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Toward a Sustainable Future Earth: Challenges for a Research Agenda

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Abstract

Future Earth is an evolving international research program and platform for engagement aiming to support transitions toward sustainability. This article discusses processes that led to Future Earth, highlighting its intellectual emergence. I describe how Future Earth has increased space for contributions from the social sciences and humanities despite powerful, long-standing preferences for bio-geophysical research in global environmental research communities. I argue that such preferences nevertheless are deeply embedded in scientific institutions that continue to shape environmental science agendas and, as such, constitute a formidable obstacle that needs to be recognized and countered to bolster efforts at effective societal transformation in the face of sustainability challenges. The analysis draws on two decades of observant participation in environmental research communities in the United States, Europe, Brazil, and elsewhere, including participation in the visioning process that led to Future Earth.

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Introduction

> It is not the strongest of species that survive, nor the most intelligent, but the ones most responsive to change.
>
> Charles Darwin[1]

> The opposite of path dependency is actually reflexivity, not adaptiveness. Reflexivity in a social context means the self-critical capacity of a structure or process or set of ideas to change itself after scrutiny of its own failures (or successes).
>
> John S. Dryzek (2015, 6)

Many agree that significant structural changes are necessary to avoid catastrophic human-induced climate change and natural resource depletion (O'Riordan and Lenton 2013; Park, Conca, and Finger 2008). History shows that societies can innovate to address threats of resource scarcity (DeFries 2014), but they tend to maintain a variant of the status quo led by ingrained habits of thought, organization, action, and defense of interests, even in face of large-scale problems (Dryzek 2015; Elliott 2012; Handmer and Dovers 2009).

Dominant institutions' aversion to fundamental change creates a dilemma (O'Riordan and Jordan 1999): how can they reform themselves and the world if their very logic contributes to their resistance? Social scientists have long stressed that global environmental risks require analyses beyond expert probability calculations because the risks are suffused with value-laden and political choices and have become an inextricable part of the social fabric (Funtowicz and Ravetz 1993; Jasanoff 2003; Sterman 2008). Understanding social and political dynamics is key to addressing the risks, not least the deeper political and economic power structures that shape risk perceptions and possibilities for societal transformation (see, among many others, Hackmann, Moser, and Clair 2014; Jasanoff 2010;

Paterson 2000; Scoones et al. 2015). The environmental social sciences and humanities (ESSH) can provide such understanding. They can narrow the gulf between knowledge and action and bring considerations of justice and equity to the fore. Besides being important from an ethical standpoint (Jamieson 2014), a growing social scientific literature concludes that greater socioeconomic equality promotes both beneficial environmental practices and higher levels of human health and well-being (Rogers et al. 2012).

Self-reform is a challenging necessity for institutions of research and higher learning. Important strides toward reform have been made under Future Earth, a new international environmental research program. This article discusses the accomplishments and challenges confronting efforts to make the ESSH more equal partners in global environmental change (henceforth, GEC) research. Focused on processes that led to Future Earth and associated websites and publications, the analysis shows the persistent preferences of influential scientists and research-related institutions for established lines of bio-geophysical research over scholarship from the social sciences and humanities. Empirical examples show that dominant science institutions incorporate values, interests, and resistances when pressures for change oppose their narrow interests and entail "uncomfortable" (Rayner 2012) knowledge. This article argues that these persistent biases need to be recognized and countered to increase the chances of positive and purposeful societal transformation in face of the sustainability challenges.

The analysis is based on observant participation by the author in GEC science in the United States, Brazil, and elsewhere. This includes roles as a social science officer in the International Geosphere–Biosphere Programme (IGBP) and as an early career researcher in the deliberations that led to Future Earth. It is offered to examine how institutions governing research and education live up to the "huge onus" placed upon them to help societies alter their own practices and "tackle, as a priority, this 'wickedest' of problems—how to re-found human civilization in a way that is sustainable into the longest of terms" (Parkin 2013, 212). Driessen, Leroy, and van Vierssen (2010) suggest that tackling it depends on greater transparency, critical reflection, and transformation in both science and society, a process that can be supported by ethnographic studies and "thick analysis" of relevant decision-making processes (Adger et al. 2003).

