities as a core member, but took part in some aspects in a peripheral manner. For example, I joined some breakout discussions and offered my views when asked, but did not contribute to plenary discussions apart from to introduce myself at the beginning of the meeting. On the other hand, my participation was active in that I organised focus groups in that context, conducted formal and informal/ad hoc interviews, and shared meals and tourist activities with participants.

During the meetings I took copious notes on the discussions and interactional dynamics as they unfolded, either using my laptop during formal plenary discussions and some breakouts, or a notebook during other breakouts and informal conversations. At some points notes were taken immediately afterwards if it would be too intrusive to do so at the time (for example, during informal chats over lunch and dinner), and at the end of each day I noted reflections and potential plans/foci for the following day. These notes were all included with the material analysed, in addition to the notes made by the Interim Secretariat members for reporting purposes.

While I was invited to participate in/observe at the subsequent joint meeting of the SC and the newly appointed EC in Argentina in December, 2014, in consultation with my supervisors I decided against doing so given the volume of data I had already generated, given that co-production was expected to take a less prominent role on the agenda than at the Beijing meeting, and given the financial, environmental and potential personal cost of another intensive international trip.

3.2.6 Focus groups

As noted above, focus groups have several advantages over one-on-one interviews: if well-facilitated they have the potential to incorporate a wider range of perspectives in a more time-efficient manner, but they also provide an occasion to explore the processes of collectively constructing – or contesting – meanings around a particular theme or topic (Barbour, 2007). In convening the focus groups I aimed:

- To explore the ways in which meanings of co-production and related concepts would be constructed, considered and contested by Future Earth actors, gaining an insight into interactive meanings and visions of co-production in a group context;
- To facilitate reflexivity of participants on this topic;
- To subsequently reflect on the researcher's own role in co-production.

The Interim Secretariat and Executive Group generously provided me with two dedicated slots in the agenda at the end of the first and second meeting days. I initially contacted fourteen potential participants, to be split into two groups of seven, judged to be the largest possible group allowing space for all to participate over a duration of an hour (Barbour, 2007; M. Bloor *et al.*, 2001). I paid careful attention to the group composition, wanting to achieve a balance firstly within, and secondly across each group between:

- SC and IEC members (and those assuming leadership positions on the committees and those not)
- Those with backgrounds in and affiliations to natural science and social science (or to realist/positivist traditions and constructivist/interpretive traditions)
- Female and male
- Those who speak English as a first language and those to whom English is a second, third or fourth language
- Geographical base (and nationality where known)
- Extent of previous involvement in Future Earth (e.g. Transition Team, programmes, projects)

Of the fourteen I originally contacted, one declined, three did not respond, and the rest agreed (some provisionally dependent on other commitments during the meetings). I then contacted a further three, who also agreed (two provisionally).

The final group compositions comprised:

- Focus group 1, total six participants: one IEC member, five SC members, three women, three men, three natural scientists, three social scientists, two based in North America, one based in Latin America, two based in Europe, one based in Asia-Pacific.
- Focus group 2, total four participants: two IEC members, two SC members, two social scientists, two men, two women, two based in North America, two based in Europe.

Both groups included one (different in each group) member who had also been interviewed one-on-one. Two provisional participants in group 2 (natural scientists, one based in Asia-Pacific, one based in Africa, one female, one male) were unable to attend, and one participant (natural scientist based in Asia-Pacific) who had agreed to participate by email decided to withdraw beforehand during the meetings, stating that they were not familiar with or expert in the topic of co-production. I checked that the participant understood that expertise was not a pre-requisite, while also reiterating that they were free to withdraw either at that moment or subsequently, and they maintained that they would prefer not to participate.

I outlined the main purposes of the focus group (encouraging participants to respectfully disagree or raise new points), and summarised the main points on the ethical consent form at the outset. The primary difference between the individual and focus group consent form was the adoption of the ‘Chatham House Rule’ in the focus groups (Chatham House, n.d.). All participants (including myself) agreed to the condition that what was discussed during the focus group could be shared outside of the focus group but that quotes or information should remain anonymous (i.e. not be attributed to particular individuals). On confirmation of verbal permission from all present I began recording using two digital recording devices (to increase the chance of all voices being picked up).

I aimed to facilitate the groups by asking two guiding questions: What co-production (and related terms such as co-design and transdisciplinarity) mean, and how they might be implemented in Future Earth. These questions were used as a 'focusing exercise' to 'concentrate the group's attention and interaction on a particular topic', rather than as a means to gather information (Barbour, 2007: 42-43). The participants contributed actively and engaged wholeheartedly in the discussions, which ranged very freely. My main facilitation effort was to encourage quieter participants to speak (usually those for whom English is a second, third or fourth language). I drew the discussions to a close after an hour, and participants signed the consent forms (this was considered too disruptive to undertake beforehand given the number of participants; consent was acquired verbally at that stage).

The focus group recordings were transcribed by the professional transcriber and have been presented in the thesis in the same way as the one-on-one interview data (detailed above).

3.2.7 Analysis of interview, focus group and observation data

The interview, focus group and observation data were also analysed thematically (see above for further discussion of this approach). The analysis was primarily conducted manually, although other approaches were explored, including NVivo and an Excel spreadsheet. In the end, the pen-and-paper approach allowed for the closest relationship to the data, and more flexibility in terms of rethinking codes and themes.

Once some initial themes had been identified, the analysis was combined with that of the documents to consider similarities and differences, and some overarching themes were developed. At various points it occurred to me that these themes aligned with concepts from the existing literature, such as the political imaginaries sketched by Nowotny (2014) and the institutional models proposed by Barron (1994; in Jasanoff & Wynne, 1998), which I tested further by looking across the data for examples that might confirm or contradict these hunches. The concepts were used as heuristic lenses in assisting and framing the interpretation of the data, rather than as theories to be proven or falsified.

While I did not broadly consult all participants on the emerging findings, there were some opportunities to receive thoughts and feedback from Future Earth, which could be seen as some form of triangulation or participant validation (Bryman, 2012; Morse, 2018). Firstly, in early 2016 I wrote a book chapter for an edited volume of work from the MSciP programme, which I sent to the Future Earth Secretariat and Science Committee in mid-2016 for their comment and approval (material from the chapter has been further developed and included in several sections of the thesis). I received two small sets of comments back: the work was considered to be an interesting and valuable account of some of the tensions and dilemmas Future Earth was dealing with and would continue to face, and my permission was sought for it to be used to frame some of the discussions at the next SC/EC meeting. I incorporated suggestions to better specify the period of study and bring out the significance of the Belmont Forum (and other Alliance members) in Future Earth's institutional development.

Secondly, I was invited to give a seminar on my work at the School of Environmental Sciences, University of East Anglia in May 2017, which, at the time, hosted the Future Earth Europe office. The talk was attended by several people currently or formerly involved in Future Earth's development (not participants in this study), who expressed interest in the findings, agreeing with some aspects (for example, the presence of multiple, sometimes conflicting, ideas of what co-production means) and raising further challenging and interesting questions, such as in what ways Future Earth can be considered to be having an impact (on science or policy). These comments and feedback played a significant role in shaping my thoughts as I finalised the thesis.

Finally, I shared the draft thesis abstract, introduction and conclusion with two members of the Future Earth Science Committee in the month before submission. I received feedback from one of them, who felt that the conclusions presented a balanced appraisal with many insights, and sought my permission to share the work with the Secretariat.

While these opportunities clearly do not represent a thorough attempt at participant validation or feedback, they suggest that the conclusions reached are not outrageously out of line with the experience of (at least a few) of the people involved.

3.3 Reflexivity

Scholars in STS have grappled with the complexities of establishing the legitimacy and validity of their own knowledge claims while analysing, deconstructing and critiquing the processes of legitimation and validation of the knowledge claims of others (e.g. D. Bloor, 1991; Lynch, 2000; Weinburg, 2009). This type of enquiry requires an active and continued reflexive engagement with its own ontological, epistemological, methodological and normative stance. Rather than undertaking a radically reflexive (Lynch, 2000) deconstruction of my own knowledge-making practices and knowledge claims (fun though that seems to be (e.g. Ashmore *et al.*, 1995; Ashmore, 1989)), here I will briefly reflect on two aspects of the project: the implications of my existing connections with the empirical context, and my role in (co-production in) Future Earth.

Firstly, while no researcher brings a completely 'blank slate' to the research process, my existing connections to the International Social Science Council – and to Future Earth (as outlined in section 1.4) – were significant in initiating and building the study. This was an advantage in many ways (e.g. facilitating access, awareness of some aspects of the institutional history, familiarity with some of the actors' language); in others it proved to be a challenge. Having been immersed in the culture of that context for two years prior to starting the PhD, I brought certain assumptions and took some things for granted that perhaps someone with stronger 'outsider' status might not (Merriam *et al.*, 2001). For example, in analysing the data I came to realise that I had been conceptualising institutional levels as equivalent to or associated with geographical/spatial levels, so the planned SC and EC would operate at the 'global' level and the research projects would operate at the 'local' level. This way of conceiving of the institutional and spatial arrangements of Future Earth is not uncommon (as I will argue in Chapter 7), but it is just one of many ways of thinking about these elements, and perhaps stands in the way of a full account of all forms of governance and spatiality.

In an attempt to avoid ethical ambiguity, I took care to address issues of ethics and consent with my existing contacts before they entered into formal participation (as with all participants), and did not use prior conversations as data (although of course they shaped the study in various ways). However, I did not fully take into account the differences I might experience in my own role when moving from the (protected and in some ways more usual and legitimate) role of employee to the role of 'independent' researcher. I found the power differentials involved very difficult to manage: I am a junior researcher still to be formally validated or qualified by the academy at doctoral level, but also have – or was perceived to potentially have – the power to have a detrimental effect on Future Earth, whether in terms of inconveniencing those involved or more seriously abusing the trust given, damaging the initiative's reputation, or producing an unconstructively critical account. Without wanting to exaggerate the potential influence I believed I could have, the way I experienced and perceived this simultaneous lack of formalised legitimacy and weight of responsibility was challenging and at times hampered the process, particularly during the second phase of data analysis, after the fieldwork concluded. This was perhaps worsened by the challenges in finding a point (or points) from which I could position my analysis (given that the initiative is (still) constantly evolving), and also by the particular complexities of Future Earth's history, development, scope and ambition. The analytical stance detailed above is one strategy to deal with these challenges in a constructive manner, and the bounding of the study as outlined in Chapter 1 is another.

Secondly, I have already characterised the interviews as a form of co-production (indeed the same could be said for the focus groups) and I will now further consider my role in (co-producing) Future Earth. All methods involve some form of intervention in the world, and from a constructivist perspective none can be considered to be completely passive or neutral. However inactive my participation at the committee meetings, my presence was visible and had thus had effects. From an interpretive, constructivist perspective that is not a problem, but it is worth considering the ways in which my participation and the research may have shaped – and indeed constituted – Future Earth (Irwin *et al.*, 2013).

My project was for the most part welcomed by many members of the governing committees, who shared a commitment – at least in principle – to ongoing reflection on Future Earth and their work. Following one of the focus groups, participants expressed gratitude for having had a less structured and formal space to discuss co-production in more depth, and during the plenary the next day two participants referred back to the discussion while suggesting that it would be necessary to think more about these concepts and find some shared ground on what they might mean for Future Earth. After the close of the meetings on the final day, I approached a group of SC and Interim Secretariat members to thank them for their cooperation; they told me they had just been discussing how valuable my presence had been in encouraging committee members to think reflexively about their own experiences of co-production. Again, without wishing to overstate this impact, this indicates that at the very least, some participants were prompted to consider co-production in new ways. It is impossible to say whether this had any enduring effects.

However, this enthusiasm for my participation was accompanied by a range of expectations – some serious, others less so – regarding my role and the work that my research could do. For example, one participant suggested that my work could feed into testing hypotheses of engagement to be formulated in a White Paper. During one breakout session, several committee members joked that it would be very useful to see the results of my project there and then. During another breakout, part of a research agenda setting exercise, how Future Earth does and should do co-design and co-production were added to a long list of potential research questions, at which point the members of the group again joked with me about the enormity of that task and their expectations of my project.

Others were less receptive. For example, during the separate meeting of the IEC, which I had been invited to join, one member (who had previously declined to participate in a focus group) suggested that I should be asked to leave the room during a sensitive discussion; of course, more than within her/his rights according to all ethical standards and the Future Earth policy by which I had agreed to abide. This request was raised by addressing the group to query whether everyone was comfortable with the presence of an observer, rather than addressing me directly; perhaps due to embarrassment, or to not feeling that it was necessary or possible to engage with me as an equal. I was invited to re-join the meeting once the sensitive portion of the discussion had concluded.

These differing responses and relations formed part of the web of connections and ideas constituting the meetings, meaning that in some ways I contributed to the co-production of Future Earth, and certainly the participants contributed integrally to the co-production of (the meanings (re)presented and constituted in) this research.[15]

[15] Moving forward, I have been invited to present a Future Earth webinar on my work, and I will also develop an executive summary of the thesis for the Future Earth community.

Chapter 4: Future Earth's background and identity

Future Earth emerged from a complex institutional landscape of existing global environmental change research programmes, its development driven by ambitions for a unified framework for GEC research and an increased impact in policy and practice. This chapter presents some background on the emergence of Future Earth and an interpretive, thematic analysis of tensions in the initiative's identity, remit and function. The chapter thus aims to contextualise the study and begins to explore the questions 'what is Future Earth?' (or rather, what visions and interpretations of what Future Earth 'is' emerge from an analysis of text and talk about – and constitutive of – Future Earth) and 'what are the visions of its identity and remit?'.

Section **4.1** introduces the background to Future Earth's institutional emergence, and section **4.2** briefly explores some of the narratives of actors involved. Section **4.3** presents analysis framed by two previously mooted institutional models for global environmental change programmes in order to explore whether Future Earth is intended to be more of a central, unified and cohesive "flagship" or a "rich tapestry" of varied initiatives. Section **4.4** outlines the wide and varied range of ambitions for Future Earth's function and remit, noting that both internal and external actors raised concerns about lack of clarity in its mandate. Section **4.5** identifies some key tensions between particular visions for Future Earth, some of which align with the flagship model and others with the rich tapestry model. Section **4.6** discusses the extent to which these ambiguities and indeterminacies are an artefact of the early stage in Future Earth's development, and considers an example of (temporary) stabilisation in the form of infrastructural architecture. Section **4.7** concludes the chapter, noting the significance of integration and co-design/co-production (of both institutions and knowledge) as two of the key principles proposed for Future Earth to address the perceived deficiencies of the existing programmes (or the GEC research field more generally), and considering the extent to which Future Earth might be considered to be a flagship or a rich tapestry.

4.1 Future Earth background

Future Earth, a major international research initiative on global environmental change (GEC) for sustainability, was officially announced by the Science and Technology Alliance for Global Sustainability[16] in June 2012 during the UN Conference on Sustainable Development (Rio+20). Its unique ambition is to provide a global framework for and international coordination of new research on GEC and sustainability. It aims to become ‘a major international research platform providing the knowledge and support to accelerate transformations to a sustainable world’ and ‘a platform for international engagement to ensure that knowledge is generated in partnership with society and users of science’, merging several existing international GEC research programmes (Future Earth, n.d.-i).

These programmes – all established and co-sponsored by the International Council for Science (ICSU) together with other international partners – aimed to plan, coordinate and promote international interdisciplinary research and collaboration on GEC, set research agendas, and make links between research and policy (Future Earth, 2013b: 13). They comprised:

- the World Climate Research Programme (WCRP); established 1980, still operating and contributing to Future Earth as of September 2017 (WCRP, n.d.);
- the International Geosphere-Biosphere Programme (IGBP); established 1987, closed December 2015 (IGBP, n.d.-a);
- the International Human Dimensions Programme on Global Environmental Change (IHDP); established 1990 as the Human Dimensions Programme (HDP), relaunched 1996 as IHDP, closed June 2014 (IHDP, n.d.);
- DIVERSITAS, an international programme of biodiversity science; established 1991, closed December 2014 (DIVERSITAS, 2015);

[16] The Alliance (formed in 2010) comprises the International Council for Science (ICSU), the International Social Science Council (ISSC), the Belmont Forum of global change research funders, the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP), the United Nations University (UNU), and the World Meteorological Organization (WMO) (The Science & Technology Alliance for Global Sustainability, n.d.).

- and their umbrella partnership, the Earth System Science Partnership (ESSP); established 2001, closed December 2012 (Leemans *et al.*, 2009; ESSP, n.d.).

The programmes, governed by Scientific Committees and supported by Secretariats and Advisory Councils, sponsored a range of their own 'core' projects (approximately 30 projects in total; e.g. Global Land Project (GLP); Surface Ocean – Lower Atmosphere Study (SOLAS); Earth System Governance (ESG), etc.) as well as several joint projects (e.g. the Global Carbon Project (GCP), Global Environmental Change and Human Health (GECHH), the Global Water System Project (GWSP), etc.), most of which were also governed and supported by their own Scientific Steering Committees and International Project Offices. Several global change committees were also established at national and regional level, whether overall global change national committees (e.g. Swedish Secretariat for Environmental Earth System Sciences, n.d.), individual national committees for each international programme (IGBP, n.d.-b; British Ecological Society, 2011), or regional networks of national committees (e.g. European Alliance of Global Change Research Committees, n.d.). In 2013, these programmes and projects were estimated to have included at least 50,000 researchers (Future Earth, 2013a).

Between 2006 and 2009, the International Council for Science (ICSU) and the other co-sponsors of the existing programmes reviewed IHDP, ESSP, IGBP and WCRP, concluding that there was a 'need to implement a single strategic framework for Earth system research in the near future' because the research landscape was 'complex, confusing, and often [led] to inefficient use of human, institutional, and financial resources' (ICSU, 2009: 2). ICSU also noted that 'this concern [was] shared by the major agencies funding Earth system research' (2009: 2). The various rationales for this institutional change, merging the existing programmes into one initiative, are discussed further below. At the 2008 ICSU General Assembly, the decision was made to 'organize a consultation, including a high-level meeting, with relevant partners to outline options for an overall framework for global environmental change research and its policy relevance, once the reviews of IGBP and WCRP are completed' (ICSU, 2009: 5).

In order to address this, ICSU and its counterpart for the social sciences, the International Social Science Council (ISSC), undertook a 'Visioning Process' between 2009 and 2011 to work towards the institutional and thematic reorganisation of the existing programmes into one initiative, initially resulting in the development of a document outlining five Grand Challenges of GEC research (ICSU, 2010). This agenda-setting and institutional reconfiguration project converged with another: the development of the 'Belmont Challenge', a funders' vision 'to deliver knowledge needed for action to avoid and adapt to detrimental environmental change including extreme hazardous events' (Belmont Forum, 2011). The Belmont Forum, a group of (mostly national) funders of the existing GEC programmes (and global change research in general) posed this challenge to refocus global and regional environmental change research towards action.[17]

In 2010, ICSU, the ISSC, the Belmont Forum, and eventually several of the other co-sponsors of the existing programmes (UNESCO, UNEP, UNU, WMO), formed the Alliance, with a view to taking the new initiative forward. The Alliance established a 'Transition Team' to design the new 10-year initiative to succeed the existing programmes; the result of their work was the *Future Earth Initial Design* report (2013), a 98-page document outlining Future Earth's purpose, research themes, governance structure and other aspects of institutional design. The Alliance now serves as Future Earth's Governing Council, together with two additional international bodies (the UN Sustainable Development Solutions Network, and the Science and Technology in Society forum) (Future Earth, n.d.-c).

Future Earth was officially announced at the Planet Under Pressure conference (March 2012) and launched in June 2012 in the context of the UN Conference on Sustainable Development (Rio+20).[18] Its Science Committee, Interim Secretariat and Interim Engagement Committee were appointed in mid- to late 2013, and its full Engagement Committee was announced in November 2014. In April 2015 the Interim Secretariat handed over to the permanent Secretariat, distributed across five

[17] The Belmont Challenge has subsequently been used as a framework for a series of Collaborative Research Action funding calls issued by the Belmont Forum and its partners.
[18] This was initially framed as Future Earth's 'launch', but has subsequently been rewritten as Future Earth's 'announcement', its launch occurring in 2015 once the permanent Secretariat was in place (Future Earth, n.d.-d).

‘global hubs’ (in Montreal, Paris, Stockholm, Tokyo, and Colorado). It became fully operational at the end of 2015, and its architecture now also comprises several regional centres and national committees, projects of the former GEC programmes, several Fast Track Initiatives and Cluster Activities funded from 2014, as well as a range of further activities and initiatives (see Figure 3 below for a visualisation of Future Earth produced in 2016, after the data collection period of this study was complete). A schematic of Future Earth’s governance structure as designed by the Transition Team can be seen in Figure 2 below.

Key features planned for the fully operational phase of FE included:

- an emphasis on integrated research across disciplines spanning natural and social science, the humanities and engineering;
- the co-design and co-production of research with stakeholder groups including funders, policy-makers, civil society and business;
- the initiative’s global scope, encompassing all regions and bottom-up input from the research community and other stakeholders;
- the accelerated delivery of solutions-oriented, policy relevant research (Future Earth, 2013b; ICSU, n.d.).

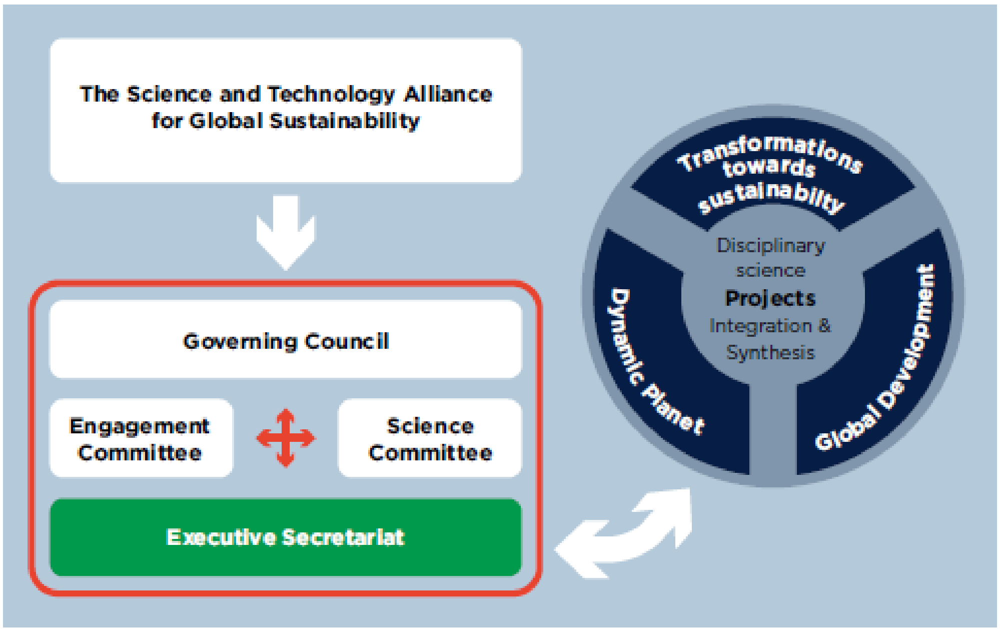
The co-design and co-production of relevant knowledge in particular are billed on the Future Earth website as ‘one of the most innovative aspects’ of the initiative (Future Earth, n.d.-e) – and in the Design Report as ‘one of the most innovative *and challenging* aspects’ (Future Earth, 2013b: 22; my emphasis). Future Earth thus exemplifies calls for transformations in research systems and knowledge-making communities towards engagement with non-academic stakeholders.

As per Figure 2 below, Future Earth research was initially envisaged as being organised around three overarching themes: Dynamic Planet; Global Development; and Transformations towards Sustainability:

> These themes […] respond to the needs to: 1) understand how the Earth system is changing, 2) provide knowledge to support human development priorities, and 3) implement transformations that move us towards sustainability.
>
> (Future Earth, 2013b: 28)

The themes structured the shape of subsequent outputs, for example, the questions of the Strategic Research Agenda published in 2014 are organised under these three overarching themes (Future Earth, 2014c), and they are still mentioned on the 'Our Vision' page of the Future Earth website (Future Earth, n.d.-g). However, the 'focal challenges' of the 2025 vision (Future Earth, 2014a) have subsequently taken a greater role in structuring Future Earth research, forming the basis for Knowledge-Action Networks established in 2016, after the period of data collection for this study had concluded (Future Earth, n.d.-f). The Knowledge-Action Networks comprise Water-Energy-Food Nexus, Ocean, Transformations, Natural Assets, Sustainable Development Goals, Urban Health, Finance & Economics, and Systems of Sustainable Consumption and Production (Future Earth, n.d.-f).

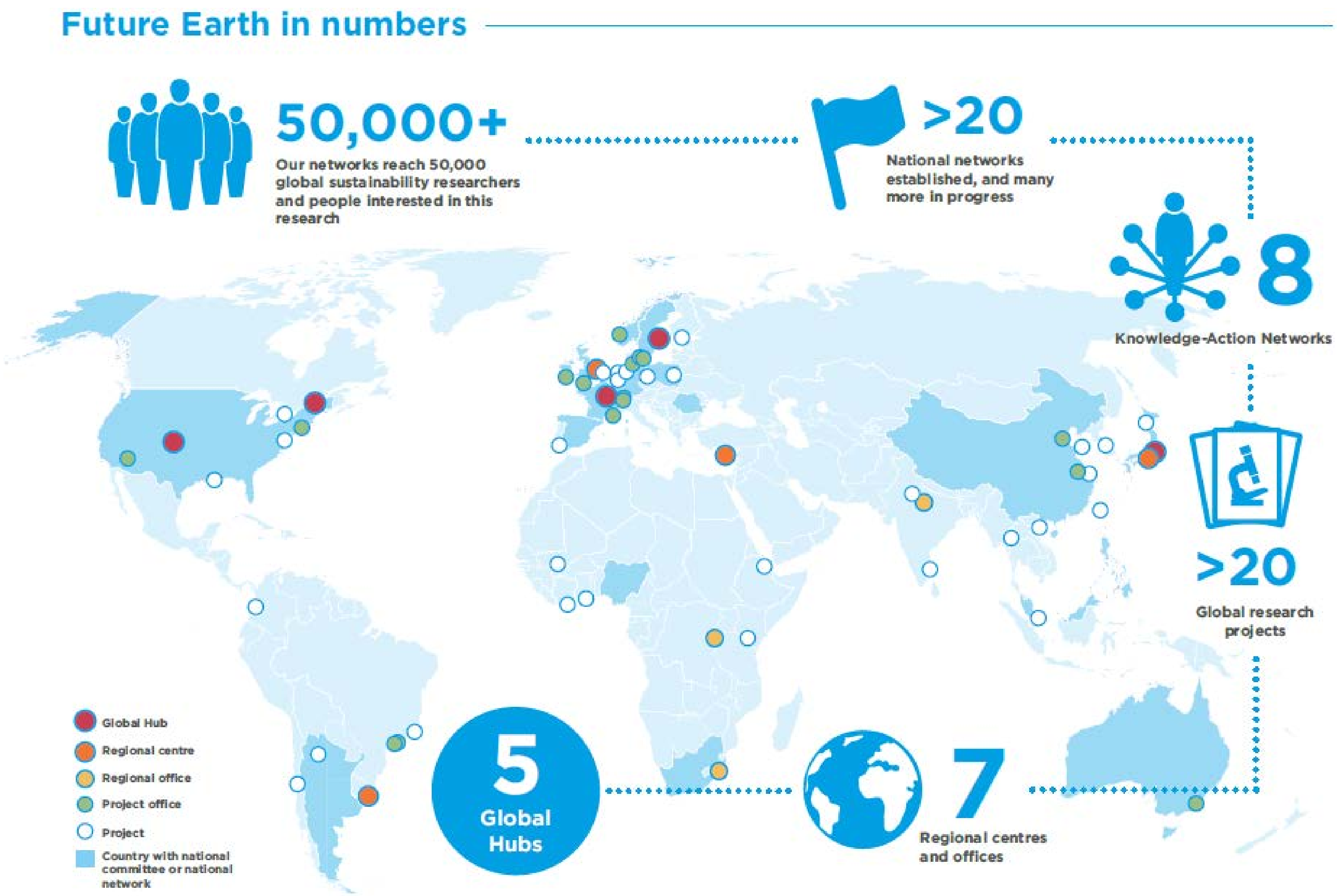
Figure 2: Schematic of the organisational structure of Future Earth[19]



(Future Earth, 2013b: 14)

[19] Rather than feeding into a separate Governing Council, the Alliance – together with two additional international bodies (the UN Sustainable Development Solutions Network, and the Science and Technology in Society forum) – now serves as Future Earth's Governing Council (Future Earth, n.d.-c).

Figure 3: Future Earth in numbers (Future Earth, 2016a)



4.2 Narratives of Future Earth's emergence

Having presented one purified, descriptive version of the emergence of Future Earth, I now move on to briefly explore the Future Earth emergence narratives of some of those involved. These narratives touch on (by no means comprehensively) some of the political and epistemic considerations in Future Earth's development.

As noted above, the sponsors of the existing GEC programmes felt that the institutional landscape was too complex and the programmes were not having enough impact in policy and practice. Two participants in this study (not directly affiliated with Future Earth, but peripherally involved) suggested that the shift to Future Earth was a branding or badging exercise to reduce complexity and increase the attention received by the science produced:

> It's partly a branding exercise, I assume. I was not party to any of the discussions before the thing popped up but I assume that some of the proprietors of some of these enormous Earth system science research programmes thought that they weren't getting enough informed attention because they all have terrible acronymic names and I mean they have more sophisticated communications operations but y'know […] *there's all this science that tells us things and nobody's paying enough attention*. We have the IPCC to review, still doesn't seem to have had much effect. But it's partly that and bringing them together under a heading or at least it will have a name that people understand.
>
> (Interview 1)

A clear institutional identity or brand is seen as important in increasing visibility and impact. Another participant discussed this in terms of greater connectivity between the programmes and authority in interacting with stakeholders (particularly given the sense that the existing programmes had not had sufficient impact):

> So at one level I would see Future Earth as an initiative to… provide greater connectivity between the four big Earth system science programmes and through that stronger connectivity to provide *a site, a forum, an institution which carries greater authority when speaking with and interacting with - let's call them stakeholders for now*.
>
> (Interview 6)

> In the global change arena people have been under pressure to do stakeholder involvement or do engagement for at least twenty years but we need to do that at a different level now… partly because the global programmes have been

> seen to be only partially successful, and partly because *we think that that is actually a better way of doing science*. You do more *excellent science* in this field when you do also engage with stakeholders I'm convinced by that too.
>
> (Interview 8)

The notion that engagement leads to better or more excellent (ways of doing) science ran across several of the participants' accounts, as further explored in Chapter 5. Some participants' narratives highlighted that the drive for change to make more of a difference was on the part of both the funders and the research community, also stressing the need for different scientific approaches:

> […] the Belmont Forum was created in part because I think some of the funders who are a member of IGFA [the International Group of Funding Agencies for Global Change Research[20]] did not feel that… they thought that IGFA has done great work over the years but *there wasn't now enough joint action to make a difference* and I think we felt that in the area of environmental change and sustainability *we really had to work together more*. And so that was the reason for creating that and creating part of the drive through the Belmont White Paper for something like Future Earth. I think on the ICSU side, through sets of programme reviews and then the visioning exercise, there was a recognition that *if we were going to make the steps forward, we needed some different scientific approaches and the attempts with ESSP had not… had made progress but not sufficient and so we were going to have to be more deliberate to create the conditions for integrated co-designed programme*.
>
> (Interview 3)

Some expressed this need for change in terms of shifting from a warning function to a solutions function, resulting in a need for interdisciplinarity and transdisciplinarity given the complexity of the questions and the intended solutions-orientation:

> […] we both feel as research funders [Belmont Forum] or as research communities [ICSU and ISSC] that we have to change the international programmes to… to respond to the bigger… much more complex question on the environment so basically global change programmes in '80s, '90s, have mainly a warning or an alert of function. So basically we look at the activities of human affect the climate, affects ozone, affect different part of the environment, biodiversities and so on. But now this warning from the scientists to societies have been well received and *now the question of society to science is not just sending alert or warning, it is help us to make some solution, to be more resilient to be more sustainable, to remedy problems*. But this kind of question is much more complex […] how environmental

[20] From which the Belmont Forum emerged and which it has now replaced.

> science could help better solution in the real life [and] that pushes the need for environmental science to have better dialogue with development issues, so meaning also the behaviour of people, the economics, the technology issues, so that [calls for] for interdisciplinar[ity] and transdisciplinar[ity] […].
>
> (Interview 4)

However, these changes were seen by some to also be motivated by a sense on the part of the funders that existing efforts were too fragmented, requesting funding often and independently:

> […] what was really important for me about the Belmont Forum is that it was the funders saying *we're tired of fragmented effort* and having four international global change programmes plus the ESSP so in effect *five major international initiatives that were all knocking on the same doors for support*, at a time when the donors were recognising that you know *effective responses from the science community to the challenges we face required joint efforts*, and that they were you know all running around dealing with requests, small requests for essentially disciplinary based efforts but that put a huge pressure on the kind of architectural re-design and at some point it just became clear that the Belmont Forum was in effect saying *we need a single conceptual approach, we need a single architectural landscape design, institutional arrangements* and that the Visioning Process really reaffirmed that.

This unified approach was perceived as a way of overcoming fragmentation and leading to solutions, as the participant continued to explain:

> The Visioning Process of course started out not so much with a focus on the institutional design but more on what are the priorities, you know? What is the agenda in the coming ten years? Where are the key issues that we should be focusing on? But essentially those two processes dovetailed and I think the harsh realities of funders saying we're tired of this fragmented world, where *we see no action, we see good science but we don't see many solutions* coming from that. But *that drove the thinking around setting up a single platform or programm*e.
>
> (Interview 5)

These narratives reveal a focus on connectivity or integration to better address environmental problems and themes because they are complex, and connectivity or integration to better link the existing programmes and efforts because they were fragmented. The desire for greater impact, making a difference and developing solutions is also apparent. These considerations of course fed into and shaped the development of Future Earth: what it would be, the form it would take, its identity, function and remit. The following section explores the multiple visions of Future Earth's identity and form.

4.3 Future Earth's identity and form: flagship or rich tapestry?

Despite the alignment of the institutional efforts and interests outlined above, the emergence of the new initiative – Future Earth – has not been straightforward. During the period of study, visions of Future Earth's identity and purpose (what it was supposed to be and what roles and functions it was supposed to have) were diverse, ambitious and, sometimes, ambiguous. In official and internal documents during its development (since 2009) and since its initial launch in 2012, as well as in the interviews, focus groups and observation conducted in 2014 for this thesis, Future Earth was conceptualised in a range of ways, sometimes evoking two potential institutional models envisaged in the 1990s for one of the existing global environmental change programmes: the flagship and the rich tapestry.

Jasanoff & Wynne (1998: 58–9) note that two potential avenues for development were mooted for one of Future Earth's precursors, the International Geosphere-Biosphere Programme (IGBP), in the mid-1990s. In a commentary for the IGBP's 'Global Change Newsletter', Barron (1994) outlines, firstly, the 'rich tapestry' model, in which diverse (sometimes pre-existing) national and individual contributions or initiatives would be grouped under the broad umbrella of the IGBP. Here, argues Barron, IGBP's role would be to facilitate communication and collaboration but its identity, visibility and ability to attract funding may be weakened. Barron's second proposed model was that of the 'flagship', where effort would be focused on 'task-oriented activity' (such as major field experiments or modelling activities) with closer integration, greater harmonisation and stricter dirigisme, reinforcing IGBP's status as an autonomous international programme at the cost of its inclusivity and diversity.

Future Earth faces similar dilemmas in relation to its structure, identity and role. Might it become – or is it best viewed as – an inclusive tapestry or network of diverse but not necessarily cohesive efforts? Or is it better viewed as a monolithic structure composed of many individuals governed by one centralised agency aiming to coordinate, prescribe, direct, harmonise and standardise knowledge production, potentially to the detriment or exclusion of some voices? Or is it both – or neither?

Flagship

On the one hand, some visions of Future Earth evoke the 'flagship' model. For example: 'governed under one unified framework […] aiming at strategically integrating the GEC Programmes and ESSP and other needed capabilities/skills into a consolidated and comprehensive effort, a flagship initiative on Earth System Research for Global Sustainability' (ICSU, 2011); 'the global research platform providing the knowledge and support to accelerate our transformations to a sustainable world' (Future Earth, n.d.-i)[21].

The early documents (through to the second Transition Team meeting summary, 16 January 2012) frequently refer to the Visioning Process as determining options for and concluding that there is a need for a 'holistic strategy on Earth system research', 'a holistic strategy for global sustainability research' or 'an overall framework for Earth system research' (ICSU, 2010: n.p., 19). This is often accompanied by and linked to visions of a single organisational structure or entity:

> [The Grand Challenges document] also emphasized the need for a single, new overarching structure, which would bring together researchers, funders, service providers and users, and allow for more integration of existing Global Environmental Change (GEC) programmes, the Earth System Science Partnership (ESSP) and other activities.
>
> (Doc 8)[22]

This integration under a single overarching structure or framework is not only imagined in terms of institutions but also themes: the second Transition Team meeting summary states that 'structurally, Future Earth will represent one overarching framework, with a set of integrated grand themes' (Doc 14). While an overarching framework could be seen as a means to inclusion, the singular nature of such a proposition is linked to notions of integration, and (less explicitly) harmonisation, and could imply stricter dirigisme.

The concept of integration is key, seemingly ranging from a type of research akin to interdisciplinarity (i.e. thematic, knowledge integration), through to the institutional

[21] This has since been changed on the website to 'a major international research platform' – perhaps as an acknowledgement that there may be other such platforms.

[22] Documents labelled 'Doc [#]' can be found in the document list in Appendix 1.

merging of the existing GEC programmes around a joint framework, strategy or structure as above. This institutional integration and streamlining of the programmes is bolstered by the partnership of their co-sponsors in the Alliance and the similarities in diagnosis and prescription in the Grand Challenges report and the Belmont Forum's White Paper.

Rich tapestry

On the other hand, some designations are more suggestive of a 'rich tapestry', in which diverse (sometimes pre-existing) contributions or initiatives would be grouped under the broad 'umbrella' of Future Earth (to use yet another pervasive metaphor). For example, some of the frequently (and often interchangeably used) metaphors include: an umbrella (e.g. I7); tent (e.g. I8); hub (Future Earth, n.d.-a); federation ('at its core a "federation" of projects and other initiatives related to Global Environmental Change' (Future Earth, n.d.-h)); network ('an innovative 10-year Initiative on Earth System Research for Global Sustainability, structured as a cutting-edge global research network, and which is highly integrative, flexible and responsive' (doc 8)); and arena ('I think we're an arena so, the point about an arena is that there's debate and dialogue and argument and dispute' (I8)). Other definitions still might fall into either, both or neither category of the flagship or the rich tapestry: e.g. 'first and foremost a community' (Future Earth, n.d.-a); part of a global innovation system (I9); amongst others.

These different visions reflect the diversity of views on and interpretations of what Future Earth "is". While the flagship implies cohesion, a unitary entity, perhaps of a leading, pioneering, high profile or exemplar nature, the tapestry implies bringing together diverse, not necessarily coherent, efforts and perhaps a greater degree of freedom in terms of their framing, approaches, methodologies, etc. Already one of the key tensions in the development of Future Earth is apparent: between singularity and multiplicity, the extent to which it is a cohesive and integrated effort as opposed to a collection of varied endeavours.

Combining the models?

Perhaps it is possible for the eventual initiative to achieve both facets expressed in these various designations; indeed, one participant's vision seemingly blended the two models, suggesting that Future Earth's role would be to integrate diverse specialist knowledge into a singular rich tapestry that would make sense of the current state of global environmental change and sustainability:

> […] one of the things we need to do is understand how we will actually monitor progress globally on sustainable development – *how the current different strands of science will be brought together* […] there's so many scientific programmes going on out there which cover off so many fields but […] people [are] getting more and more specific and being specialists on discrete topics but *there doesn't seem to be a place that it all comes back together to give you this sort of rich tapestry of what is the state of the planet and sustainable development* and I think that's something Future Earth could do very well: picking up these different programmes, these different strands of scientific research and finding a way to weave them back together. It's a bunch of loose threads at the moment and if we could do that […] it would give us such a *deeper, richer understanding* of what's really going on in the world and therefore *what needs to be done* to a) *rectify the problems* or b) to really *identify what are good practices* or best practices.
>
> (Interview 10)

This extract presents a particular view of the type of knowledge that is considered (at least by some in Future Earth) to be necessary in order to address the problems of sustainable development and/or global environmental change: a comprehensive, integrated overview of the current state of the planet. Indeed, this type of discourse runs throughout the documents, where Future Earth is primarily positioned as an integrative effort to provide richer and deeper knowledge on the state of the planet in order to solve problems and identify best practices.

However, it could be argued that the assumption that it is even possible to achieve integrated knowledge of this sort is problematic in itself (Klenk & Meehan, 2015), and, beyond this, the belief that more, better, or a particular type of knowledge is needed in order to identify 'what needs to be done' to solve problems and discover best practices is also potentially flawed. The leap from 'understanding' to 'what needs to be done' is not necessarily straightforward. For example transdisciplinary research does not necessarily lead directly to societal problem solving (Polk, 2014), more scientific knowledge does not necessarily reduce uncertainty or automatically resolve value conflicts (S. Beck, 2011), and further quantifying the extent of (agreement on) global environmental change does not provide policy options to respond (Pearce *et al.*, 2017). The tension between singularity and multiplicity has been discussed elsewhere in relation to making and governing global knowledge (Hulme, 2010) and notions of the new social contract for science (Castree, 2016) and the anthropocene (Lövbrand *et al.*, 2015) in the context of Future Earth. This work suggests that ambitions for a global 'overview' assume the possibility of a view from nowhere, erasing the differentiated and context-specific manifestations of and possible responses to issues of environmental change and sustainability.

Despite the potentially problematic nature of these aspirations, the range of terms used to describe Future Earth signifies the range of hopes and visions circulating during its early days and development. This diversity – or uncertainty – around and over exactly what Future Earth is potentially leaves plenty of space for (experimenting with) alternative pathways of development.

Having discussed Future Earth's identity (i.e. what it is or might be), the following section moves on to explore (visions of and aspirations for) its function and remit.

4.4 Future Earth's function and remit: ambition and lack of clarity

Future Earth's different definitions and designations are accompanied and informed by a diverse range of imagined roles and functions for the initiative, often characterised in terms of transforming or bringing about change in existing research systems, institutions, communities, practices and cultures. As we have already started to see in section 4.1, these roles and functions include (but are not limited to):

- integrating the existing GEC programmes; creating interdisciplinary, integrated, authoritative knowledge on the key challenges of GEC and sustainability;
- informing policy, decision-making and action in the UN system (such as the Sustainable Development Goals, the IPCC and the Framework Convention on Climate Change), and at other levels;

- mobilising, raising, redirecting and coordinating research funds, activity and capacity;
- bringing about a change in the culture or practice of scientific research, and how useful and relevant its results are (leading to greater use of research in decision making etc.);
- involving existing and new communities of researchers, particularly from the social sciences, and engaging stakeholders;
- bringing together GEC and sustainability research communities and refocusing GEC/Earth system science research on sustainability challenges[23];

amongst others, at a range of scales often spanning international, regional, national, and/or local levels.

This wide-ranging diversity in defining what Future Earth is and what its remit entails is acknowledged in passing in two early Q&A posts on the Future Earth blog. In posing questions to the Chair of the Future Earth Science Committee and to the Interim Director of Future Earth, ICSU communications staff noted respectively that 'Future Earth seems to mean different things to different people' (Mengel, 2013) and 'Future Earth may seem like all things to all people' (Young, 2013). These statements reflect the roots of Future Earth's plural definitions and purposes: on the one hand, many people have been involved (and have a stake) in its development, giving rise to a wide range of visions and interpretations; and on the other, the ambitions for its remit and scope are extremely broad even within single narratives of the initiative, incorporating a wide range of actors, knowledges, practices, phenomena, objects, and scales.

Although diverse understandings of what Future Earth is and might do emerged from the interviews, there were varying degrees of awareness of and concern about these

[23] Since the data collection concluded, this ambition has been expressed on the 'Our vision' section of the Future Earth website as 'the evolution of a new type of science – Global Sustainability Science – that links disciplines, knowledge systems and societal partners to support a more agile global innovation system' (Future Earth, n.d.-g). An interesting avenue for future research would be to explore the constitutive power (or otherwise) of Future Earth and its networks in bringing into being the new field of 'Global Sustainability Science' (beyond the more established fields of Earth system science and sustainability science) – in conjunction with other efforts, for example, the recently established journal Global Sustainability, edited by the co-chair of the Future Earth Transition Team, Johan Rockström (Global Sustainability, n.d.).

differences, with some participants retaining a strong sense of Future Earth's purpose (from their perspective), and others viewing a lack of clarity around its identity, objectives and activities as potentially problematic. Unsurprisingly, those that had been involved with the initiative for longer, or those in leadership positions, expressed a higher degree of certainty around what Future Earth should or could be (though some also highlighted the broad potential scope beyond their own specific visions, and the possibility of disagreement with their views). For example, one participant outlined the two objectives of Future Earth as she/he saw them:

> Well, *there are two great objectives of Future Earth and why Future Earth is the shape it is. One is to do with greater integration within science,* and that's to do with de-silo-ing you know the scientific domains that have been looking at climate change and biodiversity and so on and getting them to collaborate more strongly because these are global and connected problems and because they need to do that and make advances in science.

The rationale that integrated knowledge is required because the problems are interconnected and global is one that runs throughout the documents and interviews. The participant moved on to outline the second key role of Future Earth in their view:

> But *the second is to really re-think the way that we do science that is useful.* The reason that we're interested in climate change or food security or biodiversity loss is partly because they're interesting problems but mainly because *we have a role to play as science in addressing – understanding and addressing these problems.* And we understand that the kinds of questions we should be asking and the kinds of knowledge claims we make or tools we develop have to be addressed in the end to societal… partners and in order to do that kind of science we need to work closely with them in the co-creation of research agendas, sometimes in the doing of science itself, and certainly in *trying to make effective the role of science and scientific knowledge and claims and data and so on in choices and understandings and framings and decisions that are made by people in society*; so I think it's really transforming the way we do science itself.
>
> (Interview 8)

This clarity of vision regarding Future Earth's role in integrating science in order to address global and interconnected problems, and co-designing and collaborating with societal partners in order to transform the way science is done towards making it more useful (i.e., in this case, effective in choices, framings, decisions) is present throughout the documents, and was echoed by some other Future Earth actors (as discussed further in Chapter 5).

However, despite instances of certainty such as this, others were more concerned about the ambiguities around what Future Earth is and would do. In mid-May 2014, one Interim Engagement Committee member argued for more specificity about Future Earth's intended achievements, stating that 'Future Earth needs to really, really improve the definition of who and what it is and what its exact purpose is; I still think it's a bit too vague. It's this 10-year online platform to bring together different strands of science, to do science policy, that's quite vague' (I10).

Lack of clarity or focus in Future Earth's mandate was also flagged as problematic by external stakeholders. In late May 2014 Ian Thornton, Deputy Director of the UK Collaborative on Development Sciences, blogged about Future Earth, having attended an ICSU workshop. He suggested that despite considerable awareness of Future Earth among UK stakeholders, there is confusion about 'what Future Earth will do, its value-add, and whether UK funders should engage more closely' (Thornton, 2014). He attributed this confusion to the challenges inherent in articulating what coordination of research can achieve, particularly in the context of an evolving organisational mandate, arguing that Future Earth should pare back its goals and clarify what the Secretariat will do: 'Is it mainly coordination? Or, evidence synthesis and policy influence? Or being a hub for debate?' (Thornton, 2014). Indeed, during the period of study, Future Earth documents and actors suggested that the initiative (if not specifically the Secretariat[24]) is intended to take all three roles identified by Thornton, and more.

Although the functions of the Secretariat were narrowed down and specified by the incoming permanent Secretariat in 2015 and 2016, these doubts still circulated around the initiative in 2016, as can be seen in this *Nature* Editorial:

> But governments and grant-giving agencies have not yet firmly committed to funding Future Earth as a whole. *The reluctance comes from uncertainty over what the scheme might be able to deliver*. The closure of successful programmes in favour of something fashionable but conceptually unproven has earned Future Earth sceptical glances. But then, it was launched in

[24] See footnote 44 (p. 212) for further discussion of elision of or ambiguity between Future Earth taken to mean the Secretariat (and/or organisational structure including governing committees) and Future Earth taken to mean the broader institution or network.

