

Attention Anthro(s)cene, you may soon kiss the bride

Suggestion for a pre-nuptial agreement between ESS and the social sciences

Jonas Bylund, School of Life Sciences, Södertörn University, jonas.bylund@sh.se (Corresponding author)

Jonathan Metzger, School of Architecture and the Built Environment, KTH Royal Institute of Technology, jonathan.metzger@abe.kth.se

Working paper draft version 3 January 2012, no language check!

Acknowledgements

Jonas' part of this paper was funded by a Foundation of Baltic and East European Studies' *Environmental Studies Research Area* grant (Dnr: 542/42/2011). Jonathan's research was funded by FORMAS grant #250-2009-1187. Discussions with Fred Saunders has been a valuable and thought-provoking sounding-board.

Abstract

A concrete proposal for engagement between Earth System Science (ESS) and the social sciences is on the table. It is time for the latter to step up, or so at least prominent figures in the former state. In this paper we investigate the content of the present proposal and the implicit 'terms of union' that appear to be suggested. The paper particularly highlights what could be called the geography and the household economy of the proposed scientific union. It is argued that the 'marriage proposal' articulated by leading ESS scientists and directed at the social sciences appears to include quite a strict formatting of the role of social scientists as merely subservient implementers of the hard facts of the natural sciences. With inspiration from STS-scholars such as Michel Callon, Bruno Latour, John Law and Isabelle Stengers we then argue that the social sciences are – and should productively be allowed to be – so much more than this. The paper is concluded with a proposal for a sort of pre-nuptial agreement which sketches how the ideas presented in the paper can be

utilized as a foundation for a much needed extended cooperation between Earth Systems Science and the social sciences.

Keywords: wild research, secluded research, hesitation, social science, environmental science, global change.

'I can't liiiiiive, when living is without yooouuuu!' –will you m...

I do very strongly believe ... that—if anything—this is the moment for social sciences when it comes to assisting the world in a rapid transition towards global sustainability. So if there is any historic moment that is more important than ever for social sciences—not that it hasn't been important all along—is now. (Rockström, 2011)

Many social scientists working with so-called environmental issues were probably very pleased to hear a world-leading Earth System scientist such as Johan Rockström reach out a hand to the social sciences in what appeared almost like an act of courtship, inviting the social sciences to join his own community of natural scientists in the quest to save the human species from utter destruction. *Earth System Science* (ESS) is the preferred contemporary term used to denote the broad scientific field engaged with monitoring developments and changes in the global-ecological systems that sustain life on Earth. To an increasing degree, ESS as a discipline is also commissioned the task of proposing policy measures for securing the longer-term existence of human life on planet Earth through sustainable resource use and a stabilization of global life-supporting ecosystems (cf. Lawton, 2001). Rockström's message was quite clear: 'if natural scientists have been remarkably good at giving ... evidence, it is now up to the social scientists to provide the avenues towards a solution' (Rockström, 2011). If translated into the the language of romantic encounters, the overarching message of Rockströms keynote address to the *10th Nordic Environmental Social Sciences conference* (NESS) in Stockholm sounded very much like 'I can't make it through this without you, baby', followed by a marriage proposal.

Although there is nothing new in trying to get social and natural sciences to work together on issues, particularly environmental ones, the audience of mainly social scientists was given an increased sense of necessity of solidifying this union. This was understandably flattering for many of the social scientists in the audience, especially considering some rather less heart-warming episodes of the recent past, where the Earth Systems Science collective proved itself less receptive to the charms of the social sciences. A few seasoned vet-

erans in the audience perhaps even recalled the early history of the International Geosphere-Biosphere Programme (IGBP), the gigantic international programme of Earth System Science, launched by the International Council of Scientific Unions, which has been running since 1990 (launched in the mid 1980s) up until the present – and from which the social sciences were intentionally excluded, even though the mandate clearly instructed the programme's commission to inquire into the role of human influence on global environment (Kwa, 2005). Nevertheless, during the past decade or so a growing interest and emerging expressions of mutual affection and attraction has been voiced from both the natural and social sciences (not to exclude the humanities and the arts). What was new about Rockström's address was perhaps the tone of immediate urgency, consisting no longer just of the loose flattery of courtship but rather the concrete promises of life together 'until death or funding cuts do us apart'.

Finding our inspiration in the general tone of Rockström's address, and following through on the romance analogy, we believe that we are witnessing the union of a lovely couple in the realization of Rockström's sketched marriage proposal between Earth System Science and the social sciences, a union which will hopefully last for many years to come. Nevertheless, at weddings in the Western Christian tradition, before the part of clerical advice and promises between the spouses, the priest asks if there is any dissent to the marriage and that if so, that those that hold them should speak now or forever hold their peace.

As social scientists, we think that the work being done within the field of ESS is of crucial importance to humanity, and we are very happy to see that prominent figures in the field now welcome social scientists into collaboration with open arms. In this paper, we therefore in no way present a dissent on partnership per se—but we do feel a need to voice some hard-to-shake qualms. In Russian, the verb 'to marry', *выйти замуж* [*vyjyi zamuzh*], literally means 'to leave to go behind the husband'. Hence, we would like to reason a little bit about what the present marriage proposal might implicitly suggest that the social sciences would have to leave to go behind this proposed husband, and where. Where are the spouses to live happily ever after? If opting for the traditional seclusion of the homestead, the cloistered life, this will probably result in a conventionally gendered cooperation. Science enacts the script of the dominating and patriarchal 'western male', handling public issues concerning the fate of the common world and setting the agenda for the public project, while social science becomes slotted into a subordinate 'subservient female' role of the supportive spouse, taking care of the reproductive work, tending to the menial chores and making sure that things run as smoothly as possible in the implementation of the grand designs of the patriarch. What worries us about this possible setup though, is how the nar-

row scripting of these roles of ‘being-together-in-research’ (Felt et al., 2010) disables other potentially productive alternative arrangements for the mutual benefit of not only ESS and the social sciences, but also the overarching goal of securing the long-term preconditions for human life on Earth and the collective composition of living together in a good common world. To paraphrase a well-known slogan, our aim is to make sure that both the proposed spouses in the ESS/social science marriage, considering the circumstances, are given the opportunities to ‘be all they can be’.