Perceptions of the Need for Change

Future Earth—*Research for Global Sustainability* (http://www.futureearth.org) is an evolving international research program and engagement

platform. Its two-year design process was launched at the 2012 Rio+20 Summit by *The Science and Technology Alliance for Global Sustainability*. This includes the Belmont Forum of Funders (a subset of the most influential members of the International Group of Funding Agencies[2] for Global Change Research), the International Council for Science (ICSU), the International Social Science Council (ISSC), the United Nations University, the United Nations Environmental Program and its Educational, Scientific and Cultural Organization, and, more recently, the World Meteorological Organization (WMO; http://www.futureearth.org/who-we-are). This alliance decided to establish Future Earth as a single, overarching structure and research strategy for GEC research. Its remit is to gradually replace the international programs coordinating GEC research: the World Climate Research Programme, the IGBP, the International Human Dimensions Program (IHDP), and Diversitas. Evaluations of these programs as excellent scientifically but weakly coupled with policy and societal changes towards sustainability[3] led to a strengthening of moves for more action-oriented research by means of greater integration of social science (ISSC and UNESCO 2013; Mooney, Duraiappah, and Larigauderie 2013; Leemans 2016), an development that also informed the visioning process in the late 2000s which resulted in Future Earth.[4]

ICSU[5] started the visioning process in the late 2000s to identify the new knowledge, capacity, and mechanisms needed to transform the research agenda. A year or two later, it was joined by the Belmont Forum,[6] which had started a similar process. Its "Belmont Report" (ICSU 2010b) focused on the "Belmont Challenge of delivering knowledge to support human action and adaptation to regional environmental change." Other key written products from these two initially separate efforts include the Belmont Forum's White Paper[7] and ICSU's "*Grand Challenges*" report (2010c).

At a third and last visioning meeting in early 2011, a majority of the relevant institutional leaders eventually decided to combine willing GEC research programs—at the time, IGBP, IHDP, and Diversitas—under a new entity, namely, what became Future Earth. Initially resistant, the WMO and the World Climate Research Programme later followed.

Social Science and Early Career Scientists Inclusion in Visioning Process

A key part of the ICSU-led visioning process was a two-day 2009 meeting near Paris, France, composed of mid- and late-career GEC scientists and leaders of scientific and United Nations organizations to define a "new

vision'' for Earth system research. They were joined by a dozen early career (EC) researchers from around the world selected by the various GEC research program leaders after a call for applications.[8] This meeting was the most participative of the initiatives generated by ICSU. Stressing the need for inclusion of natural and social scientists with interdisciplinary expertise and a diversity of perspectives, a Process Paper prescribed that the first visioning meeting should be a ''brainstorming event'' to define a preliminary set of research questions that would become the basis of an ''Earth system research strategy.'' All participants were to be ''carefully selected, after consultation, to include current and future scientific leaders and innovators'' (Process Paper, pp. 3–4).[9] Beyond this, the Process Paper was vague. It did not define the sectors of scholarship and society to be included, how these should be selected, nor the desired profile of those doing the selection. It did not call for participation of the humanities or business—or other civil society or political representatives.

In line with the Process Paper, this first visioning meeting was opened to a dozen EC scientists. In addition to disciplinary and age diversity, their inclusion served to increase gender, ethnic, and geographical diversity among the participants.

EC Researchers' Vision

The ideas and proposals articulated by the EC scientists reflected a sense of urgency and the understanding that current environmental dangers are caused by a lack of ability or will to overcome the ''schism'' between knowledge and action (Aykut and Dahan 2014). Their perspective foreshadowed the emphases that came to mark Future Earth. What follows is a subjective account of core tenets of the interventions and suggestions made by EC scientists during plenary sessions, structured around three overlapping themes.[10]

Broadening the Focus from Climate to Sustainability

During discussions at the plenary meeting, the EC researchers outlined an agenda with a broad focus on environmental sustainability, integrating attention to environmental justice, equity, and the Millennium Development Goals. They focused on how research might become more relevant and influential in decision-making processes, and how it might better integrate issues less often addressed in GEC research, such as ecological economics and waste and pollution reduction. Studies suggest that

consumerism and unwise approaches to meeting consumption needs are problems deserving high priority (Rockström 2009; Speth 2008). Extensive carbon accounting, currently central to climate policy, fails to address consumption problems and other deeper structural drivers of unsustainability (Scrase and Smith 2009; Stevenson 2013). The congruence between sustainability and current approaches to climate policy is partial, at best.[11]