> response to complaints that previous programmes were not sufficiently linked and that the knowledge they produced was scarcely picked up in practice.
>
> (Nature, 2016; my emphasis)

To the credit of those involved in Future Earth, these challenges were already acknowledged in the ‘Design Report’ produced by the Transition Team (appointed to propose an initial institutional and strategic design for Future Earth): ‘stakeholders outside an “inner circle” of the GEC community have no concept of how they might engage with or be engaged by Future Earth, or use or contribute to Future Earth’s research.’ (2013b: 55). During the study, the Science Committee, Interim Engagement Committee and Interim Secretariat were working both to raise the visibility and status of the initiative and to resolve some of these questions, for example in two formative documents: Future Earth’s 2025 Vision (Future Earth, 2014a), and its Strategic Research Agenda (Future Earth, 2014c) (among other policy documents).

It should be noted that during the study, Future Earth was very much an organisation in-the-making; many aspects of its design and implementation were still ambiguous and to be determined. Data collection for this study was concluded before the transition from the interim to the permanent Secretariat in 2015; Future Earth has since evolved. While some aspects of the initiative may have found or still find some sort of stability following this institutional development, Future Earth will continue to evolve for its duration (as would any organisation, particularly if seen as an unbounded and fluid assemblage, rather than a bounded, rational entity (Pallett & Chilvers, 2015)).

4.5 Tensions in Future Earth’s identity, function and remit

Overall, the analysis of the data collected and generated for this study suggests (at least) six linked points of tension or dilemma between different visions and ambitions for Future Earth, at times echoing the flagship and rich tapestry models. These comprise whether Future Earth should: be a hub or arena for debate as opposed to a platform to deliver solutions-oriented knowledge; focus on consensus and integration as opposed to plurality and multiplicity; promote new ways of doing science as opposed to maintaining authority of existing ways; be inclusive as opposed to setting standards and limits; be directive as opposed to responsive; focus on demand-driven science as opposed to curiosity-driven science. These tensions and their relationship to the flagship and rich tapestry models are summarised in Table 1 below.

Firstly, related to Thornton’s point above, there is a potential conflict between visions of Future Earth as a hub or arena for debate, dialogue and deliberation, and that of Future Earth as a platform to deliver solutions-oriented, policy-relevant knowledge and innovation outputs. The ability to achieve both within the same institutional and conceptual framework has been questioned by scholars outside the initiative (Lövbrand *et al.*, 2015). However, many within the initiative would argue that these are not mutually exclusive ambitions.

This is closely linked to the second and third tensions. The second is between consensus and plurality, or between the desire to integrate knowledge (and also to create an integrated, authoritative, singular organisation, programme, or brand) and the inevitable multiplicity of a multi-scalar, multidisciplinary, multi-stakeholder international initiative and its forms of knowledge (Klenk & Meehan, 2015). The third tension is between the ambition to bring about new ways of doing science while also promoting and ensuring continued authority for existing ways.

Here we might loosely align debate and plurality with the rich tapestry model, and solutions and singularity with flagship; the rich tapestry by definition draws together plural approaches, and therefore perhaps also enables space for debate, while the flagship values cohesion, integration and task-oriented, targeted action.

However, the new versus existing ways do not align as neatly with the models. Perhaps a rich tapestry is more amenable to innovation or novelty, given that there is potentially greater space for diversity and therefore space for new or risk-taking approaches; while the (authority of the) status quo may be more easily maintained and elevated by a flagship, given the potential for a stronger identity, visibility and ability to attract funding (although funding is also needed to provide the space to pursue alternative approaches, of course). The tension between pinning things down and leaving things open is a key governance challenge for any research initiative, as discussed further in the thesis conclusion.

One participant discussed Future Earth's role as a forum for debate, highlighting tensions between new and old:

> To me, what's exciting about Future Earth is that it is pioneering a new approach to thinking about and doing science, which is integrated, interdisciplinary, co-produced, and it also should be a forum for encouraging debate and encouraging this approach but in a critically reflective way […]. But I do think it faces real tensions because at the same time it's trying to give more prominence to some fairly standard ways of doing science […].

The participant then identified a challenge:

> But the threat is that integrating everything becomes a kind of lowest common denominator and you lose, as it were, the cutting edge nature of that science – and I think both can happen there but I think we need to work very actively with those tensions and be aware of them and push on both fronts.
>
> (Interview 7)

Integrated, co-produced research is seen as a new approach, potentially at risk of losing the excellence (cutting edge) that has been seen to characterise existing modes of doing science, and, by implication, also at risk of diminishing the prominence or authority of that science. Two participants suggested that a greater diversity of research might have to come at the cost of narrowing climate models down by another decimal place. The tension between singularity and multiplicity is perhaps heightened by the authority-building and fundraising aspirations for the initiative, particularly for those imagining its place in the UN system. One participant (I8) suggested that Future Earth is 'not trying to be totalising', but that the ambition is to be 'the main place' and 'the natural platform' with which the UN, the European Commission and other international organisations wish to partner. A cohesive and singular brand might be necessary to achieve that type of visibility and authority.

Relating to authority-building, there is a fourth tension between Future Earth's ambition to be inclusive (of both existing and new research and stakeholder communities), versus upholding standards and setting limits on what counts as Future Earth knowledge or approaches. On the one hand, participants spoke about working towards making Future Earth ‘a growing tangible concern that people understand and that they want to be part of’ (I8), and opening up Future Earth not only to the core projects of the existing GEC programmes but also to other science communities, including ‘the mass of environmental social science across the world that by definition until now has been excluded from this dominant global environmental change community’ (I7). However, they also spoke about the need to ‘regulate the arena’ (e.g. through peer review, critique and allowing the most robust claims to survive), whether because scholars and/or stakeholders are not ‘fully aligned’ with Future Earth, or ‘committed enough to the codes’, or might ‘clutter up the arena with false claims or with unfounded claims’ (further explored in Chapter 6).

Processes for affiliation with Future Earth and ways of including other communities were being discussed and designed by the committees during the period these interviews were conducted, with varying ideas about the appropriate level of bureaucracy, who should be included and how:

> what’s proving slower than I would like and quite challenging is to work out how to kind of create an endorsement process whereby– but it’s happening I mean we had an initial discussion in South Africa and there is now a sort of form on the way, which enables activities, whether it’s conferences or summer schools or fairly large research projects or centres to affiliate to Future Earth, *to come under the umbrella*, which will then *create openings for interaction with the core projects*, for recognition, for participation, for access to funding and so on.
>
> (Interview 7)

This vision seems to echo a rich tapestry model, in which diverse activities can fall under the banner of Future Earth, whose role is not only to facilitate interaction, but notably also to bolster recognition and provide (or facilitate access to) funding. These latter elements challenge the flagship-tapestry dichotomy, suggesting that it may be possible to achieve a high profile and attract funding while still welcoming a range of diverse initiatives into the fold.

Linked to this ambiguity around openness to participation or affiliation, there is a fifth tension between the directive action of establishing an initiative from the top (global and centralised) level down and the ambition to be responsive to the needs of society and to include bottom up input from the scientific community. One participant (I3) argued that Future Earth is ‘a directive programme’ and is not intended to do ‘purely responsive science’, that it needs to set ‘broad strategic directions through the [strategic research agenda] process’, but that there should be ‘wide engagement’ in putting those agendas together and the research community should be given ‘wide freedoms’ to design research to meet them, without it being ‘a completely blue skies programme’.

However, elsewhere responsiveness seems to be fairly integral to visions of Future Earth. The Transition Team’s Design Report suggests that Future Earth itself is ‘the *response* to calls for international, integrated collaborative and solutions-oriented research to *respond* to the urgent challenges of global environmental change and sustainable development’ (Future Earth 2013b; my emphasis), identifying the sources of such calls as the Rio+20 “The Future We Want” declaration (UN, 2012), the ICSU/ISSC Visioning Process and Belmont Forum White Paper, the Planet Under Pressure conference declaration, and the report of the UN Secretary-General’s High-Level Panel of Global Sustainability (2012). This is key to framing Future Earth as justified and needed: performing Future Earth’s legitimacy.

Future Earth is also imagined to play a key role in providing research that is ‘responsive’ to the needs of partners, stakeholders or society:

> In the next phase Future Earth will develop a model of communications and engagement that is: suitable to its character, a complex, global interdisciplinary programme; and, that allows it to be not only truly responsive to the needs of its partners and stakeholders, but also to bring them into the processes of the programme itself.
>
> (Future Earth, 2013b: 55)

Here, responsiveness is decoupled from the involvement of stakeholders in the programme, although elsewhere responsiveness is considered to be increased through stakeholder engagement. For example, Future Earth will:

> pay particular attention to engaging the users of research early in the development of research programmes, for example by including stakeholders in advisory committees, and also seek to ramp up the research community’s understanding and practices of working with business, governments, non profit organizations and communities to identify research priorities and seek solutions to global environmental challenges. This responsiveness is

> increasingly demanded of and by the funders of research including taxpayers, foundations, and the private sector.
>
> (Doc 15)

As acknowledged here, responsive research has gained currency in research policy and funding frameworks, including at the national level, but it is not a straightforward concept (Raman, 2014). For example, whose needs (and whose good) are served by responsive research, how are these defined, and is Future Earth able to set up appropriate mechanisms to enable this?

The dilemmas between strategy/directiveness versus responsiveness and between blue-sky research versus useful research, link to a sixth tension, which itself links back to new versus existing ways of doing science. This is the tension between a utilitarian focus on demand-driven science and the more traditional, curiosity-driven model:

> In [building on the heritage of global environmental change research and focusing on finding and closing knowledge gaps], scientists involved in Future Earth can provide an invaluable service to society. And researchers in niche disciplines — palaeoclimatology or behavioural science, say — who work to fill those gaps will get a welcome chance to put their work into a broader context. Future Earth might also become a showcase for linking natural and social sciences — a real necessity given that human activity is altering the planet at worrying speed. But *sustainability research must not become tied in the straitjacket of conceptualism and utilitarianism*. Scientists are not merely *service providers*. As in any other field of science, *sustainability research must remain at its core a curiosity-driven affair*.
>
> (Nature, 2016: 8)

With a view to the institutional models, again, we might loosely align inclusivity and responsiveness with the rich tapestry model, and setting standards and strategy or direction with that of the flagship. But, similar to the tension between new versus existing modes of science, utility versus demand and curiosity versus supply do not map neatly onto the models.

Table 1: Potential institutional models and roles for Future Earth

Flagship: effort focused on 'task-oriented activity' (e.g. major modelling activities) with closer integration, greater harmonisation, stricter dirigisme. Programme's status reinforced, maybe at the cost of its inclusivity and diversity. (Barron, 1994)	**Rich tapestry:** diverse contributions grouped under the umbrella of the programme. Programme facilitates communication and collaboration. Its identity, visibility and ability to attract funding may be weakened. (Barron, 1994)
Platform to deliver solutions-oriented knowledge	Hub or arena for debate
Consensus and integration	Plurality and multiplicity
Setting standards and limits (exclusivity)	Inclusivity
Directive	Responsive
Giving prominence to existing ways of doing science? (Authority)	Promoting new ways of doing science? (Experimentation)
Demand-driven science?	Curiosity-driven science?

Table 1 tentatively maps the ambiguities and dilemmas discussed above onto the two institutional models envisaged for research programmes. However, while thinking in terms of ambiguities or dilemmas might suggest mutual exclusivity, these tensions are not necessarily dichotomous, and should be treated with caution, particularly as STS (and broader social and critical theory) has alerted us to the reductionism of binaries.[25] For example, a directive overall strategy may enable responsiveness in other areas of the initiative, and authority might be required to create space for experimentation (e.g. in raising funds, establishing legitimacy and buy in). Similarly, while delivering solutions-oriented knowledge seems to align with a demand-driven model, if the flagship is more able to achieve authority through its cohesion, perhaps curiosity-driven science (often seen as the more 'traditional' model) can more easily be carried out in that model. However, it could also be argued that an institutional form aiming for harmonisation and unification might stifle curiosity.

4.6 Institutional stabilisation

As noted above, these dilemmas are not necessarily dichotomous, and some of the subtleties of these tensions might be lost in treating them as such. However, they are

[25] Including in relation to distinctions between pure and applied, curiosity- and demand-driven research (Hackett *et al*., 2017).

issues that those involved in Future Earth were negotiating and navigating at the time of this study (as confirmed by one participant in her/his feedback by email on an earlier draft of this chapter[26]), and will likely continue to face as the initiative further develops. While this type of ambiguity can perhaps be expected in the early stages of a new initiative as its identity and remit are still in flux, it could be argued that some stabilisation may occur through the establishment of social order through the initiative's practices, structures and identities as they become more familiar and routine (prioritising some institutional identities and functions over others). The multiple roles and functions imagined for Future Earth inform design decisions made about its governance, operations, and activities, and thus in some ways solidify into particular social and technical orders.

For example, certain aspects may find some sort of stability in Future Earth's organisational structure or its infrastructural architecture. In March 2016 the headline of the 'Get Involved' page on the Future Earth website was changed from 'Future Earth is first and foremost a community' to 'Future Earth is first and foremost an open network committed to global sustainability'. [27] The latter wording intentionally stresses the openness – and therefore inclusivity – of Future Earth; perhaps seen to be important given potential tensions around who is or is not included in the Future Earth community (as highlighted by the quote above about the exclusion of social science from the GEC community, for example, or the Design Report's acknowledgement that few outside an "inner circle" knew how to get involved). It could be argued that a network is primarily defined by its connections (an interconnected group of individual actors linked by associations) (OED, n.d.-e), whereas a community is primarily defined by its shared attributes, qualities or interests, perhaps more easily seen as a closed, unitary or cohesive body or group (OED, n.d.-b). This change to the website text was implemented in conjunction with the launch of the Future Earth 'Open Network', an online networking tool to which anyone can sign up: (potentially) a concrete mechanism of openness and bottom up input, facilitating and shaping (new) social and epistemic orders. (Of course, the

[26] Published as Hadley Kershaw (2018).

[27] It should be noted that these developments were at least partly driven by personnel changes between the interim and permanent Secretariat in 2015 and the associated shifts in perspectives and approaches.

extent to which such mechanisms will be used or will enable collaboration on equal footing remains to be seen.) This infrastructural architecture and its associated social orders could be seen to be more in line with a 'rich tapestry' of multiple diverse connections, rather than a unitary, cohesive 'flagship'.

Despite these points of (temporary) stabilisation, as Future Earth further develops and is rolled out and taken up at regional and national levels (whether through its regional hubs or centres and national committees, and/or by other initiatives affiliating, or in multiple other possible ways), the same and further ambiguities are bound to emerge. As the Future Earth network extends and becomes more complex, the Future Earth model is also extended, adapted and interpreted in a diverse range of contexts. This could already be seen during the June 2014 committee meetings in Beijing, as discussed in Chapter 7. Beyond the ambiguity and polysemy of Future Earth in itself and its remit, ambiguity also emerged around co-production and transdisciplinarity within it.

While the range of visions of and aspirations for Future Earth was broad, integration and co-design/co-production of both institutions and knowledge emerged as two of the key strands in visions for Future Earth, in order to address the perceived deficiencies of the existing programmes. Institutional integration was seen as a means to reduce the complexity of the landscape and create a clearer, more authoritative identity or brand. Disciplinary integration was seen as a way to produce knowledge that addresses the complex problems of GEC and sustainability. As further discussed in Chapter 5, ambitions for institutional and knowledge co-design and co-production were driven by a range of rationales, which included strengthening the legitimacy, authority, relevance and impact of the initiative and the knowledge it produces.

4.7 Conclusion

This chapter has presented a (limited and necessarily partial) overview of Future Earth's background and emergence (what it is and wants to be), the setting in which its ambitions (including those of co-design and co-production) developed, as well as its institutional identity and remit. Future Earth emerged from an existing institutional landscape that was considered to be too complex, inefficient and ineffective in impacting on policy and practice. Integration and co-design (of both institutions and knowledge) were proposed as key principles of Future Earth to address some of these issues. However, aspirations for Future Earth's identity, remit and scope were very ambitious and multifarious, leading to ambiguity and potentially giving rise to tensions that at times echo a flagship institutional model (for example, Future Earth as a platform to deliver solutions-oriented knowledge, with a focus on consensus and integration, setting standards and limits on participation, taking a directive approach), and other times echo a tapestry model (for example, Future Earth as a hub or arena for debate, focusing on plurality and multiplicity, being inclusive and responsive).

Tensions and ambiguities are perhaps inevitable in the early stages of a new initiative or new institutional arrangement, and we might expect that some points of stabilisation (in institutional structure or infrastructural architecture) may develop in due course, even if these are temporary. Despite these points of stabilisation, as the Future Earth network is further developed and extends, the Future Earth model is also extended, adapted and interpreted in a diverse range of contexts (such as in Future Earth's national committees and regional centres); there the same and further tensions and ambiguities may emerge.

Future Earth can therefore be seen as an experiment (or a series of ongoing experiments) in transforming research and its institutions. These ambiguities, tensions and uncertainties enable ontological variability: Future Earth may now and yet be a flagship, a tapestry or both (or indeed something completely different). This is potentially also the case for its formative principles or strategies, such as co-production; indeed, as already seen in Chapter 2, co-production and related concepts are prone to multiple interpretations. Given this inevitable multiplicity, perhaps a rigid subscription to the flagship model cannot capture the diversity necessary in an initiative such as Future Earth. Therefore, maybe it is best considered to be a tapestry, in which a broad range of diverse efforts and initiatives are grouped under its symbolic institutional umbrella without the requirement of conceptual or epistemological harmonisation or integration. This formation might be more conducive to flexibility and experimentation. The idea of Future Earth as an experiment is explored further in the next chapter, following an analysis of what co-production and related terms mean in Future Earth, and the rationales for adopting them.

Chapter 5: What does co-production mean in Future Earth and why do it?

Having explored the emergence of Future Earth and some of the visions of its identity, remit, as well as the tensions therein, I now focus more specifically on co-production in Future Earth. While co-production is a key principle or strategy of Future Earth, linked to a range of broader ambitions for the initiative (as we have begun to see in the previous chapter), what it might mean in this context is not straightforward. As outlined in Chapters 1 and 2, co-production and related terms such as co-design and transdisciplinarity have diverse meanings within and between different contexts, and this is no less the case in Future Earth, particularly given its broad range of actors and large scale of ambition. This chapter explores the questions ‘what do co-design and co-production mean in Future Earth?’, and ‘why are they advocated and adopted?’ or, more specifically, ‘what are the rationales that underpin co-design and co-production in Future Earth?’.

As further detailed in Chapter 3, the meanings and rationales presented here were derived from looking at patterns and themes within the data. These understandings and their underpinning rationales are for the most part anticipatory and performative: they emerge from discourse planning and imagining what Future Earth will be, and bringing it into being. In these contexts, co-production is used together with a number of other “co-” words, such as co-design, co-creation, co-dissemination, co-implementation (here referred to collectively as the “co-’s”), which are also analysed here.

The chapter argues that during the time of this study, just as Future Earth was imagined in diverse ways, the meanings of the co-’s were similarly multiple, ambiguous and contested; this was (at least partly) driven by varying rationales for advocating the co-’s and differing levels of subscription to the idea that they should be required elements of Future Earth research. The discussions and activity around the co-’s was messy in the sense that there was little consensus on these terms. However, it is possible to identify common themes and features that coalesce around particular views on what these terms are about. I outline these different views and understandings in this chapter. While one dominant (not entirely unambiguous) view emerged (co-'s as participation of stakeholders for relevance, acceptance and utility), a minority understanding was also present (co-'s as reflexivity for democratisation). A third view of co-'s also arose, often formulated in response or resistance to the first two views: the idea that the co-'s might be a threat.

Section **5.1** explores the predominant understanding of and rationale for the co-'s: co-'s as engagement or participation of stakeholders for relevance, acceptability and use. Section **5.2** describes the minority alternative view: co-'s as reflexivity for democratisation. Section **5.3** outlines the third view: co-'s as a threat. A typology is developed to summarise the three different understandings of co-production. Section **5.4** briefly discusses an approach to resolving the contestation between these views, and explores the experimental nature of co-production in Future Earth. The chapter concludes in section **5.5** by noting that an experimental approach to co-production in practice might enable ways of navigating these multiple meanings.

5.1 Core meaning and rationale: co-'s as participation for utility

This section explores the predominant conceptualisation of co-design, co-production and related concepts in Future Earth. A core model or understanding of and rationale for these terms emerges in Future Earth documents published between 2010 and 2015 that are or have been in the public domain (comprising reports, meeting summaries, and website pages) and internal documents, and is carried forward by key actors (from a range of different disciplinary and sectoral backgrounds) in the initiative, as seen during meeting observation/focus groups and interviews conducted for this study.

As the results of the following analysis will show, the key meaning of co-design and co-production to emerge is that of **engagement** (whether participation, involvement, integration, dialogue and/or collaboration) **of non-academic actors** (with academic actors of multiple disciplines) **in research and its governance**. This is based on the rationale that it would lead to research or knowledge that has **use and impact** in the world beyond the academic/research sector, **oriented towards solutions and**

(policy) relevance (rather than deliberation or other goals, although deliberation may be a means to this end). This is embedded in a broader narrative of an urgent need for societal transformations towards sustainability, for which knowledge is required for decisions to be made and for solutions to be found. Co-design and co-production are imagined to generate knowledge that is more relevant for these purposes (in comparison to other approaches) because the questions have been defined in collaboration with the eventual ‘users’ of that knowledge (societal partners to whom the knowledge claims made or tools developed are eventually addressed, as one participant put it), and the research has a higher chance of being taken seriously, accepted and used (‘properly’) in policy and practice because users have ownership and access by being involved in the research process.

However, although this broad understanding of the co-’s runs throughout the data, there are also glimpses of the complexities and challenges of these concepts: sometimes, even within single documents or narratives, minimal or potentially conflicting detail is given on their meanings and how they might work in Future Earth. For example, there are tensions between ambitions for two-way dialogue and an emphasis on the acceptability of results (discussed below in section 5.1.1), within particular spatial metaphors for these interactions (5.1.2 and 5.1.3), and between ambitions for engagement to be continuous and active throughout the research process and indications that differing extents of involvement are preferred at different stages (5.1.4). These tensions are in part fuelled by an uncertainty around how co-design and co-production might work in this context, which is explicitly acknowledged at times.

5.1.1 Dialogue versus acceptance

As the following analysis will demonstrate, the core conceptualisation of the co-’s is the engagement, participation, involvement, integration and/or collaboration of non-academic stakeholders (together with researchers from different disciplines) in research and its governance. This is based on a rationale of providing useful, relevant and acceptable knowledge and solutions needed by stakeholders, decision makers or society.

If we turn to the (rare) explicit definitions of the co-'s and related concepts, the earliest document in the dataset to touch on this (emerging from the Visioning Process[28]) does not refer to co-design or co-production, but discusses the need for transdisciplinary research, i.e. 'greater involvement of external stakeholders in the research process', and 'co-creation of knowledge with a broad range of stakeholders through participatory practices' (ICSU, 2010: 6). Transdisciplinary research – often used synonymously in Future Earth discourse with co-designed and co-produced research[29] – is defined as:

> Research that both integrates academic researchers from different unrelated disciplines and non-academic participants, such as policymakers and the public, to research a common goal and create new knowledge and theory.
>
> (ICSU, 2010: 20)

Here, the implication is that different parties create something by working together.[30] This definition is reproduced (with the amendment from 'policy makers and the public' to 'policy-makers, civil society groups and business representatives', as discussed further in Chapter 6) in the glossary of the 2013 Design Report (the primary output of the Transition Team). That glossary also includes the following definitions of co-design and co-production:

> Co-design: The research community and other stakeholders jointly identifying and defining research agendas and priority research questions.
> Co-production: The research community and other stakeholders working together to jointly frame, design, and execute research and its applications.
>
> (Future Earth, 2013b: 69)

The understanding of transdisciplinarity or co-'s as the involvement, participation and/or collaboration of non-academic stakeholders to define research questions and priorities, create knowledge and design and execute research (and its use) together

---

[28] See Chapter 4 for more information on the Visioning Process.
[29] 'Co-designed and co-produced research is also sometimes referred to as 'transdisciplinary' […].' (Future Earth, 2013b: 23). This is also the case in sustainability science (Lang *et al.*, 2012).
[30] Throughout the documents and interviews, 'integration' more commonly refers to involving a range of disciplines, fields and/or research programmes or institutions (sometimes being used interchangeably with interdisciplinarity). Integration or interdisciplinarity is often seen as a first important step in or aim of Future Earth's work, with transdisciplinarity or co-design/co-production forming the second step or aim.

with researchers runs throughout Future Earth discourse. Some type of participation of non-academic stakeholders is present in (almost) all understandings of these concepts, not only this core understanding. The core understanding can be distinguished (in part) by its underpinning rationale: the most prevalent reason given for transdisciplinarity and the co-'s is that they will increase the relevance, use, acceptability and uptake of results (in and by 'society', 'decision makers' and/or 'users'):

> 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*.
>
> (ICSU, 2010: 6; my emphasis[31])

> The main selection and implementation criteria for any project, priority action (or new research theme) relate to […] (3) implementing an appropriate co-design between the scientists and the users *to ensure that proposed and established solutions are acceptable in actual societal contexts* […]
>
> (Future Earth, 2013b: 51)

> Dialogue with stakeholders and their participation in the co-design and production of Future Earth research will help the *delivery of better attuned, relevant and useful insights to those who will use* Future Earth research.
>
> (Future Earth, 2013b: 53)

However, there is a potential tension between calls for reciprocal or 'bi-directional' processes of joint agenda-setting, knowledge creation, etc., and the idea that results should be accepted by users and/or wider society.[32] Despite gestures towards the 'dialogue' model of engagement in which information flows between scientists and users (as opposed to the deficit model in which information supposedly flows only from knowledgeable scientists to less knowledgeable users), the non-academic stakeholders are positioned primarily as knowledge-users to be convinced by and accepting of research results; here scientists retain the prime position as knowledgeable actors. Co-production is imagined as the exchange and combination of discrete pre-held information or knowledge, as opposed to mutual co-construction of knowledge during the process, for example.

[31] Phrases pertinent to the themes are italicised throughout for ease of reading. Henceforth, where emphasis is in original, this is indicated.

[32] The implications of the word 'user' are discussed further in Chapter 6.

The potentially problematic nature of this type of framing is noted by Future Earth actors themselves in an internal document produced in 2014 (a draft Green Paper on engagement), which suggests that 'acceptability' might be a naïve goal:

> [T]he role of science is frequently contested when it comes to be applied in society – because there are conflicting values and interests. We need to be careful not to give the impression of an 'informed technocratic' decision model, that through engagement we can somehow avoid the inevitable conflicts inherent in bringing new knowledge to bear on old and highly-structured problem configurations.
>
> (Doc 79)

Despite the presence of this perspective in one of the documents, the tension between dialogue and acceptance is embedded throughout the Future Earth documents and in the discourse of many of the key actors (and indeed in society more broadly: Felt & Fochler, 2010: 221; Irwin, 2006).

5.1.2 Closing the research-policy gap

In Future Earth the tension between dialogue and acceptance as described above is linked to a broader narrative of a gap between research and policy and/or practice:

> Future Earth aims to *close the gap between environmental research and current policies and practices*. Future Earth invites the broad community of researchers working within the natural and social sciences, engineering and the humanities to engage in developing knowledge that is *co-designed with those who use research in governments, business, and civil society*. Such co-design means that the *overarching research questions are articulated through deliberative dialogues* among researchers and other stakeholder groups to enhance the *utility, transparency, and saliency* of the research. This approach embraces the concept of a *new 'social contract'* between science and society (Lubchenco 1998).
>
> (Future Earth, 2013b: 21)

Increasing the utility, transparency and saliency of research through co-design is seen as a means to close this gap between research and policy (although how such deliberative dialogues might work and the means or mechanisms by which they might lead to greater utility, transparency or saliency are not explicated). This narrative is about matching and linking knowledge provision to user/societal need, often expressed in terms of the dual ambition to work together with stakeholders to find out what challenges they are (or broader society is) facing but also to ensure that the knowledge produced is taken up in practice, as demonstrated in this interview extract:

> 'Co-designed' to me means that if we are working in a mission led programme which is there to respond to a set of *societal challenges*, then we need to find some *societal stakeholders to work with* to establish that a) we understand the challenges correctly, b) we correctly identify what the research priorities are that are going to *meet those challenges* and c) find ways of *working together during the research process*, to increase the chance a) that we *deliver the necessary knowledge* but b) that it is *taken up in to practice*.
>
> (Interview 3)

Further detail on this rationale was provided by another participant when discussing when co-production might be necessary:

> There are [research issues, questions, challenges, such as the sort of complex intersectoral societal issues that we're currently facing with global environmental change] where if you don't have that sort of *engagement* well you're probably either *not going to answer quite the right question* because it wasn't very well specified in the first place and it's actually the process of doing the research, you know *co-production mode is actually how you clarify what the real question is and home in on what sort of options or answers there might be for it* – or alternatively it's a sort of area where actually *if some of the potential users of the research aren't involved in and don't feel a sense of ownership then they won't take any notice of it anyway*.
>
> (Interview 9)

The co-'s are seen as engagement of and collaboration between researchers and stakeholders to ensure that the 'right' or 'real' (research) questions are asked and therefore relevant or useful knowledge (and/or options, answers, solutions) will be produced, and will be more likely to be used and have impact as stakeholders/users have access and ownership through being involved in its production. Co-design and co-production are seen as a process of bringing users into proximity with the research so that knowledge produced is aligned with societal challenges and needs, and stakeholders are not only aware of it but also invested in it.

This utilitarian view corresponds to the logic of accountability discussed in section 2.3: redirecting research portfolios towards societal need (Lövbrand, 2011: 227, following Barry *et al*., 2008), with an additional emphasis on impact of research by ensuring the research is accessible and credible to users. References to a 'new "social contract"' (as in the Design Report extract above) in particular suggest an implicit narrative about science fulfilling its societal responsibilities or obligations, and therefore being accountable (Castree, 2016).

In this view, two-way dialogue is often imagined as an integral aspect of co-design and/or co-production linked to the idea of getting the questions right so stakeholders' needs can be met. This is based on a particular notion of what each party might be able to offer in this exchange:

> […] co-design to me is getting a *genuine two-way discussion about what the issues are that a decision maker […] [is] facing* but not just them just telling the researchers that actually we want x, because actually there's a *two-way conversation* there as to what is researchable, *whether it's likely that research can produce a useful answer* to the sorts of questions that are being asked or indeed whether the questions can be asked in slightly different ways which still *answer the decision making needs or the understanding of options* or whatever it is that the decision maker's after, but which are then more researcher robust. […] [T]he research community […] has had a lot of money spent on it to be able to think about certain sorts of things and *think about evidence* and so on, whereas often we are not very good at thinking about these sort of *resolution of complex social issues* that policy makers have to think about for example.
>
> (Interview 9)

According to this view, scientists have a particular expertise (e.g. thinking about evidence) but lack the skills to think about the resolution of complex social issues; the latter is the domain of the societal stakeholder. This echoes the narrative of the Design Report both in terms of the type of input that might be provided through involving stakeholders in these processes (e.g. on social issues, norms, values), and in terms of the type of output that might be expected (e.g. answering needs, providing solutions, understanding options):

> Integrating global environmental change issues with development and sustainability issues involves many complexities and uncertainties and must incorporate understanding of societal norms, values and perspectives (Kates 2011). Under such conditions, *science has up-to-now tended to provide mainly understanding but not answers or comprehensive solutions* (e.g. Funtowicz and Ravetz 1990, Klein 2004b). Co-design is one way to address

> this, and it has already shown its value and utility in fields where science and policy meet.
>
> (Future Earth, 2013b: 23)

This extract draws explicitly on STS and science policy literature to suggest that co-design is a means to both incorporate understanding of norms, values and perspectives into research, and to generate answers and solutions. However, what this incorporation might mean – and how it is linked to providing answers and solutions – is elusive. Does this refer to an academic/scientific understanding of societal norms, values and perspectives (e.g. social science knowledge) or general awareness of and sensitivity to social convention or "public preference"? Is this understanding intended to inform what types of solutions might be workable? Or perhaps – less likely – the intention is to incorporate an acknowledgement of how norms, values and perspectives are already implicit in scientific research? Is this an attempt to push beyond the tendency to treat social and ethical matters 'as spatially, temporally and substantively separate from technical ones' (Raman, 2015: 117)?

Read in the context of the predominant meanings and rationales, it would seem that the intended interpretation of the above is that science will be more likely to provide (acceptable) solutions if research is framed and designed taking broader societal norms, values and perspectives into account, and the way to achieve this is to involve societal (non-academic) stakeholders in designing (and perhaps producing) research. However, underlying this rationale are several implicit (and perhaps problematic) assumptions and expectations regarding the kind of research or knowledge that is needed: new or synthesised, relevant, solutions-oriented research (or 'a new type of science that links disciplines, knowledge systems and societal partners to support a more agile global innovation system' (Future Earth, 2014c: 5)) is assumed to be necessary in order to address sustainability issues and for action to be taken (cf. Lövbrand *et al*., 2015)[33]; involving stakeholders in research design and production is

[33] As Future Earth is a research programme, its focus on the primacy and importance of research in addressing global environmental change and sustainability issues is unsurprising and inevitable, particularly as the early stages of Future Earth entailed simultaneously justifying the initiative's creation and the institutional reconfiguration it is championing. However, in performing this need and constructing Future Earth and a particular kind of research or knowledge (e.g. solutions oriented, relevant, integrated, etc.) as the response to this need, other potential framings, challenges and types of research or knowledge are potentially side-lined.

expected to lead unproblematically to more relevant research results as well as the uptake or application of those results (cf. Polk, 2014); and, finally, lack of uptake of research in policy or action contexts is assumed to be caused by a gap between research and policy.

As suggested by the earlier image of the gap between research and policy/practice, this is tied to a narrative of research that has so far been unsuccessful (or not as successful as would be desirable) in addressing socially relevant issues or questions, providing options and solutions, and/or ensuring that the research and solutions reach and influence policy, practice, decision making, etc.:

> […] where we are trying to get more *nimble* about creating a global innovation system that's really enabling nations and the global community to act on the sorts of challenges that we're facing more quickly, then I think *there's a strong case for more co-design than we've managed to do in the past*, less of the "here look there's a problem with climate" and chucking it across the fence and assuming someone will act on it but actually engaging with "so we can see there's a problem with climate but *what does that actually mean in terms of what might one do*, how might you decarbonise the economy" and all those sorts of issues. […]
>
> (Interview 9)

Language such as 'nimble' (above) and 'agile' (in the preceding paragraph) suggests the extent to which this view is fuelled by a perceived need to accelerate responses to GEC as an urgent issue. While the questions listed above clearly entail normative dimensions, for the most part this view of co-'s maintains that the researcher's role should be to provide policy options, rather than to be prescriptive or pursue particular normative agendas:

> […] as a general principle, *Future Earth should aim to be policy relevant rather than policy prescriptive* and use tools such as evidence-based scenario setting to support informed policy development.
>
> (Future Earth, 2013b: 50)

This echoes the IPCC's stance on the assessments it produces, but could be seen to be problematic. As argued by Turnhout *et al.* (2016), packaging knowledge in categories relevant to policy making is inherently a normative process, though rarely acknowledged as such.

5.1.3 Science and society as separate

In this dominant narrative of the meaning and rationale for co-design and related concepts, researchers and other societal groups are imagined as currently occupying separate spaces, and for the most part co-'s are imagined to mean stakeholders entering (participating in, getting involved in, engaging in, etc.) the 'space' (i.e. processes) of science. There is an underlying contradiction in this framing of co-design and co-production: the 'co-' (and indeed notions of 'two-way dialogue') would seem to imply shared involvement and responsibility, and equal collaboration between those involved, whilst the 'participatory' or 'engagement' framing could be seen to assume a pre-existing activity or entity into which participation or engagement might be enrolled, so science/research is the pre-established frame or context and others entering into that must adapt. These different understandings have different implications for the division of labour, responsibility, power, or ownership experienced by the various parties involved: participation *in* science versus more equal-footed collaboration *between* scientists and others. However, the co-'s consistently fall within Future Earth's 'Engagement' activities (in meeting agendas, documents, discourse), suggesting that they are not truly considered to be science either, rather some sort of add-on to existing scientific processes or frameworks (despite an overall framing of bringing about a change in science-society relations (Future Earth, 2013b: 11) and a new type of science (Future Earth, 2014c: 5)). Furthermore, the depth and intensity of this engagement is at stake: as one IEC member asked, 'does "co-" mean collaboration, consultation, or conversation?'

There are alternative views of the spatiality of the co-'s, but these still imagine some form of (current) separation between science and the rest of society to be bridged; one participant described the new approach inherent in co-design and co-production in terms of not 'simply about a communications strategy which is one-way' but rather 'an attempt to involve ourselves in societal arenas as well' and 'to see the academies active in in societal arenas' (I8) (as further discussed in Chapter 6). Here scientists are envisaged as entering the space of society, which implies a vision of scientists usually operating outside of society. An internal document (the draft Green Paper on engagement) provides a more detailed view on the potential spaces of engagement, again conceptualised as spatial ‘arenas’ or even a ‘ring’, as in fighting ring:

> - Broadly speaking, engagement with stakeholders will occur *as part of knowledge production convened by science* (internal arenas), or as *part of assessments and decision-making processes convened by societal partners* (external arenas) - in the former, researchers ‘hold the ring’, in the latter, researchers are ‘invited into the ring’.
> - These different contexts call for different engagement approaches. In internal arenas *the terms of engagement will be defined as part of the research process (structured as a process of co-creation and co-production)*, while in external arenas researchers will tend to be *responsive to the framings, processes and timelines/cycles of other parties and interests*. In general, external arenas are more complex and resource-intensive for research to service than internal arenas, but provide greater opportunities for impact.
>
> (Doc 79)

Future Earth itself is often characterised as an arena (as discussed in Chapter 4), and the ‘Impact’ section of the Future Earth website includes a figure from and a link to Cornell *et al.* (2013) in which the relationship between knowledge and action is imagined spatially in terms of an arena, drawing on Nowotny *et al.*’s (2001: 203) concept of the ‘agora’, ‘a new public space where science and society, the market and politics, co-mingle’. In the extract above, co-creation and co-production are seen as a form of research process including engagement, in which researchers ‘hold the ring’ and therefore presumably take the lead or at least hold greater power or control in overseeing and defining the terms of engagement (while the ‘agora’ could be seen as a space of peaceful gathering, ‘arena’ and ‘ring’ are more evocative of combative, gladiatorial spaces (Wiktionary, n.d.-b)). Assessments and decision-making processes convened by societal partners are not deemed to be knowledge producing processes (and co-’s do not play a role, given that these terms are here closely affiliated with the research/knowledge production process).[34]

[34] This dual framing of engagement persists in the Engagement Principles and Practice document published in 2016 after data collection for this study was complete: ‘Participation of societal partners in co-design and/or co-production of research activities will help deliver better attuned insights, which accelerate the emergence of scientifically robust, socially implementable solutions. Participation of researchers in stakeholder analysis and decision-making processes, with the aim of providing sound scientific evidence, can build a clear voice and direction for sustainability, offering solution-based answers.’ (Future Earth, 2016b).

This raises the question of the extent to which societal stakeholders are imagined as having knowledge to offer in processes of co-design and co-production. Although in the predominant vision of the co-'s the focus for the most part is on getting stakeholders' input on what the questions are and ensuring that they can access and accept the knowledge produced, there are also indications that they might have knowledge (or information) to offer in these processes:

> Co-design and co-production also recognises that researchers, information and models are now based in many different types of organisation and the great benefits from research collaborations between, for example, universities, NGOs, and the private sector.
>
> (Future Earth, 2013b: 23)

This point on the distributed nature of 'researchers, information and models' reflects ideas in research policy literature (e.g. Gibbons *et al.*, 1994), and suggests that the academic research community is not the only sector to hold relevant expertise and knowledge, implying that others may have a role in actively contributing expertise and knowledge. This is echoed elsewhere, or at least that their existing knowledge and experience should be respected:

> The Global Development theme will have the principle of co-design at its core with *extensive discussions* with international development organizations as well as regional and local groups to ensure a research agenda that is focused and solution oriented and that *respects the knowledge that already exists in these communities*. Cooperation with development agencies and communities can bring benefits to Future Earth that include international networks of field research and practitioners and *experience* with participatory approaches, vulnerable populations, local innovation, and project evaluation.
>
> (Future Earth, 2013b: 36)

This is particularly the case in the later documents; as might be expected, there are slight shifts in the language between the Design Report (produced by the Transition Team) and subsequent official documents, produced by the newly appointed Science Committee, (Interim) Engagement Committee and Interim Secretariat.[35] For

[35] And there have subsequently been shifts since the appointment of the permanent Secretariat and changes to the committees (as there will continue to be, as Future Earth personnel and collectives evolve and change).

example, the draft engagement Green Paper explicitly highlights the contribution of stakeholders in terms of knowledge and experience:

> […] Stakeholders must be fully engaged in all phases of Future Earth, i.e. in the co-design of the program to ensure the right questions are being addressed, *co-production of the projects to ensure the full range of knowledge and experiences are considered*, and co-dissemination and use of the findings for informed decision-making.
>
> (Doc 79)

In a key external document outlining the Strategic Research Agenda (2014), the research priorities are prefaced with a short statement on the importance of 'co-producing knowledge with society':

> The co-design and co-production of new knowledge, created by researchers working *in collaboration with* their societal partners, is critical to developing scientific insights, data and tools that can *contribute to* addressing the most pressing global sustainability challenges. Across all the priorities presented here, researchers and research funders are urged to work with societal partners in developing and implementing their plans. In this way science will be *contributing to* understanding the problems that matter to society and developing the solutions that are needed.
>
> (Future Earth, 2014c: 9)

Although this reproduces the narrative that co-design and co-production inherently lead to relevant research, the vision of the role of science is less hubristic with the addition of the words 'contribute to', and 'in collaboration with'. Impact and responsiveness are still foregrounded, with additional focus on the need to monitor the effectiveness of these new approaches to research:

> Key approaches for focus are:
>
> 1. Conducting fundamental and applied research in ways that engage with diverse societal partners across all regions of the world to maximise *impact and responsiveness to society's needs*, and *monitoring the effectiveness of these new approaches to research*.
>
> (Future Earth, 2014c: 7)

However, this continued ambition to conduct both fundamental and applied research might pose challenges in terms of the tensions identified in Chapter 4 between curiosity-driven, blue sky research (which is not usually targeted towards addressing particular challenges), and demand-driven or responsive research that considers or produces solutions. During the committee meetings, the suggestion to frame the fundamental research within Future Earth as ‘use-inspired basic research’ was proposed. The extent to which challenge-focus and fundamental research, and therefore by implication, co-production and fundamental research are compatible is a matter for debate. Some might consider that co-production in fundamental research is possible (for example, in the form of citizen science), but that the findings would need only be relevant to science as it is impossible to predict in what guise they will become relevant to wider society. The ways in which the committee members discussed the challenge of co-production to fundamental research is discussed further in section 5.3.

In terms of the development of notions of engagement and co-production through the documents as time progressed, the draft engagement White Paper and Green Paper developed by a sub-group of SC and IEC members expresses a more nuanced view, distinguishing between meeting needs and providing socially robust knowledge, and further characterising these processes in terms of bringing together different types of knowledge (including non-academic knowledge) and perspectives, rather than solely scientific knowledge being informed by the priorities of societal stakeholders.

5.1.4 Extent of engagement

While the overall understanding of co-’s as engagement of non-academic stakeholders to increase relevance, acceptability and use (and therefore impact) runs throughout the data, tensions and ambiguities are also present, such as between dialogue and acceptance, as described above. In addition, there is a lack of clarity around the extent of engagement at different stages during the process, and the distinction between co-design and co-production. As the following analysis demonstrates, this is the result of the initiative still ‘feeling its way’ (as participant 9 put it) forward between the programmatic and the doable and between the different visions of those involved. Although not (often) articulated as an ‘experiment’, the whole process of implementing and institutionalising the co-’s is experimental and therefore by nature tentative and uncertain.

While the Design Report (much of the text of which was also used in the "Impact" section of the Future Earth website, which held a prominent position as one of the homepage tabs until mid-2016) reasserts the significance of co-design and co-production as 'one of the most innovative and challenging aspects' of the initiative, it leaves many questions about these concepts unresolved (Future Earth, 2013b: 22). On the one hand, it is suggested that co-design and co-production 'requires an active involvement of researchers and stakeholders during the entire research process', 'continuous engagement' (Future Earth, 2013b: 22-23) and 'an understanding that co-design commences at the outset and stakeholders are partners in knowledge production throughout' (Future Earth, 2013: 54); but on the other, it seems that less active involvement of stakeholders may be preferred at some stages:

> Co-design and co-production of knowledge include various steps where both researchers and other stakeholders are involved but to different extents and with different responsibilities […]. *Whilst researchers are responsible for the scientific methodologies, the definition of the research questions and the dissemination of results are done jointly*.
>
> (Future Earth, 2013b: 23)

If researchers are responsible for the 'scientific methodologies', it is not clear what the (reduced) stakeholder involvement might entail in the 'co-production' step of the research process: would they be invited to participate in data collection and/or analysis[36], under the supervision of the researchers whose role is seen as safeguarding the methodologies? Or provide feedback on interim results? Or suggest amendments to the research focus? Although it could be argued that some types of science (for example, complex mathematical modelling) might not be conducive to non-academic involvement beyond defining the questions, this approach has been undertaken in relation to flood modelling in the UK (Landström *et al.*, 2013; Whatmore & Landström, 2011).

The text continues by highlighting the challenging nature of these interactions:

[36] E.g. citizen science is mentioned in the 'Education' section of the report, framed as a method of informal science education rather than explicitly identified as a method of co-production (Future Earth, 2013b: 57).

> One of the main challenges is how to build trust among all stakeholders, and to ensure *continuous engagement*. The challenges of co-design and particularly co-production are not underestimated by the Transition Team, and it is recognised that the programme will need to support the research community and stakeholders to develop and share the necessary skills. It is also recognised that the focus for this way of working should be on *where the research and stakeholder community feel that it will bring the greatest benefits*.
>
> (Future Earth, 2013b: 23)

This does not address questions about how to reconcile continuous engagement with the described division of responsibilities, nor how it should be decided where co-design/co-production brings the greatest benefits (and to whom). Furthermore, it is not clear here why co-production is seen as particularly challenging (though, as explored later, the internal documents, interview and observation data suggest that this might be attributed to concerns within the research community about maintaining the objectivity, independence and credibility of science, particularly the scientific method). With little detail on how non-researchers would participate in the research process, these concerns are not explicitly addressed in the Design Report, despite the acknowledgement of challenges and (implicit) recognition that the research and stakeholder community might not always feel that it does bring benefits.

In addition to the ambiguities around the extent of engagement envisaged in the co-'s, there is also ambiguity around the distinction between co-design and co-production; this ambiguity occurs in relation to both the institutional and temporal aspects of these terms (as discussed further in Chapter 7). As can be seen in the glossary definitions at the start of section 5.1.1, sometimes co-design refers to involvement of stakeholders in aspects of research governance such as agenda-setting, overarching research question definition and prioritisation (and, as seen below, sometimes in the institutional design of Future Earth itself), while co-production refers to the work of individual research projects (also including question definition and research design). However, the distinction between co-design and co-production is also often imagined in terms of steps in the research process (at project level), where co-design refers to the earlier stages of the research process (question definition and research design), co-production refers to the middle stages signifying the resultant or subsequent research work (data collection, analysis, etc.), and co-dissemination and other similar terms to the later stages. Co-production as a form of collaboration or iterative dialogue during the research process is also sometimes seen as a way of further developing and refining the research questions (as seen above in section 5.1.2).