Inspired by Harman’s (2009: 120) ‘hyperbolic thinking’, which in philosophy is devised to replace the ‘tripping and beating a philosophy for its supposed faults only to end up with the same range of mediocre biases with which we began’, what we intend to present is not a per-se critique of the research done in the ESS or of the proposition that the social sciences has much to offer. To the contrary, what we do want to suggest is the need for a closer examination of the proposed terms of union between ESS and the social sciences, trying to ensure that the identified small nagging question marks of the present do not go undiscussed until erupting as inevitable catastrophes in the future. For—again, as social scientists—we are a bit troubled by some of the ways the nature of our profession—or so to say: our place in the shared household with ESS—appears to be scripted. Thus, we are not in any way objecting to the marriage in itself. As so many others, we see it as completely necessary. At this juncture, however, given the circumstances generated through the challenge presented by the oncoming crisis of humanity, it almost takes a form close to a shotgun wedding. What we therefore would like to suggest is that it could prove unwise to rush through the proceedings at this point—and that we might instead go through some pains to try to make sure that this will be as a non-patriarchal form of wedlock as possible, so as not to succumb to the risks of ending up in a very traditional patrilocal form of co-residency between the two spouses, which in this case would mean that they would proceed to build their shared abode in the paternal home of the husband-to-be: the laboratory. We are therefore specifically concerned with probing two interrelated issues: on the one hand the ‘where?’-question regarding the proposed future place of residence for the ESS and social sciences co-habitation, and on the other hand the ‘how?’-question concerning the suggested division of household labour between the proposed spouses as scripted in the proposition from the ESS suitors. We believe that this issue touches upon the heart of some key contemporary debates about the meta-agenda or wider role of STS in society, as discussed by—among others—Bruno Latour, John Law and Isabelle Stengers.

To investigate these questions further we will in the section following immediately after this introduction take a look at some of the reasons why and how ESS in the present are making specifically pronounced and intensive approaches for collaboration with the

social sciences. In the following, third and fourth sections of the paper, we discuss what could perhaps be called the current proposed terms of union between the social sciences and ESS. In the third section we specifically look closer at the 'where'-issue while in the fourth section more closely examining the 'how'-question. In the fifth and final section of the paper we tie together these investigations in a concluding discussion where we again raise the question concerning the emerging proposed 'terms of union' between ESS and the social sciences, and discuss the need to ascertain that this proposed 'marriage' of research approaches does not risk to degenerate into a relationship between an abusive house-tyrant and disgruntled handmaiden locked into a soured marriage that can be difficult to break out of.

Scientific romance in the Age of Man

From the NESS main conference stage, Rockström boldly proclaimed that now is the time for the social sciences to help out in a transition towards global sustainability, or as he worded his message: 'This is the moment for the social sciences to step up', adding that contemporary social science must now be 'ramped up' to 'provide research for solutions' (Rockström, 2011). His proposal of the engagement was even visually striking in his bodily rethoric as he literally reached out a hand to the assembled social scientists.

In his NESS speech Rockström grounded his proposal in the conclusions of the recently held *3rd Nobel Laureate Symposium on Global Sustainability* (NLS), whose executive summary states that 'the nub and kernel of the problem is that many of the serious, recurring problems in natural resource management stem from a lack of recognition that ecosystems and social systems are dynamic and inextricably linked' (3rdNLS, 2011, p. 6). A perspective which is probably shared by many, not least many readers of this journal. It is also a main point in the analytical framework social-ecological systems (SES), a research agenda to which Rockström frequently contributes.

Leading ESS-scholars in general, and Rockström's SES-inclined group loosely based out of the Resilience Centre at Stockholm University in particular, are presently expressing a heightened sense of alarm concerning contemporary development trends in Earth's global life supporting ecosystems. As Rockström argued from the NESS main stage, and has recently done in many other noteworthy contexts, he and his colleagues see the present as the crucial moment when not only political and corporate leaders, but also the academic world in its entirety must engage in 'the quest for a safe operating space in the Anthropocene' (Rockström, 2011). What Rockström and his research colleagues mean by this is that we now, beyond reasonable doubt, and due to our own collective actions as a species, can be considered to have entered *the Age of Man* and now find ourselves in a world where

we now as a species have the fate of our own conditions of life in our hand—that is, it is the course of human action that will decide our long term chances of survival as a species. This is a world where humans are a geophysical force and the planet they inhabit has become an uncertain and unstable artefact, a spaceship Earth in dire need of airconditioning (cf. van Tuinen, 2009). A global public is now to internalise the lesson that Serres (1992) taught us two decades ago: that humans as a species have to take on the role to manage—but not master—the planet as a whole or it will be uninhabitable for us. It is either symbiosis or death.¹

Even *The Economist* (2011; almost concurrently with several other big massmedia platforms, such as BBC, 2011; Geographic, 2011; Times, 2011) has now picked up and transmitted the urgent message, an achievement no doubt to be proud of. The Economist concludes that the Anthropocene is anthropocentric not (merely) in terms of values and ethics but also in terms of power, as it ‘means treating humans not as insignificant observers of the world but as central to its workings, elemental in their force’ (Economist, 2011). There is simply no use in adhering to the established Nature–Society sorting principle when trying to understand environmental issues and how to ‘remedy’ the state of the Earth. In a way, the Anthropocene is a confirmation by the sciences of what STS has been arguing for quite some time: the highly problematic convention of sorting out activities according to Nature or Society when trying to grasp entangled environmental issues (or any other issue for that part) (see e.g. Star, 1988; Law, 2010). From an ESS perspective the separation of nature and culture was perhaps a not too implausible cosmology during the Holocene, the geological epoch immediately preceding the Anthropocene. The Holocene stretched from about 12,000 years ago to about now,² and it was characterised as an epoch of unusually stable environmental conditions ‘within which human societies as we know them have developed’ (3rdNLS, 2011p. 9). Humans developed agriculture under these circumstances some 10,000 years ago (simultaneously in four different parts of the Earth!) and thus increasingly sedentary lifestyles (until about now, one might add). But as Rockström and his colleagues are presently able to show with increasing scientific self-confidence as evidence piles up, all this appears to be about to change due to human activity, rapidly diminishing the long-term survival chances of our species as we know it.