A Relative Demotion of Prediction

Sensible policy requires an understanding of current environmental trends and their potential consequences for humans and ecosystems now and in the future. Numerical models representing bio-geophysical processes can help develop such understanding. But promotion of such models and their predictions is commonly based on the assumption that uncertainty obstructs policy action. Yet knowledge about future impacts and tipping points "shed[s] very little light on when the relevant [social] forces will bring about that change or what the outcome of it will be" (Ekins 2013, 191). They do not address the political, economic, and cultural structures that variously cause or might challenge current production and consumption patterns or associated wealth and power distributions that are undermining life-supporting ecosystems and human well-being. Important dimensions of these factors are not obviously or meaningfully conducive to quantification and predictive modeling due to their intersubjective nature and the role of interpretation and human agency (Giddens 1976). Time and resource constraints, imperfect prediction of human behavior, and the limited policy use of predictions (Allen and Frame 2007; Sarewitz, Pielke, and Byerly 2000) suggests that ever more sophisticated Earth system models and their increasingly detailed predictions should not be the singular, overarching aim of a collective research agenda. More quantification and politics-shunning analyses are not useful when, as is often the case, uncertainty is a pretext for policy inaction (Sarewitz, Pielke, and Byerly 2000). Nor are they the best choice for addressing members of the public. Illustrating this, British youths[12] appear to find the urgency of climate change *reduced rather than heightened* by descriptions of its effect on future generations, and wish to have climate discussions linked to political issues rather than sanitized to exclude them. Such attitudes reflect the reasonable view that extant science is sufficiently strong to warrant decision-making and action now, begging emphasis on efforts to speed up progress on these fronts.

An Intensified Focus on How to Improve Decision-making and Institutions

Given the above, interventions by EC scientists plus a subset of other participants at the visioning meeting emphasized the need to research how to achieve better decision-making. Social science research underscores that there are no purely technical solutions for the challenges of climate change and sustainability (Hulme 2009; Scoones et al. 2015; Sterman 2008). Many scholars identify the current elites- and corporations-controlled neoliberal capitalist order as the deeper problem (Korten 1995; Nichols and McChesney 2013; Paterson 2000). They suggest that bottom-up movements aimed at structural reform, strengthened democracy, and a "communications revolution" (McChesney 2007) are vital to progressive change (Stirling 2015).

However, such diagnoses run counter to the "antipolitics" paradigm (Mouffe 2005) that pervades climate science and associated policy processes (Newell 2011; Swyngedouw 2010), a paradigm supported by notions of proper divisions between science and politics dominant in both science and policy circles. This subcultural, normative distinction discourages analyses that interpret GEC as an expression of systemic failure driven by capital accumulation and industrial development requiring much more than technological and cost-effective, market-friendly solutions (Anderson and Bows 2012; Bjurström and Polk 2011; Newell 2011). A large body of research seeks solutions in small-scale community use of ecosystems rather than in a globalized economic and political system that favors financial gain and generates pollution, resource depletion, and steep socioeconomic and political inequality (Fletcher 2012; Shove 2010). Although it challenges deep-rooted values of science as independent and policy neutral, such research is vital. Indeed, change in such underpinning normative assumptions may reduce the schism between widespread awareness of the severity of global threats and weak contemporary efforts to address them (Aykut and Dahan 2014).

Competing Long-standing Tendencies in the Global Change Research Community

During the two days of the first visioning meeting, EC scientists and supporting scientists made suggestions for a new research agenda along these deeper and more critical lines. This engendered numerous exchanges, such as when a senior scientist claimed there was a misfit between development research proposed by an EC scientist from a less developed country and exciting "big science." A second example was the response of a Belmont

Forum leader. When nudged to specify useful social science research, he suggested "adaptation and impact studies," in line with the United Nations Intergovernmental Panel on Climate Change (IPCC's) long-standing—but contested—delimitation of climate- and sustainability-relevant social science research and action (Kelman, Gaillard, and Mercer 2015; O'Brien 2011). A third moment was when an established scientist reacted to key aspects of the EC researchers' proposed innovations to the research agenda by observing that they were commendable but "not what we in this room do" (see also Leemans 2016, 109).

The commitment to prediction and associated observation systems was reinforced when a senior scientist proposed that the group adopt the following list of research:

- Improve the usefulness of forecasts of future environmental conditions and their consequences for people.
- Develop the observation systems needed to manage global and regional environmental change.
- Determine how to anticipate, avoid, and cope with dangerous GEC.
- Determine what institutional and behavioral changes can best ensure global sustainability.
- Develop and evaluate innovative technological and social responses to achieve global sustainability.