The early documents refer as much to the co-design and co-production of the initiative itself by the different stakeholders represented by the Alliance partners (characterised as scientific community, research funders, users, and knowledge/service providers[37]), as to co-design and co-production of research or knowledge. The Transition Team is considered to be 'selected in the spirit of co-design of a new research agenda, and thus included researchers, funders and private and public sector stakeholders from many different countries and disciplines' (Future Earth, 2013b: 5). Here, co-design refers to the joint development of a new research initiative/associated research agenda between the different groups (whether sectoral, national or disciplinary) represented by the Alliance partners and Transition Team members: a sort of institutional or administrative co-design, often linked to establishing the authority or legitimacy of Future Earth (i.e., given that Future Earth is championed by a multi-sectoral, high level Alliance, and designed by a broad range of scientists and stakeholders, the sense that this initiative is justified, needed, and authoritative should increase). This type of institutional or administrative co-design/co-production can be seen again in the Design Report: Future Earth's governance structure 'embraces the concepts of co-design and co-production' (Future Earth, 2013b: 14).

This type of co-design also arises in the internal documents, observation and interview data, where some participants consider Future Earth's commitment to engagement, co-design and co-production to be demonstrated by and embodied in its adoption of not only a Science Committee (as in the existing programmes), but also an Engagement Committee. This interpretation of co-design/co-production rests on a model of collaboration between committee or team members representing various stakeholder groups or positions (different disciplines, funding, policy making, etc.).

[37] Other potential (rather than existing) partner categories are also mentioned, including development assistance agencies, business sector representatives, representatives of global observation programmes.

However, this view faces significant complexities in terms of defining what this sort of representation or representativeness might mean, as explored further in Chapter 6.

5.1.5 Summary of core meaning and rationale

In summary, the core conceptualisation to emerge from the data (primarily in the external documents, interviews/focus groups and meetings observation, voiced by actors from a range of disciplinary and sectoral backgrounds) is the co-'s as the engagement, involvement, participation, integration and/or collaboration of non-academic stakeholders (together with researchers from different disciplines) in research and its governance. This is based on a rationale of providing useful, relevant and acceptable knowledge and solutions needed by stakeholders, decision makers or society.

Stakeholders, primarily imagined as users/decision makers, policy makers, societal partners and/or representatives of particular groups, also have knowledge and expertise to offer, but this is primarily to ensure that the 'right' questions are asked and that all relevant knowledge is considered, with the goal of ensuring that the knowledge produced is relevant and used, that it reaches the places it is needed, bridging the 'gap' between research and policy/practice.

The relation and interaction between researchers and other stakeholder groups or sectors is sometimes imagined spatially, as though currently science and society are spatially separate and this is something Future Earth will address by encouraging scientists to enter societal arenas and society to enter scientific arenas, or by creating an arena for them to come together. The role of research and/or the researcher might be to provide policy options and policy relevant (not policy prescriptive) knowledge and syntheses, etc.

However, this understanding of co-'s is not without its ambiguities: little detail is provided on how this should work in practice, and there are inconsistencies around the extent to which there should be (intensive) involvement throughout the process. These ambiguities in part manifest in the varying distinctions between co-design and co-production (as further explored in Chapter 7), sometimes referring to a hierarchical split between co-'s at governance (co-design) and research levels (co-production), and sometimes referring (often temporally) to the type of activity that may occur at governance or research level or both (co-design as setting the questions whether at strategic level or project level or both; co-production as undertaking the subsequent governance/research work at either/both level(s)). There are also tensions between calls for dialogue and two-way interaction, and the view that these processes will increase the acceptance or acceptability of research results. These tensions are in part fuelled by an uncertainty around how co-design and co-production might work in this context, which is explicitly acknowledged at times.

Having outlined this core understanding of and rationale for the co-'s and some of its tensions and ambiguities, I will now explore an alternative understanding of these terms in Future Earth.

5.2 Alternative meaning and rationale: co-'s as reflexivity for democratisation

As discussed in the previous section, the predominant vision of co-design and co-production in Future Earth is that engagement or collaboration between researchers and stakeholders will ensure that the 'right' research questions are asked and therefore relevant or useful knowledge (and solutions) will be produced, and will be more likely to have impact as users have been involved in its production. However, as the following analysis will show, a minority view is also present in the internal documents, blog posts, interviews and focus groups (it is unsurprising that it should emerge in these contexts, where there is perhaps more freedom to imagine something less conventional), primarily voiced by those with a background in or affiliation to social science or humanities.

Much of the previous model is brought forward in this alternative vision (for example, co-'s are seen as iterative and sustained processes, bringing together different types of knowledge, and aiming to move from understanding to impact). This view is also about collaboration between researchers (of different disciplines) and other stakeholders, but with a greater emphasis on plurality, reflexivity, humility, and acknowledging that all perspectives are partial. Participants expressing this view saw co-design and co-production as deliberative or reflexive processes in which multiple perspectives, commitments and knowledges are brought together, discussed and socially constructed:

> I would see the sort of co-construction agenda as about people, all these people, whether they're users, whether they're different scientists from different disciplines, coming to a situation *bringing their own social commitments and drivers and understandings and assumptions about the world* and *bringing those together and reflecting on them reflexively*, realising that everybody's got a set of *partial perspectives* so those need to be *deliberated on and debated out* throughout the process, throughout the design, throughout the doing, throughout the communication.
>
> (Interview 7)

As can be seen here, this view is based on the notion that participants in co-design and co-production (both non-academics and researchers) bring particular worldviews and (normative) positions to that process and that these positionalities should be made explicit and debated during the process. This ambition was shared by another participant:

> FGP2: But I wonder how we could even introduce that *reflexivity* in to it […] that you actually brought in that transparency that this is co-design with a special interest group, that *you actually raise those questions of whose view isn't here*? […]
>
> […]
>
> FGP2: […] and I think that is one of the challenges of integrating the social science and natural sciences and across disciplines and things, that you bring in that reflexivity to say - and make it more transparent - what's included and what's not included in this research, because *if we just pretend that it's all neutral and apolitical and all good in the name of sustainability*…
>
> (Focus group 2)

This participant is calling for greater transparency on the normative, political dimensions of research, through an explicit discussion and acknowledgement of the decisions that have been made regarding what has and has not – and whose views have and have not – been included; here this is specifically linked to disciplinary integration across social and natural science and the notion of co-designing with particular interest groups.

This view could be seen to align with a logic of ontology (Lövbrand, 2011; following Barry *et al.*, 2008) in which dominant frameworks and worldviews can be challenged and ontological questions – including questions of common purpose – asked (such as how the 'objects' of research and matters at stake are defined). That is not to say that participants voicing these opinions were not interested in finding solutions, having impact or 'making a difference'. However, this was more closely associated with extending agency and the rights of knowledge production or governance to non-academic actors, valuing their perspectives and knowledge, and democratising expertise:

> [Co-production] is to recognise that *scientific knowledge or scientists are not the only people who hold relevant knowledge*. That knowledge of practitioners, decision-makers, local communities, etcetera, is *valid knowledge*. […] That is why I like to call them knowledge partners because they are not just providers of additional data, they are not witnesses, *they are active knowledge partners, their knowledge counts*.
>
> (Interview 5)

An integral part of this agenda is not only respecting the knowledge of non-academic stakeholders, but allowing it to hold equal weight in the process, rather than scientific knowledge retaining the sole position of authority; this is seen to require humility on the part of those involved.

Another key element of this view is the notion that the choices made in the process of knowledge production are inherently political – things could be otherwise – so democratising that choice and/or acknowledging what has not been included (as also seen in the focus group extract above) are both important aspects:

> So, *integrated co-produced science* is not about being monolithic, it is actually about *recognising that there is a plurality of sets of questions* that one might ask, lines of investigation that one might pursue, and *actively democratising those*, or at least if you're going to pursue a dominant, powerful line, then you need to *be very clear* that that's what you're doing and why. And make clear *what is being excluded* in the process.
>
> (Interview 7)

This view is voiced by those with backgrounds in social science and the humanities, and is grounded in and informed by ideas about knowledge politics from those fields, including STS ideas such as Jasanoff's interpretation of co-production, as explicitly acknowledged by some participants. One participant referred to Jasanoff while describing a situation in her/his previous research in which a clash occurred between ‘two co-produced sets of knowledge and practice’:

> we had a very strong co-production of [an expert/policy discourse] and a set of policies and a social ordering that repressed local practices, and at the same time there was another kind of co-production going on which was around the social relations and livelihood commitments and local knowledges of people who’d been living in those environments […]
>
> (Interview 7)

In Future Earth, the co-’s are primarily about ‘making things together’ (Chilvers et al., 2014), where “co-” signifies the multiple parties involved in research governance, design or production. The object that is co-designed or co-produced (the “what”) seems to be a less significant or more variable part of the definition than “by whom”; each view on co-production outlined in this chapter considers co-’s to be a process in which academic and non-academic stakeholders come together. Perhaps this is due to instilled research cultures: the design and production of knowledge is not seen to be new; what is considered to be new here is the “co-”, and the “co-” signifies some sort of togetherness of different (from the usual, and from each other) actors, and implies the process of them producing or making something together. This contrasts with co-production as a concept to describe co-constitution, where “co-” primarily signifies not only multiple subjects (people) but also objects, norms, identities, discourses, social orders, knowledges, etc. Here “what” is co-produced “with what” is more important (and it may not be possible to ask “by whom”, as intentional agency is not necessarily a driving force of this relational process, at least not in the ways intended by actors). The “co-” is the interaction, reciprocation and mutual embeddedness of the constitutive elements, not (necessarily) of the actors involved. Although this understanding underpins the alternative view of co-’s in Future Earth outlined in this section, that view still imagines collaboration as the core aspect of these terms in the context of Future Earth.

The extent to which ideas about co-constitution filtered into the broader Future Earth discourse was quite limited at the time the fieldwork was conducted. For example, an early draft internal document on engagement produced in November 2013 comprises a nuanced view of these concepts, noting potential ‘caricatured’ mental models that those involved might associate with engagement (e.g. ‘Link with end-users so they help us prioritise the research that we then go off and do’), acknowledging the limits of the pipeline or linear model of science-society relations, and drawing on STS literature to suggest alternative interpretations. Later versions of this document (which evolved into a draft engagement White Paper, then draft engagement Green Paper) build on some aspects of the earlier note, but the explicitly constructivist material on co-production as reflexivity and knowledge/interests as constructed through the process has been edited out. The critique of the linear model remains; here it is reconceptualised as a science-policy-society/stakeholders triangle interface, with collaboration at the centre (somewhat missing the point of the critique: that ‘science’, ‘society/stakeholders’ and ‘policy’ are not tightly bounded, independent domains or groups).

Despite this, aspects of this alternative view of the co-’s are still present in the documents to some extent and certainly carried forward by some committee members, as seen during Focus Group 1, as further explored in section 7.1. This view builds on STS and social science ideas as it is also about acknowledging the normative aspects of knowledge, the normative role of researchers, the knowledge politics at play, and using/redirecting these (e.g. to change stakeholder processes and contexts such as the IPCC and similar processes; to offer stakeholders a seat at the table, etc.).

According to this view, the role of the researcher (particularly social scientists) might be to facilitate, catalyse or enable this reflexivity, ensure the acknowledgement and inclusion of marginalised viewpoints, or to be an activist or advocate for particular trajectories:

> FGP2: […] I think *a lot of us are frustrated activists and co-design is an outlet for it*. In other words we have *greater access to people of power* and it is sort of an *increasingly legitimised form of activism for people who are officially not allowed to be activists*. Um y’know [as]-
>
> […]
>
> FGP2: […] I wonder *how much of that is not in that desire to be somehow impactful in the world*?

> FGP5: That's right. FGP4: Oh I agree.
>
> […]
>
> FGP2: But so you know if we take the extreme view of that and say it is pretty much all just interest politics I mean how- what's then the difference between having a co-production process versus just *going in to a political square and hitting each other over the head and one wins*, *what is the difference between that type of sort of political process versus the sort of more science centred […] process* of working out where we move forward?
>
> (Focus group 1)

Again, echoing the spatial and pugilistic metaphors of the arena and the ring as explored in section 5.1, conflict is central to this evocative image of people 'hitting each other over the head' in a 'political square'. FGP2 raises an important question about how the boundary can be drawn or the distinction made between science and political process if we acknowledge that all research is in some way shaped by the position of the researcher, and the researcher's desire to have impact (or, indeed, the requirement to have impact stipulated by the broader incentive system of research).

Later during the same focus group, the discussion turned to the embodied nature of collaboration, as one natural scientist spoke of her/his experiences of working together with non-academic stakeholders:

> FGP4: I want to add an aspect to this sort of activism. For once I agree because I think that for the natural scientist to be part of the co-design/co-production strategy, *take us from the comfort zone because we are not any more objective scientists with numbers because we have to be in a table and we have to confront with others and we cannot do that without our emotions, our will*… I like that at least as you put it… I think you are right, *we are persons that we bring all of us to that discussion* […]

The identity of the researcher as a scientist is at stake as much as the social relationship between researchers and others (though the extent to which this identity might also be inextricably entwined with social, embodied relations between researchers – and others – during standard research practice is not considered here).

FGP2 picked up this theme again later, noting the significance of embodied social relations to what might be considered legitimate knowledge or a legitimate process, suggesting that co-design or co-production is about more than identifying what the important questions or issues are:

> FGP2: See I think what you're pointing to is actually goes beyond identifying what's important, […] *these processes of co-anything,* are designed to find that sweet spot that identifies what's important, *what's salient, what's most credible and what's legitimate,*
>
> FGP3: [yeah]
>
> FGP2: what's a legitimate process to have all the concerns heard, all of the different positions and what not, so I think that is a really important balancing act that occurs in that process but I think it hinges on – I guess ever since the beginning of the Enlightenment – *a prioritising of information, of knowledge of a particular kind over all else* and I think we… we need not forget that you know *it doesn't exist by itself,* I think that *the process component, the relationship component of knowledge* is so huge, you know to me *it is not just identifying what's important,* it's like "I know you now
>
> FGP3: [exactly]
>
> FGP2: [and] because of that I cannot bash what you're saying because you and I are just friends now" or whatever,
>
> […]
>
> FGP2: Right and so *knowledge becomes embodied in relationships, in social relations*
>
> FGP3: [yeah, absolutely]
>
> FGP5: [yeah]
>
> FGP2: and contractual relationships and I think that we need not forget that in our definition of co-design/co-production.

Process and relationship as integral to knowledge is foregrounded here, though the word 'bash' suggests that this may be based in conflict rather than consensus. FGP2's argument could be read to suggest that the knowledge prioritised since the Enlightenment – i.e. scientific knowledge – achieved that elevated or legitimate status through its embodiment in social relations, in that 'it doesn't exist by itself'; through particular social processes and relationships it becomes considered to be legitimate, credible or authoritative. The social element of knowledge, FGP2 argues, needs to be considered in relation to co-design and co-production.

The view of researchers as activists or advocates was discussed again later during the same focus group – this again links up with issues about scientific identity and possible threats to that identity:

> FGP3: […] I'm sure you know, that knowledge, whatever we produce is a necessary condition for informed decision making. But it is not sufficient, there is lots of other factors
>
> FGP4: [yeah]
>
> FGP3: go in to every decision and that is why too many scientists get totally frustrated because they are not willing to recognise there's a bigger game basically. […] you've got vested interests, you have ideologies, all a part of the decision making process. [laughs]
>
> FGP5: [Yeah. Yeah.] Which does raise a question about *where the responsibility of scientists stops*, I mean you get some people like Roger Pielke who says all scientists can be at best is honest brokers[38], they can provide the knowledge which says… and it may be knowledge that comes from the co-design process but they *provide knowledge that says OK here are the choices that you've got* and then you hand it over to the political process at which under all these other factors and vested interests begin to intervene…
>
> FGP6: But…
>
> FGP5: I have always wondered if that is actually right, if we should stop there and taking forward that argument that actually *as scientists we are already partly running on normative agendas on politicised agendas because of who we are, because of why we are curious in the first place. I think there's a responsibility of scientists to follow it through, a couple of stages further*
>
> FGP2: [Yeah.]
>
> FGP3: [Yeah, I agree.]
>
> FGP5: [and to] *to act a little bit more like activists*,
>
> FGP3: [right]
>
> FGP5: *[to act] as advocates for particular positions*, while being very conscious of what they're doing and [appreciating that you can't necessarily] run it all the way. Yeah.
>
> FGP2: [Just do it explicitly.]

[38] An honest broker being a scientist that offers options but does not advocate a particular option over any other (Pielke Jr, 2007).

However, the participants considered that particular skills would need to be developed on the part of researchers to engage in this type of activism or political process:

> FGP5: […] *It does raise some furthers questions about capacity and the capacity of scientists to know how to… as it were play these politics*
>
> FGP3: [oh]
>
> FGP5: […] in a way it's kind of *learning how as a scientist one can begin to influence and operate within these political processes in an effective way*. [Yeah, yeah.]
>
> FGP2: [That was] my point earlier about the responsibility
>
> FGP5 and FGP 3: [yeah]
>
> FGP2: [because] if you're sort of stepping half way in and then you know *you also bash the process* or whatever, *you can do humongous [damage]* you know and people are actually often blind to the responsibility or the implication of what they say and it is… I mean it is *deeply destructive* to all the trust that is being built
>
> FGP3: [absolutely] FGP5: [yeah]
>
> FGP2: [so] I mean *the skills that needs to be built to do this*
>
> FGP5: [exactly]
>
> FGP2: *[are] really outside the typical training of a [graduate student]*.

Engaging with political processes is seen as a delicate and fragile undertaking, holding the potential for harm as well as good. To engage in co-production, on the part of scientists, is difficult, as it threatens identity and ideals, requires new skills and training and requires a lot of thinking about the relation between science and politics, which might be quite a novel thing to do for some researchers. The issue of the co-'s as 'threat' (rather than opportunity) will be explored further in section 5.3.

5.2.1 Summary of alternative meaning and rationale

In summary, in this understanding of co-'s, much of the core understanding is brought forward (e.g. co-'s are seen as iterative and sustained processes, bringing together different types of knowledge, moving from understanding to impact). Furthermore, although these broad modes or types allow us to distinguish between differing definitions and goals of co-design and co-production, they are not totally distinct, and some participants draw on each vision. For example participant 9 couched the rationale for co-design and co-production in terms of ensuring decision makers feel ownership and take notice of the knowledge created, but the participant's definition of co-production entailed bringing together different knowledge systems; the challenge to those involved posed by incommensurability – or at least incompatibility – of ideas between epistemologies; and awareness and discussion of these issues (i.e. reflexivity) as a key aspect of co-production.

In common with the core understanding, the alternative understanding explored in this section is also about collaboration or participation, but with a greater emphasis on plurality, reflexivity, and acknowledging that perspectives are partial; its underpinning rationale is around the democratisation of knowledge and the extension of rights of knowledge production to non-academic actors. This is grounded in/informed by social science/STS ideas (including Jasanoff) but the extent to which ideas about co-constitution filter into the broader Future Earth discourse/discussion is quite limited at this stage. However, this view of the co-'s builds on those ideas as it is about acknowledging the normative aspects of knowledge, the normative role of researchers, the knowledge politics at play, and democratising/redirecting these. The role of the researcher is to facilitate this reflexivity and the inclusion of marginalised viewpoints (on the part of social scientists) and/or to be an activist or advocate for particular trajectories. However, co-'s also hold the potential to do harm; the socially embodied nature of knowledge should be acknowledged (including the significance of trust, respect, etc.).

The following section explores a further view of the co-'s, often formulated in response or opposition to the core and alternative understandings outlined above: the view that co-'s might be a threat to existing and valued scientific identities and processes.

5.3 Contestation: co-'s as threat

The two conceptualisations of what co-design/co-production is and the rationales for doing it outlined above (participation for utility and reflexivity for democratisation) are (for the most part) articulated in the context of advocating or promoting this as an approach to research. However, as I will explore in this section, another view of the co-'s emerges in the internal documents, and during meeting observation, focus groups and interviews: a view of co-'s as threatening, disruptive or dangerous to existing (and valued) ways of doing research, or even to human life. While the majority of actors involved, particularly in the global committees, were on board with the co-'s, some were less keen, seeing it as a potential threat to scientific objectivity, independence and academic freedom (this is particularly the case when co-'s are imagined to mean stakeholders both contributing funding and participating in the research process). In this view, co-'s are imagined in opposition to basic or fundamental research. The tension between this vision and co-'s as reflexivity (in particular) is sometimes seen as a tension between natural science and social science.

These tensions drove some of the uncertainties around the co-'s in Future Earth. The extent and nature of involvement/engagement entailed in co-'s, and whether this should be a required feature of Future Earth work, remained ambiguous at the time of the fieldwork; the observation and focus groups featured debate around whether these concepts should imply shared responsibility (collaboration) versus co-'s as consultation, and whether these concepts are set in stone as features of Future Earth research, as further explored in this section.

While co-production is mostly seen as an opportunity, it can also be perceived as a threat to scientists or science in a variety of ways. Many participants referred to the ideal of objective, pure science; either expressing concern about how to preserve it or noting that others in Future Earth feel that it is challenged by co-design and/or co-production. Some of the most significant contestation arose around adherence or otherwise to this ideal, as well as around the notions of scientific independence and academic freedom. One participant suggested that the involvement of private sector organisations (e.g. oil companies) in research could be dangerous, considering the elimination of conflicts of interest to be 'the hallmark of science':

> […] almost all [of the criticisms of co-design and co-production] in one way or another revolve around the issues of *conflicts of interest, the potential for that to influence the outcome or the objectivity of the research and its interpretation and then the potential of suppression of the information when it doesn't support one's point of view*. The strongest proponents of co-design in Future Earth right now […] are very quick to dismiss these concerns on two grounds, one ground is that these criticisms can be easily managed but *usually there is no clear way of how they are going to managed*. […] I think those concerns are very legitimate and there has been some research examples where agendas by *oil companies* that have helped co-design research, agendas by *pharmaceutical companies* that have helped research, agendas by *tobacco companies* that have helped research have crept in to the active production of the knowledge and then its dissemination where *they actually twisted things, mis-represented things and sometimes to the death of people as the result of this*.
>
> (Interview 2)

For this reason the participant argued for a 'complete separation' between stakeholders and the middle of the research process (generating and analysing data). However, this participant was not totally against the co-design of research questions and priorities, as long as there was still support for curiosity-driven science beyond Future Earth. Other participants felt that perceived risks of bias or conflict of interest associated with involving societal stakeholders were legitimate but manageable concerns. For example, one participant suggested that accountability could be built into the research process by stipulating that projects address questions of inequality when co-designing and/or co-producing with business or other powerful actors; another proposed that political co-option could be avoided by ensuring that the academic peer review process would be undertaken by rigorous and sceptical 'top-rate' scientists (as discussed further in Chapter 7).

The view of co-'s as a threat is particularly apparent in the notes generated as part of a meeting of the existing GEC projects in January 2014 (doc 100). Sessions were held to discuss the opportunities and challenges of co-design and co-production, giving rise to discussion of many threats, risks and fears. One participant suggested that within Future Earth there was 'strong bias towards co-design whereas there are substantial scientific issues to address still', and others suggested that 'reaching out and engaging is not a bad thing, but setting up a program with co-design as a key element is dangerous' and 'engagement is more palatable – co-design can be toxic to the community'. A huge range of specific risks were mentioned, including compromising the legitimacy, independence and objectivity of science, the challenges of identifying stakeholders and balancing their needs and interests, and the time, resources and communication skills such interaction might require. Conflict of interest was considered to be particularly problematic in relation to involvement of the private sector, and co-'s were considered to threaten curiosity-driven science and basic research, with the risk that 'Future Earth becomes a consulting firm' or scientists become consultants.

These views were echoed by some participants during the observed committee meetings. The degree of shared responsibility and agreement between parties implied by the 'co-' was seen as problematic by one participant:

> FGP3: […] I have mixed feelings about the idea of co-production and I'll give you some of the positives and some of the negatives. I understand from co-production that you actually… […] you have a research project, and you design it together which means *you agree… both on the structure, the questions, how you take it forward, the implementation of it*. If *you're producing it together* and *you are responsible for the end product, for the outcomes*.

The participant went on to contrast this with the consultation of stakeholders, which was seen as beneficial (as opposed to scientists being consultants, as above):

> And it's *different from consultation* with stakeholders, so as far as consultation is concerned, I suppose you're talking about with NGOs in whose field site you're working or with policy makers, I think consultation I see as a real plus/plus because it enriches your potential questions, *it doesn't hold you responsible for actually taking… you consult but you don't necessarily agree with that, you don't have to take it in to account but it certainly broadens and deepens your research space*. The co-production requires something else which is an *agreement on the aims and objectives* and I see there are difficulties here because… especially if talking to policy makers because they could be *differences in perspectives, the differences in expertise, the methodologies*, […] A lot of the times *policy makers are actually resistant to the set of ideas you're promoting*. So going all the way and saying we're co-producing it seems to me is a real stretch.

The participant's concern is the degree to which co-production commits the researcher to taking into consideration the stakeholders' perspectives, and what might happen when stakeholders are not supportive of the approach or ideas the researcher wants to use or promote; i.e. the independence or freedom of research is compromised. The participant went on to raise another issue, relating to the limitations of a demand-driven model:

> The other negative is that *there are leaps of ideas* that you make which are not incremental and which are *not demand driven* and I think a lot of good research in science or social science is not demand driven, it's not like industry coming or a farmer coming to you and saying "look I have a real problem with rust in wheat and can you give me a solution"? It's really Borlaug sitting in Summit and saying "OK I am going to produce a new hybrid variety of wheat" and there is a leap in the idea. […] So I think research can't be limited to the notion that you have to co-produce and co-design because there can be both limitations and conflicts as well.
>
> (Focus group 2)

Linked to the projects' concerns about research as consultancy above, this participant considers a demand-led approach to stifle the 'leaps of ideas' that have led to particular (social) scientific or technological developments and innovations.

Awareness of these concerns about solutions-orientation and co-design/co-production threatening basic, fundamental and curiosity-driven research was apparent in the video interviews conducted by Interim Secretariat members with committee members during the Beijing meetings: two participants framed their responses to questions about co-design, co-production and solutions-oriented science in Future Earth in terms of defending the influence that these new approaches might have on the excellence of the science undertaken, and highlighting the important role of fundamental and cutting edge research in Future Earth. One Science Committee member suggested that 'Future Earth, rather than being something "fundamental science doesn't have a place in it", Future Earth should be a magnet for scientists interested in research which is fundamentally new within the context of socially relevant questions.' Another suggested that, rather than stopping people from doing 'basic blue sky research', 'we hope that Future Earth will bring with it a shift to more basic use-oriented, use-inspired research'. From this perspective, rather than threatening fundamental science, the approaches to research advocated in Future Earth lead to better, more excellent, reinvigorated research: 'Future Earth is not going to make our science more superficial, less interesting, less sharp – quite to the contrary.'

Further contestation arose around the co-’s in the context of a plenary discussion on engagement during the committee meetings, where the extent to which committee members were not on the same page about whether co-’s should be a core feature of all Future Earth research became apparent. There were signs that the tensions between different ideas about what the “co-” concepts mean were rooted in disciplinary or epistemological differences, particularly between those that saw co-’s as a threat (predominantly natural scientists and positivist social scientists) and those that saw it as an opportunity for reflexivity (predominantly from interpretive social science and humanities backgrounds). One participant suggested that the language of an internal presentation on Future Earth’s approach to engagement felt like ‘the revenge of social scientists on natural scientists’.

5.3.1 Summary of the three views on co-’s

Table 2 below summarises the three views on co-’s presented thus far: co-’s as participation for utility, co-’s as reflexivity for democratisation, and co-’s as threat.

These different views also echo some of the tensions in Future Earth’s identity and remit explored in Chapter 4 (Table 1): for example, co-’s as reflexivity for democratisation emphasises multiplicity, diversity and debate, while co-’s as participation for relevance, acceptance and utility might suggest a greater focus on consensus, integration and solutions; finally, co-’s are seen by some as a threat to curiosity driven research by shifting the focus to demand.

[Page intentionally left blank.]

Table 2: Three views on co-'s

Type	Co-design/co-production as **participation for acceptability, relevance, utility and impact**	Co-design/co-production as **reflexivity and deliberation for democratisation**	Co-design/co-production as a **threat**
Definition	Societal stakeholders participate in two-way dialogues and collaborate with researchers from different disciplines in order to jointly: • frame, define, design research strategies, priorities, agendas, projects, Future Earth itself [co-design, co-creation] • produce knowledge, implement research projects [co-production, co-creation] • disseminate and implement research/knowledge results, outputs, solutions [co-dissemination, co-delivery]	Societal stakeholders come together with researchers from different disciplines throughout the research process to: • reflexively debate, deliberate and make explicit everyone's partial perspectives, worldviews, assumptions; • acknowledge who/what is included and excluded, acknowledge alternatives and the normative dimensions of research; • include a range of perspectives; • democratise questions and lines of investigation, bring about epistemic equality and cognitive justice.	Co-design/co-production in which stakeholders are involved in science/research (whether through participation and/or deliberation) poses a threat to the objectivity, independence and autonomy of science/research. Co-design/co-production may be acceptable in Future Earth but not at all stages of the research process, and/or not with all types of stakeholder, and there must still be space for fundamental, basic research within and/or outside of Future Earth.
What is co-produced?	Solutions oriented, relevant (not prescriptive) research questions, knowledge, solutions, information, policy options, insights, data, tools	Socially embodied knowledge and solutions; science/research and social order, norms and worldviews	Co-design of research questions is more acceptable than involvement of stakeholders in data generation, analysis & dissemination
Rationale	Instrumental, utilitarian, logic of accountability: knowledge will be more relevant and efficacious, because: • the "right" research questions are asked; • it is co-owned by people who will use it so gains visibility, credibility and legitimacy; • answers & solutions are more likely to be suitable for/accepted by those they are intended for, and used properly by them, and therefore have impact; • higher quality research will be produced; • legitimacy & authority of Future Earth is increased through institutional co-design.	Political, emancipatory, logic of ontology: the co-design/co-production process will allow questions of common purpose and framing to be asked, assumptions questioned, and alternative options considered, which is important because: • all knowledge & perspectives are partial; • acknowledging this & taking stakeholder knowledge/experience seriously enables democratisation of knowledge production and decision making; • this enables research to make a difference in terms of social justice/power relations.	Epistemological, political, logic of autonomy: science produces independent, objective, reliable knowledge by: • avoiding conflict of interest; • independently pursuing its own agenda.

(Non-academic) participants	Users; representatives of different sectors or stakeholder groups (e.g. policy makers, funders, civil society, private sector): • have knowledge needs; • have information to exchange (or to input into ‘flows’), particularly on what challenges society is/decision makers are facing; • might have existing knowledge and experience to be considered and respected.	Cognitive, epistemic participants (whether scientists, policy makers, practitioners, decision-makers, local communities, others): • have valid knowledge and experience to offer; • have agency; • all have normative commitments and assumptions (including scientists).	Private sector and policy stakeholders: • have interests and biases that might threaten the objectivity of the research; • might prevent the researcher from pursuing particular lines of enquiry; • may twist the research results or misrepresent them.
Role of research and researchers	Lead and guide the co-production process; provide the knowledge (with input from all concerned); responsible for methodologies; provide policy options and policy-relevant (not prescriptive) knowledge (knowledge broker).	Facilitate reflexivity; question own and others’ positionality and assumptions; draw out marginalised knowledges, perspectives so they can be recognised by all; pursue or advocate particular normative agendas (activist).	Avoid conflict of interest and preserve objectivity and/or independence of research.
Science-society relation	Science and society are separate but come together (or enter each other’s spaces) in the process of co-design/co-production.	Science is part of society and the process of co-design and co-production enables the deliberation of worldviews and future visions.	Science and society are separate and should remain so, particularly in the middle of the scientific process.
Ontology/ epistemology	Realist/positivist	Constructivist	Realist/positivist

In relation to the literature discussed in Chapter 2, both van der Hel (2016) and I, working separately but within the same timeframe, revealed a variety of rationales for co-production in Future Earth. Van der Hel's logics of accountability and impact can be subsumed under the understanding of co-'s as participation for utility detailed above, and her logic of humility can be subsumed under the understanding of co-'s as reflexivity for democratisation. However, while van der Hel notes some of the tensions between these approaches and existing ways of valuing and doing research (e.g. notions of independent or autonomous science), she does not distinguish or delineate a separate view of co-'s to account for them.

Regarding delineation, while for analytical purposes I am distinguishing between these broad understandings, views, "types" or modes, as noted above in section 5.2.1, in practice there are some overlaps, with some participants drawing on aspects of more than one view. Furthermore, I am not suggesting that the utility mode and the democratisation mode are in opposition. Deliberation can be a way of making things useful (of course, depending on how 'usefulness' is defined). And although the linear aspect of the utility model might be more closed to efforts towards democratisation, just having these conversations and inviting non-academics into these processes has the potential to create new dynamics (even if they do not result in the type of democratisation, epistemic justice etc. advocated by some). As discussed in Chapter 4, some have argued that some of Future Earth's ambitions are irreconcilable (for example, solutions orientation vs. deliberation and debate), and that the dirigistic ambition to integrate and harmonise across the programme will foreclose multiplicity (Lövbrand *et al*., 2015). But the presence of multiple understandings of the co-'s is itself a form of multiplicity; multiple models and practices can be productive, as further explored in the next section.

5.4 Resolution? Co-'s as multiple and experimental

Those advocating co-design and co-production within Future Earth for the most part seemed very aware of the challenges and contestation described above, particularly that many in the existing GEC research communities (and, indeed, some Future Earth committees members) were sceptical about – or threatened by – these approaches. They were also aware that multiple definitions of these terms abounded. Partly to address the issues raised about co-'s by those that saw co-'s as a threat, and partly to deal with the ambiguities discussed in section 5.1.4 (between extent of co-design and co-production at different levels), several participants suggested that there is or would need to be a spectrum or continuum of co-'s, with different amounts of stakeholder involvement at different stages in the process for different problems (rather than having a standardised requirement for a particular type of co-production across the whole initiative). The extent to which it might be possible to devise shared meanings or principles is further explored in section 7.3.

Some participants suggested that these concepts are always likely to mean something different in different contexts. One participant outlined the multiplicity of co-'s in terms of both meaning and practice, and the need for engagement to be adapted to different contexts:

> The problem with this debate at the moment is that we don't yet have a common agreement on the terms and it's very likely as well that even in the future when people use these terms they'll *mean very different things*. I think what we're stressing right now is that *there are likely to be very diverse ways in which different communities all clustered around different problems do in practice co-creation of agenda-setting or co-production*. […] obviously if you're going to engage with the IPCC it's totally different than if you're gonna engage with the government of Malawi on a new strategy on ecosystems services, it's just fundamentally different, you've got different actor-networks, different discourses, different power relationships… different confluences on both sides.

This multiplicity leads the participant to suggest that co-'s are on a continuum – in that there is a procedural order (in which co-creation and co-production come first followed by co-implementation or co-intervention) and also different phases and configurations:

> I do see it as a *continuum, so co-creation, co-production, and then whatever, co-implementation or co-intervention whatever you want to call it*, it's a *partnership that will somehow have different phases and different configurations and possibly different people involved as well at different stages* so… […] we are currently within Future Earth having a debate about what these things ought to mean*. I think we probably agree that it's likely to mean many different things to different people, there is no correct way or one size fits all* and so […] it'll be a journey in part about learning from other areas where they're further along than we are.
>
> (Interview 8)

The metaphor of a ‘journey’ and the reference to learning suggests that developing co-production in Future Earth is seen as an ongoing process. Participants often stressed the novelty of trying to adopt these approaches in the GEC domain and at the ‘global’ level, characterising this as ‘stepping into the unknown’ and ‘exploring new ground’. Several participants suggested that it would be necessary to learn from existing fields where this type of approach is more usual (albeit at ‘national’ or ‘local’ levels): the most prominent examples being health, development and agricultural studies, but also to learn from the engagement experiences of the existing GEC programmes. Chapter 7 discusses the ways in which this ‘no one size fits all’ philosophy was operationalised and the emphasis on the importance of learning about other and Future Earth’s own attempts at the co-’s.

5.5 Conclusion

During the time of this study, aspects of the tensions in Future Earth’s identity and remit explored in the previous chapter persisted in the form of ambiguity in how co-design and co-production were imagined. The meanings of these terms were multiple, ambiguous and contested; this was (at least partly) driven by varying rationales for advocating the co-’s and differing levels of subscription to the idea that they should be required elements of Future Earth research. The discussions and activity around the co-’s was messy in the sense that there was little consensus on these terms (or indeed on many questions of Future Earth’s broader remit and activities). However, it is possible to identify common themes and features that coalesce around particular views on what these terms are about. While one dominant (not entirely unambiguous) view emerged (co-’s as participation of stakeholders for relevance, acceptance, and utility), a minority understanding was also present (co-’s as reflexivity for democratisation). A third view of co-’s also emerged, often formulated in response or resistance to the first two understandings: the idea that the co-’s might be a threat to the objectivity, independence or freedom of science.

These different visions reveal different ideas about the relationship between science and society and the source and role of the normative in research. The core view suggests that involving stakeholders in research through co-design and co-production will make knowledge more relevant, acceptable, and therefore it will be used more and have greater impact. Co-’s are seen as a means to close a gap between research and policy/practice, where science and society are seen as spatially separate, but would come together in the process of co-design and co-production. Values and the normative are the concerns or expertise of societal stakeholders, and (scientific) knowledge and skills are the expertise of researchers. The role of the researcher (or research more broadly) is that of the knowledge broker, offering policy options and scenarios but not being policy prescriptive (the notion that research might be normative in its framing etc. is rarely, if ever, acknowledged). The second view suggests that co-’s are a process of deliberation or reflexivity, enabling the (partial) knowledge and commitments of multiple parties to be debated, and democratised. It sees science as part of society; all parties, including scientists, are driven by social commitments and norms, and co-design and co-production is a means of making these explicit. The role of the researcher might come closer to that of an activist, not only identifying and making explicit the implicit normative aspects of research, but also taking steps to pursue particular normative agendas in policy or action. Finally, the third view sees science and society as separate and believes that they should remain separate, society having interests and biases that might contaminate or limit science/research in detrimental ways.

To counter the resistance to co-’s expressed partly through the third view, and to deal with some of the ambiguities and challenges of the co-’s (not least the challenges posed by transposing these concepts/approaches into different contexts) Future Earth actors proposed that it might be necessary to develop a continuum or spectrum of co-’s, meaning different things (or at least different extents of engagement) in different contexts (not yet fully specified). Co-’s were seen as innovative and experimental, as they have not been attempted in this field at the global level before (although they are seen as common in other fields, such as medicine, agricultural and development studies), and Future Earth actors are ‘feeling their way’ to work out how to implement this. The concept of co-production potentially creates an experimental condition in Future Earth.

To conclude, ambiguities in the meaning of co-production (and related terms) in Future Earth are underpinned by varying rationales for doing co-production (and related practices) – and for limiting the way that it is done. In this context, the actors involved suggest that they are conducting some sort of experiment. This is not foregrounded in their accounts, but it could potentially be a very useful lens or approach: experimenting might be the only way to proceed given the differences in understanding of what co-'s are and what they are for.

The following chapter further elucidates these different understandings by exploring who is imagined or expected to be involved, revealing in more detail the underlying political imaginaries of science and society and associated notions of the value of research.

Chapter 6: Who is involved in co-production?

Although involving societal stakeholders is key to all understandings of the co-’s in Future Earth, who these stakeholders might be is not always clear, and what this might mean in practice is not often elucidated. This chapter presents an analysis of who is (imagined/supposed to be) involved in Future Earth, thereby drawing out the underlying science-society imaginaries and models (e.g. of democracy, and of the value of research) that inform the different (anticipatory, performative) views of co-production explored in the previous chapter. These underlying imaginaries impact on how co-production can be performed, particularly through their expression in different participatory models.

The previous chapter (Chapter 5) addressed research question 2, exploring meanings of and rationales for co-design and co-production in Future Earth. This chapter addresses research question 3: Who is imagined or expected to be involved in co-design and co-production? What are the underlying models or imaginaries of science and society?

Section **6.1** briefly discusses the implications different rationales for co-design and co-production have on visions of stakeholder engagement (such as who the stakeholders might be). Section **6.2** explores how stakeholders are constructed in Future Earth, and what challenges are faced by this emerging initiative in defining and engaging its stakeholders. Section **6.3** explores tensions between different visions of ‘appropriate’ stakeholders at appropriate stages of co-design/co-production, arguing that these tensions are fuelled by and reflect broader political imaginaries of science and associated notions of public value (linked to the different understanding of co-’s discussed in Chapter 5). The chapter draws on Nowotny’s (2014) conception of political imaginaries (itself inspired by Ezrahi, 2012): ‘necessary fictions that are causative’ (Nowotny, 2014: 17), that inform and guide the visions and views expressed (and related action) by key actors in Future Earth. This conceptual tool is a useful foil against which to tease out sources and implications of the tensions, particularly in relation to differing notions of public value of science, and opinions on which type of stakeholders are appropriate or legitimate.

As Future Earth gradually emerges and stabilises as an organisation, its collective political imaginary is still in flux. This means that there is not one singular shared vision of science and politics, nor how co-production fits in at the intersections of science, politics and stakeholders (nor might there ever be). This has implications for how stakeholders are imagined in the initiative.

As explored in more depth in Chapter 2, imaginaries, whether political (Nowotny, 2014), socio-technical (Jasanoff & Kim, 2009), technoscientific (Marcus, 1994), or social (Taylor, 2004), can be considered to be instruments of the co-production (or co-constitution) of science (or knowledge) and social order (Jasanoff & Kim, 2015). Visions of scientific and technological futures draw on and are imbued with implicit (or sometimes explicit) visions of social order, including notions of identity, politics and the public good. In exploring the political imaginaries in Future Earth, I am taking steps to build a picture of the latent 'reflexive-relational' (Chilvers *et al.*, 2014) processes of co-production – or co-constitution – of science and social order occurring within and around the initiative and its deliberate agenda of co-design/co-production of research.

The following section briefly relates the core rationale for co-'s as explored in Chapter 5 to another rationale for co-'s discussed within the STS literature (increasing public trust in science), in order to clarify the different visions of stakeholder engagement entailed by each.

6.1 Implications of rationales for co-'s on visions of stakeholder engagement

The previous chapter outlined different meanings and rationales for co-design and co-production within Future Earth. These rationales have a bearing on the imagined or proposed stakeholders in co-design and co-production, whether policy makers, business, publics, or others (and the boundaries – imagined or otherwise – between them). For example, if co-'s are proposed as a governance option to address eroded public credibility of science/lack of public trust in science, publics may be envisaged as the predominant stakeholder; whereas if co-'s are seen as a means to increase the impact of research on policy making, policy makers may be envisaged as the predominant stakeholder (though publics, citizens or society might still figure as the ultimate beneficiaries of science). In either of these cases, credibility can be seen as an end and/or a means of the governance exercise, though in whose esteem might differ.

In a science governance literature review for a BIS/Sciencewise-ERC[39] project on 'Science, Trust and Public Engagement', Chilvers and Macnaghten (2011: 21) position co-design as a 'route through which publics can have influence in shaping the nature and direction of emerging science and technology (including its priorities, objectives and strategies)'. They depict governance challenges in relation to climate science and policy in terms of 'increasing public scrutiny and an erosion of public trust in climate science' (27), suggesting that science governance responses in the UK and internationally in the wake of 'Climategate' and 'Glaciergate' might extend beyond science-centric calls for openness and transparency to achieve 'restoration of trust in expert organisations' through the 'radical reframing and reconfiguration of the relationship between climate science, climate policy and societal change' (28). This is motivated by an aim to acknowledge a multiplicity of perspectives and the role of value judgements in climate science and policy, and for knowledge to be scrutinised by a broader community of citizens in order to be validated. Chilvers and Macnaghten propose various governance options to achieve this, such as widening participation on expert committees, extended peer review, and 'co-produced forms of knowledge with climate scientists working in collaboration with social scientists and non-scientists' (28).

This view of co-design and co-production seems to advocate literally finding a place for publics in and between climate science and politics, enabling them to interact directly with scientific and policy processes (although, of course, this might well be an artefact of the BIS/Sciencewise-ERC project's focus on trust and public engagement rather than on other dimensions of science governance). In contrast, as discussed in Chapter 5, Future Earth's core rationale for co-'s is motivated by an intention to increase the 'impact' of research by ensuring that knowledge is used by governments, business and civil society (which may or may not entail increasing

[39] Department of Business, Innovation and Skills / Sciencewise – Expert Resource Centre ('the UK's national centre for public dialogue in policy making involving science and technology issues').

legitimacy or credibility as means or end). This rationale favours the aforementioned societal groups as primary stakeholders, rather than ‘the public’ or publics as in Chilvers and Macnaghten’s review. Although lack of public trust in science is seen as a key issue (and reason to pursue governance options such as co-design/co-production) by organisations such as Sciencewise, it is not raised explicitly within official Future Earth publications as a rationale for co-design/co-production; it was mentioned by just one participant within one of the focus groups (and there is it linked with public acceptability). With Future Earth’s emphasis on providing knowledge for policy and decision-making and its ambition to produce ‘solutions-oriented’ knowledge, ‘the public’ is rarely mentioned as primary stakeholder – if at all.

As explored extensively in the STS literature, ‘the public’ is a complicated term (Mohr *et al.*, 2013; Wynne, 2007; Irwin, 2006; Welsh & Wynne, 2013; Felt & Wynne, 2007; Felt & Fochler, 2007). Rather than existing as a pre-established entity ‘out there’ waiting to be engaged in science, politics or both, public(s) are ‘called into existence, they are *convened*’ (Barnett, 2008: 26; original emphasis) for various purposes by various actors in various situations. This literature explores how publics – plural to acknowledge the diversity and multiplicity of possible configurations – are imagined, constructed, deployed, to what ends, and, importantly, what – or whom – may be missing or excluded from these constructions.

While much of the empirical literature on co-production in practice explores interactions between scientists and policy makers (for example, in environmental governance: Lemos and Morehouse, 2005; Dilling and Lemos, 2011; Lövbrand, 2011), the STS literature on democratisation of science (including, of course, the public understanding of and public engagement with science literature) is framed with reference to publics. This analysis will therefore explore how publics, along with other stakeholders, are imagined in Future Earth.

The following section will explore the construction of Future Earth stakeholders in more detail to give an overview of the imagined potential participants in/audiences of (co-production in) Future Earth, including how these conceptualisations link to the particular understandings of engagement and co-design/co-production as outlined in Chapter 5.

6.2 Visions of Future Earth's stakeholders

Those imagined to have a stake in Future Earth – stakeholders – are characterised in a range of ways, explored in this section. Section 6.2.1 explores the broadest framing of Future Earth's potential stakeholder or beneficiary, that is, 'society', as well as Future Earth's focus on 'users' and 'partners' and how these terms relate to the understandings of co-'s as discussed in the previous chapter. Section 6.2.2 looks more specifically at what the term 'stakeholders' means in Future Earth, what it might comprise, and the extent to which 'the public' or publics might be considered stakeholders in Future Earth. Section 6.2.3 explores the challenges of representation and representativeness that arise in relation to Future Earth's stakeholders.

6.2.1 Stakeholders as recipients? 'Society', 'users' and 'partners'

Future Earth seeks to become 'the global research platform providing the knowledge and support to accelerate our transformations to a sustainable world' and 'a platform for international engagement to ensure that knowledge is generated *in partnership with society and users of science*' (Future Earth, 2014a). Its ambitions as articulated in official Future Earth documents include: to effect 'a step change in international collaboration *in the service of all people on our planet* — a major new effort to […] identify transformations that create a better future *for humankind*' (Future Earth, 2013b: 5); and to 'realise *a new 'social contract' between science and society* to accelerate the delivery of *the knowledge that society needs* to address pressing environmental changes' (11). Throughout Future Earth discourse, science and society are positioned as separate and in need of a new, closer relationship, for the benefit of society. As seen in these extracts, society is positioned as requiring knowledge and solutions in order to address environmental change and achieve sustainability, which science can provide or contribute to providing. This framing seems to suggest a ‘transmission’ or ‘deficit’ model of communication/interaction rather than a dialogic one, and/or a ‘pipeline’ or ‘linear’ model of research, policy and innovation.[40]

While ‘society’ is positioned as a general, abstract ‘ultimate beneficiary’ (Nowotny, 2014: 16) of Future Earth research, other terms are used to specify which parties will be involved in the initiative.