The challenges of maintaining—or returning to—a Holocene-type of global environment is by Rockström and his colleagues framed as a quest for ‘planetary boundaries’ and establishing a ‘safe operating space for humanity’ (Rockström et al., 2009), key concepts which were proposed just in time for COP 15 (on quite a big scale, see the collection of accompanying materials to the Nature article at the Stockholm Resilience Centre webpage (SRC, 2009)). In conjunction, pertinent for the enticement of the social sciences, nature in these accounts does not work like supposedly ‘commonly understood’ in the social

sciences, Rockström claimed. That is: it is not a ‘Wal-Mart’ Supermarket of resources available ‘on the shelves’ (Rockström, 2011, 26:26).³ Somewhat more technically stated in an article in *Nature*: ‘Although Earth’s complex systems sometimes respond smoothly to changing pressures, it seems that this will prove to be the exception rather than the rule’ (Rockström et al., 2009, p. 472). In terms of consequences of reaching resource finitude, tipping points and thresholds make tomorrow’s weather, for instance, quite unpredictable and there is not much stability to count on anymore. Uncertainty, not just risk, will grow exponentially. So, ‘Determining a safe distance [from thresholds] involves normative judgements of how societies choose to deal with risk and uncertainty’ (Ibid., p. 473).

More specifically, the agenda proposed in the overarching research framework centres on five grand challenges articulated to mobilise the international scientific community ‘around a focused decade of research to support sustainable development in the context of global environmental change’ (Reid et al., 2010, p. 917). The five grand challenges are identified as: (1) ‘Improve the usefulness of forecasts of future environmental conditions and their consequences for people’; (2) ‘Develop, enhance, and integrate observation systems to manage global and regional environmental change’; (3) ‘Determine how to anticipate, avoid, and manage disruptive global environmental change’; (4) ‘Determine institutional, economic, and behavioral changes to enable effective steps toward global sustainability’; (5) ‘Encourage innovation (and mechanisms for evaluation) in technological, policy, and social responses to achieve global sustainability’.

It is argued that facing the above challenges, and mobilizing to meet them, requires the formation of a research community still under development. Reid et al. argues a new mix, or ‘new deal’, in the effort to take on these challenges:

This will require new research capacity, including efforts to attract young scientists, particularly in developing countries. *Research dominated by the natural sciences must transition toward research involving the full range of sciences and humanities.* A more balanced mix of disciplinary and interdisciplinary research is needed that actively involves stakeholders and decision-makers. (Ibid., p. 917, emphasis added)

Exactly how this revamped ESS will work is not yet clear, partly because funding practices and disciplinary traditions set hurdles. But for Reid et al. the Belmont Forum (2011) shows the shape of things to come. Here, discussions are underway in a group of leading global-change funding agencies of how to design

an overarching approach that would (i) coordinate and focus international scientific research to address the grand challenges; (ii) deliver at global and regional scales the knowledge that societies need to effectively respond to

global environmental change while meeting economic and social goals; and (iii) engage a new generation of researchers in the social, economic, natural, health, and engineering sciences in the necessary research. (Reid et al., 2010)

Below we will return to this view upon how the sciences and research are imagined to take on this commission. As of now, we would like to suggest that a closer examination of the conditions for ‘being together in research’ (Felt et al., 2010) for ESS and the social sciences might be warranted—perhaps focused less on the geological conditions of the Anthropocene and more on the proposed geography and household economy of the suggested union.

Where to make home? Bringing ESS into the wild

The first disquiet we wish to explicitate concerns what could perhaps be called the geography of the proposed union between Earth System Science, enacted as a ‘natural’ science by Rockström, and the so-called ‘social’ sciences. Where is this perhaps soon-to-be-newlywed couple supposed to find its home? If we cling to the image of the Earth system scientist as a somewhat stereotyped dominant and patriarchal male, it is with some concern that we realise that many cultures in the world are distinctly patrilocal, that is: newlywed spouses are expected to set up their collective life in the familiar house of the husband, which in this case would entail the somewhat cloistered life of ‘the laboratory of Science’. Callon et al (Callon et al., 2009) describe laboratory science or ‘secluded research’ as a means of increasing productivity through the introduction of strict controls on potentially interfering variables and generating the possibility of verificational reproduction of results through the standardization of procedures and equipment, what Callon et al. characterises as an amplification of some interesting traits and lowering the ‘noise’ of others, less interesting ones (Ibid.: 37 ff).

Secluded research is the comfort zone developed by the sciences on how to do things. Of course, the laboratories of natural sciences are not completely unfamiliar grounds for the social sciences. STS, for instance, has spent much time ‘over there’, although most of it as a kind of promiscuous guest (e.g. Lynch, 1982; Knorr-Cetina, 1981; Traweek, 1992; Latour and Woolgar, 1979) and at times a disturbing one at that (cf. Ross, 1996; Sokal and Bricmont, 1998). From the experiences of studies conducted from the inside or the outside looking in, social scientists in general and STS-scholars in particular know that the secluded laboratory is not necessarily a good or productive space, but comforting as it is geared to exclude disturbances and interference of the world, but it does lower horizons and by necessity and practicality induce a form of tunnel-seeing, focusing on and paying extreme attention to extremely specific challenges and problems that may

seem to bear little relevance outside of the secluded scientific context. As Callon et al (2009) elegantly show, the crucial challenge to any laboratory science aiming at making an impact outside the narrow networks of purely scientific exchange is the question of how to translate findings in a lab into interventions in a world outside of the controlled and secluded milieu of the laboratory, in other words: how to figure out the relevance of findings in environments beyond the control of the scientists? Or posed differently: how to re-enter into the world and not only become relevant in it, but also to such a large extent as possible try to make sure that one is not simply unleashing destructive powers beyond any control (cf. also Latour, 1983)?