The list retains forecasting and observation as the top three agenda items. In the third item, forecasting is embedded in "how to anticipate" GEC and references to "coping" with GEC are in line with the long-standing emphasis on adaptation. Search for technological solutions (fifth item) accords with similarly long-standing approaches to climate change mitigation.

An EC researcher noted all these, suggesting that the fourth item ought to be first and to include deliberation that should decide the shape and relative importance of forecasting (and associated observation systems) versus other lines of research. Although it was clear at other moments that senior leaders representing the atmospheric sciences were especially averse to new, critical input in favor of a more ESSH-infused research agenda, this comment met with much agreement and no expressed protests.

Nevertheless the five-point agenda was retained in subsequent communications. It appeared in a draft, presented as "a synthesis of the meeting discussions, informed by subsequent discussions of the core writing group" which aimed to be "a representative summary of areas where there is consensus." This was pointed out in the ensuing internal feedback process.

Yet this second intervention also went unheeded. Other key documents emerging from the 2009 visioning meeting, including the ICSU's two 2010 reports and a *Science* article by leaders of the visioning process (Reid et al. 2010), retained the five challenges, which had emerged in a conversation among three senior natural scientists and process leaders in a breakout session. The Process Paper did not specify the mechanisms by which input from the various participants was to be handled in final decisions, nor did it prescribe transparency, monitoring, nor any broader input before such summarizing statements and other important decisions were finalized.

Report Analysis and Intercomparison

The White Paper and ICSU's Belmont Report: Minimal Social Science Contributions

The resistances documented above are reflections of the historic, nearly exclusionary centrality of the bio-geophysical—and especially atmospheric—sciences in GEC research (ISSC 2012). Below, I briefly capture the content of the White Paper and ICSU's Belmont report because they illustrate especially clearly long-standing dominant problem framings in GEC research, the backdrop against which to understand the emergence of Future Earth.

The White Paper is represented on, and accessible via a link, from the Belmont Forum's website[13] as "a research funders' point of view" of the needed "profound change to the way we support and undertake GEC research" to meet the sustainability challenge. Both the website and the White Paper are presented as current, as late as the date of this writing (April 2016). Both propose an "Earth system analysis and prediction system" as an overarching framework for integrating research and observations "into a seamless, holistic environmental decision-support system."[14] The first of these priorities involves "systematic targeting and integration of observations and research to overcome critical limits to predictions." The remaining priorities are rather general and unspecific, consisting in improved predictions and modeling as the only specified, substantive research proposed, together with observations to aid that task.[15] The (undisclosed) authors of the White Paper acknowledge that its agenda is "conspicuously" lacking in "socioenvironmental research dimensions." Its priority list concentrates on "critical interventions" in model prediction at regional and decadal scales (p. 8).

ICSU's Belmont report's sixteen core authors were all from the natural sciences, with twelve or more specifically from the atmospheric and oceanic sciences. Two or three social scientists served among eight contributors. References to "weather" and "climate" appear in an either exclusionary or

prioritized manner throughout the report, invariably first on lists of phenomena to be studied. Aside from "dialogue between scientists, policy makers, and the general public," its concluding "requirements" call for more monitoring and observations systems, high-resolution predictions and prediction models, as well as the most advanced and powerful dedicated supercomputer facilities. In its concluding sentence, the report stresses the importance of "expos[ing] a new generation of natural and social scientists to environmental observations, analyses and predictions, and to communicate the excitement and challenge of integrating complex Earth system processes into daily-to-decadal weather and climate predictions" (p. 22).

ICSU's (2010) Grand Challenges Report

ICSU's Grand Challenges report integrates more social science elements, a reflection of the participation of Nobel Laureate Elinor Ostrom along with two other senior social scientists on the seven-member visioning process task team. This team made a concerted effort to integrate input from visioning process participants, including EC scientists. A comparative key word analysis (Table 1) reveals the important new departure that resulted from this broadened representation. Compared to the Belmont report, this ICSU report makes over ten times more references to sustainability, and fewer than one-fourth of the references to prediction, models, mitigation, and adaptation (including variant forms of these terms).