Future Earth’s focus on achieving impact through the use of the research it produces is apparent in references to ‘users’ (as seen in Chapter 5):

> Future Earth invites the broad community of researchers working within the natural and social sciences, engineering and the humanities to engage in developing knowledge that is co-designed with *those who use research in governments, business, and civil society*.
>
> (Future Earth, 2013b: 21)

However, more recent documents reflect a shift in language from ‘users’ to ‘partners’, as acknowledged by one participant:

> I think we qualitatively want to change the way in which we do agenda-setting within science, […] how we do science itself, […] So that this isn’t simply about a communications strategy which is one-way and […] [it] is really an attempt to involve ourselves in societal arenas as well […]. So I think it’s actually through that qualitative change we will have a much more intensive engagement, so also changing the language we use, *not talk about research users anymore but to talk about partners*, […] to see the academies active in societal arenas and that’s terribly difficult and terribly… nerve-wracking and we don’t have capacities on either side actually within science or within society to do this adequately yet, but I think if we look back in ten years’ time we’ll be doing something fundamentally different than what we do now […]
>
> (Interview 8)

Here, this shift in language is seen as valuable in enacting a shift in the way that science is done, including a greater intensity of academic activity beyond the academy. This shift is both temporal and spatial in nature, disrupting the one-way communication model in which non-academic stakeholders are seen as *end* users rather than as viable participants at earlier stages of research processes; but also

[40] The tension between this framing and Future Earth’s calls (throughout the documents and interviews) for collaboration, two-way dialogue, and the rejection of the linear model is discussed in more detail in the previous chapter.

encouraging academics to inhabit or enter the same space as those partners – societal arenas (as discussed in Chapter 5). It perhaps also suggests a shift in responsibility and level of investment; 'partners' taking an equal or greater role and interest in comparison with 'users'. However, in common with all of the documents and many of the interviews, the science/society dichotomy is reinforced through the characterisation of these domains as distinct, consistent with the 'participation for utility' understanding of the co-'s.

The temporal aspect of the shift in language is a view shared by other Future Earth actors. For example, one focus group participant argued that 'we as a scientific entity *need to hear from users of the information who will we will now call not just stakeholders but partners with us*, what are the challenges they see out there for decision making'. This rationale for the shift in language relates to engaging stakeholders in determining research priorities and questions, but retains the assumption that the stakeholders are users or recipients of a service, rather than participants in deliberation with their own knowledge to contribute. This seems to be the dominant view across the documents and in some interviews, although, as explored in Chapter 5, some participants considered stakeholders to be active contributors of knowledge or expertise; as expressed here in relation to the terms 'user' and 'partner':

> […] that is why I like to call them [practitioners, decision makers, local communities etcetera] *knowledge partners* because they are not just *providers* of additional data, they are not witnesses, they are *active knowledge partners*, their knowledge counts. And for me that is what is different to the more sort of participatory research approaches that we know of the past where we bring on board *users* but they are there as *users of knowledge* rather than relevant *producers of knowledge*.
>
> (Interview 5)

This conceptualisation of non-academic participants as producers of knowledge rather than solely users of knowledge relates to the reflexivity for democratisation understanding of co-'s discussed in Chapter 5.

The tension between imagining stakeholders as users/recipients and stakeholders as active contributors, indeed 'actors', is apparent in this focus group extract, which begins with one participant explaining why co-design is not the same as multi- or interdisciplinarity:

> FGP9: Because the actors, you have researchers, policy makers, you have civil society people, that's the way they've framed it, so scientists, social scientist are co-designing, the policy makers, *they are the users of what you do* or with civil society *are the users.* It's not researchers co-designing with each other, we've always been doing that, I mean that is no big deal, I don't think that is what Future Earth is talking about.
>
> […]
>
> FGP7: [...] It's not science talking to science, it's science talking to society.
>
> FGP10: *[Co-design is the buyer] of the car saying 'you know I would really like it to be like this' meaning you know you design it for me.*
>
> […]
>
> FGP8: But it is also the farmer saying 'I don't want the average monthly forecast, I want when the rain arrives I want the amount that comes on this…' and then you say 'oh gosh can our models can do that' and going back and so I think that you have described it really well with you know kind of *bringing in the multiple perspectives to actually generate something new* that hasn't-
>
> FGP10: -[But] you brought in an even more important point, which is the point that [CNC-FE member] on the first day was stressing, the cultural… the *insights of the cultural actor*, meaning that *the farmer has an immense amount of knowledge* and *knows the information that he or she needs* and so the scientist just comes in and is looking at it from a purely technical scientific perspective but is not attuned to those… *what the question really is* and then really missing the boat so…'
>
> (Focus Group 2)

Here, FGP10 firstly imagines the user in relation to a financial transaction (in which they are the 'buyer of the car', stipulating their preferences and requirements, which are then attended to by the researchers), before imagining them to hold knowledge and have insights that should shape the question/problem to be addressed by the researchers who would otherwise approach it purely from a technical perspective (cf. Wynne, 1996). FGP8 seems to be describing a similar service model in which the stakeholder defines their needs, to which scientists respond, but then moves beyond this in suggesting that the multiple perspectives generate something new (rather than just define the question). The extent to which stakeholders are explicitly imagined as having valuable knowledge beyond defining the 'right' questions in a service/utility model of co-'s perhaps depends to some extent on whether the participant is discussing co-design or co-production; as seen in the previous chapter, in Future Earth, often co-design comprises problem or question definition, and co-production comprises the generation of knowledge.

Again, here, the science/society dichotomy is reinforced with reference to 'science talking to society' and 'the cultural actor'.

In this section I have argued that Future Earth visions of 'society', 'users' and 'partners' predominantly see these entities or groups as beneficiaries, recipients and/or aids to agenda-setting, whilst a minority see them as active participants in knowledge construction, although this may depend on whether co-design or co-production is being considered. The next section will explore imagined 'stakeholders' as societal groups and 'publics' in Future Earth.

6.2.2 'Stakeholders' as societal groups: 'the public' as absent

While 'society' and 'users'/'partners' are significant to the framing and rationales for Future Earth and its co-design/co-production, participants or concerned parties in Future Earth are predominantly referred to as 'stakeholders'. An NVivo query search for 'stakeholder' finds 1017 references across the external and internal documents, 515 references to 'partner', 505 references to 'society', 229 references to 'user', and just 38 references to 'public'.[41] This section examines how the seemingly broad category of 'stakeholder' is narrowed through more targeted (although often still ambiguous) wording, as well as exploring if, where and how 'the public' is or publics are imagined as a stakeholder in Future Earth.

The Future Earth Design Report, a key document emerging from the early development of the initiative, suggests that Future Earth subscribes to the IPCC's (2007) definition of stakeholders: 'a person or an organisation that has a legitimate interest in a project or entity, or would be affected by a particular action or policy'; further elaborating that 'Future Earth recognises its legitimate stakeholders as bodies

[41] NVivo query for 'stakeholder*', 'partner*', 'society', 'user*', and 'public* NOT publication*'.

or people that have a declared or conceivable interest in its work' (Future Earth, 2013b: 53). These definitions render the scope of potential Future Earth stakeholders extremely broad, constrained only by the use of the adjective 'legitimate'. The documents do not specify who will make decisions about the legitimacy of potential stakeholders or how these decisions will be made and when asked this question in interview, participants acknowledged it as a difficult issue without giving a full response. However, the potential breadth of this definition of stakeholder is somewhat narrowed by the more targeted language throughout the documents (and to some extent the interviews), suggesting that some limits to legitimacy are already embedded into Future Earth's documents and governance structure (the interviews and focus groups are more illuminating in relation to tensions around who is considered to be a legitimate stakeholder, as discussed below in section 6.2.3).

In the documents, stakeholders are predominantly listed in terms of particular societal sectors, presumably to identify the potential scope of stakeholders:

> Future Earth will deliver science of the highest quality, integrating, as necessary, different disciplines from the natural and social sciences (including economic, legal and behavioural research), engineering and humanities. It will be co-designed and co-produced by *academics, governments, business and civil society* from all regions of the world, encompass bottom-up ideas from the wide scientific community, be solution-oriented, and inclusive of existing international Global Environmental Change projects and related research activities.
>
> (Future Earth 2013b: 10)

> Close collaboration is essential between the scientific community and stakeholders across the *public, private and voluntary sectors* to encourage scientific innovation and address policy needs.
>
> (Future Earth, 2013b: 11)

This framing suggests that a representative model of participation is perhaps at the forefront of the official Future Earth imagination of its stakeholders. This is reinforced by the Design Report's adoption of the term 'major stakeholder groups', reminiscent of UN terminology, listing the following categories: Academic research; Science-policy interface organisations; Research funders; Governments (national, regional and international); Development bodies; Business and industry; Civil society; and Media. Although the report acknowledges that it is 'difficult to unambiguously classify [stakeholder communities] into distinct groups' (24), little attention is paid to stakeholders that might fall between or outside of the groups as defined in the document. For example, 'civil society' is defined as follows (to include NGOs and indigenous communities):

> These are *groups* organised independently from governments and governmental institutions. *Civil society groups have organised themselves to represent their interests* with governments or other influential actors. The *NGOs* have nowadays taken over some roles that traditionally have been the responsibility of local or national governments. NGOs have also been instrumental in national and international policy negotiations and in producing research reports. All these accomplishments increase the relevance of these actors to Future Earth. *Civil society in this document includes indigenous communities, recognising the important knowledge that these groups can offer* and the important role they can play in Future Earth.
>
> (Future Earth, 2013b: 25)

From this definition, it is unclear whether there will be space in Future Earth for citizens who are not actively organised into or represented by NGOs or other sectoral groups that are invited to participate in the initiative, or for those that are organised into broader social movements that might not be considered to be acceptable stakeholders (e.g. 'lay', 'disorganised', 'uninvited' or 'unruly' publics (I. Welsh & Wynne, 2013; de Saille, 2015a)). However, there was consideration of this during the observed committee meetings, as further discussed in Chapter 7.

Explicit references to 'the public' or 'publics' are absent from the Design Report's definitions of the major stakeholder groups, apart from that of research funders, described primarily in terms of their support for research but also considered to 'work with [researchers] to inspire young people and engage *the wider public* with research'. Governments are described as 'responsible for managing and balancing the short and long-term well-being of their *citizens*, business, environments and resources'; development groups are considered to play a role in 'amplifying the voices of *the poorest people*' (Future Earth, 2013b: 24); and the media are not linked to the public in this text, although one participant suggested that representatives of the media are involved in Future Earth governance committees as a sort of proxy for the public.

While the Design Report (and other documents) imply that these named stakeholder groups will have an active role in the governance of Future Earth and the co-design and co-production of Future Earth research, ‘the public’ is for the most part framed as an audience of ‘outreach’, ‘education’, ‘communication’ and ‘data access’ rather than as a potential participant in research governance or production.

Stakeholders that do not necessarily fall within the major stakeholder groups (e.g. ‘spiritual and cultural leaders, and citizens who are re-evaluating their lifestyles and legacies for their descendants’ (Future Earth, 2013b: 40) are mentioned in the Design Report as necessary partners within particular research themes, suggesting that there may be space for engagement with more diverse publics and/or individuals at the research project level if not at the governance level.

Documents from the early development of the initiative characterise ‘the public’ (along with policy makers) as needing to be informed by GEC science in order to respond effectively to global change challenges. The glossary entry for ‘transdisciplinary’ in one early document suggests that ‘the public’ can also be a contributor to knowledge production:

> Transdisciplinary: Research that both integrates academic researchers from different unrelated disciplines and non-academic participants, such as *policymakers and the public*, to research a common goal and create new knowledge and theory.
>
> (ICSU, 2010: 20)

This marginal framing is lost in the glossary of the more recently published Design Report, in which ‘civil society groups and business representatives’ replace ‘the public’ in the definition of transdisciplinarity (Future Earth, 2013b: 69).

Another example of how stakeholder communities seem to be drawn broadly only to be narrowed by subsequent wording can be seen in the online ‘community consultation’ on Future Earth research priorities that was launched in April 2014, ‘intended as an inclusive, multi-stakeholder consultation’, to ‘gain new ideas from global societal stakeholders of Future Earth’. However, the Future Earth website specified that the consultation was looking to develop ‘research priorities that will be co-designed with stakeholders from the *funding, business and policy* communities' (web 55).

This section has explored the predominant categorisation of Future Earth stakeholders – societal sectors or organised groups – and whether/how 'the public' is imagined as a distinct stakeholder in the initiative, finding that 'the public' is predominantly imagined as an audience of communication/education or is subsumed into/represented by other societal groups. However, this is indicative of the challenges in defining stakeholders (particularly public(s)) on a global scale in the context of GEC as a global issue and Future Earth as a global organisation – or at all – as discussed further in the following section.

6.2.3 Challenges: scale, representativeness and representation

Ambiguities and difficulties in defining stakeholders, drawing boundaries around potential stakeholder communities and considering representativeness and representation were acknowledged explicitly or raised implicitly by several participants. At the time of the fieldwork, it was clear that many uncertainties were still to be resolved around who should be involved and how. These issues are not particular to this initiative; many of the challenges Future Earth faced (and may still face) in articulating its practices, stakeholders, and underlying visions or models of science and democracy have been discussed extensively in the STS literature.

It was apparent in the interviews that although these issues were still to be (and perhaps may never be fully) settled at the institutional level, unsurprisingly many individual actors had their own ideas about how to define (and involve) stakeholders, usually rooted in the interviewees' day-to-day practice. For example, one participant consistently referred to stakeholders as 'decision makers', and when asked what that means and whether other kinds of stakeholders are or might be involved in Future Earth, she/he responded by outlining the definition of stakeholder categories used by her/his institution, noting that there probably wouldn't be agreement on that language within the Future Earth Science Committee. In the context of her/his institution, the category of 'stakeholder' comprises 'anyone who would be affected by [the institution's] research', split into the sub-groups of 'people who are making decisions based on [the institution's] research, and people who are affected by the decisions that are made as a result of taking note of that research'. Those categories are distinguished from that of 'clients': 'people who would actually be prepared to pay for research'. The participant considered all of these categories to be relevant to Future Earth, but went on to identify limitations in using these definitions when operating on a global scale:

> I think the bigger – if you're dealing with a single farmer they can potentially be all three of those, er, if you're dealing with the entire globe [laughs] it's obviously a bit hard to interact with every individual who might possibly be affected by some research…
>
> (Interview 9)

The participant has identified one of the key flaws in arguments for greater inclusivity in terms of direct participation in the research process: they are inherently exclusive (Lövbrand *et al.*, 2011). It could be argued that this is the case for all research participation, even if operating on a smaller geographical scale than the global. But if it is not possible to include all stakeholders, how are decisions made about whom to include?

The participant does not specify how stakeholders are identified and reached, but after noting the potentially impossible scale of Future Earth's stakeholder community, she/he moved on to discuss the varying extents to which co-design, co-production might be desirable, suggesting that 'co-dissemination' is a way to 'extend the results of that research', by involving parts of the stakeholder community in considering how to deliver the research so that it can be used by those not directly involved in the project. The notion of scaling up through dissemination to achieve greater impact throughout stakeholder communities also arose during the first focus group, in which one participant suggested that capacity to undertake effective co-design and co-production techniques could itself be extended to new communities by 'leveraging through networking' and 'drawing on theories of trusted messengers, two step conversation'.

Another participant (an IEC member) also identified the potentially limitless scope of stakeholders as an issue (broadly in relation to sustainable development, in which stakeholders include the yet to be born), suggesting that it is necessary to find a 'better operational definition of what you mean by stakeholders'. She/he suggested that Future Earth might adopt a definition close to that of her/his own organisation:

> For [my organisation] we try to *rather than what you regard the general citizenry the populace of the world*, we focus on more *expert stakeholders*, people who are more active in these fields or wish to be active in terms of these international processes. That's how we do it, I think Future Earth needs to think about that a bit themselves. I think yes, their partial audience is the same expert stakeholders who can very much use the science or better science for trying to- actually get science in their hands to actually push for and advance sustainable development *but then there's the entire scientific community which has a clear stake in advancing sustainable development which maybe isn't involved in these processes*.
>
> (Interview 10)

Here, the implication is that stakeholders are self-selecting: if they wish to participate in the Sustainable Development Goals process and other international environmental and development agenda-setting and policy-making activities, they can access Future Earth science as a tool in their advocacy or in their other work to further sustainability. However, engagement is also broadened to the scientific community (separate from the general populace) who are not yet involved in international political processes. So rather than imagining stakeholders engaging in science, this participant images both scientists and other 'expert stakeholders' engaging in international processes, using science as a tool for advocacy.

Further limitations to the possibility of including (or imagining) a global public were identified by another participant, who considered technologies of participation and the enthusiasm and capacity of members of a 'lay' public:

> […] in keeping with the ambition of the research programme it would have to be *a global public*. The internet is global with different coverage in different regions but *I can't really imagine how [Future Earth] would lay their hands on the resource you would need seriously to consult a global - even a global interested public* on such a thing because it would be quite large. […] nobody's heard of [Future Earth] at the moment, why would they care, […] what would their contribution be… […] *you could have small group discussion with citizen type folks* […] *you'd have to constitute a public for the occasion, defined in certain ways* […] But I mean *you'd have to spend a lot of time explaining to them what the hell this was about*, before you had the conversation. I don't know if there's any thought of doing that or if there'd be

> any way of funding it. It'd be expensive labour intensive and delicate process to do.
>
> (Interview 1)

The participant outlines several potential challenges in engaging a global public: first, the technology and resources required, then the incentive for participation on the part of those that haven't heard of Future Earth, and the need to actively convene or constitute such a public and therefore define it in particular ways. While various attempts to define and consult global publics have been attempted, these are inevitably exclusive, limited in a range of ways (Blue & Medlock, 2014).

Ideas about how particular stakeholders might be represented within processes of co-design and co-production also arose during the second focus group. One participant argued that Future Earth should set some parameters and requirements for involving stakeholders, including the extent to which researchers should seek a 'cross-section' or 'truly representative sample' in terms of who to involve, and how far they should go to reach those that haven't responded to calls for co-design and co-production. Later she/he also raised the issue that NGOs are often treated as representatives of particular constituencies (e.g. farmers, women, etc.) but that they have not been democratically elected, so to what extent can they be considered to represent those people's interests? The significance of making decisions as to which stakeholders to work with was further elaborated by another participant in the same discussion:

> […] who are you going to co-design with? It's a big question, it is… let's take the farmers thing because that is where the inequalities are most graphic. *Are you going to co-design it with NGOs who work with poor farmers, are you going to co-design it with the NGOs who work with rich farmers?* The sugar cane cooperatives with contract farming among the richest. As far as Future Earth's mandate is concerned those- it would be fine… unless you are willing to take sides and you spell it out. Both those projects would be value free, you're co-designing with farmers but I would say unless you have a Rawlsian principle of some kind that underlies Future Earth you're going to end up with a lot of projects which don't ask questions about deprivation and inequality at all. So I think Future Earth hasn't yet grappled with the practical underpinnings of the so-called mandate really.
>
> (FGP9)

This participant outlines the implicit value judgement in selecting certain partners for co-design over others, particularly in the absence of independent principles (such as those offered by John Rawls) that might be used to inform the selection in a more intentional way. These types of questions are largely absent from the official documents, and how they might play out in practice will be discussed further in Chapter 7.

This section has outlined some of the challenges in defining and reaching Future Earth stakeholders. Altogether section 6.2 has shown that Future Earth's documents, and to some extent its key actors, subscribe to the notion of stakeholders as separate from science, recipients or beneficiaries of knowledge generated by science, and members of – and represented in Future Earth by – particular societal sectors or organised groups, in line with the participation for utility view on co-'s. However, the interview and focus group data reveals a broader range of interpretations, with some participants expressing views closer to those aligned with the reflexivity for democratisation understanding of co-'s, in which stakeholders are active participants in the generation of knowledge (although how deliberation is to be achieved on a global scale is unclear); many participants acknowledged the challenges of global engagement and raised key questions in relation to defining and engaging stakeholders.

In order to further explore tensions in how stakeholders are imagined in Future Earth, and how this is linked to particular conceptualisations of co-'s and broader visions of science-society relations, Nowotny's (2014) conception of particular political imaginaries of science provides a useful template for analysis in the next section. This allows for a consideration of the implicit models and imaginaries that underpin the more explicit visions outlined above.

6.3 Political imaginaries of science

This section explores the ways in which the political imaginaries of science outlined by Nowotny (2014) can be identified in Future Earth, and if so, how they shape expectations and action. These comprise (as already outlined in more detail in Chapter 2): 1) the neoliberal (or near-term impact) imaginary, in which research and its value is conceptualised in terms of its immediate translatability into impact or profit, sometimes imagined in terms of value for individual tax payers'/consumers' money; 2) the ‘republic of science’ imaginary, in which research is valued as an unquantifiable, non-rivalrous public good, and science should be left to independently produce (unpredictable but certain) benefits to society without hierarchical governance; 3) the deliberative imaginary of STS, in which research is valued as an object – and more importantly, site – of democratic deliberation, through which ideals of inclusivity and participation can be pursued.

In Future Earth, there are varying ideas about who should (or should not) be involved, and these views (including views on what co-’s mean more broadly, as seen in the previous chapter) are underpinned by and co-constitutive of these diverse political imaginaries of the ideal or proper roles and relationship between science, politics and their stakeholders.

6.3.1 Political imaginaries in Future Earth

Although Future Earth is a research initiative rather than a public policy organisation, its governance committee members can be considered to be policymakers in that they make decisions about and plans for Future Earth goals, principles, action, organisational structure and procedures.[42] In response to Nowotny’s call to ‘follow the formation, circulation, transformations and continued shifting of collective political imagination that link science with democracy’ (2014: 19), the three political imaginaries of science in society that she outlines – to which I will refer as ‘near-term impact’, ‘republic of science’, and ‘deliberative’ – provide a useful lens through which to consider imaginaries in the construction of Future Earth.

Nowotny argues that all of the imaginaries described in her paper invoke citizens as the ultimate beneficiaries of science and technology, and this is certainly the case in Future Earth’s imaginaries: as discussed above, citizens – or, more often, ‘society’ – are consistently invoked as the ultimate beneficiaries of Future Earth, particularly in the official documents. For this reason, political imaginaries as conceptualised by Nowotny (2014) are particularly apt as an analytical tool in relation to this case.

[42] Some of them can also be considered to be policymakers in their day-to-day roles.

In this section I explore whether and how the three archetypal imaginaries identified by Nowotny (outlined in detail in Chapter 2) appear in the context of Future Earth, drawing out tensions arising from conflicts between these imaginaries.

While the Future Earth external documents are fairly consistent in their visions of the role and stakeholders of Future Earth, the internal documents, interviews, focus groups and observation reveal a broader range of views and visions. One participant described emerging divisions, which suggests that (aspects of) all three of Nowotny's political imaginaries of science might be present within the initiative:

> If you take co-design back to its kind of roots it is about saying so *who sets the questions*. And… I think one view in Future Earth is that *it should be policy stakeholders and publics setting the questions to which scientists respond* and do their science to *deliver the answers* and perhaps to *provide the evidence*. Another view would be that *science is enquiry driven and curiosity driven and needs to respond to what are seen to be objective Earth system processes and seek to understand them* better. And uniting those views is quite hard. […] my view would be that it's actually in the debate around what questions should we be asking that a lot of the interest in a more reflexive approach comes to comes to bear. *So it's not one or the other*. It's not the scientists or the stakeholders, and *debating why they would frame their question in the particular way they'd frame it* and to think about *alternative framing* and the consequences of putting them that way.
>
> (Interview 7)

While broader notions of political economy are not explicitly mentioned, we might loosely map some elements of the **neoliberal/near-term impact**, **republic of science**, and **deliberative** imaginaries onto this narrative: a **service/product delivery** mode of science led by demand from societal stakeholders; a **curiosity-driven** mode of science led by scientists and the phenomena they investigate; and a **deliberative-reflexive** mode of science in which all parties debate the (framing of the) questions to be addressed. The participant identifies tension between these views in Future Earth and positions her/his own – deliberative-reflexive – view as a minority. Linking these modes back to the understandings of co-production outlined in Table 2, the service/product delivery mode of science seems to align with the **participation for utility** understanding of co-production, the deliberative-reflexive mode seems to align with the **reflexivity for democratisation** understanding of co-production, and the curiosity-driven mode of science aligns with the view of co-production as **threat**, in that co-production is seen as a threat to curiosity-driven research.

I will now draw out implicit and explicit tensions between and within the different imaginaries of science and appropriate stakeholders in Future Earth in more detail.

6.3.2 Imaginaries of near-term impact

As seen in Chapter 5, the narrative of increasing the utility or efficacy of research, bolstered through involving societal stakeholders from the start, is most prevalent in the documents but also appears in many of the interviews and in the focus groups and observation. This narrative might perhaps be best aligned with Nowotny's (2014) neoliberal imaginary. While it is not linked to a broader neoliberal ideology, notions of economic competitiveness, nor citizens as consumers, it is certainly preoccupied with the short-term or immediate impact of scientific activity and sees society as an abstract beneficiary of greater/more relevant knowledge production and innovation. This imaginary sees science as delivering the answers that society needs (to achieve transformations to sustainability).

The lack of an explicit neoliberal ideology within the imaginary might be due to the lack of easily marketable "products" in the existing Earth system science base of the initiative (as opposed to, e.g. in synthetic biology), or due to the normative commitments of those involved in establishing and building the initiative (for the most part environmental scientists, or science bureaucrats, to whom considerations of economic growth might not arise at all or come second to raising awareness of, confidence in, and action in response to the scientific evidence that anthropogenic global environmental change is occurring).

Appeals to this imaginary are often expressed in relation – or opposition – to the long-term view of the 'republic of science' imaginary, suggesting that the increasing rate of global environmental change requires faster and more targeted uptake of research results by stakeholders, particularly policy makers, also 'at the grassroots':

one SC member talked in terms of ‘mainlining science to decision making in local communities’.

There are several assumptions inherent in this imaginary, including: that it is possible to know in advance which stakeholders to involve and to whom the research will be relevant; and that the value of knowledge is in its application/use outside of the research field to feed into policy making and/or solutions:

> But what is the point of having done [some science] if it doesn’t have any impact until it’s too late or years down the road? I mean part of what we’re talking about is having resonance with decision making because […] what’s the point if it doesn’t really have an impact? Or you’re not targeting a policy window or you don’t have a policy user as a receptive audience? *I mean what is then the point of science? Are you doing science just for the sake of science or are you doing it to actually enact a change?*
>
> (FGP7)

Here, the point of science is seen as enacting change, and enacting change is associated purely with use of research in policy, while other means of enacting change through research – or other roles for research or ways of considering the value of research – are not considered.

In general, in this imaginary the public value of science seems to be in its direct translatability into impact, action or change. One participant imagined science as delivering the knowledge that society needs within the framework of a ‘global innovation system’ (and this language was subsequently adopted in a range of Future Earth documents, e.g. Future Earth (2014c)) in which emphasis shifts from competition between national economies, towards global collaboration; here the public value of science is conceptualised as a non-rivalrous good, maintaining some aspects of the neoliberal imaginary (e.g. product/service-delivery model, aim to achieve impact) but decoupling the value-for-money/direct exchange conception of the public value of science.

There is an increased role for policymakers and business/private sector as stakeholders in this imaginary in Future Earth, and while this is not imagined as related to growth or profit, in conjunction with the idea that science is “delivering” knowledge or a service (as per the financial transaction model mentioned in section

6.2.1, with reference to ‘the buyer of the car’), some participants expressed concerns about involving business, private sector or policy stakeholders; particularly where the donors, funders or ‘clients’ of the research are also the stakeholders with whom to co-design/co-produce. I will discuss some of these tensions in section 6.3.4, after first exploring imaginaries of deliberation.

6.3.3 Imaginaries of deliberation

Unsurprisingly, since the deliberative imaginary is rooted in ideas emerging from STS and broader social theory, it was voiced for the most part by social scientists (and was a minority view). Ideals of participation and inclusiveness through the incorporation – and deliberation – of diverse perspectives are a key part of this imaginary, as seen in Chapter 5. In contrast to the ideal of authoritative, objective, untainted scientific knowledge as explored in the next section, this imaginary acknowledges that both stakeholder and scientist perspectives are partial and informed by social commitments, and argues that these should be made explicit and debated:

> co-production is inherently a process of making explicit your partial perspectives and making explicit sort of social commitments they’re founded on and then getting together in ways that encourage all parties to be reflexive about those and have a *deliberation and debate*.
>
> (Interview 7)

This imaginary is very much tied to notions of social justice and research that ‘makes a difference’ in relation to that objective. In this respect, it is not dissimilar to the neoliberal/near-term impact imaginary, in that some form of impact is taken to be desirable. One participant described this view with reference to her/his own work:

> […] I’ve seen the purpose of research not just as understanding the world but attempting to influence it for the better with a very strong emphasis on working to reduce poverty, to try and create conditions of social justice […]

In the participant’s own research, stakeholders are local communities and policy makers, and social science’s role is to give grounds for alternative ways of governing based less on elite and technocratic narratives of policy/scientific knowledge, and more on the knowledges and practices of local communities:

> […] and *part of that [social] justice […] has been about […] cognitive justice*, about trying to uncover the ways that powerful policy discourses enrapt with certain kinds of science and knowledge production justify interventions which do things in people's lives, often harmful things as well as good things, and about *trying to uncover or trying to challenge those orthodoxies and point to alternatives*, including those that emerge from the perspectives of people who are marginalised by those formal channels. Which either gives them *a sense of cognitive justice in the process of creating knowledge and change*, or allows us to take advantage of missed opportunities that would otherwise remain concealed when the world is seen in a particular way.
>
> (Interview 7)

So while all versions of co-production have the aim of meeting societal need, the deliberative view enables questions about what this means, whose need is met, etc., whereas this might not always be specified or differentiated in the participation for utility/near-term impact view. The deliberative approach aims to extend the rights of knowledge production to those that would otherwise be marginalised. However, questions still remain about which stakeholders should – and can – be included in this deliberative way in Future Earth.

6.3.4 Imaginaries of a republic of science

The imaginary of science as independently governed and producing unpredictable (and therefore impossible to target) benefits to society arises throughout the interview data. A minority of participants seemed to subscribe to this imaginary themselves (to varying extents), while others discussed its endurance in the scientific communities of the existing GEC programmes. Several participants discussed the impossibility of predicting where important breakthroughs may occur:

> So that's part of the tension in applied science and that is a lot of what we're talking about here because science for sustainability is mission oriented but it may be the *thing that's over there in the dark corner that no-one's thinking about*, that actually would be the breakthrough that could be important and it's a real… and there's tension there always.
>
> (FGP10)

This imaginary is also strongly tied to the idea of science being 'curiosity-driven' (I9) or 'supply-driven' (I10) (as opposed to demand-driven); in other words, scientists 'do[ing] some science because […] it's plain interesting to them' (I10) without external direction and achieving insights that are 'over there in the dark corner that no-one's thinking about'. Despite the acknowledgement of the role of scientists' interest in science in this imaginary, other types of interest are resisted strongly. The imaginary is tied to notions of objective, disinterested, independent science, kept separate from – and 'uncontaminated' by – private (or other 'societal') interests and bias. One (social scientist) participant noted that it is not easy to discuss co-production theoretically with natural scientists because it 'cuts at the heart of what scientists feel is the objective nature of what they do'. Many participants referred to the ideal of objective, pure science; usually either expressing concern about how to preserve it or noting that some within Future Earth feel that it is challenged by the co-'s. Some of the most significant loci of contestation within the committee meetings in June 2014 arose in relation to adherence or otherwise to this ideal, and the related notions of scientific independence and academic freedom, as already discussed in Chapter 5.

Concerns were raised about co-design/co-production with (societal) stakeholders that have interests and biases generally, and more specifically linked to involving private sector partners in research, with the tobacco industry cited most frequently as an illustrative example, and big oil/seed companies causing particular concern as imagined potential Future Earth stakeholders. As discussed in section 5.3, one participant suggested that the involvement of business such as oil companies could lead (and has led in the past) to fatalities, considering the elimination of conflicts of interest and the objectivity enabled by the scientific method to be 'the hallmark of science':

> For me in the middle [of the research process] *there should be a complete separation*, I do not believe that stakeholders should ever be involved in the process of generating data, interpreting data or peer reviewing data. That to me provides egregious conflicts of interests that are going to… it will *ruin the integrity of science for society* in my opinion.
>
> (Interview 2)

The 'integrity of science for society' is seen to reside in the preservation of the scientific method as independent from stakeholder involvement.

As touched on in Chapter 5, other participants felt that the ‘risks’ of bias or conflict of interest associated with involving ‘societal stakeholders’ are legitimate but manageable concerns (and necessarily so because the initiative needs to secure external funding to support itself). Suggested means of managing these issues included building accountability into the research by requiring projects to address questions of distribution and inequality if co-designing/co-producing with business or policy actors (FGP9, as further explored in Chapter 7); or through the academic peer review process, undertaken by ‘top-rate scientists’ that are rigorous and sceptical:

> you don’t want the arena to be populated by people who have… clear… disruptive or other kinds of interested… who clutter up the arena with false claims or with unfounded claims, so there is *there is a need to regulate the arena* but again that’s normal in democracy, that’s normal in science as well, through peer review and so on, critique, there’s an attempt to allow in the end the most robust claims to survive, but it’s a complicated thing to do.
>
> (Interview 8)

Here there is a distinction drawn between legitimate stakeholders and those that are ‘disruptive’ or ‘interested’; although regulation of this distinction appears to occur in knowledge validation (by the academic community) rather than in terms of who is able to participate in general.

This imaginary also informed the governance architecture of the initiative (as discussed further in Chapter 7), with the separate Science Committee and Engagement Committee established (as opposed to one combined committee) to achieve ‘inoculation’ against dominance of interest groups within the initiative.

6.4 Conclusion

This chapter has shown that Future Earth actors draw on different political imaginaries in their conceptualisations of science and its public value, and what these imaginaries mean for who is considered an appropriate or legitimate stakeholder. Some espouse a near-term impact imaginary in which society and stakeholders are treated as beneficiaries, recipients and audiences of research whose impact is of primary interest. The public value of science in this case is either in its translation into action or as a non-rivalrous, international public good. A minority of Future Earth actors adopt deliberative imaginaries in which all stakeholders, including scientists, hold partial perspectives and social/political commitments. The public value of science is in making a difference (in relation to social justice), and, linked to that, research as an object or site of democratic deliberation. Finally, others subscribe to a republic of science imaginary in which societal stakeholders – particularly private sector, and sometimes policy, stakeholders – are seen as holding interests that can endanger the ideal of objective, autonomous science and even endanger lives. The public value of science is seen as lying in its ability to produce objective, value-free and/or independent knowledge, which is or gives rise to unpredictable public good(s).

Many challenges are apparent in the definition and engagement of Future Earth's stakeholders, not least conflicting ideas about the extent to which involvement is desirable at different stages of research, and whom should be involved, often fuelled by these different political imaginaries of science and its public value.

On the basis of this analysis, the table distinguishing between different understandings or models of co-production developed in Chapter 5 is updated below in Table 3. It is clear that particular notions of the public value of science as summarised above in relation to the imaginaries – and their associated models of democracy or participation, whether deliberative or representative – can also be aligned with particular models of co-production: three further rows have been added to indicate 'Imaginary', 'Public value of science' and 'Model of democracy'. The clearest overlap is between the deliberative imaginary and the reflexivity for democratisation model of co-production. The 'exchange'/service concept and the 'non-rivalrous public good' concept of public value within the neoliberal/near-term impact imaginary align with the understanding of co-production as participation for utility. The 'republic of science' imaginary aligns with the notion of co-production as threat, and its emphasis on the public value of objective, independent knowledge.

This chapter, then, has demonstrated that there are varying ideas about who should (or should not) be involved in co-'s in Future Earth, and these views (including views on what co-design and co-production mean more broadly, as outlined in the previous chapter) are underpinned by and co-constitutive of diverse conceptualisations (political imaginaries) of the ideal or proper roles and relationship between science, politics and their stakeholders. Particular notions of the public value of science/research – as a service, as an object/site of democratic deliberation, as a public good – are tied to different notions of legitimate scientific stakeholders and their appropriate representation and involvement in the initiative; reproducing, or co-producing, established democratic models.

These comprise, firstly, the representative-utilitarian model in which an epistemic deficit and/or gap between research and action on GEC/sustainability can be addressed by inviting societal stakeholders to help define research questions and participate in the research process and research governance. Society/stakeholders are imagined as recipients/beneficiaries of knowledge primarily produced by science, and as members of – and represented in Future Earth by – particular societal sectors or organised groups (e.g. business, government, civil society). The value of science is as a public good or service/product to meet societal need (partially in line with a 'neoliberal' political imaginary, in which short term impact and immediate translatability of research into action is of most value).

Secondly, the deliberative-reflexive model in which a democratic deficit in science (and in society more broadly) is addressed by recognising all knowledge as partial, admitting plural perspectives into knowledge making processes, and reflecting on tacit assumptions embedded in existing framings. Stakeholders (including scientists) are imagined as active contributors to knowledge creation, with rights and social/political commitments. The value of science is in making a difference (in relation to e.g. social justice), and as a site/object of democratic deliberation. All versions of co-production have the aim of meeting societal need, but the deliberative view enables questions about what this means, whose need is met, etc., whereas this is not always specified or differentiated in the representative-utilitarian view.

Thirdly, a more traditional (republic of science) model, in which co-production poses a threat to curiosity-driven research, academic freedom, and the scientific ideals of objectivity and independence. Stakeholders (e.g. private companies, policy makers) are imagined as having interests and biases that endanger the public value of science in its ability to produce objective, independent, value-free knowledge.

[Page intentionally left blank.]

Table 3: Three views on co-'s including imaginary, public value of science, and model of democracy

Type	**Representative-utilitarian model** Co-design/co-production as **participation for acceptability, relevance, utility and impact**	**Deliberative-reflexive model** Co-design/co-production as **reflexivity and deliberation for democratisation**	**Republic of science model** Co-design/co-production as a **threat**
Definition	Societal stakeholders participate in two-way dialogues and collaborate with researchers from different disciplines in order to jointly: • frame, define, design research strategies, priorities, agendas, projects, Future Earth itself [co-design, co-creation] • produce knowledge, implement research projects [co-production, co-creation] • disseminate and implement research/knowledge results, outputs, solutions [co-dissemination, co-delivery]	Societal stakeholders come together with researchers from different disciplines throughout the research process to: • reflexively debate, deliberate and make explicit everyone's partial perspectives, worldviews, assumptions; • acknowledge who/what is included and excluded, acknowledge alternatives and the normative dimensions of research; • include a range of perspectives; • democratise questions and lines of investigation, bring about epistemic equality and cognitive justice.	Co-design/co-production in which stakeholders are involved in science/research (whether through participation and/or deliberation) poses a threat to the objectivity, independence and autonomy of science/research. Co-design/co-production may be acceptable in Future Earth but not at all stages of the research process, and/or not with all types of stakeholder, and there must still be space for fundamental, basic research within and/or outside of Future Earth.
What is co-produced?	Solutions oriented, relevant (not prescriptive) research questions, knowledge, solutions, information, policy options, insights, data, tools	Socially embodied knowledge and solutions; science/research and social order, norms and worldviews	Co-design of research questions is more acceptable than involvement of stakeholders in data generation, analysis & dissemination
Rationale	Instrumental, utilitarian, logic of accountability: knowledge will be more relevant and efficacious, because: • the "right" research questions are asked; • it is co-owned by people who will use it so gains visibility, credibility and legitimacy; • answers & solutions are more likely to be suitable for/accepted by those they are intended for, and used properly by them, and therefore have impact; • higher quality research will be produced; • legitimacy & authority of Future Earth is increased through institutional co-design.	Political, emancipatory, logic of ontology: the co-design/co-production process will allow questions of common purpose and framing to be asked, assumptions questioned, and alternative options considered, which is important because: • all knowledge & perspectives are partial; • acknowledging this & taking stakeholder knowledge/experience seriously enables democratisation of knowledge production and decision making; • this enables research to make a difference in terms of social justice/power relations.	Epistemological, political, logic of autonomy: science produces independent, objective, reliable knowledge by: • avoiding conflict of interest; • independently pursuing its own agenda.

(Non-academic) participants	Users; representatives of different sectors or stakeholder groups (e.g. policy makers, funders, civil society, private sector): • have knowledge needs; • have information to exchange (or to input into 'flows'), particularly on what challenges society is/decision makers are facing; • might have existing knowledge and experience to be considered and respected.	Cognitive, epistemic participants (whether scientists, policy makers, practitioners, decision-makers, local communities, others): • have valid knowledge and experience to offer; • have agency; • all have normative commitments and assumptions (including scientists).	Private sector and policy stakeholders: • have interests and biases that might threaten the objectivity of the research; • might prevent the researcher from pursuing particular lines of enquiry; • may twist the research results or misrepresent them.
Role of research and researchers	Lead and guide the co-production process; provide the knowledge (with input from all concerned); responsible for methodologies; provide policy options and policy-relevant (not prescriptive) knowledge (knowledge broker).	Facilitate reflexivity; question own and others' positionality and assumptions; draw out marginalised knowledges, perspectives so they can be recognised by all; pursue or advocate particular normative agendas (activist).	Avoid conflict of interest and preserve objectivity and/or independence of research.
Science-society relation	Science and society are separate but come together (or enter each other's spaces) in the process of co-design/co-production.	Science is part of society and the process of co-design and co-production enables the deliberation of worldviews and future visions.	Science and society are separate and should remain so, particularly in the middle of the scientific process.
Ontology/ epistemology	Realist/positivist	Constructivist	Realist/positivist
Imaginary	Near-term impact	Deliberative	Republic of science
Public value of science	As a service, provides (exchangeable) knowledge of use to stakeholders; and/or as a non-rivalrous public good	As an object and site of democratic deliberation	In its ability to produce independent, objective, value-free knowledge; as an unpredictable public good
Model of democracy	Representative: politics is a negotiation of the different views/interests of society, represented by interest groups/organisations; scientific knowledge is an instrumental resource that can be struggled over, but is not political itself.	Deliberative: all aspects of social life are political; democratic deliberation should be extended to knowledge production; the source of democratic legitimacy is process of preference formation through debate/deliberation.	Representative.

While these models are not as distinct as the matrix suggests, they are broad 'types' that can be seen in Future Earth (and beyond). The first and third of these models are perhaps more standard, traditional modes of research policy or ways of viewing science. The second could be seen as a means of mediating between or attempting to steer the more established modes in new directions, through processes that acknowledge the contingency of existing understandings and arrangements and highlight the possibility of alternatives. Each of these views exists in the research community as a whole (beyond Future Earth). However, there could be space for each model (rather than one dominant model, as is often the case) if an experimental approach is adopted, allowing difference to co-exist.

While established models seem to be reproduced, Future Earth is venturing into new territory for an international science initiative of this scale and ambition: territory in which conversations have started about who the stakeholders of research are, how they can be represented and involved in research governance and projects, and what sorts of issues will arise along the way. These conversations give rise to difficult questions, but in their asking, new possibilities open to rethink established practices and procedures. The next chapter explores how this has played out in the ways that the implementation of co-production in Future Earth has been imagined and undertaken.

Chapter 7: How is co-production implemented?

The previous two chapters explored meanings of co-production and related concepts in Future Earth, why they are advocated and adopted, and who might be involved. The analysis of the documents, interviews, focus groups and observation data found that co-production and related terms are ambiguous and contested in Future Earth, with varying definitions, extents to which they are considered appropriate, and rationales for increased (or, indeed, limited) involvement of non-academic stakeholders in research design and process (from ensuring relevance to democratising expertise to preserving scientific objectivity and independence). Furthermore, there are varying ideas about who should be involved. All of these views are underpinned by and co-constitutive of diverse conceptualisations of the proper roles and relationship between science, politics and their stakeholders. Particular notions of the public value of science/research – as a service, as an object/site of democratic deliberation, as a public good – are tied to particular notions of legitimate scientific stakeholders and their appropriate representation and involvement in the initiative; reproducing, or co-producing, and perhaps challenging, established democratic (and scientific) models.

Having explored (visions of) the what, why, and who of Future Earth's co-production, this chapter turns to the "how". It explores how implementation of co-design, co-production and engagement is discussed and imagined in the documents, interviews, focus groups and during the observation of the committee meetings, and how the understandings of co-'s described in Chapters 5 and 6 shaped (potential) implementation.

It is clear from the documents and interviews that work at the time of the study had focused primarily on establishing institutional structures (appointing the Science Committee, Interim Engagement Committee, Interim Secretariat, and ongoing work towards appointing the full Engagement Committee and Secretariat), closing the existing programmes (IGBP, IHDP, DIVERSITAS) and transitioning their core projects into Future Earth. Several participants noted the relatively early stage in Future Earth's development (or at least in the term of the newly appointed committees) and suggested that co-design, co-production and engagement had not yet started in earnest. In addition to (and perhaps in part due to) this feeling of it being early days for the initiative, throughout the data there is a sense that Future Earth is experimenting in co-design and co-production: that these concepts/practices are (relatively) unknown, unused and novel in this context (although they are seen as more common in other fields of research) and that establishing them within Future Earth will be a tentative process of trial and error, learning, and negotiation – including between the committee members. Indeed these negotiations actively played out during the observed committee meetings and the focus groups.

In analysing the data, several elements came to the fore when considering implementation. These comprised temporal, institutional, scalar and substantive aspects: when co-design/co-production might happen, at which institutional and geographical levels or scales, in which organisational configuration, around which problems. The following sections explore the key (interlinked) aspects of the Future Earth experiment in co-'s. Section **7.1** focuses on temporality and institutional levels, that is, when co-design/co-production happens and at which institutional level. Section **7.2** explores organisational structure and process, considering how different models of co-production influenced the organisational shape and processes of Future Earth. Section **7.3** explores tensions between establishing principles and developing co-production in practice. Section **7.4** outlines the interconnections between spatial (geographical) scale and the substance of the problems or challenges Future Earth seeks to address. Section **7.5** discusses evaluation, monitoring and iterative learning, and **7.6** concludes by considering how these elements relate to the broader theme of experimentality.

7.1 Temporality and institutional levels

In institutionalising co-design in Future Earth, questions of when co-design (should) occur(s), and at which (institutional, geographical, semantic) level, are linked to the different understandings of co-production outlined in Chapters 5 and 6; in particular, representative-utilitarian co-production and deliberative-reflexive co-production. Ambiguities about whether co-design should happen from 'the start', about whether ‘the start’ comprises governance, and about whether co-design is already happening are also underpinned by (differing) assumptions about the linear temporal (and hierarchical institutional) relationship between governance and research.

How co-design should be implemented is of course deeply linked to the question of what it is: what sort of activities, interactions or relations it might comprise, which actors are or should be involved, and where this might take place. These aspects are intertwined with when it should happen, whether it is already happening, and where/in which part(s) of Future Earth it should happen. This section focuses on how these questions manifested and were handled, focusing in particular on several key issues or tensions: whether co-design should happen within governance or research or both; within the governing committees, the projects and/or in between; and whether it happens from the beginning and throughout, at other particular stages or whether it is always happening anyway. The distinction between co-design and co-production sometimes emerged as key to these considerations.

As noted in Chapter 5, there is a tension between aspirations for co-design and co-production to occur throughout Future Earth from the outset, and a degree of ambiguity around what ‘the outset’ and ‘throughout’ might comprise (in addition to the real-time organisational constraints of setting up such an ambitious and far-reaching initiative). The Design Report notes the emphasis in STS and science policy literature on ‘the critical need to engage stakeholders from the very beginning of the research process to and beyond its conclusion’, and lists as one of the key principles that should underpin Future Earth stakeholder and engagement strategy: ‘an understanding that co-design commences at the outset and stakeholders are partners in knowledge production throughout’ (Future Earth, 2013b: 34). However, it is unclear whether governance is considered to be part of the ‘research process’ (more likely not), and therefore whether or not the temporal markers of ‘at the outset’ and ‘throughout’ comprise the establishment and ongoing activity of the governing bodies.

On the other hand, the Design Report also suggests that (by design) the governance structure inherently ‘embraces the concepts of co-design and co-production’ (Future

Earth, 2013b: 14) (or engagement is ‘part of the DNA of the whole programme’, as one participant put it), while the Transition Team before it was considered to be ‘selected in the spirit of co-design of a new research agenda, and thus included researchers, funders and private and public sector stakeholders from many different countries and disciplines’ (Future Earth, 2013b: 5). While not explicitly stating that these governing bodies are *doing* co-design/co-production, the implication is that these committees embody or at least play a very significant part in co-design/co-production. This type of institutional or administrative co-design (the participation of multiple stakeholders – primarily from different sectors/organisations, and, to a lesser extent from different disciplines and countries – in the initiative’s design and governance committees) most closely aligns with the representative-utilitarian model of co-’s, in which co-design/co-production means the collaboration of stakeholders representing different sectors.