Following Callon et al's discussion of secluded research, we may ask ourselves: given the radical challenge posed by the rapid deterioration of the Earth's life-sustaining systems, and further, given the urgency of the task to radically halt or even turn-around some of the destructive human-induced processes underpinning this destructive spiral—is 'secluded' research even a viable option in the Anthropocene? Put bluntly, scientific homesteading—a secluded cottage on the plains—may at this specific point in time appear as archaic as the Holocene. Of course research can still make use of secluded places—we all have to at times—but as a pragmatic option, not a totalizing necessity. For secluded research in its purified form, argues Callon et al., is not very resilient in tackling the specificities of concrete challenges, or in the words of Harry Collins, 'when science is applied without taking local knowledge into account, it is often the poorer for it' (in Callon and Rabeharisoa, 2003: 196). The problem lays not so much in the form of organization itself, but rather in the kinds of 'products' or solutions it often generates, and the problem of applying them in any form of concrete practice.

One potential solution to this quandary might be the option of simply never retreating into full seclusion, what Callon et al call the option of 'research in the wild' which instead of working with 'purified objects' opts for facing 'composite, impure, polluted realities' (Callon et al., 2009: 86). Tackling emerging problems and challenges in the world, 'research in the wild' constitutes a process of co-enrollment of 'experts' and 'laypeople' in tackling concrete and located problems of crucial local interest but with wider implications or repercussions, both 'specific' and 'general' at the same time. Sustaining the necessary preconditions for human life on the planet, which must always entail local responses to combined local and global challenges, might be construed as a prime example of such a type of problem.

Callon and Rabeharisoa (2003) have listed at least five reasons why this type of research in the wild may prove more efficacious in tackling this type of challenges and producing concrete changes in the world than purified laboratory science:

1. Researchers in the wild are directly concerned with the knowledge they produce because they are both the objects and the subjects of their research.
2. Production and appropriation overlap to a large extent, since it is one group that in the same movement elaborates and uses the knowledge.
3. Incentives are of a different nature, for what is at issue in the case of research in the wild is fate and the survival of the group whose members wish to save their lives.
4. Largely as a consequence of the preceding points, we cannot separate the elaboration of knowledge from the construction of an identity because this identity is also common and shared before being individual.
5. Research in the wild makes a strong contribution to the formulation of problems and questions that become intelligible for confined researchers, some of whom have participated in their elaboration. The concerned groups, owing to their investment in research, are no longer the only ones concerned. (Ibid.: 202—203)

Fortunately, it appears as if Earth System Science to a large extent recognises the limitations of ‘secluded’ research in the Anthropocene. For instance, in the report of the 3rd NLS, a section on ‘social-ecological innovation’ includes the statement that:

Studies on *innovative responses to social and natural disasters* increasingly stress the need for governments and institutional aid mechanisms to take a step back and ‘listen and engage’ with communities rather than ‘orchestrate and plan’ on their behalf. (3rdNLS, 2011: 14–15, emphasis added)

And further, regarding the case of illegal fishing in the Antarctic waters and the regulation thereof, recognises that:

Effective international collaboration between states was initially hampered by political sensitivity, but non-state actors (NGOs and the fishing industry itself) and their engagement in the Commission for the Conservation of Antarctic Marine Living Resources enabled the emergence of new ways to address the problem. A small number of key individuals living in countries remote from Antarctica mobilised personal networks and *produced reports*, which in turn *raised political awareness, produced voluntary monitoring schemes* and *imposed informal pressure on states and industries involved in the industry*. Although illegal and unregulated fishing has not completely disappeared, it has been considerably reduced through the complementary roles filled by the state and non-state actors. (Ibid.: 7, emphasis added)

And, to round it off:

What is needed is financial and political support for safe-fail experiments in communities around the world, using diverse technologies, organisations and ideas, for instance in ‘Policy Laboratories’ or ‘Change Labs’. (Ibid.: 15, emphasis added)

Hopefully, the quotes are not a mere paying lip-service to common concerns in the field of political ecology. The above displayed sensibility among ESS-scientists to the need of proceeding with research to some degree ‘in the wild’ has further resulted in the rapid growth of the academic subfield suitably labeled Earth System Governance (ESG). An ESG science plan was adopted in 2008 and the ICSU recently launched (28 September 2011) the ten year funding programme Earth System Sustainability Initiative (ESSI) (ESG, 2011; Biermann et al., 2009; ICSU, 2011).

The translation (in the now and here hopefully familiar ANT sense) made by the handful of social scientists already ‘engaged’ runs something like this: the Anthropocene is ‘in essence a crisis of societal governance’ (Biermann and Zondervan, 2010, p. 273). The latter is inefficient and insufficient at all levels, and not well understood from a social scientific point of view; thus warranting a ten year research initiative of the Environmental System Governance Project (ESGP), launched in October 2008 in the International Human Dimensions Programme on Global Environmental Change (IHDP) under the wings of the Earth System Science Partnership (ESSP). ESG seems to have learnt a lesson by Jasanoff (2004), that the abstracted view of the planet from a satellite may make global politics blind to local and particular pertinent issues by simply generating a global layer of governance without any real local traction—floating above it all, so to speak. However, to avoid getting stuck in a global limbo, ESG seems to take such a broad scope as to target anything under the sun even remotely relevant to governance, as in the following definition of ESG as the ‘system of formal and informal rules, rule-making systems and actor-networks [*sic!*] at all levels of human society (from local to global) that are set up to steer societies towards preventing, mitigating and adapting to environmental change and earth system transformation’ (Biermann and Zondervan, 2010: 273).