The task team's efforts at redefinition in a prepublication version were adjusted in the final Grand Challenges report in favor of the more familiar prediction-oriented science agenda, however. The June 2010 prepublication adopted the term "global sustainability research" over the long-standing term of "Earth system science" to capture all GEC-relevant research. Although common in the bio-geophysical science circles of GEC research, in discussions at the 2009 visioning meeting, some of the participants rejected the term "Earth system science" as a catchall term for GEC research in general, finding it too specific to the natural sciences. Integrating that criticism, the June 2010 Grand Challenges prepublication report adopted "global sustainability research" because it more explicitly recognizes the human dimensions of GEC and the central importance of social science (p. 6). By contrast, the October 2010 final version undid that, reverting without explanation to the common, less inclusive term of "earth system science." It replaced the prepublication's explicit argument in favor of the other term with an additional stress on the need to "improve our ability to predict future risk patterns" (p. 6).

Table 1. Intercomparison of References to Key Words in Institutional Proposals for the Global Environmental Research Agenda.

	Belmont Forum: White Paper	ICSU (2010b): Belmont Report	ICSU (2010c): Grand Challenges Final Report	ISSC (2012): Four Cornerstones Report	Transition Team: 2012 Design Document for Future Earth	Future Earth: Strategic Research Agenda 2014	Future Earth: 2025 Vision (2014)
Total word count	5,744	8,786	8,747	9,921	3,991	4,983	1,040
Frequency of key terms per 1,000 words							
Sustainability/sustainable (sustaina*)	3.83	0.57	6.29	2.42	6.51	16.46	20.19
Integrat*	4.70	4.78	1.71	2.32	4.26	2.61	—
Model*	3.13	4.89	1.14	0.30	1.25	3.21	—
Predict*	4.53	4.67	0.69	0.20	0.25	1.61	—
Predict + forecast	5.05	5.46	1.94	0.30	0.75	1.61	—
Climat*	2.79	3.76	2.17	6.85	2.00	2.81	—
Meteor* (excl. WMO)	1.74	0.34	—	—	—	—	—
WMO*	1.39	—	0.11	0.10	0.25	—	—
Mitigat*	1.39	1.25	0.23	0.30	0.50	0.60	—
Adapt*	2.09	4.21	0.80	0.81	1.25	1.61	—
Transform*	0.35	—	0.46	4.84	2.76	4.62	0.96
Social (excl. ISSC)	1.22	4.55	5.94	18.65	4.26	6.62	4.81
Social science(s) (subset of the above excl. ISSC)	0.17	1.93	0.46	10.68	0.75	0.20	—
Inequality/inequity/ unequal/equity/ equitable/poverty/ poor/(in)just*	0.70	0.11	2.63	3.12	1.25	2.80	1.92

Note: Asterisk signifies word endings of all variations. The ISSC uses the word "predictors" rather than "predictions" in both cases. References to the word "equitable" was not counted in any of the documents where it appeared in ICSU's standardized institutional self-description as advocating for "freedom in the conduct of science promotes equitable access to scientific data and information." WMO = World Meteorological Organization; ICSU = International Council for Science; ISSC = International Social Science Council.

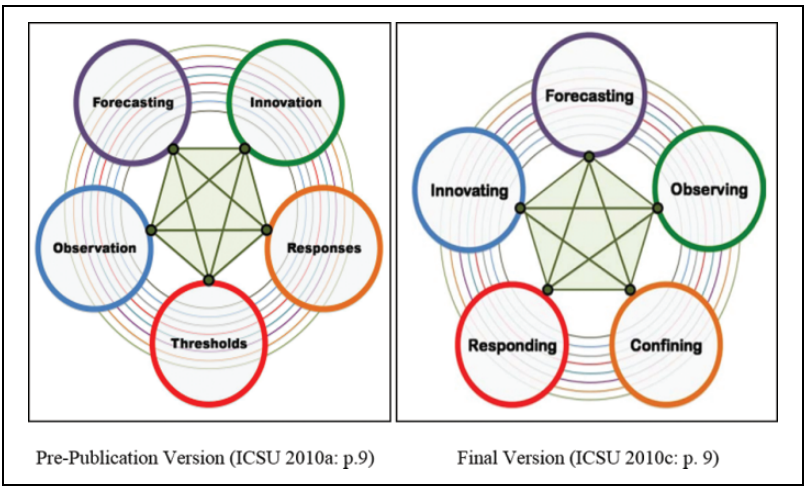

Figure 1. Comparison of five challenges image in the International Council for Science (ICSU)'s prepublication and final version of its 2010 Grand Challenges report. Prepublication version (ICSU 2010a, 9). Final version (ICSU 2010c, 9).