Certainly some participants argued that co-design should occur at the level of the committees: one participant thought that ‘there’s a very good case to be made for high level strategic directions to be set with a pretty strong involvement of co-design’, but that ‘co-implementation’ of strategy at that level would not be necessary. Later, in personal email correspondence, the same participant suggested that the multi-stakeholder members of the Alliance (now assuming the role of Governing Council) ‘indicate some […] efforts at co-design at that level’, a view shared by participant 5:

> Well I think [co-design, co-production and transdisciplinarity] has to happen *at all levels*, it has to happen at the research performance level within projects and we have to accept that transdisciplinarity is not… might not always be appropriate or relevant, that projects need to think it through; it needs to happen *at the level of programmatic design and priority setting*. Erm… you know so that is why we want a multi-stakeholder governing council, that is why we have an engagement committee so that at your programmatic level it is a sense in which you’re not just, you’re opening this up to non-academics to shape what is happening *at the research performance level* and it has to happen *at the international policy making level* like at the Alliance, we need to have these discussions in global fora of funders so at all levels.
>
> (Interview 5)

For the most part, there was strong insistence on the need for co-design in the sense of opening up Future Earth strategy and governance to be shaped by (discussions with) non-academic stakeholders (whereas co-design, and particularly co-production, might not always be needed in all projects). However, when asked about current efforts towards co-design and co-production, few participants explicitly identified the current work of the committees as an instance of co-design: in general these concepts (co-production in particular) were considered in relation to the research work that will take place within Future Earth, whether encouraging the existing projects and new initiatives to adopt these approaches, or thinking in more general hypothetical or abstract terms.

This could suggest that the activities of the committees would not be considered to be co-design or co-production until the permanent Engagement Committee had been appointed (participant 7 suggested – before the Beijing committee meetings, when the IEC had only met face-to-face once – that the IEC '[hadn't] done very much yet I mean they have been an interim holding committee, they haven't really got to work in thinking about these things', and participant 10 – one of the IEC members – said the IEC was 'still very much acting very interimly'); or that the committee structure is seen as a gesture or step towards co-'s, which then happen elsewhere in Future Earth, rather than the committee structure itself comprising these processes/activities. This potentially implies a distinction between 'high level' strategy, priority setting, design work that takes place within the committees, and the 'actual work' of research/science that would be conducted by the projects or other elements of the initiative. This is perhaps also accompanied by a temporal assumption that governance (should) happen(s) first before research, and a hierarchical assumption that governance happens at a higher level than research (rather than governance and research being deeply intertwined and/or distributed, for example, as characterised in notions of distributed or decentred governance (Irwin, 2008)).[43]

[43] However, even if the ideal would be to co-design and co-produce (in whichever way) from the very outset of Future Earth (if it would be possible to identify that moment), there are considerable practical, institutional, epistemological (and other) challenges in doing so.

When asked about the current state of co-'s in Future Earth, several interviewees suggested that co-'s had not really started in earnest yet, as existing efforts had focused on establishing the institutional structure of the initiative:

> Researcher: So in terms of what's currently happening, what's happened to date, do you feel that the current co-production processes or engagement mechanisms and processes are working well, or do you think there's room for improvement?
>
> Participant 7: I mean it's still very, very early days, slightly frustratingly so. Big umbrellas take a long time to get up and running. I mean *there hasn't really been so far any of what I would call science or engagement that's happened yet under the Future Earth umbrella* – what we've been principally busy with is setting up the committees and their ways of working, moving towards those permanent committees, raising funds so there were these calls out now for fast-track and cluster initiatives, and the really key process of bringing the existing core GEC projects under the Future Earth umbrella.

The metaphorical 'umbrella' (that takes time to set up and get running) (see also Chapter 4) could represent Future Earth as a whole (as in umbrella organisation), comprising all projects, people and activities adopting the 'Future Earth' label. Or it could represent, more specifically, the overarching institutional (governance) structure, comprising the committees, funding and other organisational apparatus.[44] A distinction is made between a) what the participant would consider to be science and engagement, and b) the processes of putting in place the committees, fundraising, and transitioning the existing core projects into Future Earth. The science/engagement work of the existing programmes is not yet considered to be part of Future Earth (presumably because the projects are not yet formally affiliated), and getting the 'umbrella' 'up and running' has been a priority before moving forward on co-'s and the many other aspects of the initiative. If the umbrella is the institutional/governance structure, a distinction is made between that structure (where, by implication, science and engagement do not happen) and the science and engagement that happens under it.

[44] This ambiguity around what is and is not 'part' of Future Earth could be symptomatic of the early stage in the development of the initiative's structure and identity: in the data, 'Future Earth' is often used to refer to the Future Earth Secretariat, the Future Earth Science and/or Engagement Committees, or the Future Earth governance structure more generally; this could be read as synecdoche *totum pro parte*, or just an accurate reflection of what 'Future Earth' comprised at that point in time.

The view that co-'s had not yet fully started was shared by other participants:

> Researcher: So, to date do you feel that Future Earth has managed to do any successful stakeholder engagement or co-production or co-design – is that already happening within the Future Earth umbrella?
>
> Participant 8: I think it's just starting up, so we have a link now to the SDG [UN Sustainable Development Goals] process, we're following that, we're trying to put into that, *I can't say that is really yet a "co-"* you know, I mean we're talking to them. Um, we… you know… have an Interim Engagement Committee an active group of people who are helping us think through these things… In the Strategic Research Agenda process that we have right now we are *consulting with stakeholders at a global level* in business and in cities and so on, so we're doing some of that but I can't, no, I wouldn't be able to claim that we've done a lot of this so far, I mean the limitation of this is only nine months in so I think *we're still in the process of building the building* and we've got some activities but I'm not sure we've got lots y'know to boast about yet.

Here a distinction is made between, on the one hand, the early stages of connecting with and 'talking to' people involved in the SDG process (also 'think[ing] through these things' with the Interim Engagement Committee, and 'consulting with stakeholders') and, on the other hand, the presumably more developed relationships and practices involved in 'a "co-"'. From this participant's perspective, talking, thinking and consulting with stakeholders do not in themselves constitute co-design and co-production: something more is needed, whether that is imagined to be a longer-term, more involved, or balanced process or relationship with equality of responsibility and investment between those taking part, or whether it is imagined to be the involvement of non-academic actors in formally defined steps of the research process. If co-'s are considered to be a form of engagement, these activities were not deep enough to count; if co-'s are considered to be a form of research, these activities were not part of an identifiable 'research process'.

Activities considered by this participant to be efforts towards 'doing some of that' (i.e. co-design, co-production, engagement) comprise global level governance (the IEC), agenda-setting (the SRA process) and policy-interface activities (SDGs), but similar to the previous participant's (slightly mixed) metaphor of getting the 'umbrella' 'up and running', this participant talks about still being in the process of 'building the building': in both extracts there is the sense that it has been necessary to establish institutional structure before moving on to focus on co-design, co-production, engagement, etc. within that, rather than the umbrella or building itself consisting of these concepts/practices; again temporal and institutional distinctions are made between what does and does not count as co-design/co-production (and, perhaps, by implication, what does and does not count as science and/or engagement).

Having already argued that it might be possible to distinguish between co-design as 'focusing on those principles of […] shaping and funding […] initiatives of knowledge creation', and co-production as 'the more ongoing iterative process of how knowledge is made and continually changed in any process of conversation, dialogue, exchange', one participant (interviewee 6) highlighted the difficulties in and perhaps also inadequacies of thinking in terms of institutional levels or scale and temporal orders in this way:

> […] I suppose you could […] use this distinction I've made between co-design and co-production you could say that *at strategic levels it's actually more about co-design*, whereas when you come down to *the execution of specific pieces of research then it's the co-production that becomes a little bit more important* although *that's probably not an adequate way of thinking about these scalar issues*.

The participant moved on to describe an alternative view:

> I think I've sort of heard [SC member] … er… […] defending [her/his] involvement […] in Future Earth as saying well actually you know [it's] an opportunity for me to […] *influence and change the culture of the institution* to be *a culture that is more… open and aware of and sensitive to some of these principles of co-production* that [she/he] would want to promote.

The participant then summarised:

> So at one level you could say maybe it's specific decisions at the top level, maybe it's specific practices of co-production at the project level, but also you could say it's something about […] is the culture of that institution… one that shares a certain *tacit or more explicit commitment to certain principles*, […] which is another way of thinking about how co-production might work in institutional settings.
>
> (Interview 6)

While ‘specific decisions at the top level’ and ‘specific practices at the project level’ seem to be more in line with a vision of co-’s as collaboration or participation, the institutional culture in which certain principles are tacitly or explicitly shared seems to evoke the deliberative-reflexive model (as discussed in the preceding chapters), in which co-’s are a site or object of democratic deliberation – or a means of adopting and promoting particular normative principles (whether that be towards democratising science or something else). The idea that co-’s operate at different semantic or communicative levels as well as at different organisational and geographical levels or scales, demonstrates that making distinctions between governance and research, global and local, is perhaps an inadequate way of accounting for ‘co-’ concepts and practices (particularly without a thorough consideration of what constitutes Future Earth governance, research, global, local, etc.).

The view that co-’s might already be happening (tacitly) within the committees also arose during the first focus group (conducted on day one of the joint Science and Interim Engagement Committee meeting), in which one participant proposed an STS-informed definition of co-design and co-production, and another quickly adopted this idea, suggesting that the Science and Interim Engagement Committees had earlier that day partaken in implicit co-design in defining the issues to be addressed within Future Earth’s 2025 Vision and research priorities:

> FGP5: I’m going to throw out a devil’s advocate issue here which would be to say *isn’t actually all science co-designed and co-produced*, even if we don’t always recognise it. To what extent there may be some… there may be a few pure curiosity driven areas of science which could be outside of this but *isn’t the vast majority of all the science that’s done actually driven by – and people’s curiosity is driven by – their position in society*
>
> FGP3: [Oh yeah.]
>
> FGP5: *[or their] interest in societal issues? And therefore to some extent co-designed, even if one can’t identify always who the stakeholder is*, it’s more the kind of process that Sheila Jasanoff writes about in her ideas about co-production of science and social order or indeed that Brian Wynne wrote about kind of back in the 1980s and the early days of the climate change debates about the ways that the mutual construction of science and policy domains led to certain kinds of folky and climate science and others not being taken on at that point to focus on mitigation and weather modelling as

> opposed to adaptation. Perhaps another way of looking at this whole issue is *to become more explicit about the implicit bits of co-design that are going on all the time*, and begin to ask some more strategic questions about *how we direct those co-design processes* [laughs] in ways that are going to be productive for particular normative agendas.

This direct translation of Jasanoff's co-production (as latent or implicit) is then taken up by the other focus group participants:

> FGP3: - I think that's actually an interesting point… is the scientists' view of… say for example when we put up the ten issues, you know what did I look at and [SC member] and all any of us? We looked at what were the big international debates
>
> FGP5: exactly! [yeah]
>
> FGP3: so there is… I like what you've said,
>
> FGP5: [yeah, yeah]
>
> FGP3: there is an *implicit co-design*
>
> FGP5: [yeah]
>
> FGP3: but it is our scientific interpretation and so it is *the next level down* [where you]…[a- a-]
>
> FGP5: [Next level down,] you then go again to a different [kind of co-design and say let's get stakeholders together to design the questions]…
>
> FGP3: [Absolutely, absolutely I think that is a very good one so] there is a lot of *implicit co-design* and there are some parts that *need to be a bit more explicit*, interesting way of looking at it.

Here, in a moment that enacts the type of reflexivity (or 'becoming more explicit') proposed by FGP5, FGP3 notes that the committee members' 'scientific interpretation' of 'the big international debates' informed which issues were put up on a slide during an exercise to define Future Earth's 2025 vision and research priorities; so that agenda was indeed driven by '[people's] position in society' or 'their interests in societal issues': a type of co-design that operates at a different (higher and more implicit) level from (as specified by FGP5) the kind of co-design in which stakeholders are brought together to design the questions. This former type of co-design is something that is already (always) happening to produce and maintain particular norms; the role of institutions such as Future Earth as envisaged by FGP5 would be to steer such processes, although this might not necessarily look like co-design as imagined by the majority in Future Earth (i.e. participation or collaboration). This is evocative of Jasanoff's 'constitutive co-production' in particular (2004b: 22-28), which draws on Foucauldian notions of embedded and productive power, and suggests it is necessary to challenge the notion of status quo as neutral or apolitical.

In fact, this type of reflexivity was apparent during the discussions regarding the development of the Future Earth 2025 vision earlier that day, with some participants questioning the use of particular SDG-like global challenges to frame the vision, making the distinction between a) these visions of 'the world we would want to see' and b) visions of success for Future Earth as a programme, suggesting that it is not Future Earth's role to decide on which global challenges are the most important but rather to define the type of research outputs, research culture or capacity building it might undertake. One participant asked where the co-design was in the process of defining the 2025 vision, if broader constituencies (beyond the committees) had not been consulted. Furthermore, other instances of reflexivity occurred throughout the meetings, for example in terms of questioning the 'Sutherland' workshop process (Sutherland *et al.*, 2006), which was used to winnow down a long list of research questions/priorities that had been collected through various means (including online consultation), ready to then be further narrowed down by the SC and IEC to form the Strategic Research Agenda. Participants were concerned about the criteria for inclusion (of both questions and workshop participants) and the (disciplinary and regional) diversity of the workshop participants undertaking that initial sorting.

So, to conclude this section, there was ambiguity around whether co-'s should happen (explicitly) from the 'start' of Future Earth, whether the 'start' comprises governance (and governing committees) or just research (and research projects), and furthermore whether co-design/co-production is always happening anyway – 'implicitly' – and therefore whether Future Earth could become reflexive about implicit premises and consider the possibility of working with different assumptions. These ambiguities and the different understandings of co-design underlying them have implications for implementation. While the participatory/collaborative form of co-'s is far from straightforward in implementation and raises multiple questions around when, where, how and with whom it should take place, it is perhaps easier to translate into action once these details have been settled (or indeed, before they are settled, by muddling through).

Co-'s as institutional culture and tacit (or even explicit) shared principles, or an existing process that might be steered in alternative directions, raises further difficult questions for implementation. Institutional culture is not necessarily amenable to intentional shaping by (a minority, or even a majority, of) actors involved, and even without the extreme heterogeneity and scope of Future Earth, shared principles are difficult to settle and maintain. If the norms implicit in existing inherent co-design/co-production are to be made explicit and redirected, entry points are needed. How and when might these processes be interrupted; which points of intervention are possible? Once the co-production of research and normative agendas has been made explicit, what does it mean to intervene and steer these?

The following section explores how the different ambiguities and understandings outlined above played out in more detail in the design and implementation of Future Earth's organisational (governing committee) structure and processes.

7.2 Organisational structure and process

While Future Earth's committee structure is seen by those involved as an innovation, whether or not the Science Committee and Engagement Committee should remain separate was a matter of debate, with varying concerns raised, some underpinned by the representative-utilitarian co-production model and others by the co-production as threat model; in both cases assumptions are made about the separation of science and society. How the Engagement Committee should be populated was also raised as an issue, with advocates of the representative-utilitarian model pushing for stakeholder representation on the committee and adherents of reflexive-deliberative model emphasising the importance of processes of doing, leading and governing co-'s (rather than solely who sits on the committee). These different understandings have implications for how the committees are designed and work together, and what they and their work represents and means, although of course the design and work of the committees are also informed (and sometimes constrained) by practical and strategic considerations.

Not least of the challenges in implementing co-design is the existing architecture and legacy of the GEC programmes: in dismantling the existing programmes, building an institutional structure into which the core projects could transition was key, and the Transition Team's design for this to some extent took its cues from existing governance formats, establishing a set of overarching committees that would lead on strategy and decision making and a Secretariat that would lead on execution and implementation, with affiliated research projects 'on the ground' (as well as regional and national committees and centres to coordinate and link between levels). Much of the activity to establish this structure was informed by awareness of the political sensitivities involved in institutional change, particularly when it involves closing down large-scale programmes and their executive and administrative support teams. However, Future Earth can be seen (and is seen by some involved) as an experiment and/or innovation at the institutional level, and despite the need for authoritative – and cohesive – structure and leadership, several notable divergences have been made from the standard set up of the international programmes: notably the shift from a sole Science Committee to the dual Science Committee and Engagement Committee format (as well as the overarching 'multi-stakeholder' Governing Council, aka the Alliance, and the multi-hub structure of the global Secretariat).

The appointment of both a Science Committee and Engagement Committee was noted as a 'statement of intent' by one participant peripherally involved in Future Earth:

> Participant 1: I mean, we know they have a Science Committee and an Engagement Committee, which is an interesting move in its- y'know that's a *statement of intent* of a kind – we know who's on the Engagement Committee we know they're discussing co-production and what it means – at some point a document will emerge which is the negotiated, agreed, more detailed rubric, protocol, strategy, whatever it is about, what- how they will implement the intention to have co-production but I don't know what it's going to say.

> Researcher: So when you say that there are these two committees and that's a kind of a statement of intent, what exactly do you mean by that?
>
> Participant 1: Well I think the one is I mean the- *it's a departure from what you more typically find* which would be there'd be a research committee and *as an appendage* a communications or engagement function and this […] it's clear if you look at the structure they're *intended to have equal weight* in the governance of Future Earth.
>
> (Interview 1)

The introduction of an Engagement Committee alongside the more usual Science Committee is seen to signify Future Earth's commitment and aspiration to co-design: the equal division of authority or responsibility implicit in some understandings of <u>*co-*</u>design and <u>*co-*</u>production comes to the fore. In addition to the committee structure reflecting Future Earth's aspiration towards co-production, the committees are seen as playing a significant role in developing Future Earth's co-production strategy and issuing a statement on Future Earth's position.

Tensions between the three models of co-production and associated worldviews outlined in Chapters 5 and 6 (representative-utilitarian co-production, deliberative-reflexive co-production, and co-production as threat) were very present in discussions and decision-making around the (implementation of the) governance structure of the initiative.

The issue of whether the Science Committee and Engagement Committee could have been or should be merged into one committee arose in the Science Committee teleconference recordings and minutes. When asked about this during interview, one participant (interviewee 9) suggested that: 'if you're going to have true co-design you have to have those sorts of committees working closely together. I'll say my own personal view was that you probably could've tried to design a single committee really […]'. This view implies that the committee(s) would embody co-design and co-production in their structure and working practices, in line with the representative-utilitarian vision of the documents as explored in the previous section.

However, some participants identified logistical and strategic reasons for establishing separate committees. One participant (interviewee 3), who had been involved in the

Transition Team since the early stages of the development of Future Earth suggested that having a combined committee was not considered early on, emphasising the experimental nature of Future Earth's governance design:

> […] *the engagement committee is an innovation* in the structure and so I don't think it was initially a discussion about whether to have an engagement committee and you know to have a science committee all merged. It was you know a *new point* that they were suggesting […].

Having suggested that having a joint committee was not initially considered as an option as the Engagement Committee was seen as building on existing arrangements, the participant moved on to identify the issue of stakeholder time limitations and potential to be bored by the Science Committee's discussions (and vice versa):

> I think a number of us had experience of this that whilst the research community is often willing to give up you know considerable time because they see it as part of their career roles to come to meetings like this, *it can be harder for stakeholders to devote that much time*. And that if the full set of stakeholders were exposed to the full set of discussions that the scientific committee had to have, we have seen experiences before where *people have got very bored* and I think the opposite is true as well, and I think that was at least part of the drive for separating the groups, recognising that they should […] come together often […]
>
> (Interview 3)

The issue of time commitment was flagged by participant 9 as well, who suggested that more influential, 'active people from industry, from government' would be able to devote much less time to committee meetings than 'science bureaucrats' who would have more time to offer.

Another participant (interviewee 5) suggested that in addition to avoiding the Engagement Committee feeling bored or overwhelmed, keeping the committees separate was seen as a way of curating a 'safe space' in which stakeholders could raise their concerns on an equal footing in comparison with the Science Committee:

> I think [the committees were designed to be separate] partially because they [members of the Transition Team] felt that *co-design and co-production was so out there*, that you needed to allow stakeholders to have an *equal advisory role* and not be out-manoeuvred and out-spoken by scientists so that there is a danger if you put them in the same group that they will just feel *overwhelmed* or they will feel *disinterested* or you know what I mean?

> […]
>
> You need to *curate a kind of safe and secure space* for them to raise their concerns but yes I am not very convinced by that.
>
> (Interview 5)

Here, there is an implication that Transition Team members believed that the Science Committee might not easily accept, welcome or adapt to collaborating with stakeholders, given the novelty of co-design and co-production in this field (it being 'so out there'), although participant 5 did not agree with that view. Another participant (interviewee 8) also suggested that it would be necessary to have a protected space to enable the learning process around engagement:

> Well, there was apparently an intense debate in the Transition Team about whether there should be one or two committees. I think… there are a number of reasons why they're separate […] one is that we're learning how to do engagement and therefore it's good to you know have *a really focused group that is just helping us with engagement* […] *and reflecting on that* and keeping that for the moment separate from you know from the scientific agenda-setting but of course these committees will work very closely together.

The implication is that the Engagement Committee will not be learning about co-design of scientific agendas by doing it at the global governance level (in the sense of collaborating with the Science Committee on scientific agenda setting); but rather that engagement and scientific agenda-setting are two distinct activities that initially need to occur separately (rather than the togetherness implied by "co-") (although in practice this agenda-setting was – at least in part – done by the two committees together). The participant went on to talk about 'inoculation':

> The second argument which I think relates to […] the question about the risk of the whole project becoming dominated by particular… interest groups from business or policy… erm or NGOs for that matter - and people wanted to guard against that so it was seen as *a kind of inoculation from that risk* partially to keep the two things separate.
>
> (Interview 8)

This second argument resonates with the 'co-production as threat' model discussed in the previous chapters, in which societal interests might damage the impartiality or objectivity of science. The decision to establish separate committees seems to have been at least partly made on the basis of assumptions about the separation of science and society (evoking deficit and linear model assumptions as well). Tensions between this view of science-society relations and a more constructivist approach were flagged by participant 7:

> Researcher: […] in some of the documents the fact that the SC and the EC are separate has been questioned, I wonder what you think about that?
>
> Participant 2: Yeah. Um, no, indeed it has been questioned and there's also been a set of justifications from the Transition Team for preserving that separation to *preserve the credibility and legitimacy of science and scientific evidence as something pure*. I'm with those that *see this separation as somewhat false*. […] I mean the other aspect though is that the Science Committee to my mind needs to be thinking more like an engagement committee and the Engagement Committee needs to be thinking like a science committee, so if you're going to keep them separate you've nevertheless got to have some sort of some *common understandings* of these things like co-design and co-production embedded into each and *each has to take a view that their perspectives are positioned and partial, whether they're scientists or stakeholders*.

Again, here the co-production as threat model is echoed in the idea that science and scientific evidence would no longer be pure, credible or legitimate if the Engagement Committee members (i.e. stakeholders) were to work on the same committee as the Science Committee members (i.e. scientists/researchers). However, given that this participant sees all committee members' perspectives as positioned and partial and does not afford objective or impartial status to the Science Committee members and their knowledge, she/he sees this separation as 'false'. The implication is that the shared, common understandings of co-design and co-production would (or at least should) entail an acknowledgement of the positionality of scientists (as well as non-scientists), in line with the deliberative-reflexive model of co-production.

In practice, the Science Committee and (Interim) Engagement Committee have remained as separate entities nominally but mostly meet together, and also members from each committee work together in sub-committees and sub-groups on particular tasks and areas of work.

All of the discussion and negotiation around whether the committees should stay separate or merge and how they should work together shows those involved in Future

Earth trying to work out the status and role of the committees, as well as what co-'s might mean in Future Earth and in the process of establishing a new institutional model for Future Earth. Do the committees embody co-'s by default in that they are composed of different disciplinary (Science Committee) and sectoral (Engagement Committee) representatives, or is something more needed? Different ideas about what co-'s are (participation, reflexivity, other) and how it should be done run throughout these discussions. Of course, the committees' role is about more than the co-'s, as this is not the only principle or ambition of Future Earth; so design decisions have been made on that basis too (as outlined in Chapter 4, for example, integrating knowledge and integrating the programmes, building the authority of this type of research, etc.). However, this institutional structure seems to be key to implementing co-'s, whether it is seen to be actively undertaking co-'s in itself, whether it is seen to represent co-'s or a commitment to co-'s, or whether it is seen to be in the position to bring about co-'s elsewhere in Future Earth.

Beyond whether the Science and Engagement Committees should be merged or separate, participant 7 also raised the issue of membership of the Engagement Committee:

> The other factor in this, I think there's been a certain amount of debate about whether the Engagement Committee should consist of *stakeholders*, in other words the people and groups with whom scientists should be engaging, *who can then be representative and feed ideas and questions in and out to their respective kind of constituencies*, or whether it should also include within it people who are as it were *experts in engagement*, so people who have thought about or researched or have experience to bear around science and public engagement, science communication, research-policy interactions, science and technology studies, co-production perspectives and so on. And I've felt it would be very useful to have some of the latter, some *people who can think through some of the processes rather than simply stakeholders* […]
>
> Researcher: And how do you feel that's played out in the Interim Engagement Committee?
>
> Participant 7: The Interim Engagement Committee is very largely stakeholders, and that's the view that that dominates it, […] *this is very much a collaboration view*. […] the way the Interim Engagement Committee has been constituted, there are one or two people who have a kind of journalistic role […], but mostly it's kind of stakeholder groups […]

The participant sets in opposition EC members as representative of different stakeholder sectors or constituencies versus EC members as experts in engagement, although argues that both are needed. Interestingly, the former is seen as both an embodiment or enactment of the representative-utilitarian (collaborative/ participatory) form of co-'s, and the members of that committee are also seen to hold the view that co-'s equals collaboration. The mention of representativeness and representation links back to questions discussed in Chapter 6.

The strategic reasons for adopting sectoral representatives (such as their access to broad networks), as well as the ambiguities of the language of representation are highlighted by participant 8:

> Well if you read the call for the [permanent] Engagement Committee we specify nine sectors I think. So it's going to be quite a puzzle. I think we are sensitive to the idea that there ought to be some possibly some people on the committee who are expert in engagement but in general we're interested in having *stakeholders who represent some sector in society* who are *well-networked*, but who also are *regionally representative*, there's got to be a *gender balance*, so we've got all these kind of decision criteria that we to meet which is gonna be quite a tricky thing to do-
>
> […]
>
> So […] I think the stakeholder committee will -or the Engagement Committee will represent stakeholder -I don't- we need again- it's sort of term- about framing and language but *will represent certain, will be representative of different sectors in society* so we'll have people representing in some way or although in their own capacity *they'll be representing that voice anyway in the [committee]*.
>
> (Interview 8)

In this quote the issue of representation and its ambiguity is apparent: this participant feels that it is about ensuring that particular (sectoral) voices (as well as regions and genders) are present on the committee, rather than the members representing (speaking on behalf of, as spokespeople for) a broader constituency to whom they would be accountable. While the EC is recruited to ensure that particular sectoral experience is present in the committee (as can be seen in the list of stakeholder groups/sectors required), the 2014 call explicitly states that 'Members of the Engagement Committee should serve in an individual capacity and will be chosen on the basis of their expertise and experience. They will not represent an organization, sector of activity or particular vested interests.' (doc 31).

The important strategic role of the committee members in connecting Future Earth to particular networks was also mentioned by participant 3:

> So I think where we've come to is yes *we didn't want to make it a theoretical group about engagement*, we wanted to make it a group… which maybe had some of that capacity but we're partly populated by people that had *access to large networks* who could help to bring them y'know to *involve them in the programme* and I think that is where we have alighted.
>
> (Interview 3)

This view of the committee members as links to broader or different communities suggests that beyond ensuring that particular views are present in the committee's discussions, the members are seen as important bridges or links between Future Earth and particular networks, perhaps increasing the inclusivity of the initiative (at least towards chosen sectors). However, the contrast between experts comprising a theoretical group about engagement and stakeholders bringing new communities on board – and by implication actually doing engagement in practice rather than talking about it in theory – suggests that certain assumptions are made about the nature of expertise in engagement and the roles that stakeholder members of the committee might be able and expected to play. It seems that having a range of stakeholders present (in this case on the committee) is half the battle won towards implementing co-'s; however, this view of co-'s as embodied in the members (and what/whom they represent) is challenged by participant 7:

> But it's not I think only about who – I mean *the Engagement Committee will also have to work on process it's not just […] about representing constituencies*, so I think […] what I hope is that Committee will include people who've got experience or interest in engagement processes […] that's what I'd like to see. Um and that through interacting with the Science Committee we can begin to sort of invent some *common principles and practices*.
>
> (Interview 7)

Representation is seen as one possible but not the only role of the committee, and less important than its role in developing process. So experts in engagement would not only work on theory (although common principles would be devised), they would also work on process and practice. Here, engagement is seen as something enacted in processes and practices rather than solely embodied in the range of people present: this distinction reveals one of the differences between the representative-utilitarian mode of co-production and the deliberative-reflexive mode of co-production (although, of course, this distinction is not clear cut, as, of course, from the representative-utilitarian perspective, the issue of what the stakeholders do once they have been brought together remains).

Similarly, participant 5 felt that more attention should be paid to designing and facilitating processes:

> I actually think that what we've underestimated and what most people underestimate is the extent to which *co-design and co-production is not about the committees you set up or about how many stakeholders you bring on board,* it is about how you… *it is about the processes we design and how you facilitate and run those processes* so I believe if you had one committee which was mixed, that could work or not depending on *whether leading that process are people who have the right skills and process design skills*, we always underestimate that you know? […]

The participant went on to express frustration at the amount of time and resources that had been spent designing what she/he considered to be an overly cumbersome governance structure:

> […] if I think now about the selection of the permanent Engagement Committee, when you think about how long in effect it is going to take us to have a permanent Engagement Committee, the fact that we had to have an interim… *you know, how much time and energy and resources go in to this?* So and then you think well actually why didn't we just have one committee, one Future Earth committee that had the right people on it and that can eventually organically you could have said OK what do we need? You know? Do we need to have a separate working group that looks at engagement issues? […] But instead *we spend two years designing a complex governance structure that is going to take us another year or two to set it up,* and then we're four years down the line you know? That is a bit frustrating and I know… *it is really important to get those processes right because of transparency and global representivity* [*sic*] and all of that but if we had designed something leaner and meaner I am sure that that wouldn't have been a worse way to go, I think it would have been better […]
>
> (Interview 5)

The participant feels that it would have been better to establish one smaller committee ‘with the right people’ than to spend time designing and appointing the complex governance structure. However, she/he notes that the reason it was important to get the design and appointment processes right, and thus to take time over their design, was ‘transparency’ and global representativeness. When asked why the establishment of the governance structure occurred in this way, the participant suggested that it was partly because this has never been done before at the global level so they did not know better, again stressing the need for transparency:

> I think it is… it really is because we don’t know better, *it is the first time we have done this at the global level*, and many, many voices and many people were involved in the Transition Team and its recommendations and in the Alliance and so the complex architecture that we see now, governance structure, is a result of complex processes and I think *they offer a compromise and make everybody happy, they are transparent because they have been round the block, there have been consultations on them* etcetera and *it is the first time we are doing it so we don’t have a better alternative*.
>
> (Interview 5)

Transparency is considered necessary due to the political sensitivities in dismantling the former programmes and bringing their projects into Future Earth; this participant perhaps believes that this stood in the way of more imaginative or pragmatic thinking regarding the initiative’s governance apparatus. However, compromise probably would be necessary whatever the existing programmes’ legacy, given that this is an experiment in organisational structure to stimulate and enact co-production at the global level. The participant’s comments indicate frustration with the representative-utilitarian model of co-’s in which committee (and stakeholder) recruitment potentially becomes a tick-box exercise to ensure that particular sectors (as well as geographical regions, genders, and career stages) are represented rather than thinking beyond recruitment towards the actual processes and practices carried out.

However, despite this discontent with the pace of development and the nature of the governance structure established, others saw work to date as an achievement, given hurdles encountered along the way:

> […] I think we have come on so far, you know, when I took on this role we had no Design Report, *the programmes were all trying to kill each other and kill Future Earth*, you know there was no concept of how the Secretariat was

> going to be formed and *great strides have been taken on all of those* but each time you unpeel the level of the onion, you know the next challenges come […] but if I look back over the last two and a half years, […] *I think we have made amazing structural progress and we're starting on the research path now*, recognising of course that the existing programmes have continued to deliver throughout this time.
>
> (Interview 3)

The intensity of the controversy around the establishment of Future Earth among the existing programmes is apparent here (as well as the feeling shared by many involved that it was necessary to acknowledge that great work had been and continued to be done by the existing programmes). The sensitivities and complexity of this situation necessitated care and time for the processes of bringing about institutional change (including performative attempts to affirm or assert the need for change and the legitimacy of the new arrangements).

Building on this exploration of how these political sensitivities (around institutional change) and various tensions (between governance and research, between different models of co-production, and between structure – linked to the representative model – and process – linked to the deliberative model) played out in the negotiations around how the committees should be populated and work, the following section explores another aspect of the implementation of co-design: the relationship between principles and practice.

7.3 Principles and practice

During the period of the fieldwork, a White Paper on engagement drafted by a sub-group of Secretariat, Science Committee and Interim Engagement Committee members was seen to reveal some of the tensions between different understandings of co-'s. It was also considered to play a key role in resolving these different understandings, and associated challenges and tensions, by setting down agreed principles to guide practice. However, the extent to which it might be possible to resolve these differences on paper was questioned by some, suggesting that it might only be possible to do so in practice, that is, in a sense, experimentally, through trial and error.

Many participants discussed the White Paper on engagement as key to setting out engagement, co-design and co-production definitions, principles and strategy, and a common Future Earth position on these concepts, including articulating who will be responsible for making decisions about when these kinds of working are appropriate or necessary. However several participants noted that working on the paper revealed differences in understanding of these terms within the IEC/SC, for example between constructivist and more instrumental understandings of the terms:

> [….] at the moment several members of the SC are engaged in writing what's being called a White Paper on co-production – […] there was an initial note […] which sort of laid out some of these views a little bit and actually revealed some of the gulfs, because there was one kind of view […] as one would expect from a very particular kind of scientific organisation that had worked *in collaboration with stakeholders*, and then I think that [others] from a different more *constructivist social science tradition* were bringing a rather different view, so that I think was exposed a bit in that note. So I think this White Paper process is an attempt to kind of *develop the beginnings of a position*.
>
> (Interview 7)

Here a tension has been identified between representative-utilitarian and deliberative-reflexive co-production. As seen earlier (in section 7.2), developing a common understanding of (and commitment to) co-'s is seen by some as key to moving beyond 'rhetoric' to implementation, as also voiced by participant 5:

> […] despite the fact that there are many people passionate about co-design and co-production, there are a lot of people in Future Earth and I don't just mean the committees and the Secretariat but in the wider family that still don't share a common understanding of what this means and even if you clarify the meaning that they really don't think that this is necessarily the way for science to go. So I think there is still a lot of… it's opened debate clearly *this paper that is being drafted at the moment, is an attempt and a reflection of the degree to which we're not all on the same page on these issues*.
>
> […]
>
> […] I think the will is there, the talk is there but it is a little bit at the level of rhetoric still and *the reality of implementing it is tough because we don't share a common understanding of what it means and we don't share a common conviction of whether this is the way to go*.
>
> (Interview 5)

Other participants saw the paper as having a role in trying to find a balance between arguing that a) everything should be co-designed/co-produced and b) nothing should be (because some are nervous about involvement of industry):

> […] this leads us down a whole interesting area of what do we mean by co-design and co-production and how much – how much is appropriate for different sorts of purposes um I think there's a bit of *rhetoric* around Future Earth which on the one side suggests that *everything should be fully co-designed and fully co-produced* and everything else, or on the other hand has people *extremely nervous and mistrustful of having industry involved* in research and things like that and I think *the truth is somewhere in between and I think that the White Paper that we're developing on engagement will try and articulate this* […]
>
> (Interview 9)

Here the model of co-production as threat is again apparent in the perceived nervousness and mistrust about involving industry in research, prompting the need for such guidelines. This participant further expanded on the potential role of the White Paper later in the interview:

> There's quite a bit of thinking about [how to do co-production] in development research and in agricultural research […] I think we're trying to ask parallel questions in a in a *pretty novel domain at this sort of global level*. […] I think *we're feeling our way* to […] to actually answer the question of how much engagement is appropriate in different circumstances at this level […] the Science Committee and the Engagement Committee together drawing on thoughts from the community more broadly need to actually […] produce a bit of a White Paper about these issues which can become part of the discussion and I hope things like your research will feed into this as well. Such that over the next few years we gradually develop a – well *hopefully within a year we produce some sort of position paper* on this but *we don't imagine for a moment that it's the perfect final answer*, but that we start to actually work in a in a reflective sense using it and *testing* whether these sort of ideas that we think might be right there are in fact correct. *So I hope that this White Paper will actually produce a table which actually says something about how much engagement we think might be appropriate in different circumstances at different stages of research or in different stages of the process and that that itself becomes a testable hypothesis*.
>
> (Interview 9)

Here engagement in Future Earth is seen as an experiment in the sense of testable hypothesis *and* improvisation as those involved 'feel their way'. The White Paper is intended to provide a structure to guide practice; however, this is not seen as a prescriptive one-size-fits-all policy, nor a 'perfect final answer': there is expected to be a spectrum of options for engagement in different circumstances, and there should also be flexibility regarding the development of the paper itself and the framework it presents. This is perhaps an attempt to both deal with the contestation around these concepts and also operationalise their multiplicity. This is (temporarily) crystallised in the engagement paper drafts, all of which suggest variation according to circumstances, including (the need to develop) a menu of possible options.

Flexibility, a spectrum of options for engagement, and the degree of prescriptiveness was also noted as important during the second focus group:

> FGP2: I was going to say I agree very much with [FGP3's] perspective on that not all of it is necessarily appropriate for that, sometimes critical research doesn't get buy in because you are coming in or things, but I think what we're saying is there's kind of the *spectrum* too and if Future Earth makes this *very rigid and just makes it co-produced, not co-produced* or something then we probably would lose out a lot because *it can be relevant in different projects and different cases to different degrees*.

Another participant in the same focus group referred to the need for a 'basket of possibilities' for co-production. As discussed in Chapter 5 and explored further in section 7.4 below, some participants suggested that these concepts would be interpreted in different ways in different contexts, so despite efforts to define and provide principles and guidelines at the 'global' governance level, any such frameworks developed are not intended to be entirely prescriptive.

While participant 7 saw the need for common and agreed understandings to promote co-'s as reflexivity (section 7.2), others saw such principles as necessary to avoid conflict of interest and ensure that vested interests of stakeholders do not undermine research results, bringing the deliberative-reflexive co-production and co-production as threat models into contrast. In the latter case, generally there is a view that such principles should be prescriptive 'rules' to deal with the threat of stakeholder interests twisting or misrepresenting results with potentially devastating outcomes (as discussed in Chapters 5 and 6):

> I don't think these concerns [about conflict of interest and threats to the objectivity of research] can be dismissed and just glossed over as if they are irrelevant, they are real and a very large number and large fraction of

> scientists have those concerns and pride themselves on trying to keep those conflicts of interest off of their research and I think Future Earth needs to deal with them in a much more direct and *transparent* way. I do believe that can be navigated but I think *we need some very erm… well defined rules of engagement first and foremost in the scientific process.*
>
> (Interview 2)

The view that transparency and 'well-defined rules of engagement […] in the scientific process' are needed to manage (critiques about) conflict of interest was shared by other participants. This is seen as particularly urgent in engaging with the private sector:

> I do think that particularly when it comes to private sector engagement and funding of research… *we just need to have clearly defined principles for these kind of public private partnerships so you know under what conditions is it OK for us as a research community to work on problems identified by private sector and take resources from the private sector?* But for the rest I feel very strongly that unless we are able to find acceptable principles for such partnerships and therefore are able to work with private sector and its interests, we will never really shift in the direction that we need to shift, so getting that right, finding ways of working with the private sector, of working on issues that the private sector also find important, erm… *in ways that the research community feels maintains its autonomy and integrity when it comes to issues of data… open access* etcetera we just have to get that right and that is I think one of our biggest challenges in Future Earth. It is fine you know we are kind of used to now working with policy makers and practitioners, NGOs can be difficult especially if they are activists, but private sector I think we are way behind.
>
> (Interview 5)

Here the concerns about working with the private sector are linked to the autonomy and integrity of the research community, particularly around issues such as intellectual property. Others expressed worries about how working with private sector stakeholders might prevent the pursuit of particular normative research agendas. During the second focus group, one participant suggested that it might be possible to build accountability into the research framework by insisting that questions of inequality be addressed when co-designing with private sector organisations:

> FGP3: I suppose you know we were talking actually at lunch with… was it [Alliance member] who was there, you know co-designing with business, I mean suppose you had… which company did you say?

FGP1: I just said big oil, I didn't mention any specific company.

FGP3: [Big oil, yes or or] a big seed company whatever, you co-design with them […] it still means that *which side are you on is implicit* so you… if you're co-design and they're willing to do it – is that *you ask the hard questions*. Please tell us um you know… um how is it going to impact X or Y what are the distribution consequences of it? *So that you build in possible implications for inequalities and you insist on that.* That could be one way out.

[…]

[…] *we could co-design with [those] who we feel could… may not have distributional or inequ… er issues of the poor etcetera in their minds* but if they are willing to co-design *we insist that those questions be put as part of the framework of the research so it is possible to build in some issues of accountability right there*. Now how far that would go is an interesting ha [laughs] question you know?

FGP1: Yes I guess what came up very clearly for me in terms of yesterday's discussion was *there probably is some need for us to work on some principles and procedures*

FGP3: [Mm]

FGP1: *[of] co-design and so it is very clear there are ground rules,*

FGP3: [Yes]

FGP1: *[there're] parameters and things they that you know must be undertaken*, […] I mean have you tried your utmost in terms of reasonable effort to get a cross section of truly representative sample in terms of who you have spoken to? But the question then becomes how far do you go to get to certain elements you know exist but who haven't come to you naturally or haven't responded to the call for co-design or co-production, do you have to really go to where they are and force them to speak to you? I don't know, I think we need… those are really quite fundamental questions I think we probably need to do some soul searching on and *put down on to paper as agreed principles*. Otherwise it is going to be quite hard to really get to grips with what is I think a very *amorphous concept*, you know it's hard to really describe what you mean by it because *it could be huge*.

FGP3 argues that (given that co-design with powerful actors as opposed to less powerful actors entails an implicit value judgement as to 'which side you are on'), Future Earth could insist that questions of inequality and distribution are asked 'as part of the framework of the research so it is possible to build in some issues of accountability right there'. FGP1 follows up on this by suggesting there is a need for agreed principles, procedures and ground rules to reign in the scope of potential co-design, for example in relation to how far to go in recruiting particular actors. While this could be interpreted as closing down FGP3's concerns about how inequality will be addressed (by defining them away through procedure), it could also be seen as support for developing Future Earth specifications for the types of questions and issues of accountability that need to be addressed in projects.

In this way, introducing the 'co-' concepts can be seen to open up questions that might not previously have been asked. Simply starting conversations about why and how to co-produce research has the potential to introduce unfamiliar questions and perhaps reflexivity:

> I mean, one really good thing is even having discussions about [power relations], because in somewhere like the IGBP Science Committee I can assure you the notion of talking about power would never have come up [laughs].
>
> (Interview 9)

Whether this change extends beyond the governing committees of Future Earth, and the extent and nature of its further effects, is a question for future research.

However, despite many participants arguing for defined principles and ground rules (whether to ensure reflexivity, to prevent conflict of interest, to ensure that accountability and questions of inequality are built into the research, or to ensure shared understanding of how far to go to reach particular stakeholders), and citing the White Paper as an arena for clarifying Future Earth's stance on co-design and co-production, the difficulties of doing this were mentioned several times, for example, by this IEC member:

> […] I wish that we had come to this meeting with a much more… with a signed off and agreed and completed, engagement strategy or engagement White Paper, something that we could say specifically with science community but I guess maybe that is impossible in the sense *that if we don't maybe know what the science committee is planning on doing, specifically, how can we complete our work about saying how we will engage?* […]
>
> (Interview 10)

While this statement perhaps reflects linear and deficit model assumptions, the lack of familiarity between the committees and each other's work was an important issue at this early stage of Future Earth's development (the interview took place before the two committees met together face-to-face for the first time), just as the lack of agreement and shared understanding within the committees is seen as an issue. (This is presumably one of the reasons some participants felt that it would be important to have a joint committee or for the committees to work closely together.)

When asked how differences in understandings of co-'s might play out, participant 7 suggested that deliberative-reflexive co-production is perhaps impossible to implement through abstract discussion:

> Researcher: […] as FE moves forward, how might that kind of reflexivity be implemented or how might those two different understandings of co-production be implemented or play out?
>
> I7: Yeah I mean I wonder whether they're really so opposed. I think what we probably need to work with is a kind of gradual coming together. […] So I think that [the White Paper] will get a discussion going that I hope we can take forward in the Beijing meeting. But *it's not very easy to do in a theoretical sense* because a lot of this cuts at the heart of what scientists feel is the objective nature of what they do and a particular view of stakeholders as stakeholders with a kind of preformed interests. So I think there may be a bit of a sort of *set of conceptual bridges to be crossed which are not very easy to do in theory* – in my experience the best way to try and get people thinking in this -get to work with scientists and policy makers and try to get them thinking in this slightly more reflexive way- actually comes through quite *tangible field level or problem-focused engagement*.

The participant moves on to discuss examples of this in her/his own research work, noting that what encourages people to think differently and reflexively is to expose them to different findings enabling them to recognise, make explicit and question their own assumptions during 'real field engagements around a problem'. Here the participant argues that it is only really possible to achieve the deliberative-reflexive form of co-production (on the ground) around a particular problem:

> […] where I've found in my work […] it's proved most successful in actually *encouraging scientists and policy makers to think differently* has been around things like exposing policy people to these very different findings about

> [research topic][45] so that they begin then to *question their own assumptions* and so they begin actually to ask new questions about "ok so what was this science saying if it's actually contradicted so starkly by something else?" So facing people with contradictions and discussing them or *real field engagements around a problem* […] if you want to try and integrate participatory modelling, mathematical modelling, environmental modelling, it isn't just a question of taking different techniques and integrating them to create a fuller picture, you also have to realise that each of those modelling approaches comes with a set of assumptions, with a set of particular questions that you're asking, things you're black-boxing, things that you are interested in, and those assumptions are also conditioned by the politics that you bring shaped by who you as a scientist might be and bringing some of those hav- *talking through some of those encounters in real field situations* […] where the values as well as the ecological expertise of […] scientists versus social scientists becomes very clear and very stark *around a particular problem* I think *begins to get some of this more reflexive interaction going.*

So, while firm principles are seen to be required by those that view co-'s as a threat to objectivity and independence, and common understandings and principles are also seen to be needed by those who see co-'s as deliberative-reflexive, the possibility of creating such shared principles is possibly challenged by the incommensurability of these approaches. Deliberative-reflexive co-production is seen as something that is best achieved in practice, at project level, around concrete problems, rather than conceptually or in theory (cf. Marres, 2007).

7.4 Scale and substance

Linked to the issue of implementing co-'s in practice around concrete problems is the question of scale, which runs throughout Future Earth, given its ambition to operate at multiple scales from global to local. Co-'s are not only seen as relevant to different institutional levels (as seen in section 7.1), but are also considered to operate at different geographical scales. Indeed, these two different types of scale are interlinked: the governing committees might be considered to be operating at the global or international level, the projects operating in a more 'localised' way (still international but presumably to some extent more explicitly 'grounded' in particular – local, national or regional – empirical contexts), with regional and national

[45] Ironically (given the participant's argument about the importance of specific empirical contexts and problems), the details of the research discussed have been removed to increase the chances of preservation of anonymity.

committees and centres and global Secretariat hubs bridging these institutional and geographical levels.