In ESG, the five grand challenges already presented above are known as and translated into the five analytical problems of ‘architecture’, ‘agency’, ‘adapiveness’, ‘accountability’, and ‘allocation and access’ (Ibid.; ESG, 2011). The research movements that may be called resilience thinking and complex coupled social-ecological systems (SES) vie for a central role in this endeavour (although ESG ‘proper’ does not put it centre stage) (Duit et al., 2010; cf. Galaz et al., 2011). In SES and resilience thinking, the main interest lies in the durability (sustainability) of quite complex ‘coupled social-ecological systems’, which are argued to permeate much of the ESG project (cf. Janssen and Ostrom, 2006). Even

though this broad agenda seems to chime well with a lot of insights from STS and related political ecological thinking, it still seems to script what in line with Callon et al could be called wild research practices as being part of the realm of politics rather than as knowledge practices of equal standing to (natural) Science. It is still slightly patronizing.⁴

The problem with some of the methods and solutions proposed by the terms of engagement of ESG is that they hold steady the absolute truths of Science (capital 'S'), while seeing lay knowledge and also social scientific knowledge as simply contingent and necessary factors for the successful implementation of programmes of action based on the former. It thus risks generating a milieu in which particular challenges and problems are not seen to induce a need also for the natural scientists to reconsider their knowledge or 'oblige them to think', where the power of the natural scientific knowledge becomes enacted as so absolute that no concrete case in itself is seen to challenge this knowledge (cf. Stengers, 2005).⁵ The detrimental hazards that may result from ending up in such a state of taken-for-grantedness of (newly) established truths can at this point not be exaggerated, for as ESS so succinctly have shown in relation to global ecological systems, we can not always know beforehand in what contexts what factors and knowledges will prove most valuable, productive and relevant. This is an issue that will be specifically tackled in the following section of the paper, which explicitly discusses the potentials and hazards of the proposed union between the social sciences and ESS.

How to work things out together: social science beyond the implementation-script

In his NESS-address one could say that Rockström implicitly scripted the future role of the social sciences in relation to ESS in quite narrow terms, after the natural scientists—'remarkably good at giving evidence'—have laid down the rock hard facts, the social sciences step in to 'assist' and 'provide the avenues towards a solution'. Using a somewhat more provocative and meaner language, one could almost say that it appears as if Rockström sees the social sciences as little but a handmaid to the natural sciences, a subservient set of disciplines that while unfit to clarify 'the nature of things' still can come in handy as 'implementors' and carriers of (subordinate) engineering techné in relation to the natural scientists ascertained episteme—certainly giving a sort of back-to-the-future flavor to the classic slur of 'social engineering'!

In the world picture that Rockström appears to be painting we now know the facts, all we need to do is act upon them—and this is where social science comes in. This mise-en-scène will probably strike a chord with those familiar with Callon et al's (2009) discussion

of the conceptual difference between calculable risk and fundamental uncertainty. According to Callon et al's (Ibid.: 19) conceptualization, the term 'risk' denotes 'a well-identified danger associated with a perfectly describable event or series of events for which we can perhaps only calculate the probabilities for their occurrence—but where we can have definite knowledge of the effect of their occurrence'. Callon et al further note that dealing with calculable risk calls upon the deployment of a rational decision framework in which we must first be able to establish an exhaustive list of the options open to us. Second, for each of the options under consideration the decision maker must be able to describe the entities constituting the world presupposed by that option, the outcome-determining factors needed to be taken into account in the consideration of the options. Third, the assessment of the significant interactions that are likely to take place between these entities must be feasible, that is: the depicted chain of causalities must be ascertained to a more than reasonable degree of probability. If these three conditions are met, decision makers can make a reasonable comparison between the options on offer, but as Callon et al further note, this is a 'truly exceptional situation' (Ibid.: 20) when '[w]e are completely familiar with these events and know the conditions necessary for them to take place, even if we do not know if they will in fact occur, and even if all we know is the probability of their occurrence' (Ibid.: 20). In these very rare cases, we may come to a rational decision by weighting alternative courses of action, and then go out and implement them full force.

The problem in relation to the ESS-research is that a central argument of Rockström and his colleagues is that we *cannot* know the future possible states of the world for certain—the only thing that we *do know* is that radical change can occur on a global ecological level—but due to the non-linearity and complexity of these systems and processes it is, to say the least, hard-to-predict exactly when, how and with what degree of catastrophic effects these changes can/will occur (Rockström et al., 2009; cf. Steffen et al., 2007; Schneider, 2004). Hence the vagueness of the argument by Rockström et al. (2009) on the need for environmental geopolitics and a 'rapid transformation of industrial metabolism' (Rockström, 2011) to try to *keep* a Holocene *type* of global environment.⁶ The issue of dramatic global socio-ecological change is therefore most probably what Callon et al call a situation of fundamental, perhaps even radical, uncertainty. Of course, as Callon et al put it, 'there is a vast space between dismal ignorance and an impeccable knowledge of the states of possible worlds' (Callon et al., 2009: 21), and much thanks to the research conducted by Rockström and the colleagues in his field, we today know a great deal more about human-generated global environmental changes. But what we have learned to a large extent is mostly about the depths of our great ignorance and lack of understanding of the dynamics of that which we previously have called 'nature', and the difficulties of predicting its behav-

our. In situations such as the Anthropocene where we cannot anticipate the consequences of the decisions that are likely to be made, we do not have a sufficiently precise knowledge of the conceivable options, descriptions of possible states of the world are put in serious question and the behaviour and interaction of the entities that are proposed to be taken into account remain enigmatic—a different type of approach than mere ‘implementation’ or ‘providing avenues towards solutions’ might be called for.

One such alternative approach to the potential role of the social sciences can be found in the notion of *cosmopolitics*, as developed primarily by Isabelle Stengers (2010a, 2010b) and Bruno Latour (2004, 2010). The term cosmopolitics is used by these authors to denote a somewhat hesitant and searching relation to the world, a relation where we recognise that we may not always know what may become, or under what conditions. A relation to the world that does not withdraw itself from concrete engagement, but which can rather only unfold in the concrete—albeit always with a sensibility or sensitivity that attempts to curtail the megalomaniac human streak of believing that we ever know all we need to know about some-thing or situation. In a way, it is an attempt at reducing the risks of once again just reproducing the modernist error of fleeing in such horror from the problems of the past through action in the present, that we fail to consider how our action in the present might generate future problems (Latour, 2010).