A diagram featuring a version of the five challenges was also revised. In the final version, the "thresholds" circle is redefined as "confining." This is a term ICSU associates with determining "how to anticipate, recognize, avoid, and manage disruptive global environmental change." (Retrieved from http://www.icsu.org/news-centre/press-releases/2010/scientific-grand-challenges-identified-to-address-global-sustainability, accessed October 30, 2015.) Forecasting and observation are moved such that they appear in the most prominent positions for Western-trained eyes. The latter typically move from the top and left downward toward the right, such that objects in those two positions (top and lower right) capture most attention. In the prepublication version, the forecasting circle appears in the top left corner, sharing top position with innovation. In the final version, it stands above the others, top and center, and observation appears in the prominent position immediately after it on the right side where innovation previously appeared.

Future Earth Reports

Future Earth's documents have important roots in ICSU's Grand Challenges report (2010c) and in the ISSC's *Transformative Cornerstones of Social Science Research for Global Change* (2012, henceforth referred to as its "*Cornerstones*" report), which resulted from an ISSC-led Belmont

Forum-funded social science agenda-setting workshop. Future Earth's brief *2025 Vision* document sets Future Earth's high-level directions, while the scope and details of its agenda are best captured in three broad thematic foci defined in the 2012 Initial Design document by a transition team, which included biophysical and social scientists.[16] Captured in three transdisciplinary megathemes—dynamic planet (i.e., study, including modeling, of the dynamics of planetary systems), global development, and transformations toward sustainability—its scope breaks new territory in GEC science, as does its solicitation of research contributions beyond the biophysical and social sciences, from the humanities and professions such as law and architecture. Also path breaking in GEC science is its stress on collaboration with governments, business, and community organizations in the design of research and action strategies, and in capacity building, engagement, and mobilization to support a transition to sustainability.[17]

Word Count Comparison

A word count exercise (Table 1) shows that the emphasis on climate prediction lessens dramatically after the White Paper and the Belmont reports were published. References to meteorology also disappear entirely, and the need for social transformation begins to be mentioned, together with issues of inequality. The White Paper mentions climate and sustainability roughly equally; the Belmont report mentions climate over eight times more than sustaina(bility) (42 times vs. 5). The White Paper and the Belmont report use the word "integration" and variants with much greater frequency compared to subsequent reports, with the exception of the transition team's design document. Yet, ironically, their agendas are far less integrated, as reflected in their scant references to social science research. Given that, it is similarly ironic that the twice mentioned term transform(ational) appears in the Belmont report only to characterize its own proposed agenda for research and capacity building.[18]

Intermediary between Future Earth and the earlier agenda definitions, the ISSC's *Cornerstones* report mentions climate three times more than sustainability, but it foreshadows Future Earth by containing only six references to modeling and predictions (including "forecast") in contrast to its many references to transform(ation) and "social." Future Earth's *2014 Strategic Research Agenda* mentions sustainability nearly six times more than climate (82 vs. 14) and is strong on references to transform(ation) and social. Future Earth's brief "*2025 Vision*" (Retrieved from http://www.futureearth.org/news/future-earth-2025-vision-sets-framework-programmes-contribution-global-sustainable-development, accessed May 11, 2015) does

not mention climate a single time and tops all the charts in its references to sustainability, with a frequency of 20.19 per 1,000 words.

The word count also reflects a gradually strengthening attention to issues of equity and justice. For example, Future Earth's documents call for research on poverty and inequality that attends to their systemic nature and consequences,[19] whereas the White Paper and Belmont report scarcely mention poverty, inequality, or (in)justice (frequency per 1,000 words: 0.70 and 0.11 vs. over 2.0 in the other reports), and much less their systemic relationship with sustainability and human well-being. The White Paper calls for research probing how ecosystem services might help improve the conditions of "the poorest" people (p. 10), but not for research into the sustainability, wellbeing and fairness to be gained through changes in sociopolitical and economic systems and reduced consumption on the part of the urban rich. These formulations reveal and reinforce weak understanding of the systemic, sociopolitical and economic nature of the drivers and impacts of GEC.