Scale is considered particularly important in Future Earth due to the nature of the problems of GEC and sustainability the initiative intends to explore and address, which are often conceptualised (and governed) globally but manifest in different ways at different levels and in different contexts, as expressed by one focus group participant:

> FGP3: The other thing you've heard here is *we need to look beyond global to regional, to sub-regiona*l so if you ask yourself the question about food security or food water energy too, *the challenges in sub-Saharan Africa are totally different from the challenges in the UK or the US, Europe or Latin America* and therefore we can talk about global food security but one has to understand what the real issues are so it is not a science and technology issue in sub-Saharan Africa, it's distorted trade policies, it is lack of empowerment of women, lack of infrastructure get food to markets, lack of micro-financing for better seeds etcetera it is a major governance rural development issue in many parts of sub-Saharan Africa, um, so you could easily increase food production factors by two or three with today's knowledge, those… but there's some big governance issues there. Big food waste issue in Europe so dissecting how do we become food secure has got lots of different elements to it which again talking to end users, one gets one can get a better… and *on an issue like that it is region by region so global is an issue too big* to… global commons mitigation of climate change is global commons, global concern is we have got food security issues around the world but they vary from – and water - from one place to another place.

Beyond this, participants suggested that co-design and co-production might face more or fewer hurdles depending on the sector (for example co-production might be easier in disaster risk management than in agriculture, or easier in agriculture than in technology development). It was also suggested that co-design might be easier to manage at the international level than at regional or local levels, but also that connecting the local and the global/international poses issues of representation again:

> FGP3: I mean again I am biased here, *I think doing [co-design] at the international level is straightforward*. Working with the assessment bodies, working with the conventions, working with all the science-policy interfaces and the UN agencies I think that's… I think we can do that fairly easily, whether it is actually members of the Engagement Committee, members of the Science Committee or of this final Secretariat I think that's going to be

quite straightforward and there'll be challenges but I think it is quite doable, it's an extension… it's really an evolution of what has been going on. *I think it's when you come down those next levels and which is where I think these national committees and regional committees are going to be unbelievably important, because so many of these issues are national, regional, sub-regional and national,*

FGP6: [This should be different from region to region yes.]

FGP3: [so the global one I don't think is a big challenge], I think it is those levels below.

FGP5: I would say that OK the international may not be such a challenge and the very local is not a challenge and maybe we could argue that this isn't so relevant to global change research but there are certainly strong traditions of co-design, co-production and participatory research in very local levels, in cities, in towns, in villages. *I think the biggest challenge is connecting up the local and the global* and the way it's been done to date in most international assessments has been through *representation mechanisms* so you have an indigenous person

FGP3: [yeah]

FGP5: [or…] and so on being part of your CBD [UN Convention on Biodiversity] process and so on. And that runs in to all sorts of problems of *who represents who and who can speak for who*

FGP3: [yes]

FGP5: [and] so on. And we have seen similar processes in the World Bank around voices of the poor and so on and there are representation problems and also problems of instrumentalising local voice to serve global agendas. *I am wondering if we can get to some different modes of linking local and global* which perhaps try and work with and through some of the existing network processes through which local, vibrant local forms of action and knowledge are already linking up through networks, then through processes of institutionalisation, through activism, through movements and connecting up across the world and putting pressure on governments, on international agencies etc. And I think *there aren't very many examples yet of how science connects with local to global activism* but it would be very exciting to explore these as ways forward.

Here FGP3 implies that representative-utilitarian co-design is straightforward at the international/global level (where one 'only' has to deal with established agencies, conventions and so on), but FGP5 challenges this assumption, particularly in relation to how local voices (and voices of activists) can or should be represented in global processes (earlier, during the plenary discussion on engagement, similar suggestions were raised in terms of engaging with spontaneous activism and initiatives beyond invited forms of participation, such as Transition Towns, Slum and Shack Dwellers International, peasant movements around food sovereignty).

Later on, assumptions about scale and hierarchies of power were also challenged:

> FGP2: [Can I add a point to this] in connecting it with what [FGP3] said which is the issue that you know we have a pretty much a clear idea of where to focus our work at an international level. I think it was this morning or yesterday when [IEC member] said you know at the same time we have a big shift going on
>
> FGP3: [mm]
>
> FGP2: where you know the ultimate decisions get made somewhere else so you know *if we still function from this sort of hierarchical model of the top will somehow determine what the rest of us will do*,
>
> FGP5: [yeah, yep]
>
> FGP2: then that might be the right model to focus our energy on the few places… *but what if that is not the right model*
>
> FGP3: [yeah, sure]
>
> FGP2: [of how to think about it?] Then you know… then how do we think about capacity building? Then how do we think about networking in ways
>
> FGP4: [exactly]
>
> FGP2: [or even] a selection of the few priority areas in ways that really, really matter,
>
> FGP5: [indeed]
>
> FGP2: you know I think we haven't fully thought that one through. But to me that's really important.

This question challenges the authority or efficacy of top-down governance models, and suggests that despite their best efforts to steer what happens within the projects and beyond, the Future Earth committees might not be the locus of power those that designed it might have hoped. So, more is needed than top-down governance, principles and mechanisms. As argued by Irwin (2008: 594), 'once we move beyond the modernist paradigm of science and technology as being amenable to centralised, rational control, scientific governance is revealed as a much more challenging, but also more intellectually intriguing process.’

Relating to the issue of top-down governance is the question of whether ideas about co-’s developed in a particular ‘global’ context will work in the range of contexts that might be involved in a ‘global’ initiative. As already discussed, there was awareness within the committees of a need to adapt according to context. For example, the draft engagement Green Paper noted:

> The drive for participation in engagement reflects a specific set of political assumptions that may not be universally shared, or even practicable (Engagement in Norway likely to be very different than in Iran, and likely to be different in getting an oil major involved in decarbonisation than in giving advice to IPBES).
>
> (Doc 79)

Aspects of a discord between ‘globally’ articulated visions for co-’s and the way in which they might play out at a national/local level were perhaps apparent at the one-day symposium convened by the Chinese National Committee for Future Earth (CNC-FE) on 3 June 2014 in Beijing, before the joint SC and IEC meetings on 4-6 June. The symposium was primarily an opportunity for the CNC-FE to share its progress and to showcase Chinese science.

The notion of institutionally embedding co-design through participation of representatives of stakeholder groups (in committee membership and other aspects of the initiative), in line with the representative-utilitarian model, was the primary way in which the co-’s were taken up in this context. A presentation on the formation and ambitions of the CNC-FE outlined its goal to adopt a ‘new mode of communications and engagement, i.e., co-design, co-produce and co-deliver’ by including funding agencies and media representatives in addition to natural scientists, social scientists and engineers in its 40-member committee. In addition, a ‘Co-design framework of Future Earth in China’ would be developed through a project funded by the Chinese Academy of Sciences between 2014 and 2016, during which the implementation plan of Future Earth in China would also be co-designed with stakeholders, policy makers, funding agencies and the public. The meaning of ‘co-design, co-production and co-delivery’ was not explicitly discussed, although it was linked to another objective, which echoed the ‘gap bridging’ metaphors discussed in Chapter 5: ‘bridging the gaps between natural science and social science, between science and policy making’.

In the substantive presentations and discussions intended to showcase existing research in China (organised into three sessions on air pollution, urbanisation, and transformations to sustainability), co-design and co-production were rarely mentioned. Policy makers and publics were predominantly constructed as audiences of research, whether to be influenced (policy makers), or who are in need of information, whose attitudes and behaviours might constrain decision making and effective practices, and who are ‘impatient to see how research can contribute to making their lives better’ (the public and ‘people on the ground’).

During the symposium and at the closed committee meetings the following day, Future Earth leaders heralded the CNC-FE’s work on co-design as exemplary. However, points of concern were also raised by both SC and CNC-FE members themselves regarding the lack of social scientists on the CNC-FE and at the symposium (suggested to be a result of the lack of social science capacity and lack of existing connections between natural and social scientists within the Chinese research community more broadly), lack of stakeholder presenters (although each thematic panel was supposed to include one stakeholder, the presenters were mostly academic), and the very small proportion of female symposium presenters and participants. Further concerns were raised in relation to an emphasis on technocratic and market-based solutions rather than critical approaches to politics, social justice, fairness and institutions.

So, while CNC-FE had substantial plans to develop a framework for co-design, the research presented at the symposium had not yet incorporated co-design, and current worldviews (of the relationship between science, policy and publics, and the needs and interests of non-scientific stakeholders) and hierarchies (of discipline or gender) may not be conducive to enacting co-’s in the ways envisioned by some Future Earth actors (i.e. beyond science communication and the deficit and linear models, towards multi-directional dialogue and/or epistemic equality). Some of the “global” meanings were reproduced: inclusion of non-academic participants in institutional structure, the emphasis on interdisciplinarity and co-design/co-production as associated steps, and the view of co-'s as a new form or mode of communication or engagement with stakeholders. However, these ambitions were (or might potentially be) challenged in practice by local contextual factors.

The symposium offered a snapshot of the complexities of bringing together new ("global") frameworks and outlooks with existing – and highly diverse – national and local structures, cultures and practices (Knorr Cetina, 1999; Jasanoff, 2005; Miller, 2008).

The following section explores another key element of implementation of (co-production in) Future Earth: efforts to evaluate and learn from the ongoing experimentation (or from existing examples).

7.5 Evaluation, monitoring, and iterative learning

Throughout the preceding chapters it is clear that many of those involved in developing and governing Future Earth experienced uncertainty around whether co-design/co-production is the right or the best approach, method or path to take and/or about how it can and should be done, and therefore treat it as an experiment, whether in terms of testing hypotheses or in terms of improvising and trying things out given the aforementioned uncertainty. Several participants stressed the importance of ongoing monitoring and evaluation:

> […] I think what is really critical therefore is that any initiative that tries to promote and resource and support this new approach or this kind of approach, needs to also *carefully monitor and evaluate its outcomes*. We're *not sure* whether transdisciplinarity will allow us to come up with more effective solutions from this side of science. *We need to test that*.
>
> (Interview 5)

This was frequently considered in terms of methodology and evidence, whether looking forward to future evaluation:

> […] I think we also need to have been able to show that we have helped introduce new ways of working, […] and that *we need to test the extent to which we think those have been helpful or not*. You know so has the concept that this is a good thing to do, has it been… *do we have any evidence* that actually it was or would we have done better to you know stick to particle physics […]
>
> (Interview 3)

Or questioning whether it is the right approach to adopt now:

> FGP3: Well it- I think that the boot should be on the other foot, you give a justification for co-designing and so on, you don't give a justification for not doing so. Otherwise you already set the gold standard. You're saying everything should be co-designed and you justify it if you're not going to do it but there is no… I don't think there's *a body of evidence enough for us to say that only co-designed research has major benefits for society. I mean where is the evidence for that, that you insist on something, on a methodology which is far from proven* and already I know across the tables we have a… we have er quite a divide.
>
> (Focus group 2)

This might include learning from the engagement experiences of the existing projects, or from other fields that have already adopted participatory approaches, as discussed in Chapter 5. Others spoke in terms of an iterative learning process regarding Future Earth's own processes:

> FGP2: I think we're going to have to have […] *a learning process* in Future Earth also that we might… start with co-design and then realise wait, this is a little bit problematic, *step back, let's re-think what we're doing and how we're doing it and then go again and again* so I see it as almost if we're talking about transforming science over the next ten years it's probably… probably have a lot of learning and lessons to learn about erm… you know, implementation.
>
> (Focus group 2)

Some framed co-production as an 'evolving concept' or 'evolving methodology', noting the importance of accepting the possibility of failure and discomfort:

> FGP1: Yes. Um, I agree and I think that you know it's… it's part of… it's one of our sort of ten year, 2025 objectives and it's by no means we are going to get it right and apply it throughout the next ten years, I think it is going to take us ten years and *after ten years we may if we're lucky, have a reasonable methodology of how to do it* […] *it's not going to be something that we can crack in the next couple of months and then all Future Earth projects will just apply it, I think it's going to take us a long time and it is an evolving concept*

> and even more so it's going to be an *evolving methodology* of how to do this and I think people need to be patient with that as well and expect *potentially to get it wrong sometimes* and therefore even *potentially upset some people* so…
>
> (Focus group 2)

However, a tension between mission orientation and possibility of failure was identified by another participant in the same focus group, as discussed in Chapter 6:

> FGP4: […] So in many of these cases whether it's improving agricultural yield or coming up with a better battery design, if you are adverse to failure, which is – *a big chunk of science is about failure*, you know you want to sort of test ideas, proving the negatives you know just as invaluable as proving your concept and erm *if you end up with an aversion to failure then you're cutting off areas of enquiry that might actually be the place where you want the breakthrough*. So that's part of the tension in applied science and that is a lot of what we're talking about here because *science for sustainability is mission oriented but it may be the thing that's over there in the dark corner that no one's thinking about, that actually would be the break through that could be important* and it's a real… and there's tension there always.

As suggested by this participant, perhaps one way of dealing with this tension – also the tension between putting structures in place whilst maintaining experimentality and flexibility – might be to focus on characteristics rather than goals:

> FGP4: […] To me it's much more important to focus less on those bullet points, the research points now and to focus on the architecture of this tool for facilitating those cross disciplinary, end-user friendly relationships. It comes down to- I've been describing recently, *focusing on characteristics more than goals*. In a world of a lot of *uncertainty and change*, whether you are looking at society generally or it's some… or a child of yours, you want them to develop to be adaptable, innovative, you can look at your kid and say 'I want you to be a doctor' you know 'and earn $300,000 when you're 30' or you can lead your kid and say 'what qualities would I want you to give you the best chance of navigating a turbulent,
>
> FGP3: [right]
>
> FGP4: [complicated] century' and *they are qualities, they are traits, they're characteristics of that system*, that young person that you can nurture and with for Future Earth so I would focus more on qualities you know *interactivity*, making sure that *when there's a proposal that comes in the door, it goes in all directions, so people are thinking about the different vantage points*. [And then… and you know actually]

> FGP3: [yeah that's a very good way to put it yeah.]
>
> FGP4: being a little less focused on proving a positive result because that's already [tweaking] […] towards your known solution that you think is the right thing to do then you're going to miss your… you could actually be distorting the process in ways that you would regret later and again that is why *I think there is a lot of potential in something like this, as long as it has certain qualities*.

FG4 is arguing that during times of uncertainty and change, it would be better to aim to develop characteristics such as interactivity and enabling multiple perspectives, rather than aiming for particular pre-defined solutions. The other participants seemed to agree with this approach, also suggesting that co-production could be phased in gradually as a characteristic of the science that Future Earth does:

> […]
>
> FGP1: […] it's a *phased approach*, *we're not saying that hard-line from now on everything needs to be co-design and co-production*, we need to slowly bring it in and *introduce it as a characteristic which characterises the type of* [science…]
>
> FGP4: [I mean it is part of the…]
>
> FGP1: But *it characterises the type of science that Future Earth does do*.
>
> FGP3: [Or could do.]

Thinking of co-production as a characteristic, or composed of particular characteristics, is perhaps reminiscent of the notion of bringing about a particular ethos within Future Earth discussed earlier. Perhaps these tendencies towards viewing Future Earth and co-'s as an experiment, and the approach of viewing co-'s as a characteristic or quality, or composed of particular characteristics, might enable a way forward in which some of the differences in understanding of these concepts and how to implement them might be bridged and productively made to work together. This may however bring with it its own problems of assessment and evaluation in an institutional context.

7.6 Conclusion

This chapter has explored how the implementation of co-'s in Future Earth was imagined, discussed and rolled out. There are several elements of this experiment, which emerged as themes running through the qualitative data: temporality and institutional levels; organisational structure and process; principles and practice; scale and substance; and evaluation and learning. These elements comprise key questions that are (or will need to be) negotiated in the implementation of co-'s in Future Earth: when co-design/co-production might happen; in which institutional configuration; at which institutional, geographical and communicative scales and levels; and around and through which processes, principles, practices and problems. These interlinked elements are underpinned and shaped by the models of co-production identified in Chapters 5 and 6 (representative-utilitarian co-production, deliberative-reflexive co-production, and co-production as threat), which influence (views on the appropriate) implementation of co-design and co-production through Future Earth's organisational structure, processes and practices, across the range of different scales and levels detailed above.

Due to the novelty of attempting intentional co-production at/from the global level in the GEC and sustainability domain, Future Earth actors are experimenting, improvising, and compromising because this has not been done before (or if it has, those involved have not done it before). Their suggestions about iterative learning and the tentative nature of the existing and potential activities are manifestations of the experimental setting. While on the one hand the importance and primacy of the organisational/institutional structure and frameworks (including but not limited to the governance committees and their outputs such as the engagement White Paper) is stressed, on the other hand, these structures potentially (but do not necessarily) place limits on the ways of working. Others were more keen to see co-'s play out in practice in a problem-focused context, learning from existing or own practices, and imitating other fields with greater experience of stakeholder engagement. However, the interplay and balance between these different levels and models is key: global level strategy and structures are themselves composed of locally enacted practices, and local-level co-design and co-production often relies on broader frameworks of meaning.

In Chapter 2, the distinction was made between improvisation as ‘the action or fact of doing anything spontaneously, without preparation, or on the spur of the moment’ and improvisation as ‘the action of responding to circumstances or making do with what is available’. In Future Earth’s experimentality, the latter understanding is more apt, whereby tentativeness, responsiveness and flexibility might be coupled with an acknowledgement that it is not possible to know (and therefore prepare for) everything before acting (or in some cases, ever). However, it should be noted that experimentation and improvisation – analytically and in practice – do not (in this context) mean that ‘anything goes’. There is still purpose, order and structure, and there is still a need to steer efforts in practice. The question then is how and, more importantly, for which purpose. Those involved in Future Earth are grappling with serious issues, and viewing the initiative or co-’s within it as an experiment should not undermine that. Similarly, acknowledging that publics (including stakeholders), issues/objects, practices, norms, etc. are emergent should not remove the commitment to establishing better, fairer systems of science and democracy.

However, institutionalising experimentality faces significant challenges – indeed ‘institutionalising experimentality’ might be regarded as an oxymoron: how can a top-down organisation allow for open-ended bottom up input, experimentation, and reflexivity? In establishing the structures, procedures and principles (along with the identities, discourses, representations) necessary for institutional, community and epistemic cohesion, how can closure, settlement and stabilisation be balanced with openness, flexibility and responsiveness? This and other questions are considered in the final, concluding chapter.

Chapter 8: Conclusion

Since 2012, Future Earth, a major international research initiative on global environmental change (GEC) and sustainability, has set out to transform GEC research by various means, including through co-design and co-production. This thesis has taken Future Earth as a case study and used this unique opportunity to investigate the meanings, implementation of and experimentation with co-design and co-production in global research governance.

While existing research on co-production and related concepts or approaches has mainly focused on the involvement of non-academic stakeholders in research design and process on the ground in local, national and regional contexts, little work to date has explored what co-production might mean in research governance, particularly at the international level and for global institutions. This study therefore aimed to contribute towards knowledge on co-production as an intentional principle, practice or framework for research governance and conduct, and explore the translation of co-production as an analytical concept originating in STS into a notion or practice of knowing actors.

Future Earth has been, in some regards, an ideal site to study what co-production might mean in an international and institutional research governance setting. As an evolving, young institution at the time of study, it also can be seen as an ideal site to explore the reworking of established categories and configurations of knowledge and social order, or the emergence of new ones; the co-constitution of the epistemic and the normative. However, this opportunity is simultaneously a challenge, as the quickly shifting and sometimes nebulous nature of an emerging initiative, particularly at the scale of ambition of Future Earth, can be hugely complex and difficult to 'pin down' for long enough to make sense of it and make meaningful claims. Of course, from the perspective adopted in this study, which views all efforts towards science governance (whether institutional, collective, individual, or otherwise) as constantly in-the-making, this is a challenge whatever the focus of study, but I would argue that this is particularly the case here, given the complexity and ambition of the Future Earth endeavour. The findings of the research reflect that complexity, presenting a partial picture of some aspects of (the activities comprising) Future Earth at a particular moment in its development.

The overall research aim has been to investigate attempts to transform global environmental change (GEC) research systems, communities, cultures and practices through the adoption and institutionalisation of co-design and co-production, using Future Earth as a case study. This overarching aim was operationalised through the following research questions:

1. What is Future Earth? What are the visions of its identity and remit?
2. What do co-design and co-production mean in the context of Future Earth? Why are they advocated and adopted; what are the rationales underpinning these concepts?
3. Who is imagined or expected to be involved in co-design and co-production? What are the underlying models or imaginaries of science and society?
4. How are these ideas being – and how will they be – implemented in practice to govern, coordinate and conduct research?
5. So what? How can findings from this case contribute to the literatures on co-production and international research governance, on experiments in science and democracy, and what are the implications for research governance in practice?

To answer these questions I have used qualitative methods and sources of data: documents around Future Earth's emergence and development between 2010 and early 2015, ten semi-structured interviews with key actors involved in or aware of Future Earth, two focus groups with Future Earth committee members conducted in the context of the joint Science Committee and Interim Engagement Committee meetings in Beijing, June 2014, and participant observation at that same meeting. This body of data was analysed thematically and interpretively, exploring emerging meanings and themes and drawing on theoretical concepts from existing literature (e.g. political imaginaries of science, experiments in science and democracy) to further inform the analysis and relate it to the broader context and theory development.

Overview of findings, argument and response to research aim

Overall, the analysis and findings suggest that visions of Future Earth's identity, function and remit were ambitious, diverse and sometimes ambiguous, evoking two potential institutional forms: a centralised, unified and cohesive 'flagship', or a 'rich tapestry' of varied initiatives. Aspects of the tensions between these visions revealed themselves in how co-production and related concepts were understood in Future Earth. These terms were ambiguous and contested, with varying definitions underpinned by different rationales for increased (or, indeed, limited) involvement of non-academic stakeholders in research governance, design and process (from ensuring relevance to democratising expertise to preserving the objectivity or independence of science). These different notions of appropriate engagement and legitimate stakeholders were underpinned by disparate conceptions of the value of research – as a service to society, site of democratic deliberation, or public good. Such science-society imaginaries reproduce – and potentially challenge – established models of science and democracy, shaping how the implementation of co-production was imagined and undertaken.

I argue that, while this diversity and ambiguity in visions of (co-production in) Future Earth can provoke tensions, it can also be seen as an opportunity if we move beyond an evaluative stance to consider Future Earth – and co-production – as an ongoing (series of) experiment(s). From an experimental perspective, ambiguity can make space for openness and flexibility, enabling differences to co-exist. As implied throughout the preceding chapters, and as will be argued in this chapter, this might require new (and maybe radical) thinking about how to organise, conduct and value research and its outcomes, with an increased emphasis on fostering, appreciating and productively working with diversity and institutional indeterminacy.

In relation to the research aim, while Future Earth can be seen as an attempt to transform GEC institutions, communities, cultures and practices, as well as broader research systems, through the adoption of principles including co-design and co-production (also institutional and knowledge integration, greater involvement of social science, etc.) these goals are variously understood, expressed and are not necessarily shared by all involved. On top of the sensitivities inherent in large-scale organisational change when long-standing structures (and jobs) will be disbanded or reconfigured, the introduction of these ideas in this context was not straightforward, in some instances creating controversy and contestation (for example, as manifested in resistance to co-production when it is considered to be a threat to objective or independent research).

Introducing these concepts has also led to substantial challenges, many of which confirm findings in the literature in other contexts and at other scales, but some of which are new due to Future Earth's ambition to operate at a global scale across a huge range of topics, sectors and disciplines. The problems of GEC and sustainability that the initiative intends to address are often conceptualised (and governed) globally but manifest themselves in different ways at different levels and in different contexts. Furthermore, operating at the global scale poses challenges for representation, and for the authority or efficacy of top-down governance models.

Although it is beyond the scope of this thesis to conclude whether the ambition to transform GEC research has worked (that would require a longer-term study, and investigation into other parts of Future Earth, its broader networks and interactions with its partners, as well as the environmental and sustainability research field beyond Future Earth) – and while the study has explicitly avoided assessing Future Earth's successes and failures against pre-determined ideal ways of doing co-production (or science-democracy relations) – it is clear that co-production in this context has had and will continue to have constitutive and performative effects (even if not the ones intended by all of its proponents). These are solidified in new institutional arrangements, such as the multi-stakeholder Engagement Committee and multi-disciplinary Science Committee and their joint working groups, distributed global Secretariat hubs and centres, and thematic, challenge-centric (rather than disciplinary) organisation of research, as in the more recently established Knowledge-Action Networks (on Transformations, Ocean, Health, etc.) (Future Earth, n.d.-f). These developments signal clear departures from the existing GEC programmes, with the potential to effect further change to well-established social and epistemic orders.

Introducing these concepts has also had less tangible effects, particularly in making space for discussions about the role of (GEC and sustainability) science in relation to society. Simply starting conversations about why and how to co-produce research has the potential to introduce unfamiliar questions and perhaps reflexivity to existing communities and projects (as explored in Chapter 7). Whether this change extends beyond the governing committees of Future Earth, and the extent and nature of its further effects, is a question for future research.

In terms of the institutional models discussed in Chapter 4, Future Earth might best be considered to be a tapestry (rather than a flagship), in which a broad range of diverse efforts and initiatives are grouped under its symbolic institutional umbrella without the requirement of conceptual or epistemological harmonisation or integration. The formative stages of Future Earth entailed potentially homogenising language and ambitions – in part due to the struggles in carving out an identity and support for the initiative – and there will perhaps always be some element of this in a single institution (however distributed and networked) attempting to lead, coordinate or operate at the 'global' level. However, as acknowledged by some Future Earth actors, co-design and co-production will likely always be interpreted in a range of different ways. An appreciation of this diversity was already apparent within the Science and Interim Engagement Committees at the time of the fieldwork, and they demonstrated a high degree of reflexive capacity. Although the experimental nature of Future Earth was not always foregrounded, the need for (organisational) learning and flexibility was emphasised.

During and since the period of study there are many signs of sophistication and subtlety in Future Earth's construction. For example, the Engagement Principles and Practice published in 2016 (after the data collection for this study was complete) leave considerable space for flexibility, experimentation and learning. The second principle is 'Engagement needs to be flexible' (Future Earth, 2016b: 5) and the publication itself is introduced as 'a living document that will build on the experiences of Future Earth engagement activities', that 'will be updated based on new learning and periodic review processes' (Future Earth, 2016b: 2). It presents a vision of Future Earth that evokes the rich tapestry model, in which a broad range of efforts are grouped under its symbolic institutional umbrella, united by a commitment to engagement (perhaps without the requirement of conceptual or epistemological harmonisation or integration):

> Future Earth provides an umbrella under which projects funded separately by a number of agencies are united by a shared philosophy – one which recognises the importance of engagement (which includes transdisciplinarity, co-design and co-production).
>
> Many in the Future Earth research community are already working in this way and through the Committees and Secretariat, Future Earth provides leadership, and secretariat support for knowledge sharing, facilitating and guiding participants in a journey which can develop organically over time.
>
> (Future Earth, 2016b: 6)

Future Earth might yet provide the space and legitimacy for new thinking about how to organise, conduct and value research and its outcomes, with an increased emphasis on fostering, appreciating and productively working with diversity and institutional indeterminacy.

The following section (**8.1**) recaps the thesis findings in more detail. *Section **8.2**: Overarching contribution* links the findings to the broader context and literatures presented in Chapters 1 and 2 by addressing the final research question: How can findings from this case contribute to the literatures on co-production and international research governance, on experiments in science and democracy, and what are the implications for research governance in practice? Section **8.3** then discusses the limitations of the research, and section **8.4** presents a forward look to potential future research.

8.1 Summary of findings

The following sections summarise the key findings emerging from the analysis in response to research questions 1-4 (as presented in Chapters 4-7).

8.1.1 What is Future Earth? What are the visions of its identity and remit?

Chapter 4 presented background on the emergence of Future Earth, followed by an analysis of tensions in visions of the initiative's identity, remit and function. Future

Earth emerged from a complex institutional landscape of existing GEC research programmes, its development driven by ambitions for a unified framework for GEC research and an increased impact in policy and practice. Integration and co-design (of both institutions and knowledge) emerged as key principles of Future Earth to address some of the perceived issues with the existing programmes. Despite the alignment of institutional efforts and interests on the part of the co-sponsors of the existing GEC programmes (international research councils, funders, and UN agencies), the development of the new initiative – Future Earth – has not been simple. During the period of study, visions of Future Earth's definition and purpose were diverse, ambitious and sometimes ambiguous. Lack of clarity in Future Earth's identity and remit was occasionally seen as problematic by both those inside Future Earth and those commenting on it from the outside, who called for less vague definitions of the initiative, its goals and what it would deliver, and/or a less ambitious mandate. The committees were working to resolve these concerns and questions.

The analysis demonstrated that, at the time of study, Future Earth was mainly conceptualised in two broad ways. Some of the visions that were extracted from documents, interviews and focus groups, evoke a 'flagship' model, in which there is a focus on unification and harmonisation. By contrast, others suggest a 'rich tapestry' model, which would bring together diverse initiatives, allowing for multiplicity. Future Earth's different definitions and designations were accompanied and informed by a diverse range of imagined roles and functions. However, there were potential tensions between different ambitions for Future Earth, some of which align with the flagship model (for example, Future Earth as a platform to deliver solutions-oriented knowledge, with a focus on consensus and integration, setting standards and limits on participation, taking a directive approach), while others align with the tapestry model (for example, Future Earth as a hub or arena for debate, focusing on plurality and multiplicity, being inclusive and responsive). Some of the tensions did not map clearly onto one model or the other: for example, whether Future Earth should give prominence to existing ways of doing science or promote new ways, and whether it should promote demand-driven or curiosity-driven research.

I suggested that such tensions and ambiguities are perhaps inevitable in the early stages of a new initiative or new institutional arrangement, and we might expect that some points of stabilisation may develop in due course, even if these are temporary. This might be, for example, in institutional design or infrastructural architecture, such as the Future Earth Open Network online tool, to which anyone can sign up. Despite points of (temporary) stabilisation such as this, as the Future Earth network is further developed and extends, the Future Earth model will also be extended, adapted and interpreted in a diverse range of regional, national and local contexts; there the same and further tensions and ambiguities may emerge.

Future Earth can therefore be seen as an experiment (or a series of ongoing experiments) in transforming research and its institutions. The ambiguities, tensions and uncertainties enable ontological variability: Future Earth may now be or may yet become a flagship, a tapestry or both (or indeed something completely different). What eventually emerges also depends on how co-design and co-production are imagined, used – and, of course, how the 'words and concepts with which we describe society' and, in this case a global institution, 'become part of the self-conscious apparatus of reflection' (Jasanoff in Turney, 2014).

Given this inevitable multiplicity, perhaps a rigid subscription to the flagship model with its accompanying centralisation and unification cannot capture the diversity necessary in an initiative such as Future Earth. Therefore, for now it might best be considered to be a tapestry, in which a broad range of diverse efforts and initiatives are grouped under its symbolic institutional umbrella without the requirement of conceptual or epistemological harmonisation or integration. This conceptualisation and associated formation could be more conducive to flexibility and experimentation.

8.1.2 What do co-design and co-production mean in Future Earth? What are the underlying rationales for advocating and adopting them?

Chapter 5 set out to explore meanings of co-design and co-production in Future Earth and the reasons for adopting them. The analysis revealed that while co-production is a key principle or strategy of Future Earth, linked to a range of broader ambitions for the initiative, what it might mean in this context is not straightforward. During the time of the study, the meanings of these terms were multiple, ambiguous and contested. This was (at least partly) driven by varying rationales for advocating the co-'s and differing levels of subscription to the idea that they should be required elements of Future Earth research. The discussions and activity around the co-'s was messy in the sense that there was little consensus on these terms. However, it is possible to identify common themes and features that coalesce around particular (anticipatory and performative) views on what these terms are or should be about. While one core (not entirely unambiguous) view emerged (co-'s as participation of stakeholders for relevance, acceptance and utility), a minority understanding was also present (co-'s as reflexivity for democratisation). A third view of co-'s also emerged, often formulated in response or resistance to the first two models: the idea that the co-'s might be a threat to scientific ideals and norms such as objectivity, independence and academic freedom.

These different visions reveal different ideas about the relationship between science and society and the source and role of the normative in research. The core view (adopted by a range of actors and prevalent in the official documents) suggests that involving stakeholders in research through co-design and co-production will make knowledge more relevant, acceptable, and therefore it will be used more and have greater impact. In this view, co-'s are seen as a means to close a gap between research and policy/practice, where science and society are seen as spatially separate, but would come together in the process of co-design and co-production. Values and the normative are seen as the concerns or expertise of societal stakeholders, and (scientific) knowledge and skills are seen as the expertise of researchers. The role of the researcher (or research more broadly) is seen as that of the knowledge broker, offering policy options and scenarios but not being policy prescriptive.

The second view (primarily voiced by those with backgrounds in or affinities for social science/humanities) suggests that co-'s are a process of deliberation or reflexivity, enabling the (partial) knowledge and commitments of multiple parties to be debated, and democratised. It sees science as part of society; all parties, including scientists, are driven by social commitments and norms, and co-design and co-production is a means of making these explicit. The role of the researcher might come closer to that of an advocate or ‘activist’, not only identifying and making explicit the implicit normative aspects of research, but also taking steps to pursue particular normative agendas in policy or action.

Finally, the third view (held by a range of actors including natural and social scientists) sees science and society as separate and believes that they should remain separate, society having interests and biases that might contaminate or limit science/research in detrimental ways.

These different views echo some of the tensions in Future Earth’s identity and remit explored in Chapter 4: for example, co-’s as reflexivity for democratisation emphasises multiplicity, diversity and debate, while co-’s as participation for relevance, acceptance and utility might suggest a greater focus on consensus, integration and solutions; finally, co-’s are seen by some as a threat to curiosity driven research by shifting the focus to demand.

To counter the resistance to co-’s expressed partly through the third view, and to deal with some of the ambiguities and challenges of the co-’s, Future Earth actors proposed that it might be necessary to develop a continuum or spectrum of co-’s, meaning different things (or at least different extents of engagement) in different contexts (not yet fully specified). Co-’s were seen as innovative and experimental, as they have not been attempted in this field at the global level before (although they are seen as common in other fields, such as medicine, agricultural and development studies), and Future Earth actors are ‘feeling their way’ to work out how to implement this. The concept of co-production therefore creates an experimental condition in Future Earth, although this is not foregrounded in the actors’ accounts. However, it potentially could be a very useful lens or approach: experimenting might be the only way to proceed given the differences in understanding of what co-’s are and what they are for.

8.1.3 Who is imagined or expected to be involved in co-design and co-production? What are the underlying models or imaginaries of science and society?

While Chapter 5 examined visions and meanings of various concepts of and related to co-production, Chapter 6 homed in in more detail on visions of who should be involved in these processes. Although involving societal stakeholders is key to all understandings of the co-'s in Future Earth, who these stakeholders might be is not always clear, and what this might mean in practice is not often expounded. This chapter presented an analysis of who is imagined or expected to be involved in Future Earth and what this can reveal about the underlying science-society imaginaries and models (e.g. of democracy, of the value of research) that inform the different views of co-production explored in the previous chapter. These latent imaginaries impact on how co-production can be performed, particularly through their expression in different participatory models, a topic further explored in Chapter 7.

'Society', 'users' and 'partners' were predominantly constructed as beneficiaries, recipients and/or aids to agenda-setting, while a minority saw them as active participants in knowledge construction (although this may depend on whether co-design or co-production is being considered). 'Stakeholders' were mostly characterised as societal sectors or organised groups to be represented in Future Earth, and 'the public' was predominantly imagined as an audience of communication/ education or subsumed into/represented by other societal groups. This is indicative of the challenges in defining stakeholders on a global scale in the context of GEC as a global issue and Future Earth as a global organisation, but also suggests that Future Earth is primarily aiming to inform policy (across various sectors) rather than other spheres of social activity.

There are varying ideas about who should (or should not) be involved, and these views (including views on what co-design and co-production mean more broadly, as outlined in the previous chapter) are underpinned by and co-constitutive of diverse conceptualisations (political imaginaries) of the ideal or proper roles and relationship between science, politics and their stakeholders. Particular notions of the public value of science/research – as a service, as a public good, as an object/site of democratic deliberation – are tied to particular notions of legitimate scientific stakeholders and their appropriate representation and involvement in the initiative; reproducing, or potentially challenging, established democratic and scientific models.

These comprise, firstly, the representative-utilitarian model in which an epistemic deficit and/or gap between research and action on GEC/sustainability can be addressed by inviting societal stakeholders to help define research questions and participate in the research process. Society/stakeholders are imagined as recipients/beneficiaries of knowledge primarily produced by science, and as members of – and represented in Future Earth by – particular societal sectors or organised groups (e.g. business, government, civil society). The value of science is as a public good or service/product to meet societal need (partially in line with a 'neoliberal' political imaginary (Nowotny, 2014), in which short term impact and immediate translatability of research into action is of most value, but in this case the economic focus of that imaginary is absent).

Secondly, a deliberative-reflexive model was apparent, in which a democratic deficit in science (and perhaps more broadly) is addressed by recognising all knowledge as partial, admitting plural perspectives into knowledge making processes, and reflecting on tacit assumptions embedded in existing framings. Stakeholders (including scientists) are imagined as active contributors to knowledge creation, with rights and social/political commitments. The value of science is in making a difference (in relation to e.g. social justice), and as a site/object of democratic deliberation (in line with a deliberative political imaginary (Nowotny, 2014)). All versions of co-production have the aim of meeting societal need or concerns, but the deliberative view enables questions about what this means, whose need is met, etc. whereas this is not always specified or differentiated in the representative-utilitarian view.

Thirdly, a more traditional republic of science (Polanyi, 1962) model emerged, in which co-production poses a threat to curiosity-driven research, academic freedom, and the scientific ideals of objectivity, independence and autonomy (Nowotny, 2014). Stakeholders (e.g. private companies, policy makers) are imagined as having interests and biases that endanger the public value of science in its ability to produce objective, independent, value-free knowledge.

The first and third of these models are perhaps more standard, traditional modes of research policy or ways of viewing science. The second could be seen as a means of mediating between or attempting to steer the more established modes in new directions, through processes that acknowledge the contingency of existing understandings and arrangements and highlight the possibility of alternatives. Each of these views exists in the research community as a whole (beyond Future Earth). However, there could be space for each model (rather than one dominant model, as is often the case) if an experimental approach is adopted, allowing difference to co-exist.

8.1.4 How will these ideas be – and how are they being – implemented in practice to govern, coordinate and conduct research?

Having explored understandings of co-production, related visions of who should be involved and the underpinning science-society imaginaries, in Chapters 5 and 6, Chapter 7 explored how the implementation of co-'s was imagined in Future Earth, and how the early efforts towards co-design and co-production played out during the period of study. It found that the three (sometimes competing) modes of co-production outlined in Chapters 5 and 6, influenced the (potential) implementation of (co-production in) Future Earth across and within several key aspects of the initiative: institutional and temporal levels, organisational structure and process, principles and practice, scale and substance, and evaluation and learning. Ambiguities about whether co-design and/or co-production should happen within governance or research or both; within the governing committees, the projects or in between; whether it happens from the beginning or throughout, at other particular stages; or whether it is always happening anyway, were also underpinned by (differing) assumptions about the linear temporal (and hierarchical institutional) relationship between governance and research. When considering whether co-production may already be happening, STS understandings of this term (i.e. co-constitution of science and social order) were discussed, leading to the suggestion that Future Earth's work could comprise making explicit – then redirecting – implicit social ordering or normative framings of research agendas.

Tensions between the three views of co-production (representative-utilitarian co-production, deliberative-reflexive co-production, and co-production as threat) were very much present in discussions around the (implementation of the) organisational/governance structure of the initiative, including the way in which the committees should be populated (e.g. advocates of the representative-utilitarian model pushed for stakeholder representation on the EC and adherents of reflexive-deliberative model emphasised the importance of processes of doing, leading and governing co-design, rather than solely who sits on the committee).

A paper on Engagement drafted by a sub-group of Secretariat, Science Committee and Interim Engagement Committee members was intended to play a key role in resolving these different understandings, and associated challenges and tensions, by setting down agreed principles to guide practice. However, the extent to which it might be possible to resolve these differences on paper was questioned by some, suggesting that it might only be possible to do so in practice. While firm principles and ground rules were seen to be required by those that view co-'s as a threat, and common understandings and principles were also seen to be needed by those who see co-'s as deliberative-reflexive, the possibility of creating such shared principles is possibly challenged by the incommensurability of (or at least the differences between) these approaches. Deliberative-reflexive co-production is seen as something that is best achieved in practice, at project level, around concrete problems, rather than conceptually or in theory (cf. Marres, 2007).

Linked to the issue of implementing co-'s in practice around concrete problems is the question of scale. Co-'s are not only seen as relevant to different institutional levels but are also considered to operate at different geographical scales; in fact, these two different types of scale are interlinked: the governing committees might be considered to be operating at the global or international level, the projects operating in a more 'localised' way (still international but presumably to some extent more explicitly 'grounded' in particular – local, national or regional – empirical contexts), with regional and national committees and centres and global Secretariat hubs bridging these institutional and geographical levels. Scale is considered particularly important in Future Earth due to the nature of the problems of GEC and sustainability the initiative intends to explore and address, which are often conceptualised (and governed) globally but manifest themselves in different ways at different levels and in different contexts. However, operating at the global scale poses challenges for representation, and one focus group questioned assumptions about the authority or efficacy of top-down governance models (this argument, if applied to Future Earth, suggests that the committees might not be the locus of power those that designed them might have hoped). More might be needed than top-down governance, principles and mechanisms. This was illustrated by the ways in which notions of co-'s developed at the 'global' level might face challenges when applied in particular national contexts, as seen at the symposium of the Chinese National Committee for Future Earth.

Seeing Future Earth and co-'s as an experiment might enable a way forward in which some of the differences in understanding of these concepts and how to implement them might be bridged and productively made to work together. Indeed, during one focus group the idea of viewing co-'s as a characteristic or quality (or composed of particular characteristics) arose; this could be extended to view experimentality as an important characteristic. As identified throughout, many of those involved in developing and governing Future Earth experienced uncertainty around whether co-design is the right or the best approach or method to take and/or about how it can and should be done, and therefore treated or described it as an experiment (whether in terms of testing hypotheses and truth claims or in terms of improvisation). Several participants stressed the importance of ongoing monitoring and evaluation. However, any 'experiment' founded in principles of openness to the unexpected and new productivities may bring with it its own problems of assessment and evaluation in an institutional context. Furthermore, institutionalisation (including establishing rules, structures, legitimacy and reputation – and importantly, securing and maintaining funding) is not necessarily conducive to experimentality.

Having revisited the answers to the research questions, I now turn to the final question: How can findings from this case contribute to the literatures on co-production and international research governance, on experiments in science and democracy, and what are the implications for research governance in practice?

8.2 Overarching contribution to the literature and practice

This section addresses the contribution of this study, first to the literature on co-production and scientific governance (8.2.1), then to the literature on experiments in science and democracy (8.2.2), and finally it outlines the implications for Future Earth (and by association for research governance and practice more broadly), listing some tentative suggestions for future development (8.2.3).

8.2.1 Literatures on co-production

In my review of the existing literature on co-production in Chapter 2, I found that the majority of work has focused on intentional, collaborative methods or practices at local, national or regional levels, and in individual projects and organisations, or has adopted the analytical idiom of co-production to explore the broader processes of co-constitution of science and social order in a range of contexts. However, few of these studies have explored co-design and co-production in research governance, nor how this relates to the translation of co-production as an analytical STS concept into a notion or practice of knowing actors.

In order to address this gap, the preceding chapters have explored how co-design, co-production and related concepts are understood, imagined, and implemented in Future Earth, how they relate to visions of institutional identity and remit, and to broader social and natural orders, particularly as expressed in imaginaries and models of science-society relations.

Governance of co-production in international contexts

As noted above, few studies have examined co-production as an intentional principle and practice in a research governance and coordination context. This study therefore outlines what co-production might mean and some of the challenges faced in its governance at the ‘global level’. In Future Earth, that imperative is interpreted in a range of ways, including the co-design and co-production of Future Earth as an initiative or institution (through the appointment of a multi-disciplinary, multi-stakeholder Transition Team, then Science and (Interim) Engagement Committees); co-design of ‘global’ level strategy, such as the Strategic Research Agenda; and the promotion of co-design and co-production within Future Earth research projects and activities. The extent to which the activities of the Committees were acknowledged to be co-design or co-production in the moment of their undertaking was variable.

Visions of co-production in these different settings, and institutional design and implementation decisions (e.g. the composition of the Engagement Committee) were shaped by different understandings of co-production and its importance, primarily a representative-utilitarian model, a deliberative-reflexive model and the notion of co-production as threat (the representative-utilitarian might be better suited to a flagship institutional model, and the deliberative-reflexive model to a rich tapestry institutional model, although this binary view is questionable). Between these different understandings and settings, co-production can occur in many different ways: across institutional and temporal levels, between organisational structure and process, in principle and practice, and around particular problems at particular scales. It is a multiple and ambiguous concept and practice, particularly in this international, multi-disciplinary, multi-sectoral context. However, it is also a productive and generative concept: attempting to do it has opened up conversations and connections that would not otherwise have happened.

Future Earth faced (and will face) many challenges in trying to institutionalise co-production (e.g. resistance on the part of those that feel it threatens the objectivity or independence of research), and these challenges are perhaps even more significant and complex than those identified in the existing literature due to the complexity and global ambition of the initiative. Institutions and individuals face familiar challenges when co-design and co-production are considered as a means to involve stakeholders in research design and process; questions of representation and representativeness arise, all the more so due to the ambition to be a global initiative with reach across all world regions (Blue & Medlock, 2014). How to decide with whom to co-produce, and what role those involved would assume (Pohl *et al.*, 2010) came to the fore as significant and charged questions with no easy answers, particularly when discussed hypothetically without reference to particular project details. This confirms findings and arguments in the existing STS literature about the mobilisation or formation of publics (or stakeholders) around concrete issues (Marres, 2007; Felt & Fochler, 2010), and the difficulties of finding (or taking the time to develop) a consistent source of legitimacy for particular democratic models for participation (Lövbrand *et al.*, 2011).

Further difficulties emerge when attempting to develop guidelines or models of co-design and co-production at the 'global level' to be applied in a diverse range of international, regional, national and potentially also local contexts. The symposium hosted by the Chinese National Committee for Future Earth hinted towards a range of potential intercultural dissonances between particular visions of co-design/co-production developed by the central committees and context-specific conditions that might challenge the implementation of those visions in the ways imagined, as might be expected on the basis of STS research into the situated and context-specific nature of ways of organising, generating, legitimising and using knowledge, characterised by concepts such as epistemic cultures and civic epistemologies (Knorr Cetina, 1999; Jasanoff, 2005; Miller, 2008).

The study also takes seriously Nowotny's (2014) call to pay more attention to political imaginaries of science: here several familiar political imaginaries of science can be seen to circulate and shape the understandings and design decisions as described above. Two standard political imaginaries of science and its value – the service-delivery mode of the representative-utilitarian model, and the public good mode of the republic of science model – can potentially be challenged or mediated by the deliberative-reflexive model, which draws more attention to the contingency of current arrangements, potential problem framings, and knowledge politics. However, it will be important to pay attention to the basis for the legitimacy of this approach, as stressed by Lövbrand *et al.* (2011). The presence of these imaginaries within the early stages of the initiative proffers hope for continued co-existence, perhaps moving towards innovative ways of combining these understandings and approaches.

Translation of analytical co-production into research policy

The deliberative-reflexive understanding of co-production in Future Earth can be seen to be informed by STS and related ideas about knowledge politics, and a similar (if not the same) 'democratic impulse'. While there were moments of reflexivity during the meetings (for example, in questioning the legitimacy of participatory approaches or in recognising the normative elements of agenda-setting), this did not happen in a systematic, organised or consistent way. However, recent developments suggest that these voices have shaped the central visions as crystallised in Future Earth documents, such as the Engagement Principles and Practice (2016).

In terms of translation into research policy, this might be seen to be very challenging. While the representative-utilitarian form of co-production as envisaged in Future Earth (and beyond) faces many challenges in implementation (in terms of representation, competing interests, etc.), it is perhaps more straightforward (in some ways) than deliberative-reflexive co-production as envisaged in Future Earth (and beyond). In order to take seriously the notion that the normative aspects of particular knowledge agendas or pathways should be made explicit and consciously steered in particular directions, time, space, and skills are required for such reflexivity, and entry points for steering would be required. How to identify these moments remains to be seen.