It is therefore encouraging to see that what—following Stengers and Latour—perhaps could be called a ‘cosmopolitical sensitivity’ shines through, at least in passages, in the declaration of the 3rd NLS. In the summary presentation of what global sustainability is about, the issue of governing global dynamics (which is about governing the ‘dynamic interactions between social and ecological systems’) has as a key-concern ‘adaptive governance’ which is now seen as emerging on local, regional, and international levels (3rdNLS, 2011).

But even if we would conclude that a general adaptive governance approach rather than an implementational approach to the role of the social sciences in relation to ESS will most probably create better preconditions for this research cooperation to deal with radical and foundational uncertainty, such a formatting of cooperation might still be too narrow to really provide room for the development of the full potential of what the social sciences can bring to such a joint venture. Here an issue is taking shape reminiscent of Shove’s illustration of the asymmetry of the ‘stock’ of knowledge in the social sciences and the ‘crumbles’ which actually reach policy and decision makers, particularly concerning transition issue in sustainable development and climate change (Shove, 2010b; see also Shove, 2010a). Shove suggests that we do not heed the perhaps conventional advice to ‘translate’ or ‘format’ the knowledge in a presumably more accessible language for the policy sphere,

but to put more efforts into enhancing the social scientific competence and skills *among those policymakers*. Hence, if the social sciences would (or *should*, as many Anthropocene proponents and not least ourselves argue) become more involved in these issues, can the interface be reduced to the kind of modelling format used by ESS (cf. Clifford and Richards, 2005)?

For cosmopolitics, in its Stengerian guise, is not only about working out solutions in mutual respect between recognised parties of ‘stakeholders’, it is more about forming fragile practices in divergence and through minority techniques (what governance and empowerment usually betrays since it translates all articulations into ‘stakeholders’ slotted for a very rigidly framed space of deliberation (Stengers, 2010c)). Hence, it is about recognizing the radical contingency, not only of any framing of a situation but also of the knowledge called upon to make articulations and create closure around a common response to a particular situation. It is about constantly generating the means for collectivizing the frightful and nagging personal question ‘what am I busy doing?’ into a question of ‘what are *we* busy doing?’ (cf. Stengers, 2005).

To return to the main conference theatre of the NESS-conference, another of the keynote speakers, STS-scholar Noortje Marres—perhaps one of the brightest shining stars of contemporary environmental social science—discussed the proliferation of devices and popular technologies meant to show users how the environment, society and technology are always ‘already entangled’, a statement that has been a mainstay of and rallying cry for much of STS-scholarship for the past three decades or so (See Marres and Asdal, 2011). But if this is now becoming an accepted truth, even hardwired into many popular technologies, what do social studies of the environment in general, and STS-scholars in particular really have to add? Does this mean ‘mission accomplished’, at least partially, for STS? Marres’ answer appears to be a resounding ‘no’, for the methods of social scientists can perform something that is very difficult to achieve by other means – that is: to ‘problematize the object’ and to provide for ‘radical form[s] of frame expansion’ that ‘create trouble’ by posing fundamental questions in the register of ‘what is this?’, ‘what does it do?’, ‘what can happen?’, without providing any clear answers—simply because we are in an inquiring mode, reminding us that our knowledge at any time-space conjunction is always by necessity limited and circumscribed—and also pointing out some of the ways in which it may be so. So what the social sciences can provide for is the generation of knowledge that puts-into-question ‘the neat alignments of ... normative projects’.

Relating Marres’ above articulation to the prospective role of the social sciences in relation to global ecological concerns, we see the social sciences enacted not only as a means of ‘providing avenues towards solutions’ based on the seemingly rock-hard facts of

the ‘natural sciences’, but also as a set of methods and technologies for opening up issues and perspectives through destabilizing taken-for-granted issue-framings and established truths. In his NESS-speech, Rockström labelled this as the crucial role of ‘big foresight’, engendering that which in the context of STS been discussed as ‘slowing down thought’ (Stengers, 2005) or simply: social science as ‘interference’ (Law, 2009b). It is a question which relates to a current/recent discussion on intervention, the normative turn, and the possibility ‘to have it both ways’ in STS: ‘to ‘deconstruct’ *positivistic* claims about the intrinsic certainty of scientific facts or the inherent efficiency of technical innovations, while at the same time using STS knowledge *positively* as a basis for political action and policy recommendations’ (Lynch and Cole, 2005). So here we see a potential role for the social sciences in relation to ESS, not only as ‘implementers’ of established truths or even as a means of helping us act in an uncertain world, but rather as a *generator* of uncertainty and hesitation by raising troubling questions and thus generating new research agendas. An example of one such issue which perhaps needs to be revisited in new ways and again brought to the table in this context is the (old) politics concerning (global) equity which was one of the main stumbling blocks that made the limits to growth agenda (which ‘planetary boundaries’ is an obvious attempt of resurrecting) fail to gain broad political traction back in the 1970s.

Or else forever hold your peace

In this brief paper we have impressionistically sketched an argument which could perhaps be formulated as suggestion for a ‘pre-nup’ regarding the proposed, relevant and perhaps pressingly necessary ‘marriage’ between Earth Systems Science and the social sciences. Our reservations have primarily centred around two specific sets of conditions or ‘terms of union’. To begin with, we have a concern about the geography of the proposed union, the type of milieu where the partners are supposed to set up shop together. Are we looking at a homesteading in a secluded laboratory, where the social scientist just hangs out at the doorstep of the natural scientists’ laboratory, tending to chores? If we see residencies as specifically formatted concrete sociomaterial spaces which to various degrees both enable and disable different types of relations or couplings (cf. Royoux and Sloterdijk, 2005), the strictly formatted *and formatting* spaces of laboratories may not allow for forms of coupling between the so-called ‘natural’ and ‘social’ sciences that fully enable the social sciences to realise its radical potential to destabilise taken-for-granted (natural) Scientific framings of wicked and entangled problems that transverse regular socio-natural dividing lines. There is a strong possibility that this set-up will only provide factors to take into regard to be included in already framed and stabilised models of explanation.