Conclusion

Future Earth took form despite the persistent force of long-standing intellectual currents that also marked interventions in the visioning process. The word count analysis above suggests an important change toward a progressively more inclusive GEC research agenda. Table 1 can be read as reflecting gradual learning and expansion of research horizons between initiatives: ICSU and the Belmont Forum set in motion processes that led to Future Earth, the creation of which they supported, resulting in adoption of a more comprehensive, social science-integrative and action-oriented research agenda. Along these lines, the Belmont Forum formally recognizes "the valuable contribution of the social sciences to the understanding of and response to global environmental change." (Retrieved from http://www.belmontforum.org/news/issc-belmont-forum-agenda-setting-workshop, accessed January 13, 2016).

Future Earth has experienced important intellectual victories and demonstrated its strength. But it also confronts continued challenges. In 2014, an ISSC-led call for proposals issued under Future Earth elicited action-oriented research proposals focused on transformations to sustainability. It found funds to cover only three of eighty-eight full proposals. By contrast, pooling funds from research funding agencies from many of the world's richest nations in addition to some middle-income countries such as Brazil, the Belmont Forum dispenses vast research funds. Despite an increased inclusion of topics such as food and freshwater security, its research calls

invariably lead attention to bio-geophysical processes and their impacts.[20] To this day (19 April, 2016), its website (https://igfagcr.org/belmont-challenge) refers singularly to the White Paper as their—apparently still current—"funders vision" of the "priority knowledge and capabilities . . . that society needs," thus placing the entire weight of this formidable group of funding agents behind a research agenda that even the White Paper authors recognized as conspicuously lacking of social science research. In line with the White Paper, the website also specifies a "seamless, global Earth system analysis and prediction system" as a central if not exclusionary research need, despite ESSH scholars' now published, high-profile criticism of its narrow, exclusionary scope (Castree et al. 2014; Lahsen et al. 2015). The website also retains the precursor formulation of the five challenges. As noted above, this formulation places prediction first and lacks contributions from the social sciences, calling merely for unspecified "interaction" of the latter with the natural sciences.

Resistance to a transformed science agenda as documented here is deeply embedded in scientific institutions that continue to shape both international and national environmental science programs. ICSU and the Belmont Forum are umbrella organizations that subsume national science academies and funding agencies. These major national science research and funding institutions manifest similar dynamics and resistances to the ones documented here. Their environmental research agendas are strongly shaped by natural scientists and integrate a deeply rooted social hierarchy of intellectual worth that favors "hard" science and quantitative approaches, especially physics and mathematics.[21] The deep national or local institutional roots of such evaluations form formidable obstacles that need to be recognized and countered to bolster efforts at effective societal transformation in the face of sustainability challenges.

Funding is a key means of maintaining or changing status quo. It is therefore significant that the Belmont Forum mainly supports the natural sciences, and that the ESSH have no equivalent institutional backing by powerful national agencies. This absence underscores the need to rethink science funding structures at both national and international levels (Viseu 2015), without ignoring that the underpinning norms embedded in organizational cultures are as important—and difficult—to change (Keely 2014). It is also essential to bring in the key Future Earth stakeholders of government (at all scales), business, and civil society.

Waiting expectantly in the wings are cadres of EC scientists looking for signs of support to forge new approaches to interdisciplinary learning. Unless they are encouraged, championed, and financially supported, Future Earth cannot be regarded as meeting its pioneering aims.

We should not assume that the current institutions that govern research and education are able to live up to the huge onus placed upon them to help societies alter their policies and practices in favor of long-term sustainability. The magnitude and speed of needed societal transformations highlight the importance of more transparent and accountable structures that can strengthen the evaluation and improvement of their efforts to "tackle, as a priority, this 'wickedest' of problems—how to re-found human civilization in a way that is sustainable into the longest of terms." We surely still have a long way to go.

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Notes

1. Cited in Monkelbaan (2015).
2. International Group of Funding Agencies (IGFA) later merged into the Belmont Forum.
3. See, for instance, http://www.icsu.org/publications/reports-and-reviews/igbp-review. As social science officer in the Brazilian regional office of the International Geosphere–Biosphere Programme from 2007 to 2009, I read these reports and participated in processes associated with them.
4. Throughout this text, the term "social science" is meant to include the behavioral and economic sciences. Since the arts and humanities are much less included in the described processes and in the global environmental change (GEC) community as a whole, this text does not mention or focus on them as much as the social sciences, despite the important contributions they can make

to environmental research and to efforts to support a transformation to sustainability.