It could be harder to adopt this approach due to the current framing of the problem as requiring immediate action: the representative-utilitarian model of co-production is bolstered by the wider resonance with notions of impact and the sense of urgency of GEC problems as they are currently framed in this (and many) context(s). Other scholars have noted the potential dangers of focusing too restrictively on instrumental or utilitarian understandings of co-production (or of Future Earth's purpose more generally) (Lövbrand *et al.*, 2015; Castree, 2016). The space required to undertake more deliberative and reflexive forms of co-production (and perhaps to develop other understandings of co-production), enabling questions to be asked about how problems and solutions are defined, could be facilitated by an experimental approach as explored in section 8.2.3 below, encouraging ‘slow’(er) forms of science (Stengers, 2017).

However, existing dominant political imaginaries and models of democracy are driven by and associated with deeply entrenched power relations. Whether or not the moment of collaboration or participation is too late – or the best means – to challenge these existing orders is open to question. Yet, in considering new approaches and encouraging others to do so, Future Earth holds the potential to develop more subtle understandings of co-production and of the possible active roles actors and institutions might take in addressing pathologies of current epistemic and social orders. Co-production as variously imagined in Future Earth might not be the ‘solution’ (to any or all of the problems it and others have identified), but from an experimental perspective, perhaps starting somewhere is better than not acting at all.

8.2.2 Literatures on experiments in science and democracy

The adoption of an ‘experimental’ approach, in which Future Earth and/or co-production are viewed as an experiment (or series of nested or linked experiments) was adopted as an analytical lens to move beyond the stance of much STS and public engagement work in which engagement practices are critiqued for failing to adhere to particular normative ideals, such as particular notions of (deliberative) democracy. This enables a greater focus on the multiple meanings, understandings and practices of these concepts and their constitutive effects. Drawing on Irwin (2006) amongst others, Chilvers and Kearnes (2016a) (and others working in this vein, e.g. Pallett, 2015a; Laurent, 2016) adopt this approach in relation to public participation, seeing participation exercises as emergent social experiments. This implies that rather than (or as well as) aiming for a fixed ideal form of intervention, the intervention itself is constitutive of such norms and ideals. Here the significant element of ‘experiment’ is the (unknown in advance and ontologically variable) constitutive effect of the intervention, and the emergent nature of the actors, objects, concerns and norms (including standards of legitimacy) involved.

The present study builds on that work by adopting the ‘experimental’ lens in a new setting: international research governance in the field of GEC and sustainability. Much of the existing work on experiments in science and democracy focuses on instances or forms of public participation. In this thesis I have extended it to another relevant context at the science-policy or science-democracy interface, less explicitly focused on public or citizen participation (in the sense of e.g. ‘ordinary’ or ‘lay’ publics), but still concerned with the public or societal use and value of science and knowledge (and which is still, for the most part, supported by public funding from national governments).

Experimentality is a particularly productive analytical lens in the context of a young and emerging initiative, enabling a generous and fair approach rather than an overly critical evaluative stance. From this perspective, Future Earth did not ‘succeed’ or ‘fail’ in its scientific or engagement activities during the period of study; what is more interesting is what introducing the idea of co-production opened up or made possible: its generative, productive or performative power. Simply starting conversations about why and how to co-produce research has opened up questions and practices that might not otherwise have been considered at this level in relation to this type of research. Institutional developments – such as the introduction of an Engagement Committee in addition to the standard Scientific Committee, and thematic rather than disciplinary organisation of research communities – have the potential to effect further change to well-established social and epistemic orders. Here we can see that Future Earth is productive in a broad range of ways, for example in generating (or consisting of) dynamic epistemic assemblage(s) or collective(s) of researchers, policymakers, and other professionals who are juggling diverse and sometimes conflicting agendas, and in (re)producing (and sometimes challenging) different political imaginaries and models of democracy in its various structures and activities.

Across these chapters it is evident that the uncertainty and ambiguity around understandings of co-’s (and other aspects of Future Earth) have been acknowledged by many of the actors involved. At various points co-’s have been conceptualised as an experiment, or experimental, and Future Earth more broadly has been seen as stepping into the unknown and/or to be attempting something that has not been attempted before (i.e. co-production at a global scale, and/or large-scale coordination of a broad range of knowledge communities and domains). From this perspective, co-production creates an experimental condition in (or of) Future Earth, and the tensions and ambiguities within Future Earth are not necessarily problematic, as ambiguity can make space for openness and flexibility (Nerlich & Clarke, 2001). Viewing, indeed acknowledging, co-production in Future Earth as an experiment and adopting experimental approaches may hold the potential to overcome problems posed and impasses reached by conflicting views of what Future Earth is, what co-design/co-production is, and what they are for. Notions of experiments in science and democracy allow us to make sense of and make the most of institutional and semantic multiplicity and indeterminacy: this study contributes to that field in beginning to explore how that might work in the case of international GEC research governance.

8.2.3 Implications for research governance in practice

If, as I have argued, Future Earth is better understood as a ‘tapestry’ rather than a ‘flagship’, it could be productive to foreground experimentality in Future Earth’s thinking and framing. Experimentality potentially presents an opportunity for co-existence, finding a way to live with difference (and make it work) rather than trying to stamp it out. This raises the question of whether Future Earth’s institutional structure and accreditation/affiliation processes are open and flexible enough to enable such multiple meanings and practices. Future Earth aims to institutionalise a new type of science, or a different approach to science from that of the existing GEC programmes. However, institutionalisation is not necessarily conducive to improvisation, responsiveness or flexibility. So, how can experimentality, flexibility and openness be maintained in contexts where some degree of (institutional) closure is desirable (or necessary) (for example in putting policy and structures in place, in building and maintaining legitimacy and authority, and where the initial hope was to reduce institutional complexity)? How can a balance be found between institutionalisation and experimentality?

Experimentality invites us to think about what the alternatives to existing arrangements might be. This might require new (and potentially) radical thinking about how to organise, conduct and value research and its outcomes, in order to accommodate the co-existence – or 'alongsideness' (Latimer, 2013) – of different views of how research should work, what it is for, and the impacts it might have. Ways of accounting for and valuing intangible or unexpected processes and outcomes may need to be developed, and it may be necessary to remain open-minded about where and how results, impact, influence, solutions and outcomes are found and defined. While in some cases the use of tools and knowledge developed in Future Earth within policy or decision-making contexts might be the intended and desirable outcome, in other cases, starting conversations between different stakeholders (some of whom would not normally have a seat at the table) could be seen as a significant result (which may in turn lead to small changes in perspective or development of skills or capacities of (some of) those involved).

However, Future Earth and its partners may need to take some risks in adopting this approach, particularly given increasing cultures of short-term quantifiable 'impact' (Strathern, 2000; RCUK, n.d.-b)[46], particularly on the part of funders who are under increasing pressure to demonstrate (instrumental) "value" for taxpayers' and investors' money (Nowotny, 2014). Finding ways to value process, learning and unanticipated outcomes (rather than – or in addition to – direct and quantifiable impact or utility) would enable – and be enabled by – a more open-ended experimental agenda. One option may be to shift the focus from solutions-orientation towards 'clumsy solutions':

> [an escape] from the idea that, when faced with contradictory definitions of problems and solutions, only one definition must be chosen and all others rejected. Clumsiness allows for several or all such contradictory goals to be simultaneously pursued.
>
> (Hulme, 2009: 338)

This creates greater space for and maybe acceptance of improvisation in times of uncertainty. More importantly, it does not require an overhaul of Future Earth's

[46] For example, it was recently announced that impact now makes up 25% of the UK Research Excellence Framework (rather than 20% as previously) (HEFCE, 2017).

existing (sometimes contradictory) framings and goals. Indeed, as argued by others, it may be possible to adapt the predominant frameworks in these contexts, for example, to diffract the conceptual holism implicit in notions of the Anthropocene (Lövbrand *et al.,* 2015); or to broaden the service-delivery mode of the new social contract between science and society to incorporate a richer understanding of accountability and democracy (Castree, 2016). This would achieve more space for diversity and difference: moving towards co-existence. Attention must now be paid to the conditions under which this would be possible.

Tentative suggestions for Future Earth and others

In order to foreground experimentality and productively work with some of the tensions and ambiguities discussed in this thesis, the following steps (Table 4 below) could be adopted (and are already being adopted[47]) in Future Earth and similar initiatives. It should be noted that Future Earth has developed a great deal since the fieldwork for this project was completed, so rather than recommendations, these points are put forward as tentative suggestions to perhaps prompt discussion or thought.

[47] In addition to Future Earth's own evaluation and monitoring processes, at least one independent research project is currently underway at the time of writing (September 2017) aiming to further explore co-production and transdisciplinary practices in Future Earth.

Table 4: Tentative suggestions for Future Earth and others

Foregrounding experimentality	
a.	Facilitate learning from existing projects where experimentality has been foregrounded, for example in the ISSC Transformations Programme. Explore what conditions are conducive to open, diverse, flexible and inclusive approaches.
b.	Facilitate risk-taking and openness to the unexpected within projects and activities (e.g. by promoting open-ended frameworks of impact and outcome).
c.	Alongside standard monitoring and evaluation, consider qualitative, interpretive approaches to explore emergent features of co-production work, and unexpected productivities, unanticipated impacts and outcomes.
d.	Consider how to value unconventional aspects of research, including, for example, valuing process over outputs.
e.	Consider a range of experimental methodologies in designing participatory work, including those informed by social psychology (e.g. Bellamy *et al.*, 2017); action research (Levin & Greenwood, 2011); and experimental, participatory arts practice (e.g. Horst, 2011).
f.	A focus on solutions-orientation might be enriched and opened up by foregrounding the potential for 'clumsy' solutions and improvisation.
Encouraging reflexivity and learning	
g.	Alongside standard monitoring and evaluation, consider sourcing and providing the means for all affiliated projects and activities to involve a researcher with expertise in knowledge politics (e.g. anthropologist or sociologist of science, expert in engagement) in every project to study the ongoing dynamics and facilitate reflexivity.
h.	Establish a regular workshop or conference to review and share experiences on how co-production is done, integrated, perceived, transformed, adapted in the projects and other activities, including in the governing committees.

8.3 Limitations of the research

As outlined in the thesis introduction, this study took up the opportunity to investigate Future Earth as an empirical case unique in its ambition to adopt and institutionalise co-design and co-production as principles for research and its governance at the global level, but also emblematic of current shifts and trends in research governance and conduct towards openness, accountability and participation. The study focused on a particular moment in the early emergence of the initiative, and for the most part on the governing structure of the organisation rather than on its projects and broader networks.

Beyond the standard limitations of qualitative research, the focus of the study on the emergence of Future Earth through its global committees limits the extent to which it is possible to speak to the broader 'ecologies' of participation within and beyond Future Earth. In accordance with a decentred or distributed approach to governance, the central committees of Future Earth are not the only locus of power, and a richer, perhaps more comprehensive picture could be drawn by exploring other parts of the initiative and the broader networks that it constitutes and in which it is embedded. Further attention could be paid to broader institutional, political and cultural orders and change.

In addition to this limitation of spread, the study also faced temporal restrictions: according to some of the actors involved, co-production was not yet happening in practice, particularly on the ground in research projects (and in some instances it was not possible to gain access to funding bids or Memoranda of Understanding that might have provided an insight into project activities and framings). Furthermore, I did not have the financial or personal capacity to interview project team members. However, all research in some way or other places artificial boundaries around its 'object of study'. So while acknowledging the present study as a partial and artificially bounded view of a particular moment in Future Earth's development, I hope that in exploring the political imaginaries and participatory/science-society models reproduced and performed in Future Earth, this study contributes a snapshot of one part of a broader ecology of participation and reflects wider trends in science-society relations.

The distinction between the analytical idiom of co-production (in the sense of co-constitution of science/knowledge and social/political order) and more strategic or instrumental uses of the term (in the sense of making something together) structures the analysis in that both meanings are adopted by various actors in Future Earth (as explored in Chapters 5-7), but also in that the ontology and epistemology implied in the constructivist STS on which the co-productive idiom is founded informs the conceptual and methodological background for this thesis. However, it should be noted that this study is not strictly speaking a study of constitutive co-production in the sense intended by Jasanoff and colleagues (2004c; Hilgartner *et al.*, 2015); it does not explore constitutional change or state-making, for example, nor does it affiliate with either the interactionist or the constitutive strands of this literature; rather it explores some of the smaller steps that might contribute to (or be considered symptomatic of) broader processes of co-constitution of science and social order. These can be seen to comprise the reproduction or performance of established (or even new) political imaginaries of science through particular understandings of co-production and associated institutional and participatory mechanisms.

Finally, while I did not set out to evaluate Future Earth's co-production practices against pre-determined criteria or norms (e.g. standards of a particular type of democratic engagement), this could be seen as a limitation of the study. The research does not present useful or readily portable guidelines on what does and does not work well and the implications for future co-production practice. Furthermore, based on the data collected and generated for the study, it is difficult to draw strong conclusions about the difference that Future Earth made to research governance and practice more broadly: its influence and impacts. This is partly due to the formative stage in Future Earth's development under consideration (as detailed above), but also because this was not the intention of the study: rather than exploring whether transformation occurred, it explores how different visions and practices of co-production entail particular imaginaries of science-society relations, and how these meanings and visions influence implementation. While I am not able to answer the question as to whether Future Earth will enable shifts in knowledge and politics that allow Earth's futures to be imagined and produced by the many rather than the few, I hope that in exploring what is envisaged for and implemented in the name of Future Earth, this study opens up a partial but different perspective on some familiar issues in a new and still emerging context.

8.4 Future research

There are several particular avenues that could provide an interesting basis for future research on Future Earth, on co-production, and on transformations in research institutions, cultures and communities.

Given the limitation noted above in relation to the specific focus on the governing structure of Future Earth, with greater resources it would be possible to explore how co-production is conceptualised and practiced in other parts of Future Earth and its wider networks, including its affiliated projects, building up a broader and more detailed picture of Future Earth's ecology of co-production and the broader ecologies of participation, systems of science-society relations and epistemic/political regimes that it shapes and is shaped by (Chilvers & Kearnes, 2016). One approach would be to follow some of the forms and technologies of participation used in this context (for example, Sutherland workshops, committee memberships) for a more thorough and systematic exploration of where these methods originate, how they translate in this context (Soneryd, 2016), and perhaps how they are carried forward into the many national and local contexts comprising Future Earth's networks.

There are other potential topics of interest that could be explored within Future Earth, particularly with resources to examine work at the project level. For example, more attention could be paid to global North/South relations and what it means to bring together natural science, social science and 'local' knowledge (particularly in relation to the epistemological challenges outlined in section 2.2 of the literature review (Rayner & Malone, 1998)).

To broaden the research scope to Future Earth's wider networks and ecologies, it might be interesting to compare Future Earth with other international knowledge institutions, whether assessments that synthesise knowledge (IPCC, IPBES) (De

Pryck & Wanneau, 2017), or perhaps comparable programmes or schemes in other fields (for example in health or in agriculture through bodies such as the CGIAR – formerly the Consultative Group on International Agricultural Research – now ‘a global research partnership for a food-secure future’ (CGIAR, n.d.)), and the ways in which these institutions intersect with decision making (and other spaces of acknowledged or unacknowledged knowledge production) at a range of scales in a range of sectors and contexts.

To further extend the project of the ‘experimental’ approach, it would be attractive to explore whether there are empirical examples where experimentality has been foregrounded in an institutional context, what conditions enabled this, and how others might learn from it. How can experimentality be maintained while policy and structures are being put in place? How can a balance be achieved between bringing institutions into being – and maintaining them – while also allowing space for development, new and multiple perspectives, and bottom-up initiative? (How) can intangible processes and outcomes of research be valued in a culture of solutions-orientation, policy relevance and increasing quantification and audit (Strathern, 2000)? How can tensions between openness and closure be negotiated?

Other scholars have suggested that humility, institutional reflexivity and organisational learning are key to ensuring ongoing space for plurality, flexibility, diversity and capacity-building (S. Beck *et al.*, 2014; Felt & Wynne, 2007; Jasanoff, 2003; Pallett & Chilvers, 2015). There are strong indications that Future Earth aspires to achieve this type of practice, whether through a reflexive form of co-production, through monitoring and evaluating its own processes and outcomes, or in acknowledging and encouraging ongoing learning. Future research could (care-fully and generously) explore whether and, more importantly, how Future Earth is – or indeed other institutions and actors are – managing to achieve this within and beyond their ever-expanding and complex structures and networks. While the problems facing us are seemingly intractable and multiple, to see people collaborating and striving for better future worlds provides many reasons to be hopeful.

References

Ashmore, M. (1989). *The reflexive thesis: Wrighting sociology of scientific knowledge*. Chicago: University of Chicago Press.

Ashmore, M., Myers, G., & Potter, J. (1995). Discourse, rhetoric, reflexivity: Seven days in the library. In S. Jasanoff, G. E. Markle, J. C. Petersen & T. Pinch (Eds.), *Handbook of science and technology studies* (2nd ed., pp. 321-342). London: Sage.

Barbour, R. S. (2007). *Doing focus groups*. London: SAGE.

Barnett, C. (2008). Convening Publics: The parasitical spaces of public action. In K. Cox, R, M. Low & J. Robinson (Eds.), *The SAGE Handbook of Political Geography* (pp. 403-417). London: SAGE.

Barron, E. J. (1994). IGBP Core projects: a 'rich tapestry' or 'flagship' model. *Global Change Newsletter, 17*(2).

Barry, A., Born, G., & Weszkalnys, G. (2008). Logics of interdisciplinarity. *Economy and Society, 37*(1), 20-49. doi: 10.1080/03085140701760841

Basit, T. (2003). Manual or electronic? The role of coding in qualitative data analysis. *Educational Research, 45*(2), 143-154. doi: 10.1080/0013188032000133548

Beaulieu, A., Scharnhorst, A., & Wouters, P. (2007). Not another case study. *Science, Technology, & Human Values, 32*(6), 672-692. doi: 10.1177/0162243907306188

Beck, S. (2011). Moving beyond the linear model of expertise? IPCC and the test of adaptation. *Regional Environmental Change, 11*(2), 297-306. doi: 10.1007/s10113-010-0136-2

Beck, S., Borie, M., Chilvers, J., Esguerra, A., Heubach, K., Hulme, M., . . . Görg, C. (2014). Towards a Reflexive Turn in the Governance of Global Environmental Expertise. The Cases of the IPCC and the IPBES. *GAIA - Ecological Perspectives for Science and Society, 23*(2), 80-87. doi: 10.14512/gaia.23.2.4

Beck, S., & Forsyth, T. (2015). Co-production and democratizing global environmental expertise: The IPCC and adaptation to climate change. In S. Hilgartner, C. A. Miller & R. Hagendijk (Eds.), *Science and Democracy: Making Knowledge and Making Power in the Biosciences and Beyond* (pp. 113-132). Abingdon: Routledge.

Beck, S., Forsyth, T., Kohler, P. M., Lahsen, M., & Mahony, M. (2017). The making of global environmental science and politics. In U. Felt, R. Fouché, C. A. Miller & L. Smith-Doerr (Eds.), *The Handbook of Science and Technology Studies* (4th ed.). Cambridge, MA: MIT Press.

Beck, U. (1992). *Risk society: Towards a new modernity*. London: Sage.

Beck, U. (2009). *World at risk*. Cambridge: Polity.

Beebeejaun, Y., Durose, C., Rees, J., Richardson, J., & Richardson, L. (2014). 'Beyond text': exploring ethos and method in co-producing research with communities. *Community Development Journal, 49*(1), 37-53. doi: 10.1093/cdj/bst008

Bellamy, R., Lezaun, J., & Palmer, J. (2017). Public perceptions of geoengineering research governance: An experimental deliberative approach. *Global Environmental Change, 45*, 194-202. doi: http://dx.doi.org/10.1016/j.gloenvcha.2017.06.004

Belmont Forum. (2011). The Belmont Challenge: A global, environmental research mission for sustainability. Retrieved 10 September, 2017, from http://igfagcr.org/sites/default/files/documents/belmont-challenge-white-paper.pdf

Bensaude Vincent, B. (2014). The politics of buzzwords at the interface of technoscience, market and society: The case of 'public engagement in science'. *Public Understanding of Science, 23*(3), 238-253. doi: doi:10.1177/0963662513515371

Benton, T., & Craib, I. (2011). *Philosophy of social science: The philosophical foundations of social thought* (2nd ed.). Basingstoke: Palgrave Macmillan.

Berger, P. L., & Luckmann, T. (1967). *The social construction of reality : a treatise in the sociology of knowledge*. London: Allen Lane.

Bergmann, M., Jahn, T., Knobloch, T., Krohn, W., Pohl, C., Schramm, E., & Klein, J. T. (2012). *Methods for transdisciplinary research: a primer for practice*. Chicago: University of Chicago Press.

Bloor, D. (1991). *Knowledge and Social Imagery* (2nd ed.). Chicago: University of Chicago Press.

Bloor, M., Frankland, J., Thomas, M., & Robson, K. (2001). *Focus groups in social research*. London: SAGE.

Blue, G., & Medlock, J. (2014). Public engagement with climate change as scientific citizenship: A case study of World Wide Views on Global Warming. *Science as Culture, 23*(4), 560-579. doi: 10.1080/09505431.2014.917620

Böhme, G., van den Daele, W., Hohlfeld, R., Krohn, W., & Schäfer, W. (1983). *Finalization in science: The social orientation of scientific progress* (Vol. 77). Dordrecht: D. Riedel Publishing Company.

Born, G., & Barry, A. (2010). Art-Science: From public understanding to public experiment. *Journal of Cultural Economy, 3*(1), 103-119. doi: 10.1080/17530351003617610

Bovaird, T. (2007). Beyond engagement and participation: User and community coproduction of public services. *Public Administration Review, 67*(5), 846-860. doi: 10.1111/j.1540-6210.2007.00773.x

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. doi: 10.1191/1478088706qp063oa

British Ecological Society. (2011). Should a DIVERSITAS National Committee be established in the United Kingdom? Retrieved 20 September, 2017, from http://www.britishecologicalsociety.org/wp-content/uploads/DIVERSITAS.pdf

British Sociological Association. (2002). Statement of ethical practice for the British Sociological Association. British Sociological Association. Retrieved 10 September, 2017, from http://www.britsoc.co.uk/media/23902/statementofethicalpractice.pdf

Brown, M. B. (2009). *Science in democracy: Expertise, institutions, and representation*. Cambridge, MA: MIT Press.

Bruce, S., & Yearley, S. (2006). *The Sage dictionary of sociology*. London: Sage.

Bryman, A. (2012). *Social research methods* (4th ed.). Oxford: Oxford University Press.

Bulkeley, H., & Castán Broto, V. (2013). Government by experiment? Global cities and the governing of climate change. *Transactions of the Institute of British Geographers, 38*(3), 361-375. doi: 10.1111/j.1475-5661.2012.00535.x

Bush, V. (1945). Science: The endless frontier. *Transactions of the Kansas Academy of Science (1903-), 48*(3), 231-264.

Callon, M. (1999). The role of lay people in the production and dissemination of scientific knowledge. *Science, Technology and Society, 4*(1), 81-94. doi: 10.1177/097172189900400106

Campbell, D. T. (1969). Reforms as experiments. *American Psychologist, 24*(4), 409-429.

Campbell, H., & Vanderhoven, D. (2016). Knowledge that matters: Realising the potential of co-production. N8/ESRC Research Programme. Retrieved 28 August, 2017, from http://www.n8research.org.uk/media/Final-Report-Co-Production-2016-01-20.pdf

Carson, R. (1962). *Silent spring*. London: Penguin.

Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., . . . Mitchell, R. B. (2003). Knowledge systems for sustainable development. *Proceedings of the National Academy of Sciences, 100*(14), 8086-8091. doi: 10.1073/pnas.1231332100

Castree, N. (2016). Geography and the new social contract for global change research. *Transactions of the Institute of British Geographers, 41*(3), 328-347. doi: 10.1111/tran.12125

Castree, N., Adams, W. M., Barry, J., Brockington, D., Buscher, B., Corbera, E., . . . Wynne, B. (2014). Changing the intellectual climate. *Nature Clim. Change, 4*(9), 763-768. doi: 10.1038/nclimate2339

Caswill, C., & Shove, E. (2000). Introducing interactive social science. *Science and public policy, 27*(3), 154-157. doi: 10.3152/147154300781781968

CGIAR. (n.d.). About us. Retrieved 28 August, 2017, from http://www.cgiar.org/about-us/

Chatham House. (n.d.). Chatham House Rule. Retrieved 26 June, 2017, from https://www.chathamhouse.org/about/chatham-house-rule

Chilvers, J., & Kearnes, M. (2016a). Science, democracy and emergent publics. In J. Chilvers & M. Kearnes (Eds.), *Remaking Participation: Science, Environment and Emergent Publics* (pp. 1-27). London: Routledge.

Chilvers, J., & Kearnes, M. (Eds.). (2016b). *Remaking participation: science, environment and emergent publics*. London: Routledge.

Chilvers, J., & Macnaghten, P. (2011). The future of science governance: A review of public concerns, governance and institutional response. Retrieved 10 September, 2017, from https://ueaeprints.uea.ac.uk/38119/1/Future_of_Science_Governance_Lit_Review_Apr11.pdf

Chilvers, J., Mahony, M., & Kearnes, M. (2014). *The co-production of co-production: relational perspectives on 'making things together'*. Session convened at the RGS-IBG Annual International Conference 2014, London. http://conference.rgs.org/AC2014/390

Clark, N. (2010). Volatile Worlds, Vulnerable Bodies. *Theory, Culture & Society, 27*(2-3), 31-53. doi: 10.1177/0263276409356000

Cooke, B., & Kothari, U. (Eds.). (2001). *Participation: The new tyranny?* London: Zed Books.

Cornell, S., Berkhout, F., Tuinstra, W., Tàbara, J. D., Jäger, J., Chabay, I., . . . van Kerkhoff, L. (2013). Opening up knowledge systems for better responses to global environmental change. *Environmental Science & Policy, 28*(Supplement C), 60-70. doi: https://doi.org/10.1016/j.envsci.2012.11.008

Cutcliffe, S. H. (2000). *Ideas, machines, and values: An introduction to science, technology, and society studies*. Lanham, MD: Rowman & Littlefield.

Cutts, B. B., White, D. D., & Kinzig, A. P. (2011). Participatory geographic information systems for the co-production of science and policy in an emerging boundary organization. *Environmental Science & Policy, 14*(8), 977-985. doi: https://doi.org/10.1016/j.envsci.2011.05.012

Daly, M. (2016). *Co-production and the politics of usable knowledge for climate adaptation in Tanzania (preview).* (Doctoral Thesis), University of Colorado, Colorado. Retrieved from https://search.proquest.com/docview/1868361943?pq-origsite=gscholar

Davies, G. (2010). Where do experiments end? *Geoforum, 41*(5), 667-670. doi: 10.1016/j.geoforum.2010.05.003

De Pryck, K., & Wanneau, K. (2017). (Anti)-boundary work in global environmental change research and assessment. *Environmental Science & Policy*. doi: http://dx.doi.org/10.1016/j.envsci.2017.03.012

de Saille, S. (2015a). Dis-inviting the Unruly Public. *Science as Culture, 24*(1), 99-107. doi: 10.1080/09505431.2014.986323

de Saille, S. (2015b). Innovating innovation policy: the emergence of 'Responsible Research and Innovation'. *Journal of Responsible Innovation, 2*(2), 152-168. doi: 10.1080/23299460.2015.1045280

Deakin, H., & Wakefield, K. (2014). Skype interviewing: Reflections of two PhD researchers. *Qualitative Research, 14*(5), 603-616. doi: 10.1177/1468794113488126

Dear, P. (2004). Mysteries of state, mysteries of nature: Authority, knowledge and expertise in the seventeenth century. In S. Jasanoff (Ed.), *States of knowledge: The co-production of science and social order* (pp. 206-224). London: Routledge.

Denzin, N. K. (2001). The reflexive interview and a performative social science. *Qualitative Research, 1*(1), 23-46. doi: 10.1177/146879410100100102

Denzin, N. K., & Lincoln, Y. S. (2018). Paradigms and perspectives in contention. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (5th ed., pp. 97-107). Los Angeles: SAGE.

Dewey, J. (1991). *The public and its problems*. Athens: Swallow Press. (Original work published 1927)

DIVERSITAS. (2015). DIVERSITAS an international programme of biodiversity science. Retrieved 20 September, 2017, from https://web.archive.org/web/20161120054727/http://www.diversitas-international.org:80/

Doorn, N., Spruit, S., & Robaey, Z. (2016). Editors' Overview: Experiments, Ethics, and New Technologies. *Sci Eng Ethics, 22*(3), 607-611. doi: 10.1007/s11948-015-9748-8

Downey, G. L., & Zuiderent-Jerak, T. (2017). Making and doing: Engagement and reflexive learning in STS. In U. Felt, F. Rayvon, C. A. Miller & L. Smith-

Doerr (Eds.), *The Handbook of Science and Technology Studies* (4th ed., pp. 223-251). Cambridge, MA: MIT Press.

Durose, C., Beebeejaun, Y., Rees, J., Richardson, J., & Richardson, L. (n.d.). Towards co-production in research with communities: AHRC Connected Communities. Retrieved 10 September, 2017, from http://www.ahrc.ac.uk/documents/project-reports-and-reviews/connected-communities/towards-co-production-in-research-with-communities/

Durose, C., & Richardson, L. (2015). *Designing public policy for co-production: Theory, practice and change*. Bristol: Policy Press.

Edelenbos, J., van Buuren, A., & van Schie, N. (2011). Co-producing knowledge: Joint knowledge production between experts, bureaucrats and stakeholders in Dutch water management projects. *Environmental Science & Policy, 14*(6), 675-684. doi: https://doi.org/10.1016/j.envsci.2011.04.004

Edge, D. (1995). Reinventing the wheel. In S. Jasanoff, G. Markle, J. Petersen & T. Pinch (Eds.), *Handbook of science and technology studies* (2nd ed., pp. 3-24).

Edquist, C. (1997). *Systems of innovation: Technologies, insitutions and organisations*. New York: Pinter.

Edwards, P. N. (2010). *A vast machine: Computer models, climate data, and the politics of global warming*. Cambridge, MA: Mit Press.

Elzinga, A. (2001). Science and Technology: Internationalization. In N. J. Smelser & P. B. Baltes (Eds.), *International Encyclopedia of the Social & Behavioral Sciences* (pp. 13633-13638). Oxford: Pergamon.

ESSP. (n.d.). Earth System Science Partnership (ESSP). Retrieved 20 September, 2017, from http://web.archive.org/web/20140119094957/http://www.essp.org/

Ettelt, S., Mays, N., & Allen, P. (2015). Policy experiments: Investigating effectiveness or confirming direction? *Evaluation, 21*(3), 292-307. doi: 10.1177/1356389015590737

Etzkowitz, H., & Leydesdorff, L. (1998). The endless transition: A "triple helix" of university-industry-government relations. *Minerva, 36*(3), 203-208.

European Alliance of Global Change Research Committees. (n.d.). European Alliance of Global Change Research Committees. Retrieved 20 September, 2017, from http://ea-globalchange.org/

European Commission. (n.d.). Paris Agreement. Retrieved 28 August, 2017, from https://ec.europa.eu/clima/policies/international/negotiations/paris_en

Ezrahi, Y. (1990). *The descent of Icarus: Science and the transformation of contemporary democracy*. Cambridge, MA: Harvard University Press.

Ezrahi, Y. (2012). *Imagined democracies: Necessary political fictions*. Cambridge, UK: Cambridge University Press.

Felt, U., Barben, D., Irwin, A., Joly, P.-B., Rip, A., Stirling, A., & Stöckelová, T. (2013). Science in Society: Caring for our futures in turbulent times. *Science policy briefing*. 50. European Science Foundation. Retrieved 20 September, 2017, from http://archives.esf.org/fileadmin/Public_documents/Publications/spb50_ScienceInSociety.pdf

Felt, U., & Fochler, M. (2010). Machineries for Making Publics: Inscribing and De-scribing Publics in Public Engagement. *Minerva, 48*(3), 219-238. doi: 10.1007/s11024-010-9155-x

Felt, U., Igelsböck, J., Schikowitz, A., & Völker, T. (2016). Transdisciplinary sustainability research in practice: between imaginaries of collective experimentation and entrenched academic value orders. *Science, Technology, & Human Values, 41*(4), 732-761. doi: 10.1177/0162243915626989

Felt, U., & Wynne, B. (2007). Taking European knowledge society seriously. Brussels: Directorate-General for Research, European Commission.

Fiorino, D. J. (1990). Citizen participation and environmental risk: A survey of institutional mechanisms. *Science, Technology, & Human Values, 15*(2), 226-243.

Flyvbjerg, B. (2011). Case study. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE Handbook of Qualitative Research* (4th ed., pp. 301-316). Thousand Oaks: SAGE.

Franklin, S. (2000). Life itself: Global nature and the genetic imaginary. In S. Franklin, C. Lury & J. Stacey (Eds.), *Global nature, global culture*. London: Routledge.

Fung, A., & Wright, E. O. (2001). Deepening democracy: Innovations in empowered participatory governance. *Politics & Society, 29*(1), 5-41.

Funtowicz, S. O., & Ravetz, J. R. (1993). Science for the post-normal age. *Futures, 25*(7), 739-755. doi: http://dx.doi.org/10.1016/0016-3287(93)90022-L

Future Earth. (2013a). December 2013 Future Earth Newsletter. Retrieved 20 September, 2017, from http://us5.campaign-archive1.com/?u=2e9b648776114e2888e7ea8c5&id=89ba56dcfb&e=653b244010

Future Earth. (2013b). Future Earth Initial Design: Report of the Transition Team. Paris: International Council for Science (ICSU). Retrieved 10 September, 2017, from http://www.futureearth.org/sites/default/files/Future-Earth-Design-Report_web.pdf

Future Earth. (2014a). Future Earth 2025 Vision. Paris: International Council for Science (ICSU). Retrieved 10 September, 2017, from http://futureearth.org/sites/default/files/files/Future-Earth_10-year-vision_web.pdf

Future Earth. (2014b, 19 August 2014). Future Earth and WCRP affirm strong partnership. Retrieved 10 September, 2017, from http://www.futureearth.org/news/future-earth-and-wcrp-affirm-strong-partnership

Future Earth. (2014c). Future Earth Strategic Research Agenda 2014. Paris: International Council for Science (ICSU). Retrieved 10 September, 2017, from http://www.futureearth.org/sites/default/files/strategic_research_agenda_2014.pdf

Future Earth. (2016a). Future Earth booklet: What is Future Earth? Retrieved 20 September, 2017, from http://www.futureearth.org/sites/default/files/futureearth_booklet.pdf

Future Earth. (2016b). Future Earth engagment principles and practice. Retrieved 28 August, 2017, from http://futureearth.org/sites/default/files/futureearth_engagementprinciplespractice_2016.pdf

Future Earth. (n.d.-a). About Future Earth. Retrieved 2 March, 2014, from http://futureearth.info/blog/about-us. Now available at: https://web.archive.org/web/20140227152100/futureearth.info/about-us

Future Earth. (n.d.-b). Engagement Committee. Retrieved 26 June, 2017, from http://www.futureearth.org/engagement-committee

Future Earth. (n.d.-c). Governing Council. Retrieved 20 September, 2017, from http://www.futureearth.org/governing-council

Future Earth. (n.d.-d). History. Retrieved 10 September, 2017, from http://www.futureearth.org/history

Future Earth. (n.d.-e). Impact. Retrieved 28 August, 2017, from http://futureearth.org/impact

Future Earth. (n.d.-f). Knowledge-Action Networks. Retrieved 28 August, 2017, from http://www.futureearth.org/knowledge-action-networks

Future Earth. (n.d.-g). Our Vision. Retrieved 10 September, 2017, from http://www.futureearth.org/our-vision

Future Earth. (n.d.-h). Research. Retrieved 25 March, 2016, from http://futureearth.org/projects. Now available at: http://web.archive.org/web/20160329130624/http://futureearth.org/projects

Future Earth. (n.d.-i). Who we are. Retrieved 25 March, 2016, from http://futureearth.org/who-we-are. Earlier version (accessed April 2015) available at: http://web.archive.org/web/20150430035528/http://futureearth.org/who-we-are

Gabrys, J., & Yusoff, K. (2012). Arts, sciences and climate change: Practices and politics at the threshold. *Science as Culture, 21*(1), 1-24. doi: 10.1080/09505431.2010.550139

Garfinkel, H. (1967). *Studies in ethnomethodology*. Englewood Cliffs: Prentice-Hall.

Garforth, L., & Stöckelová, T. (2011). Science Policy and STS from Other Epistemic Places. *Science, Technology, & Human Values, 37*(2), 226-240. doi: 10.1177/0162243911417137

Gibbons, M. (1999). Science's new social contract with society. *Nature, 402 (Suppl)*, C81-C84.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. London: Sage.

Gieryn, T. F. (1995). Boundaries of science. In S. Jasanoff, G. Markle, J. Petersen & T. Pinch (Eds.), *Handbook of science and technology studies* (2nd ed.). London: Sage.

Gillard, S., Simons, L., Turner, K., Lucock, M., & Edwards, C. (2012). Patient and public involvement in the coproduction of knowledge. *Qualitative Health Research, 22*(8), 1126-1137. doi: 10.1177/1049732312448541

Global Sustainability. (n.d.). Welcome to Global Sustainability: A new Open Access journal. Retrieved 10 September, 2017, from http://gsus-journal.com/

Godin, B. (1998). Writing performative history: the new New Atlantis? *Social Studies of Science, 28*(3), 465-483.

Gomart, E. (2002). Methadone: Six effects in search of a substance. *Social Studies of Science, 32*(1), 93-135. doi: 10.1177/0306312702032001005

Granjou, C., Mauz, I., Louvel, S., & Tournay, V. (2013). Assessing Nature? The Genesis of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). *Science, Technology and Society, 18*(1), 9-27. doi: 10.1177/0971721813484232

Greenberg, D. H., & Robins, P. K. (1986). The Changing Role of Social Experiments in Policy Analysis. *Journal of Policy Analysis and Management*, *5*(2), 340-362.

Gross, M., & Krohn, W. (2005). Society as experiment: sociological foundations for a self-experimental society. *History of the Human Sciences, 18*(2), 63-86. doi: 10.1177/0952695105054182

Guston, D. H. (1999). Stabilizing the boundary between US Politics and Science. *Social Studies of Science, 29*(1), 87-111. doi: 10.1177/030631299029001004

Haas, P. M. (1992). Introduction: epistemic communities and international policy coordination. *International organization, 46*(1), 1-35.

Hackett, E. J., Parker, J. N., Vermeulen, N., & Penders, B. (2017). The social and epistemic organisation of scientific work. In U. Felt, F. Rayvon, C. A. Miller & L. Smith-Doerr (Eds.), *The Handbook of Science and Technology Studies* (4th ed., pp. 733-764). Cambridge, MA: MIT Press.

Hacking, I. (1983). *Representing and intervening: Introductory topics in the philosophy of natural science*. Cambridge, UK: Cambridge University Press.

Hackmann, H., & St Clair, A. L. (2012). Transformative Cornerstones of Social Science Research for Global Change. Paris: International Social Science Council (ISSC). Retrieved 28 August, 2017, from http://www.worldsocialscience.org/documents/transformative-cornerstones.pdf

Hadley Kershaw, E. (2018). Leviathan and the hybrid network: Future Earth, co-production and the experimental life of a global institution. In B. Nerlich, S. Hartley, S. Raman & A. Smith (Eds.), *Science and the politics of openness: Here be monsters*. Manchester: Manchester University Press.

Hammersley, M. (1992). *What's wrong with ethnography? Methodological explorations*. London: Routledge.

Haraway, D. (1988). Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist studies, 14*(3), 575-599.

Harding, J. (2006). Questioning the subject in biographical interviewing. *Sociological Research Online, 11*(3), 1-10. doi: 10.5153/sro.1411

Haynes, L., Service, O., Goldacre, B., & Torgerson, D. (2012). Test, learn, adapt: Developing public policy with randomised controlled trials. London: Cabinet Office. Retrieved 20 September, 2017, from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/62529/TLA-1906126.pdf

HEFCE. (2017). Initial decisions on the Research Excellence Framework 2021. Retrieved 10 September, 2017, from http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2017/REF,201701/REF2017_01.pdf

Hegger, D., Lamers, M., Van Zeijl-Rozema, A., & Dieperink, C. (2012). Conceptualising joint knowledge production in regional climate change adaptation projects: success conditions and levers for action. *Environmental Science & Policy, 18*(Supplement C), 52-65. doi: https://doi.org/10.1016/j.envsci.2012.01.002

Hessels, L. K., & van Lente, H. (2008). Re-thinking new knowledge production: A literature review and a research agenda. *Research Policy, 37*(4), 740-760. doi: http://dx.doi.org/10.1016/j.respol.2008.01.008

Hilgartner, S. (2000). *Science on stage: Expert advice as public drama*. Stanford: Stanford University Press.

Hilgartner, S., Miller, C. A., & Hagendijk, R. (Eds.). (2015). *Science and democracy: Making knowledge and making power in the biosciences and beyond*. Abingdon: Routledge.

Horst, M. (2011). Taking our own medicine: on an experiment in science communication. *Sci Eng Ethics, 17*(4), 801-815. doi: 10.1007/s11948-011-9306-y

Hulme, M. (2009). *Why we disagree about climate change: Understanding controversy, inaction and opportunity*. Cambridge, UK: Cambridge University Press.

Hulme, M. (2010). Problems with making and governing global kinds of knowledge. *Global Environmental Change, 20*(4), 558-564. doi: https://doi.org/10.1016/j.gloenvcha.2010.07.005

Hulme, M., & Mahony, M. (2010). Climate change: What do we know about the IPCC? *Progress in Physical Geography, 34*(5), 705-718. doi: 10.1177/0309133310373719

ICSU. (2009). Developing a new vision and strategic framework for Earth system research. ICSU Visioning Process Paper. . Paris: ICSU.

ICSU. (2010). Earth system science for global sustainability: The grand challenges. Paris: ICSU. Retrieved 10 September, 2017, from https://www.icsu.org/cms/2017/05/GrandChallenges_Oct2010.pdf

ICSU. (2011). Summary of the 3rd Earth System Visioning meeting. *ICSU Meeting Report*. Paris: ICSU.

ICSU. (n.d.). Future Earth. Retrieved 25 March 2016, from www.icsu.org/future-earth. Now available at: http://web.archive.org/web/20170416140248/www.icsu.org/future-earth

IGBP. (n.d.-a). History of global-change research. Retrieved 10 September, 2017, from http://www.igbp.net/about/history.4.1b8ae20512db692f2a680001291.html

IGBP. (n.d.-b). National committees. Retrieved 20 September, 2017, from http://www.igbp.net/networks/nationalcommittees.4.950c2fa1495db7081e1622e.html

IHDP. (n.d.). About IHDP. Retrieved 10 September, 2017, from http://www.ihdp.unu.edu/pages/?p=about

Irvine, J., & Martin, B. (1984). *Foresight in science: Picking the winners*. London: Frances Pinter.

Irwin, A. (2006). The politics of talk: Coming to terms with the "new" scientific governance. *Social Studies of Science, 36*(2), 299-320. doi: 10.1177/0306312706053350

Irwin, A. (2008). STS perspectives on scientific governance. In E. J. Hackett, O. Amsterdamska, M. Lynch & J. Wajcman (Eds.), *The Handbook of Science and Technology Studies* (3rd ed., pp. 583-607). Cambridge, MA: MIT Press.

Irwin, A. (2016). On the local constitution of global futures: Science and democratic engagement in a decentred world. *Nordic Journal of Science and Technology Studies, 3*(2), 24-33.

Irwin, A., Jensen, T. E., & Jones, K. E. (2013). The good, the bad and the perfect: Criticizing engagement practice. *Social Studies of Science, 43*(1), 118-135. doi: 10.1177/0306312712462461

Irwin, A., & Michael, M. (2003). *Science, social theory and public knowledge*. Maidenhead: Open University Press.

Jacob, M., & Hellström, T. (Eds.). (2000). *The future of knowledge production in the academy*. Buckingham: Open University Press.

Jasanoff, S. (1990). *The fifth branch: Science advisers as policymakers*. Cambridge, MA: Harvard University Press.

Jasanoff, S. (2001). Image and imagination: The formation of global environmental consciousness. In C. A. Miller & P. N. Edwards (Eds.), *Changing the atmosphere: Expert knowledge and environmental governance* (pp. 309-337). Cambridge, MA: MIT Press.

Jasanoff, S. (2003). Technologies of humility: Citizen participation in governing science. *Minerva, 41*(3), 223-244. doi: 10.1023/a:1025557512320

Jasanoff, S. (2004a). The idiom of co-production. In S. Jasanoff (Ed.), *States of knowledge: The co-production of science and social order* (pp. 1-12). London: Routledge.

Jasanoff, S. (2004b). Ordering knowledge, ordering society. In S. Jasanoff (Ed.), *States of knowledge: The co-production of science and social order* (pp. 13-45). London: Routledge.

Jasanoff, S. (2005). *Designs on nature: Science and democracy in Europe and the United States*. Princeton: Princeton University Press.

Jasanoff, S. (Ed.). (2004c). *States of knowledge: The co-production of science and the social order*. London: Routledge.

Jasanoff, S., & Kim, S.-H. (2009). Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea. *Minerva, 47*(2), 119. doi: 10.1007/s11024-009-9124-4

Jasanoff, S., & Kim, S.-H. (Eds.). (2015). *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power*. Chicago: University of Chicago Press.

Jasanoff, S., & Martello, M. L. (Eds.). (2004). *Earthly politics: local and global in environmental governance*. Cambridge, MA: MIT Press.

Jasanoff, S., & Wynne, B. (1998). Science and decisionmaking. In S. Rayner & E. L. Malone (Eds.), *Human choice & climate change* (Vol. 1: The Societal Framework, pp. 1-87). Columbus, Ohio: Battelle Press.

Jaspal, R., & Nerlich, B. (2014). When climate science became climate politics: British media representations of climate change in 1988. *Public Understanding of Science, 23*(2), 122-141. doi: doi:10.1177/0963662512440219

Kemp, R., & Rotmans, J. (2009). Transitioning policy: Co-production of a new strategic framework for energy innovation policy in the Netherlands. *Policy Sciences, 42*(4), 303. doi: 10.1007/s11077-009-9105-3

Kivimaa, P., Hildén, M., Huitema, D., Jordan, A., & Newig, J. (2017). Experiments in climate governance – A systematic review of research on energy and built environment transitions. *Journal of Cleaner Production*. doi: 10.1016/j.jclepro.2017.01.027

Klein, J. T. (2004). Prospects for transdisciplinarity. *Futures, 36*(4), 515-526. doi: http://dx.doi.org/10.1016/j.futures.2003.10.007

Klenk, N., & Meehan, K. (2015). Climate change and transdisciplinary science: Problematizing the integration imperative. *Environmental Science & Policy, 54*, 160-167. doi: 10.1016/j.envsci.2015.05.017

Knorr Cetina, K. (1999). *Epistemic cultures: How the sciences make knowledge*. Cambridge, MA: Harvard University Press.

Koskela-Huotari, K., Friedrich, P., & Isomursu, M. (2013). *Jungle of "co"*. Proceedings of the Naples Forum on Service. Retrieved from http://www.naplesforumonservice.it/uploads/files/Koskela-Huotari,%20Friedrich,%20Isomursu.pdf

Krohn, W., & Weyer, J. (1994). Society as a laboratory: the social risks of experimental research. *Science and public policy, 21*(3), 173-183.

Lahsen, M. (2016). Toward a sustainable Future Earth: Challenges for a research agenda. *Science, Technology, & Human Values, 41*(5), 876-898. doi: 10.1177/0162243916639728

Lancaster, K. (2017). Confidentiality, anonymity and power relations in elite interviewing: Conducting qualitative policy research in a politicised domain. *International Journal of Social Research Methodology, 20*(1), 93-103. doi: 10.1080/13645579.2015.1123555

Landström, C., Whatmore, S. J., & Lane, S. N. (2013). Learning through computer model improvisations. *Science, Technology, & Human Values, 38*(5), 678-700. doi: 10.1177/0162243913485450

Lane, S. N., Odoni, N., Landström, C., Whatmore, S. J., Ward, N., & Bradley, S. (2011). Doing flood risk science differently: An experiment in radical scientific method. *Transactions of the Institute of British Geographers, 36*(1), 15-36. doi: 10.1111/j.1475-5661.2010.00410.x

Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., . . . Thomas, C. J. (2012). Transdisciplinary research in sustainability science: Practice, principles, and challenges. *Sustainability Science, 7*(1), 25-43. doi: 10.1007/s11625-011-0149-x

Latimer, J. (2013). Being Alongside: Rethinking Relations amongst Different Kinds. *Theory, Culture & Society, 30*(7-8), 77-104. doi: 10.1177/0263276413500078

Latour, B. (1987). *Science in action: How to follow scientists and engineers through society*. Cambridge, MA: Harvard University Press.