A different option would be for the partners to throw themselves into the cosmopolitical jungle, the ‘wild’ side of research cooperation, which can perhaps—following Serres (via Latour, 1988)—be likened not just to traffic over a strait but as a great archipelago like the Northwest Passage. An intricate ‘throwntogetherness’ (Massey, 2005) where it is already ‘among the living.’ In this aspect, we are somewhat encouraged by contemporary developments in the field of ESG, which attempts to engage in concrete and specific processes of knowledge production ‘in the world’, including many forms of knowledge. Still, we are a bit worried about the set-up of many of these endeavours and to what extent they are strictly formatted according to a taken-for-granted pre-eminence of ‘natural’ science. For academic experts must also allow for the margin to let the world surprise them, to have their presuppositions destabilised, or else run the risk of irrelevance or even heroic but catastrophic failure.⁷

This takes us to the second issue we have raised, which concerned the ascription of roles between the natural and social sciences in the proposed union. Our primary concern in this regard is that the role that is being implicitly scripted for the social sciences in the union with ESS is as a form of subservient ‘implementer’ of the (supposedly) rock-hard and non-negotiable truths of the natural sciences. Our argument here is that the social sciences definitely can and must be part of developing the programme of action for sustaining the preconditions of human life on our planet. But we must take care not to reduce the social sciences only to this role. To (mis)use the language of Thomas Kuhn, we see that the social sciences in relation to the natural sciences in general, and ESS in particular, might prove extremely valuable not only as a partner in ‘puzzle-solving’ but also in the role of ‘anomaly producers’, or ‘paradigm-shakers’—putting into doubt unproductively taken-for-granted ‘collateral realities’ (Law, 2009a). This is Rockström’s ‘big foresight’, the causing of outrageous domestic disturbances, destabilizing established frames by continuously and iteratively interrogating and reconsidering the epistemological foundations for action, deliberately complicating things, highlighting the excluded margins and ‘slowing down thought’ in a way that may also facilitate for a continuous reinvigoration and renegotiation of research agendas (cf. Stengers, 2005).

Throughout the paper, we have used the metaphor of a proposed marriage between ESS and the social sciences, as it appeared to be staged by leading ESS-scientist Johan Rockström. We do not think the social sciences would mind being ‘female’, but a running point of the metaphor is of course that probably no one would like to be the ‘woman’ in a patriarchal and misogynist household, or—perhaps more to the point made of ‘secluded research’—being anyone’s ‘prison bitch’. We wish to finish off by again stressing that we are in no way objecting to the, perhaps even necessary, proposal—per se. We are only a bit wary

about what we fear to be some of the implied terms of union in this proposed marriage. We want to avoid the construction of a traditional (western) binary attribution of roles in this marriage, where ESS as (stereotypically male) dominant ‘Science’ would set the agenda and establish ‘the truth’, while the social sciences as a (stereotypically female) subservient supportive spouse would be left with the role of tending to reproductive tasks and simply making sure that things run as smoothly as possible in the implementation of the grand designs of the patriarch. The purpose of this text has simply been to highlight this risk, not in order to stop the party, but rather to make sure that we can avoid a narrow definition of strictly formatted roles, performed within a secluded and strictly formatted milieu—and instead make sure that the spouses come to be unified under conditions that help both of them support the other to be ‘all it can be’, through skirting the prison-house of the traditional gendered roles of the secluded homestead of the laboratory, and instead letting ‘a thousand tiny sexes’ proliferate (cf. Deleuze and Guattari, 1987; Grosz, 1993), generating all sorts of ‘strange spaces’ (cf. Metzger, 2011). These strange spaces may be utopian, but not in the meaning of transcendent or beyond reach, but rather as Stengers has written (Stengers, 2005), as spaces of risky becoming and action in a ‘dangerous world ... where any proposition may be falsified’—where no participant is left unaffected and which therefore constantly call into question all the over-simplistic, self-assured and always premature proclamations of ‘one would just need to...’.

Endnotes

1. However, it is probably a rather complex, not to say metaphysical, question of what uninhabitable practically and politically means in the Anthropocene: does it merely imply the implausibility of life more or less as we are presently used to it, or does it entail total biological extinction of our species? This question goes right to the heart of humanism and correlating issues of how ‘we’ humans are prepared to live. Furthermore, this might also be phrased as a topological issue (cf. Law and Singleton, 2005), where the search for where the ‘breaking points’ for being human might be in various kinds of spaces (an issue many times explored in popular culture). In a more pragmatic vein, if humanity is a fractional and a ‘multiple object’ (Law, 2004; Mol, 2002), then this question also highlights the complexity upon which so-called lateral agreements on global environmental issues many times seems to stumble.

2. The timing of the transition from the geological epoch of the Holocene to the Anthropocene is slightly controversial in Earth System Science. Crutzen and Stoermer (2000) put it at the end of the Eighteenth Century and the Industrial Revolution; others argue that the onset of the Anthropocene began already about 10–12,000 years ago, hence cancelling out the Holocene in effect. In the keynote, Rockström dates the transition to 1955 loosely in line with Steffen et al (2004). However, the Anthropocene is not yet a formal geological epoch recognised by the Geological Society of London or the International Commission on Stratigraphy—it is proposed and decision, as of writing this, still pending (see Zalasiewicz et al., 2011).
3. Extended transcript snippet on how Rockström (2011) phrased the Wal-Mart analogy: ‘What we are learning more and more, through 30 years of complex systems research, resilience science, and understanding of coupled social-ecological systems, is that nature is not behaving at all as, I’m sorry to say, most social science has assumed over the decades—or, for that matter, economics, governance, the way we design societies. [26:26] Because we always believe that nature is some kind of, you know, Wal-Mart Supermarket. [That] its a static resource where you pick services, and when you run down a resource either you kind of substitute it for something else or you find a way of managing it better so it grows back to its earlier state. But it certainly changes linearly, it certainly changes incrementally, and therefore predictably and controllable. That’s our optimization and efficiency model that we have applied and adopted in full in every facet of how we, so to say, do social—eh, I was just about to say “social science”, I know that you are good examples of doing it differently, I’m sure [27:08]. But the way we apply our relationship with nature and our own societal development.’
4. In Callon et al’s (2009) procedural proposal, this ‘political’ activity is as necessary as the ‘scientific’ (both secluded and in the wild). Indeed, they amount to or move around the same things—literally: the parliaments (in Latour’s vocabulary), hybrid forums (in Callon et al’s terms), or the main challenge for speculative political research practices (in perhaps Stengers’s (2010c) terms) where a common world can be composed or explored. In all of these versions, a common point is to try to keep the practice of politics on equal terms between actors, whereas the ESG