5. International Council for Science (ICSU) is a nongovernmental organization formerly named the International Council of Scientific Unions. Its members are national and international scientific bodies, mostly scientific academies, although some are national funding agencies or other national representative science bodies. For more, see http://www.icsu.org/about-icsu/about-us.
6. In practice, the Belmont Forum is the aggregation of national science funding streams. For more on IGFA and the Belmont Forum, see http://igfagcr.org/index.php/about-us.
7. Accessed May 11, 2015, https://www.igfagcr.org/sites/default/files/documents/belmont-challenge-white-paper.pdf. The authors are not identified but presumably it is an institutional document produced by the Belmont Forum.
8. The Process Paper specified that the meeting was to include ''meeting chair; a representative of each of the global environmental change programmes plus ESSP, as chosen by these bodies; review chairs, funders; experienced global environmental change scientists; science policy experts; and early career Earth system scientists'' (pp. 15-20), with roughly four representatives for each of the listed sectors unless indicated otherwise.
9. More by circumstance than original design, two of the early career (EC) researchers also participated in the third meeting in February 2011, a meeting oriented toward decisions for redesigning the institutional structures, including decision among the GEC programs leaders about the termination or transformation of GEC research programs under a broader umbrella, which became Future Earth (http://www.icsu.org/news-centre/news/pdf/Visioning_ThirdMeeting_Summary.pdf).
10. A subset of the EC researchers was less vocal; I can only strive to represent the key tenets of ideas, positions, and suggestions that were vocalized.
11. For analysis highlighting congruence between climate change policy and environmental sustainability, see Dubash and Morgan (2013), and for conclusions to the contrary, see Stevenson (2013).
12. For the full report and conclusions from this London School of Economics study, see http://www.climateoutreach.org.uk/research-reveals-current-climate-engagement-strategies-are-failing-to-reach-young-people/ (accessed October 31, 2015).
13. https://igfagcr.org/belmont-challenge (accessed April 19, 2016).
14. Unless otherwise noted, sources for all parts of this paragraph are https://igfagcr.org/belmont-challenge and White Paper (pp. 1-2).
15. These are ''research which takes account of coupled natural, social, and economic systems'' (includes social dimensions but uses language common in modeling), ''strategic governance to establish key priorities among competing demands'' (of what is not specified), cooperation and collaboration across

scientific disciplines and geographical areas, as well as "improved mechanisms for transnational research funding."

16. 2025 Vision Future Earth produced the 2014 *Strategic Research Agenda* in response to the Belmont Forum's request for a guide for how external funders and research communities could help achieve its 2025 vision. Future Earth's own research agenda is thus above all captured in the Initial Design and *2025 Vision* documents.
17. Future Earth planned to be defining these megathemes in more detail in 2015 and articulate the architecture of Future Earth going forward, including the future of existing "core projects" carried over from the previous GEC research programs, a new focus on knowledge networks by which to achieve major engagement with societal decision-making processes, as already witnessed in the International Social Science Council Transformations to Sustainability program.
18. The word appears in characterizations of (1) the research agenda being proposed ("to deliver this transformative international research agenda . . . ," p. 3) and (2) the called for effort to train new researchers ("a major and transformative effort will be required to train graduate, doctoral and post-doctoral researchers . . . ," p. 12).
19. Future Earth's 2012 *2025 Vision* report (http://www.futureearth.org/media/future-earth-2025-vision, accessed January 13, 2016) states already in its introduction that "we need to achieve a global transition that goes beyond gradual incremental change, and which addresses major equity challenges in a world that hosts 7 billion of people—4 billion of them living in poverty" (p. 2). The 2014 *Strategic Research Agenda* seeks to steer research toward questions such as "What are the consequences of different economic growth strategies for social and economic outcomes (e.g., poverty, inequality, employment and quality of life) and for the environment (e.g., climate stabilisation, ecosystem health and resilience)?" (p. 19).
20. Since 2012, these calls have focused on mountains, the arctic, scenarios of biodiversity and ecosystem services, food security and land use change, coastal vulnerability, and freshwater security (https://igfagcr.org/belmont-challenge, accessed October 30, 2015).
21. For how this hierarchy underpins the science politics around GEC, see Lahsen (2013b). See Mugnaini, Packer, and Meneghini (2008) for evidence of the dominance of physicists in Brazilian science, as an example, not least in the Brazilian National Academy of Science, and Norgaard (2016) for a commentary of how this hierarchy of value affects sustainability research, limiting capacity to understand and address the crucial social dimensions of the challenges.

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