Latour, B. (1993). *We have never been modern* (C. Porter, Trans.). Cambridge, MA: Harvard University Press.

Latour, B. (1998). From the world of science to the world of research? *Science, 280*(5361), 208-209.

Latour, B. (1999). *Pandora's hope: essays on the reality of science studies*. Cambridge, MA: Harvard University Press.

Latour, B. (2004). *Politics of nature: How to bring the sciences into democracy*. Cambridge, MA: Harvard University Press.

Laurent, B. (2009). Replicating participatory devices: the consensus conference confronts nanotechnology. *CSI working papers series*. 018. Retrieved 29 June, 2017, from https://halshs.archives-ouvertes.fr/halshs-00441232/document

Laurent, B. (2011). Technologies of democracy: experiments and demonstrations. *Sci Eng Ethics, 17*(4), 649-666. doi: 10.1007/s11948-011-9303-1

Laurent, B. (2016). Political experiments that matter: Ordering democracy from experimental sites. *Social Studies of Science, 46*(5), 773-794. doi: 10.1177/0306312716668587

Law, J., & Urry, J. (2004). Enacting the social. *Economy and Society, 33*(3), 390-410. doi: 10.1080/0308514042000225716

Leemans, R. (2016). The lessons learned from shifting from global-change research programmes to transdisciplinary sustainability science. *Current Opinion in Environmental Sustainability, 19*(Supplement C), 103-110. doi: https://doi.org/10.1016/j.cosust.2016.01.001

Leemans, R., Asrar, G., Busalacchi, A., Canadell, J., Ingram, J., Larigauderie, A., . . . Young, O. (2009). Developing a common strategy for integrative global environmental change research and outreach: The Earth System Science Partnership (ESSP). *Current Opinion in Environmental Sustainability, 1*(1), 4-13. doi: https://doi.org/10.1016/j.cosust.2009.07.013

Lemos, M. C., & Morehouse, B. J. (2005). The co-production of science and policy in integrated climate assessments. *Global Environmental Change, 15*(1), 57-68. doi: http://dx.doi.org/10.1016/j.gloenvcha.2004.09.004

Levin, M., & Greenwood, D. (2011). Revitalizing universities by reinventing the social sciences: bildung and action research. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE Handbook of Qualitative Research* (4th ed., pp. 55-87). Thousand Oaks: SAGE.

Lezaun, J., Marres, N., & Tironi, M. (2017). Experiments in participation. In U. Felt, R. Fouche, C. A. Miller & L. Smitt-Doer (Eds.), *The Handbook of Science and Technology Studies* (4th ed., pp. 195-222). Cambridge, MA: MIT Press.

Liberatore, A., & Funtowicz, S. (2003). 'Democratising' expertise, 'expertising' democracy: What does this mean, and why bother? *Science and public policy, 30*(3), 146-150. doi: 10.3152/147154303781780551

Lorimer, J., & Driessen, C. (2014). Wild experiments at the Oostvaardersplassen: rethinking environmentalism in the Anthropocene. *Transactions of the Institute of British Geographers, 39*(2), 169-181. doi: 10.1111/tran.12030

Lövbrand, E. (2011). Co-producing European climate science and policy: A cautionary note on the making of useful knowledge. *Science and public policy, 38*(3), 225-236. doi: 10.3152/030234211X12924093660516

Lövbrand, E., Beck, S., Chilvers, J., Forsyth, T., Hedrén, J., Hulme, M., . . . Vasileiadou, E. (2015). Who speaks for the future of Earth? How critical social science can extend the conversation on the Anthropocene. *Global Environmental Change, 32*, 211-218. doi: http://dx.doi.org/10.1016/j.gloenvcha.2015.03.012

Lövbrand, E., Pielke, R., & Beck, S. (2011). A Democracy Paradox in Studies of Science and Technology. *Science, Technology & Human Values, 36*(4), 474-496. doi: 10.1177/0162243910366154

Lövbrand, E., Stripple, J., & Wiman, B. (2009). Earth System governmentality: Reflections on science in the Anthropocene. *Global Environmental Change, 19*(1), 7-13. doi: https://doi.org/10.1016/j.gloenvcha.2008.10.002

Lubchenco, J. (1998). Entering the Century of the Environment: A New Social Contract for Science. *Science, 279*(5350), 491.

Lynch, M. (2000). Against reflexivity as an academic virtue and source of privileged knowledge. *Theory, Culture & Society, 17*(3), 26-54. doi: 10.1177/02632760022051202

Macnaghten, P., & Chilvers, J. (2014). The future of science governance: publics, policies, practices. *Environment and Planning C: Government and Policy, 32*(3), 530-548.

Mahony, N., Newman, J., & Barnett, C. (2010). *Rethinking the public: Innovations in research, theory and politics*. Bristol: Policy Press.

Marcus, G. E. (Ed.). (1994). *Technoscientific imaginaries: Conversations, profiles, and memoirs* (Vol. 2). Chicago: University of Chicago Press.

Marres, N. (2007). The issues deserve more credit: Pragmatist contributions to the study of public involvement in controversy. *Social Studies of Science, 37*(5), 759-780. doi: 10.1177/0306312706077367

Marres, N. (2012). *Material participation: technology, the environment and everyday publics*. Basingstoke: Palgrave Macmillan.

Marres, N. (2013). Why political ontology must be experimentalized: On eco-show homes as devices of participation. *Social Studies of Science, 43*(3), 417-443. doi: 10.1177/0306312712475255

Masterman, R. (2017). Research Priority Areas: a vital part of our research ecosystem. Retrieved from http://blogs.nottingham.ac.uk/researchexchange/2017/08/02/11581/

Mauser, W., Klepper, G., Rice, M., Schmalzbauer, B. S., Hackmann, H., Leemans, R., & Moore, H. (2013). Transdisciplinary global change research: the co-creation of knowledge for sustainability. *Current Opinion in Environmental Sustainability, 5*(3), 420-431. doi: https://doi.org/10.1016/j.cosust.2013.07.001

McManus, P. (2009). Pollution. In D. Gregory, R. Johnston, G. Pratt, M. J. Watts & S. Whatmore (Eds.), *The Dictionary of Human Geography*. Chichester: Wiley.

McNeil, M., Arribas-Ayllon, M., Haran, J., Mackenzie, A., & Tutton, R. (2017). Conceptualizing imaginaries of science, technology, and society. In U. Felt, F. Rayvon, C. A. Miller & L. Smith-Doerr (Eds.), *The Handbook of Science and Technology Studies* (4th ed., pp. 435-463). Cambridge, MA: MIT Press.

Mengel, J. (2013). Q&A with Mark Stafford Smith, Science Committee Chair. Retrieved 25 March, 2016, from http://futureearth.org/blog/2013-jul-30/qa-mark-stafford-smith-science-committee-chair

Merriam, S. B., Johnson-Bailey, J., Lee, M.-Y., Kee, Y., Ntseane, G., & Muhamad, M. (2001). Power and positionality: Negotiating insider/outsider status within and across cultures. *International Journal of Lifelong Education, 20*(5), 405-416. doi: 10.1080/02601370120490

Mill, J. S. (2002). On individuality, as one of the elements of wellbeing. *On liberty, the basic writings of John Stuart Mill*. New York: The Modern Library. (Original work published 1859)

Miller, C. A. (2001). Hybrid Management: Boundary Organizations, Science Policy, and Environmental Governance in the Climate Regime. *Science, Technology, & Human Values, 26*(4), 478-500. doi: 10.1177/016224390102600405

Miller, C. A. (2004). Climate science and the making of a global political order. In S. Jasanoff (Ed.), *States of knowledge: The co-production of science and social order* (pp. 46-66). London: Routledge.

Miller, C. A. (2007). Democratization, international knowledge institutions, and global governance. *Governance*, *20*(2), 325-357. doi: 10.1111/j.1468-0491.2007.00359.x

Miller, C. A. (2008). Civic epistemologies: Constituting knowledge and order in political communities. *Sociology Compass, 2*(6), 1896-1919. doi: 10.1111/j.1751-9020.2008.00175.x

Miller, C. A., & Edwards, P. N. (Eds.). (2001). *Changing the atmosphere: Expert knowledge and environmental governance*. Cambridge, MA: MIT Press.

Mohr, A. (2011). Publics in the making: mediating different methods of engagement and the publics these construct : commentary on: "Technologies of democracy: experiments and demonstrations". *Sci Eng Ethics*, *17*(4), 667-672. doi: 10.1007/s11948-011-9312-0

Mohr, A., Raman, S., & Gibbs, B. (2013). Which publics? When? Exploring the policy potential of involving different publics in dialogue around science and technology. Didcot: Sciencewise-ERC. Retrieved 10 September, 2017, from http://www.sciencewise-erc.org.uk/cms/assets/Uploads/Which-publics-FINAL-VERSION.pdf

Montana, J. (2017). Accommodating consensus and diversity in environmental knowledge production: Achieving closure through typologies in IPBES. *Environmental Science & Policy*, *68*, 20-27. doi: http://dx.doi.org/10.1016/j.envsci.2016.11.011

Morse, J. (2018). Reframing rigor in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE Handbook of Qualitative Research* (5th ed., pp. 796-817). Los Angeles: SAGE.

Moser, S. C. (2016). Can science on transformation transform science? Lessons from co-design. *Current Opinion in Environmental Sustainability, 20*, 106-115. doi: http://dx.doi.org/10.1016/j.cosust.2016.10.007

Mouffe, C. (2005). Some reflections on an agonistic approach to the public. In B. Latour & P. Weibel (Eds.), *Making things public: Atmospheres of democracy* (pp. 804-807). Cambridge, MA: MIT Press.

MSciP. (n.d.). Making Science Public: Challenges and Opportunities. Retrieved 12 September, 2017, from http://www.nottingham.ac.uk/sociology/research/projects/making-science-public/index.aspx

Muñoz-Erickson, T. A. (2014). Co-production of knowledge–action systems in urban sustainable governance: The KASA approach. *Environmental Science & Policy, 37*(Supplement C), 182-191. doi: https://doi.org/10.1016/j.envsci.2013.09.014

Nature. (2016). Future present: A young global-sustainability platform deserves time to find its feet. *Nature*, *531*(7-8).

Nerlich, B. (2012). Making concepts public: Experiments in ‘conceptual show and tell’. Retrieved from https://blogs.nottingham.ac.uk/makingsciencepublic/2012/12/03/making-concepts-public/

Nerlich, B. (2015). The co-production confusion. Retrieved from http://blogs.nottingham.ac.uk/makingsciencepublic/2015/03/20/the-co-production-confusion/

Nerlich, B., & Clarke, D. D. (2001). Ambiguities we live by: towards a pragmatics of polysemy. *Journal of Pragmatics, 33*(1), 1-20. doi: http://dx.doi.org/10.1016/S0378-2166(99)00132-0

Novick, G. (2008). Is there a bias against telephone interviews in qualitative research? *Research in Nursing & Health, 31*(4), 391-398. doi: 10.1002/nur.20259

Nowotny, H. (2014). Engaging with the political imaginaries of science: Near misses and future targets. *Public Understanding of Science, 23*(1), 16-20. doi: 10.1177/0963662513476220

Nowotny, H., Scott, P., & Gibbons, M. (2001). *Re-thinking science: Power and the public in an age of uncertainty*. Cambridge, UK: Polity Press.

OED. (n.d.-a). Co-production. Retrieved 28 August, 2017, from http://www.oed.com/view/Entry/41255?redirectedFrom=co-production#eid

OED. (n.d.-b). Community. Retrieved 10 September, 2017, from http://www.oed.com/view/Entry/37337?redirectedFrom=community#eid

OED. (n.d.-c). Experiment. Retrieved 10 July, 2017, from http://www.oed.com/view/Entry/66530

OED. (n.d.-d). Improvisation. Retrieved 3 July, 2017, from http://www.oed.com/view/Entry/92872

OED. (n.d.-e). Network. Retrieved 10 September, 2017, from http://www.oed.com/view/Entry/126342?rskey=CZJ5MI&result=1&isAdvanced=false#eid

Ostrom, E. (1996). Crossing the great divide: Coproduction, synergy, and development. *World Development, 24*(6), 1073-1087. doi: http://dx.doi.org/10.1016/0305-750X(96)00023-X

Ostrom, E., Parks, R. B., & Whitaker, G. P. (1978). *Patterns of metropolitan policing*. Cambridge, MA: Ballinger.

Oxford Dictionary of Literary Terms. (2015). Experimentalism. Retrieved 26 June, 2017, from http://www.oxfordreference.com/view/10.1093/acref/9780198715443.001.0001/acref-9780198715443-e-432?rskey=7GbF5B&result=3

Pallett, H. (2012). The (Re)publics of Science: Changing policy and participation. *3S Working Paper*. 04. Norwich: Science, Society and Sustainability Research Group. Retrieved 10 July, 2017, from https://uea3s.files.wordpress.com/2014/12/3s-wp-2012-04-pallett.pdf

Pallett, H. (2015a). *Organising science policy: Participation, learning & experimentation in British democracy.* (Doctoral Thesis), University of East Anglia, Norwich.

Pallett, H. (2015b). Public Participation Organizations and Open Policy. *Science Communication, 37*(6), 769-794. doi: 10.1177/1075547015612787

Pallett, H., & Chilvers, J. (2015). Organizations in the making. *Progress in Human Geography, 39*(2), 146-166. doi: 10.1177/0309132513518831

Pearce, W., Grundmann, R., Hulme, M., Raman, S., Hadley Kershaw, E., & Tsouvalis, J. (2017). Beyond Counting Climate Consensus. *Environmental Communication*, 1-8. doi: 10.1080/17524032.2017.1333965

Pearce, W., & Raman, S. (2014). The new randomised controlled trials (RCT) movement in public policy: challenges of epistemic governance. *Policy Sciences*, *47*(4), 387-402. doi: 10.1007/s11077-014-9208-3

Perrow, C. (1984). *Normal accidents: Living with high-risk technologies*. New York: Basic Books.

Pickersgill, M. (2012). The co-production of science, ethics, and emotion. *Science, Technology, & Human Values, 37*(6), 579-603. doi: 10.1177/0162243911433057

Pielke Jr, R. A. (2007). *The honest broker: making sense of science in policy and politics*. Cambridge: Cambridge University Press.

Pohl, C., Rist, S., Zimmermann, A., Fry, P., Gurung, G. S., Schneider, F., . . . Wiesmann, U. (2010). Researchers' roles in knowledge co-production: Experience from sustainability research in Kenya, Switzerland, Bolivia and Nepal. *Science and public policy, 37*(4), 267-281. doi: 10.3152/030234210x496628

Polanyi, M. (1962). The republic of science: Its political and economic theory. *Minerva, 1*(1), 54-73.

Polk, M. (2014). Achieving the promise of transdisciplinarity: A critical exploration of the relationship between transdisciplinary research and societal problem solving. *Sustainability Science, 9*(4), 439-451. doi: 10.1007/s11625-014-0247-7

Polk, M. (2015). Transdisciplinary co-production: Designing and testing a transdisciplinary research framework for societal problem solving. *Futures, 65*(Supplement C), 110-122. doi: https://doi.org/10.1016/j.futures.2014.11.001

Popa, F., Guillermin, M., & Dedeurwaerdere, T. (2015). A pragmatist approach to transdisciplinarity in sustainability research: From complex systems theory to reflexive science. *Futures, 65*, 45-56. doi: http://dx.doi.org/10.1016/j.futures.2014.02.002

Raman, S. (2014). Responsive research? Putting the innovative back into agendas for innovation. *Paper for Sciencewise-ERC, UK*. http://www.sciencewise-erc.org.uk/cms/assets/Uploads/Responsive-ResearchFINAL-VERSION.pdf

Raman, S. (2015). Science, uncertainty and the normative question of epistemic governance in policymaking. In E. Cloatre & M. Pickersgill (Eds.), *Knowledge, Technology and Law: Interrogating the Nexus* (pp. 17-32). London: Routledge.

Rayner, S. (2012). Uncomfortable knowledge: the social construction of ignorance in science and environmental policy discourses. *Economy and Society, 41*(1), 107-125. doi: 10.1080/03085147.2011.637335

Rayner, S., & Malone, E. (1998). The challenge of climate change to the social sciences. In S. Rayner & E. Malone (Eds.), *Human Choice & Climate Change* (Vol. 4: What have we learned?, pp. 33-69). Columbus, Ohio: Battelle Press.

RCUK. (n.d.-a). Co-producing legacy: What is the role of artists within Connected Communities projects? Retrieved 10 September, 2017, from http://gtr.rcuk.ac.uk/projects?ref=AH/L013185/1

RCUK. (n.d.-b). Pathways to impact. Retrieved 28 August, 2017, from http://www.rcuk.ac.uk/innovation/impacts/

Renn, O., Webler, T., & Wiedemann, P. M. (Eds.). (1995). *Fairness and competence in citizen participation: Evaluating models for environmental discourse* (Vol. 10). Dordrecht: Springer Science & Business Media.

Rheinberger, H.-J. (1997). *Toward a history of epistemic things: Synthesizing proteins in the test tube*. Stanford: Stanford University Press.

Ribeiro, B. E., Smith, R. D. J., & Millar, K. (2017). A mobilising concept? Unpacking academic representations of Responsible Research and Innovation. *Sci Eng Ethics, 23*(1), 81-103. doi: 10.1007/s11948-016-9761-6

Robinson, J., & Tansey, J. (2006). Co-production, emergent properties and strong interactive social research: the Georgia Basin Futures Project. *Science and public policy, 33*(2), 151-160. doi: 10.3152/147154306781779064

Rowe, G., & Frewer, L. J. (2000). Public Participation Methods: A Framework for Evaluation. *Science, Technology, & Human Values, 25*(1), 3-29.

Sarewitz, D. (1996). *Frontiers of Illusion: Science, technology, and the politics of progress*. Philadelphia: Temple University Press.

Saunders, B., Kitzinger, J., & Kitzinger, C. (2014). Anonymising interview data: Challenges and compromise in practice. *Qualitative Research, 15*(5), 616-632. doi: 10.1177/1468794114550439

Scott, A., Skea, J., Robinson, J., & Shove, E. (1999). Designing ‘interactive’ environmental research for wider social relevance. *Special Briefing*. 4.

Scott, J., & Marshall, G. (Eds.). (2009) A dictionary of sociology. Oxford: Oxford University Press.

Shapin, S., & Schaffer, S. (1985). *Leviathan and the Air Pump: Hobbes, Boyle, and the Experimental Life*. Princeton: Princeton University Press.

Shove, E., & Rip, A. (2000). Users and unicorns: a discussion of mythical beasts in interactive science. *Science and public policy, 27*(3), 175-182. doi: 10.3152/147154300781781959

Sismondo, S. (2010). *An introduction to science and technology studies* (2nd ed.). Chichester: Wiley-Blackwell.

Slaughter, S., & Leslie, L. (1997). *Academic capitalism: Politics, policies, and the entrepreneurial university*. Baltimore: John Hopkins University Press.

Social Research Foundation. (2003). Ethical guidelines. Retrieved 10 September, 2017, from http://the-sra.org.uk/wp-content/uploads/ethics03.pdf

Soneryd, L. (2016). Technologies of participation and the making of technologized futures. In J. Chilvers & M. Kearnes (Eds.), *Remaking Participation: Science, Environment and Emergent Publics* (pp. 144-161). London: Routledge.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks: SAGE.

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, `translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science, 19*(3), 387-420. doi: doi:10.1177/030631289019003001

Stengers, I. (2017). *Another science is possible: A manifesto for slow science* (S. Muecke, Trans.). Cambridge, UK: Polity Press.

Stephens, N., Atkinson, P., & Glasner, P. (2013). Institutional imaginaries of publics in stem cell banking: The cases of the UK and Spain. *Science as Culture, 22*(4), 497-515. doi: 10.1080/14636778.2013.764071

Stilgoe, J. (2012). Experiments in Science Policy: An Autobiographical Note. *Minerva, 50*(2), 197-204. doi: 10.1007/s11024-012-9199-1

Stilgoe, J. (2015). *Experiment earth: Responsible innovation in geoengineering*. London: Routledge.

Stilgoe, J., Lock, S. J., & Wilsdon, J. (2014). Why should we promote public engagement with science? *Public Understanding of Science, 23*(1), 4-15. doi: 10.1177/0963662513518154

Stirling, A. (2008). "Opening Up" and "Closing Down": Power, participation, and pluralism in the social appraisal of technology. *Science, Technology, & Human Values, 33*(2), 262-294. doi: 10.1177/0162243907311265

Stoker, G., & John, P. (2009). Design Experiments: Engaging Policy Makers in the Search for Evidence about What Works. *Political Studies, 57*(2), 356-373. doi: 10.1111/j.1467-9248.2008.00756.x

Strathern, M. (Ed.). (2000). *Audit cultures: Anthropological studies in accountability, ethics, and the academy*. London: Routledge.

Suni, T., Juhola, S., Korhonen-Kurki, K., Käyhkö, J., Soini, K., & Kulmala, M. (2016). National Future Earth platforms as boundary organizations contributing to solutions-oriented global change research. *Current Opinion in Environmental Sustainability, 23*(Supplement C), 63-68. doi: https://doi.org/10.1016/j.cosust.2016.11.011

Sutherland, W. J., Armstrong-Brown, S., Armsworth, P. R., Tom, B., Brickland, J., Campbell, C. D., . . . Watkinson, A. R. (2006). The identification of 100 ecological questions of high policy relevance in the UK. *Journal of Applied Ecology, 43*(4), 617-627. doi: 10.1111/j.1365-2664.2006.01188.x

Swedish Secretariat for Environmental Earth System Sciences. (n.d.). About us. Retrieved 20 September, 2017, from http://www.sseess.org/about-us/

Swyngedouw, E. (2005). Governance innovation and the citizen: The Janus face of governance-beyond-the-state. *Urban Studies, 42*(11), 1991-2006. doi: 10.1080/00420980500279869

Taylor, C. (2004). *Modern social imaginaries*. Durham: Duke University Press.

The Research Ethics Guidebook. (n.d.). Limits of confidentiality: professional and elite interviews. Retrieved 10 September, 2017, from http://www.ethicsguidebook.ac.uk/Limits-of-confidentiality-elite-interviews-232

The Science & Technology Alliance for Global Sustainability. (n.d.). Promoting integrated sustainability research to ensure the future we want. Retrieved 20 September, 2017, from http://www.stalliance.org/

Thoreau, H. D. (2008). *Walden : And On the Duty of Civil Disobedience*. Auckland: The Floating Press. (Original work published 1854)

Thornton, I. (2014). What does coordination actually achieve? Some thoughts on Future Earth. Retrieved 25 March, 2016, from www.ukcds.org.uk/blog/what-does-coordination-actually-achieve-some-thoughts-on-future-earth

Tolich, M. (2004). Internal confidentiality: When confidentiality assurances fail relational informants. *Qualitative Sociology, 27*(1), 101-106. doi: 10.1023/B:QUAS.0000015546.20441.4a

Turner, B. L., Kasperson, R. E., Meyer, W. B., Dow, K. M., Golding, D., Kasperson, J. X., . . . Ratick, S. J. (1990). Two types of global environmental change. *Global Environmental Change, 1*(1), 14-22. doi: http://dx.doi.org/10.1016/0959-3780(90)90004-S

Turney, J. (2014). 'To be inclusive, you need more voices' - Q&A with Sheila Jasanoff. Retrieved from http://www.futureearth.org/blog/2014-jul-23/be-inclusive-you-need-more-voices-qa-sheila-jasanoff

Turnhout, E., Bloomfield, B., Hulme, M., Vogel, J., & Wynne, B. (2012). Conservation policy: Listen to the voices of experience. *Nature, 488*(7412), 454-455.

Turnhout, E., Dewulf, A., & Hulme, M. (2016). What does policy-relevant global environmental knowledge do? The cases of climate and biodiversity. *Current Opinion in Environmental Sustainability, 18*(Supplement C), 65-72. doi: https://doi.org/10.1016/j.cosust.2015.09.004

Uhrqvist, O. (2014). *Seeing and knowing the Earth as a system: An effective history of global environmental change research as scientific and political practice.* (Doctoral Thesis), Linköping University Electronic Press, Linköping.

Uhrqvist, O., & Lövbrand, E. (2014). Rendering global change problematic: the constitutive effects of Earth System research in the IGBP and the IHDP. *Environmental Politics, 23*(2), 339-356. doi: 10.1080/09644016.2013.835964

UN. (n.d.). The Sustainable Development Agenda. Retrieved 28 August 2017, from http://www.un.org/sustainabledevelopment/development-agenda/

UNFCCC. (n.d.). The Paris Agreement. Retrieved 28 August, 2017, from http://unfccc.int/paris_agreement/items/9485.php

University of Lancaster. (n.d.). Experimentality: A unique, open-ended conversation about the power of experimentation. Retrieved 26 June, 2017, from https://www.lancaster.ac.uk/experimentality/

van der Hel, S. (2016). New science for global sustainability? The institutionalisation of knowledge co-production in Future Earth. *Environmental Science & Policy, 61*, 165-175. doi: 10.1016/j.envsci.2016.03.012

Waldby, C. (2000). *The visible human project: Informatic bodies and posthuman medicine*. London: Routledge.

Waterton, C., & Wynne, B. (2004). Knowledge and political order in the European Environment Agency. In S. Jasanoff (Ed.), *States of knowledge: The co-production of science and social order* (pp. 87-108). London: Routledge.

Watkins, J. (2015). Spatial imaginaries research in geography: Synergies, tensions, and new directions. *Geography Compass, 9*(9), 508-522. doi: 10.1111/gec3.12228

WCRP. (n.d.). WCRP History. Retrieved 20 September, 2017, from https://www.wcrp-climate.org/about-wcrp/about-history

Webster, A. (2007). Crossing boundaries: Social science in the policy room. *Science, Technology, & Human Values, 32*(4), 458-478.

Wehrens, R. L. E. (2013). *Beyond Two Communities: The co-production of research, policy and practice in collaborative public health settings.* (Doctoral Thesis), Erasmus University Rotterdam, Rotterdam. Retrieved from http://www.bmg.eur.nl/fileadmin/ASSETS/bmg/Onderzoek/Promoties/Promoties_2013/Wehrens/Proefschrift_Rik_Wehrens_Beyond_Two_Communities_2013.pdf

Weinburg, D. (2009). Social constructionism. In B. S. Turner (Ed.), *The New Blackwell Companion to Social Theory* (pp. 281-299). Chichester: Wiley-Blackwell.

Weingart, P. (1997). From “Finalization” to “Mode 2”: old wine in new bottles? *Social Science Information, 36*(4), 591-613. doi: 10.1177/053901897036004002

Welsh, E. (2002). Dealing with data: Using NVivo in the qualitative data analysis process. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research, 3*(2).

Welsh, I., & Wynne, B. (2013). Science, scientism and imaginaries of publics in the UK: Passive objects, incipient threats. *Science as Culture, 22*(4), 540-566. doi: 10.1080/14636778.2013.764072

Wetmore, J. M. (2004). Redefining risks and redistributing responsibilities: Building networks to increase automobile safety. *Science, Technology, & Human Values, 29*(3), 377-405.

Whatmore, S. J., & Landström, C. (2011). Flood apprentices: an exercise in making things public. *Economy and Society, 40*(4), 582-610. doi: 10.1080/03085147.2011.602540

Wiktionary. (n.d.-a). Experimentality. Retrieved 16 June, 2017, from https://en.wiktionary.org/wiki/experimentality

Wiktionary. (n.d.-b). Hold the ring. Retrieved 10 September, 2017, from https://en.wiktionary.org/wiki/hold_the_ring

Wilsdon, J., & Doubleday, R. (2013). Hail to the chief: Future directions for scientific advice in Whitehall. Retrieved 10 September, 2017, from http://sro.sussex.ac.uk/47848/2/FDSAW_Wilsdon_Doubleday.pdf

Wyatt, S., & Balmer, B. (2007). Home on the range: What and where is the middle in science and technology studies? *Science, Technology, & Human Values*, *32*(6), 619-626. doi: 10.1177/0162243907306085

Wynne, B. (1996). May the sheep safely graze? A reflexive view of the expert-lay knowledge divide. In S. Lash, B. Szerszynski & B. Wynne (Eds.), *Risk, environment & modernity: Towards a new ecology* (pp. 44-83). London: SAGE.

Wynne, B. (2010). Strange Weather, Again. *Theory, Culture & Society*, *27*(2-3), 289-305. doi: 10.1177/0263276410361499

Yearley, S. (1995). The environmental challenge to science studies. In S. Jasanoff, G. Markle, J. Petersen & T. Pinch (Eds.), *Handbook of science and technology studies* (2nd ed., pp. 457-479). London: Sage.

Yearley, S. (1996). *Sociology, environmentalism, globalization: Reinventing the globe*. London: Sage.

Yearley, S. (2008). Nature and the environment in science and technology studies. In E. J. Hackett, O. Amsterdamska, M. Lynch & J. Wajcman (Eds.), *The Handbook of Science and Technology Studies* (3rd ed., pp. 921-948). Cambridge, MA: MIT Press.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Thousand Oaks: SAGE.

Young, D. (2013). Q&A with Frans Berkhout, Future Earth Interim Director. Retrieved 25 March 2016, from http://futureearth.org/blog/2013-jul-15/qa-frans-berkhout-future-earth-interim-director

Ziman, J. (2000). *Real science: What it is, and what it means*. Cambridge, UK: Cambridge University Press.

Appendices

Appendix 1: Documents

Publications (external documents in the public domain)

Ref	Year	Month (of publication)	Type of document	Publication title
Doc 1	2010	August	Key document: report	What does it take to meet the Belmont Challenge?
Doc 2	2010	Oct	Key document: report	Earth System Science for Global Sustainability: the Grand Challenges
Doc 3	2010	11 Nov	Press release	Scientific Grand Challenges identified to address global sustainability
Doc 4	2011	after 11 Feb	Meeting summary	Summary of the 3rd Earth System Visioning meeting
Doc 5	2011	March	Key document: White Paper	Belmont Forum White Paper
Doc 6	2011	May	Key document: statement of intent	Towards a 10 year Earth System Research initiative for Global Sustainability: A joint statement of intent from the Belmont Forum, ICSU and the ISSC
Doc 7	2011	After 23 June	Meeting summary	Earth System Sustainability Initiative: Summary of the first Transition Team meeting
Doc 8	2011	29 Jun	Key document: conceptual paper	Earth System Research for Global Sustainability: A New 10-Year Research Initiative Final version: 29 June 2011
Doc 9	2011	29 Jun	Operational document	Establishment of a Transition Team Terms of Reference
Doc 10	2011	Unknown – July/Oct?	Operational document	Earth System Sustainability Initiative Transition Team Working Group 1: Draft Terms of Reference
Doc 11	2011	07 Jul	Operational document	Earth System Sustainability Initiative Transition Team Working Group 2: Draft Terms of Reference
Doc 12	2011	Unknown – July/Oct?	Operational document	Earth System Sustainability Initiative Transition Team Working Group 3: Draft Terms of Reference
Doc 13	2011	28 Sep	Press release	Research solutions for sustainability in a rapidly changing world
Doc 14	2012	16 Jan	Meeting summary	Future Earth (Earth System Sustainability Initiative) Summary of the 2nd Transition Team meeting
Doc 15	2012	Feb	Key document: framework document	Future Earth: Research for global sustainability A framework document by the Future Earth Transition Team
Doc 16	2012	27 Mar	Press release	Future Earth: New global platform for sustainability research presented at Planet Under Pressure
Doc 17	2012	14 Jun	Press release	Future Earth: New global platform for sustainability research launched at Rio+20

Doc 18	2012	Oct	Newsletter	Future Earth Newsletter - October 2012
Doc 19	2013	14 Jan	Newsletter	Future Earth Newsletter - January 2013
Doc 20	2013	17 Apr	Key document: design report	Draft initial design report. 17th April 2013
Doc 21	2013	26 Apr	Newsletter	Future Earth Newsletter - April 2013
Doc 22	2013	18 Jun	Newsletter	Future Earth Science Committee announced
Doc 23	2013	1 Jul	Press release	Professor Frans Berkhout named Interim Director of Future Earth
Doc 24	2013	3 Jul	Newsletter	Future Earth Interim Director announced
Doc 25	2013	Jul	Operational document	Process to establish the permanent secretariat of Future Earth. Call for expressions of interest
Doc 26	2013	23 Oct	Newsletter	Future Earth Newsletter - October 2013
Doc 27	2013	4 Nov	Key document: design report	Future Earth Initial Design
Doc 28	2013	17 Dec	Operational document	Process to establish the permanent Secretariat of Future Earth. Call for full bids
Doc 29	2013	23 Dec	Newsletter	Future Earth Newsletter – December 2013
Doc 30	2014	7 Jan	Key document: design report executive summary	Initial Design Executive Summary
Doc 31	2014	10 Jan	Operational document	Future Earth Engagement Committee. Call for applications
Doc 32	2014	14 Feb	Newsletter	Call for applications: Future Earth Engagement Committee
Doc 33	2014	23 Apr	Newsletter	News from Future Earth: Online Consultation on Strategic Research Agenda, Calls for Funding Proposals & New Website
Doc 34	2014	7 Aug	Newsletter	New initiatives to accelerate global sustainable development
Doc 35	2014	2 Jul	Newsletter	Future Earth Permanent Secretariat Announced
Doc 36	2014	15 Sep	Newsletter	Future Earth Executive Director: Vacancy Announcement
Doc 37	2014	4 Nov	Key document: Vision	Future Earth 2025 Vision
Doc 38	2014	18 Nov	Newsletter	Engagement Committee announced, 2025 Vision published, 2015 conference for early career scientists
Doc 39	2014	4 Dec	Key document: Strategic Research Agenda	Strategic Research Agenda 2014
Doc 40	2015	23 Jan	Newsletter	Call for Transformative Knowledge Networks, Strategic Research Agenda published, Vacancies

Internal documents

Science Committee & Interim Engagement Committee minutes & papers

Ref	Document name	Notes
Doc41	SC1_20130710_minutes	Teleconference
Doc42	SC2 03_09_2013 agenda	
Doc43	SC2 papers: Draft_ToR_Future Earth SC	
Doc44	SC2 papers: Future Earth IEC ToR	
Doc45	SC2 papers: GECHH	
Doc46	SC2 papers: mou_v4	
Doc47	SC2 papers: Program project summary_v3	
Doc48	SC2 papers: workstreams	
Doc49	SC2_20130903_minutes	Teleconference
Doc50	SC3 01_10_2013 agenda	
Doc51	SC3_20131001_minutes	Teleconference
Doc52	SC4 05_11_2013 agenda	
Doc53	SC4 papers: Future Earth - engagement v3 011113	**Early draft paper on Engagement**
Doc54	SC4_20131105_minutes	Teleconference
Doc55	SC5 papers_November 2013	
Doc56	SC5_20131119_minutes	Teleconference
Doc57	SC6 20131203 agenda	
Doc58	SC6 papers: 2025_comments	
Doc59	SC6 papers: Future Earth 10-year 2013-11-30	
Doc60	SC6_20131203_minutes	Teleconference
Doc61	SC7 20140204 agenda	
Doc62	SC7 papers: Secretariat activities_Feb2014	
Doc63	SC7 papers: medium-term RP_process	
Doc64	SC7 papers: RP_info to core projects	
Doc65	SC7 papers: project_transition_review	
Doc66	SC7_20140204_minutes	Teleconference
Doc67	SC8_20140304_minutes	Teleconference
Doc68	SC9_20140401 minutes	Teleconference
Doc69	SC10_20140506 minutes	Teleconference
Doc70	SC11EC3 Beijing papers_v4_correct bookmarks	**Includes draft Engagement White Paper**
Doc71	SC11EC3_reporting	Complete set of Interim Secretariat notes & presentations
Doc72	SC11EC3_ 20140604_minutes_general	First joint face-to-face meeting of the SC & IEC, Beijing, China
Doc73	SCEC12 20140708 minutes	Teleconference
Doc74	SCEC13 20140805 minutes_general	Teleconference
Doc75	SCEC14 20140902 minutes	Teleconference
Doc76	SCEC15 20141007 minutes	Teleconference
Doc77	SCEC16 20141104 minutes	Teleconference
Doc78	SCEC17 20141201 minutes_general	First joint face-to-face meeting of the SC & full EC, Buenos Aires, Argentina
Doc79	SCEC18_papers & reporting	Complete set of meeting papers & Interim Secretariat notes. **Includes draft Engagement Green Paper**
Doc80	SCEC18 20150203 minutes	Teleconference
Doc81	SCEC19 20150303 minutes	Teleconference
Doc82	EC Terms of Reference_FINAL 2014-09	
Doc83	IEC 19_11_2013 minutes	Teleconference
Doc84	iEC NY Meeting Minutes_Final	First face-to-face meeting of the IEC
Doc85	Selection Committee Members	Operational doc

Projects webinars minutes & papers

Ref	Document name	Notes
Doc86	Webinar I - agenda and practical information_final	
Doc87	Webinar I GEC projects - report_17-07-2013	
Doc88	agenda Sep 23 2013	
Doc89	minutes Sep 23 2013	
Doc90	agenda 12 Nov 2013	
Doc91	minutes 12 Nov 2013	
Doc92	agenda 10 Dec 2013	
Doc93	minutes 10 Dec 2013	
Doc94	agenda 14 Jan 2014	
Doc95	minutes 14 Jan 2013	
Doc96	agenda_day1-2	
Doc97	agenda_day3	
Doc98	FTIs and Clusters_v2	
Doc99	Mid-term priorities_v5	
Doc100	uncork_output	Includes feedback on risks and opportunities of co-’-s
Doc101	report_day1_2	Face-to-face meeting, January 2014
Doc102	report_day3	Face-to-face meeting, January 2014
Doc103	agenda 18 Feb 2014	
Doc104	task forces	
Doc105	webinar6_20140218	
Doc106	webinar8_20140408	
Doc107	webinar8_comms_presentation	

ICSU web pages

Ref	Page name
Web1	About
Web2	AGU Town Hall
Web3	Biographies of members
Web4	Cape Town workshop
Web5	Events
Web6	Food Futures Young Scientists Networking Conference
Web7	Future Earth
Web8	Future Earth Event
Web9	Future Earth in the Media
Web10	Future Earth launch event
Web11	Future Earth meeting London
Web12	Future Earth Newsletter
Web13	Future Earth North America Webinar
Web14	Future Earth North America Webinar 1
Web15	Future Earth regional workshop for Europe
Web16	Future Earth side event at RioCentro
Web17	Future Earth symposium at the AAAS annual meeting
Web18	Future Earth Town Hall at EGU General Assembly
Web19	Future Earth Workshop for Middle East and North Africa
Web20	GEC Community Workshop
Web21	Governance Structure
Web22	Interim Engagement Committee

Web23	Kuala Lumpur Workshop
Web24	Mexico City Workshop
Web25	News
Web26	Photos
Web27	Press Releases
Web28	Publications
Web29	Resources
Web30	Science Committee
Web31	Transition Team
Web32	Videos
Web33	Working Groups

Future Earth blog posts (until 20 March 2014)

Ref	Page name
Web34	About us
Web35	Q&A with Bob Watson, Why Future Earth needs an Engagement Committee
Web36	Q&A with Frans Berkhout, Interim Future Earth Director
Web37	Q&A with Mark Stafford Smith, Science Committee Chair

Future Earth web pages and blog posts (from 20 March 2014)

Ref	Page name
Web38	About us
Web39	Deconstructing the Anthropocene
Web40	Dynamic Planet
Web41	Get involved
Web42	Global Development
Web43	History
Web44	Home
Web45	Impact
Web46	Interim Engagement Committee
Web47	Multimedia
Web48	Research Projects
Web49	Science Committee
Web50	Secretariat
Web51	Structure and Governance
Web52	The Alliance
Web53	The next big thing for global transformation
Web54	Transformations towards sustainability
Web55	What should the Future of Global Change Research look like?
Web56	Who we are

Appendix 2: Example information sheet (interviews)

The New Co-Production of Knowledge? Challenges and Opportunities of Transforming Global Environmental Change Research Systems

The University of Nottingham

Information for Participants

Who is carrying out the research?
Eleanor Hadley Kershaw, Doctoral Researcher, Institute for Science and Society, University of Nottingham, UK. The PhD project is part of the broader 'Making Science Public' research programme, funded by the Leverhulme Trust.[48]

What is the study about?
The study aims to investigate the challenges and opportunities associated with transforming research systems in response to global environmental change (GEC), using Future Earth as a case study. In particular, it aims to examine notions and practices of transdisciplinarity and co-production, focusing on the roles envisioned for various disciplines and stakeholder groups (e.g. natural sciences, social sciences, non-academic actors), as well as the factors shaping their capacity to contribute to the framing, conduct and use of GEC research and associated sustainability solutions.

What type of research questions will the project address?
Using qualitative methods, the project will address questions such as: What do transdisciplinarity and co-production mean in Future Earth? What roles are envisioned for different stakeholders? How will these ideas be implemented at research governance and research production levels? What drives these developments? What factors shape the capacity of stakeholders to contribute to or influence Future Earth governance and research? What sorts of challenges and opportunities arise from this?

What will participation involve?
A mutually convenient date, time and location will be arranged for a face-to-face, telephone or Skype interview. The interview will last from minimum 30 minutes to maximum 90 minutes, depending on your availability. The interview questions will cover your thoughts on and experiences of Future Earth's development and implementation, as well as your perspective on transdisciplinarity and co-production more broadly. The researcher may also observe select Future Earth committee meetings and/or events. Notice of observation will be given to attendees in advance of as well as during meetings/events.

What are the benefits of participating in the study?
This study will engage reflexively with Future Earth, making space for the consideration of the challenges and opportunities it faces in relation to transdisciplinarity and co-production. The results of the data analysis overall will generate recommendations for the further implementation of the initiative and perhaps for similar initiatives in the future. By participating you will be helping to broaden the range of sources of data, increasing the chances of outputs being useful and relevant to Future Earth committees and stakeholders, and to the broader research and research policy communities.

---

48 The Leverhulme Trust is one of the largest all-subject providers of research funding in the UK. For more information on the Making Science Public Programme, please see: www.nottingham.ac.uk/makingsciencepublic

Are there any foreseeable risks to the individual if they participate in the research?
Every effort will be made to ensure anonymity (unless explicit permission is given otherwise). In some cases, participants may occupy unique roles that would make quotes identifiable to those within the Future Earth community. In such cases, the researcher will discuss this with the individual participant(s) concerned and reach an agreement on whether further permission is required for the use of quotes and/or descriptors in research outputs.

Are there any costs or inducements to taking part in the research?
No.

What should you do if you do not want to participate?
Participation is voluntary and consent can be withdrawn any time by contacting the researcher. Please contact the researcher about any queries or concerns you have.

What happens to the collected information?
All data generated through this study will be analysed according to the research questions above. Recordings and anonymised transcripts will be stored and then destroyed in accordance with University policy. Anonymous quotes may be used in research outputs, unless explicit permission is given for quotes to be attributed. The data collected may be used in other research projects that have ethics approval, but your name and contact information will be removed before it is made available to other researchers. Confidentiality and anonymity cannot be guaranteed in the case of disclosure or evidence of illegal activity or significant harm, abuse, or neglect to participants or to others.

What are the research outputs?
An executive summary of research findings and any resulting recommendations will be shared with all research participants. Other primary outputs will include a doctoral thesis, and research publications in the form of journal articles. Additional outputs may include blog posts and other materials for audiences beyond the research community.

Who else is being asked to take part and how are they being selected?
Interviews will be undertaken with key stakeholders: 1) those involved in past and current Future Earth governance and implementation; 2) those involved in Future Earth research programmes/projects; 3) participants in consultation exercises and initial Future Earth activities; 4) those not currently involved in Future Earth but whose work is relevant to transdisciplinary global environmental change research. Interviewees will be selected with consideration of the balanced representation of gender, geographical location, and sectoral, institutional, and disciplinary affiliation.

Contact details

Researcher:

Eleanor Hadley Kershaw
Institute for Science and Society
School of Sociology and Social Policy
Law and Social Sciences Building
University of Nottingham, University Park
Nottingham NG7 2RD, United Kingdom
http://nottingham.ac.uk/sociology/people/lqxecha

E: lqxecha@nottingham.ac.uk
T: +44 (0)115 846 6560

Supervisors:

Brigitte Nerlich (above address)
Professor of Science, Language & Society
Director, Making Science Public
E: brigitte.nerlich@nottingham.ac.uk
T: +44 (0)115 846 7065

Dr Sujatha Raman (above address)
Lecturer, Science & Technology Studies
Deputy Director, Making Science Public
E: sujatha.raman@nottingham.ac.uk
T: +44 (0)115 846 7039

Making Science Public Programme: www.nottingham.ac.uk/makingsciencepublic

Complaint procedure

If you wish to complain about the way in which the research is being conducted or have any concerns about the research then in the first instance please contact the researcher or the supervisors (contact details above). If this does not resolve the matter to your satisfaction then please contact the School's Research Ethics Officer, Dr Simon Roberts (T: +44 (0)115 846 7767; E: simon.roberts@nottingham.ac.uk).

Appendix 3: Example consent form (interviews)

Institute for Science and Society, School of Sociology and Social Policy, University of Nottingham

Participant Consent Form: The New Co-Production of Knowledge? Challenges and Opportunities of Transforming Global Environmental Change Research Systems

In signing this consent form I confirm that:

I have read and understand the Participant Information Sheet. I have had the opportunity to ask questions, which have been answered satisfactorily.	Yes		No	
I understand that my participation is voluntary and I may withdraw from the research project at any stage, without having to give any reason.	Yes		No	
I understand that while information gained during the study may be published, any information I provide is confidential (with the exception of disclosure or evidence of illegal activity or significant harm, abuse, or neglect to participants or to others, in which case confidentiality may be violated). I understand that every effort will be made to maximise the anonymity of participants. In cases where there is a chance that I may be identifiable to Future Earth colleagues (or others) from the use of quotes or descriptors in reports/publications, the researcher has discussed this with me and will seek further permission where required.	Yes		No	
I agree that extracts from the interview may be anonymously quoted in any report or publication arising from the research.	Yes		No	
I understand that the interview will be recorded using electronic voice recorder.	Yes		No	
I understand that data will be securely stored.	Yes		No	
I understand that the information provided can be used in other research projects which have ethics approval, but that my name and contact information will be removed before it is made available to other researchers.	Yes		No	
I agree to take part in the above research project.	Yes		No	

Participant's name (BLOCK CAPITAL)	Participant's signature	Date

Researcher's name (BLOCK CAPITAL)	Researcher's signature	Date

Appendix 4: Example interview schedule

1. Could you tell me briefly about your work and your institutional/ disciplinary affiliations?

Future Earth: what it is & involvement

2. **Could you tell me a bit about Future Earth?** What is it?
3. **Why is it needed?**
4. What role have you played so far in Future Earth?

Future Earth: stakeholders, governance & activities

5. **Who is involved in Future Earth and how?** Who might be involved in the future?
6. **How are/should they be involved? Why?**
7. How might these different parties relate to each other in Future Earth?
8. How is Future Earth governed or how will it be?
9. **What type of activities are happening or will happen** within Future Earth? Who is or will be involved in those?

Future Earth implementation & impacts

10. **How are these activities playing out so far?**
11. Do you think that Future Earth could lead to significant transformations in the way that research is governed, conducted or used? How?

Challenges and opportunities

12. **What do you consider to be the major challenges in achieving the vision of Future Earth?**
13. **And the major opportunities?**
14. Are there any exemplars that you have been able to draw on in developing Future Earth?
15. Do you feel that there is currently anything missing from Future Earth, or that needs further thought or attention?

Co-production and closing questions

16. [Prompt if hasn't arisen in response to other questions: **"Co-production" seems to be a significant feature of Future Earth. What does this mean?** How is it novel? How will it work in practice? How will it contribute to the

broader aims of Future Earth? (Also transdisciplinarity, integration, interdisciplinarity, engagement.)]

17. Where did you first come across the concept of co-production? Have you worked on other projects or programmes featuring co-production?
18. Is there anything else that you would like to share about your experience working on/with Future Earth?