seems to contain a philosophical materialist ontology as a matter of course, in that it grounds the political and social scientific enquiry firmly within a naturalistic scientific (i.e. ESS) frame (cf. Harman, 2010).

5. See e.g. Dryzek and Stephenson's (2011) proposition to ESG of what in effect is a democracy machine built to produce certified deliberated decisions.
6. Again, as in the question of what 'habitable' means for a multiple humanity in note 1: the assumption that humanity wants a Holocene-type of environment which seems to be made in the proposition on planetary boundaries is problematic on at least three counts (even if we have nothing against a Holocene type of environment per se): 1) that the Holocene type of climate is the *only* way to increase (or maintain, depending on current worldview) global equity and 'a good life'; 2) that it is what humans wants, since it is thinkable (albeit not plausible) that a majority of humanity could vote for collective suicide or at least more of a roller-coaster climate; 3) that the Holocene was such a 'smooth ride' after all from a landscape perspective, even if more stable than most epochs and eras in Earth's history, since the relative plateau of the Holocene contains curves which were, to say the least, probably quite bumpy rides for the humans and nonhumans that lived through them (or failed to do so) (cf. Crumley, 2011; Costanza et al., 2007, Figure 1).
7. For historical examples of catastrophic effects of such massive societal mobilizations, see for instance Scott (1998) and Diamond (2005).

References

- 3rdNLS (2011) 3rd Nobel Laureate Symposium on Global Sustainability: Transforming the World in an Era of Global Change, Executive Summary of Scientific Background Papers, 16–19 May, Stockholm: The Stockholm Resilience Centre, The Royal Swedish Academy of Sciences, The Stockholm Environment Institute, The Beijer Institute of Ecological Economics, The Potsdam Institute for Climate Impact Research.
- BBC (2011) Anthropocene: Have humans created a new geological age?, BBC, 10 May, at <http://www.bbc.co.uk/news/science-environment-13335683?p>, accessed 2011-06-15.

- Belmont (2011) Towards a 10 year Earth System Research initiative for Global Sustainability, A joint statement of intent from the Belmont Forum, ICSU and the ISSC, accessed 2011-07-11.
- Biermann F, Betsill MM, Gupta J, Kanie N, Lebel L, Liverman D, Schroeder H and Siebenhüner B (2009) Earth System Governance: People, Places and the Planet, Science and Implementation Plan of the Earth System Governance Project, Earth System Governance Report 1, IHDP Report 20, Bonn: IHDP: The Earth System Governance Project.
- Biermann F and Zondervan R (2010) Editorial. International Environmental Agreements: Politics, Law and Economics 10(4): 273–276.
- Callon M, Lascoumes P and Barthe Y (2009) *Acting in an Uncertain World: An Essay on Technical Democracy*. Cambridge MA, London: The MIT Press.
- Callon M and Rabeharisoa V (2003) Research 'in the wild' and the shaping of new social identities. *Technology in Society* 25: 193–204.
- Clifford N and Richards K (2005) Earth System Science: an oxymoron? *Earth Surface Processes and Landforms* 30: 379–383.
- Costanza R, Graumlich L, Steffen W, Crumley C, Dearing J, Hibbard K, Leemans R, Redman C and Schimel D (2007) Sustainability or Collapse: What Can We Learn from Integrating the History of Humans and the Rest of Nature? *Ambio* 36(7): 522–527.
- Crumley C (2011) The Ampersand and the Hyphen: an update on the science-society endeavor, Seminar in honour of Prof. Carole Crumley, winner of the 2011 Johan August Wahlberg medal by the Swedish Society for Anthropology and Geography, 26 October 2011, Stockholm: Stockholm University.
- Crutzen PJ and Stoermer EF (2000) The 'Anthropocene'. *IGBP Newsletter* 41: 17–18.
- Deleuze G and Guattari F (1987) *A Thousand Plateaus: Capitalism and Schizophrenia*. Minneapolis: University of Minnesota Press.
- Diamond J (2005) *Collapse: How Societies Choose to Fail or Succeed*. New York: Viking Penguin.
- Dryzek JS and Stevenson H (2011) Global democracy and earth system governance. *Ecological Economics* 70: 1865–1874.
- Duit A, Galaz V, Eckerberg K and Ebbesson J (2010) Governance, complexity and resilience. *Global Environmental Change* 20(3): 363–368.
- ESG (2011) Earth System Governance Science Plan, Earth System Governance: People, Places and the Planet, at <http://www.earthsystemgovernance.org/publication/biermann-frank--earth-system-governance-science-plan>, accessed 2011-10-15.

- U Felt, L Sigl and V Wöhrer (2010) Multiple Ways of Being Together Alone: A Comparative Analysis of Collective and Individual Dimensions of Academic Research in Two Epistemic Fields, Department of Social Studies of Science, University of Vienna, at <http://sciencestudies.univie.ac.at/publications>, accessed 2011-09-20.
- Galaz V, Biermann F, Crona B, Loorbach D, Folke C, Olsson P, Nilsson M, Allouche JH, Persson Å and Reischl G (2011) Planetary Boundaries: Exploring the Challenges for Global Environmental Governance, Beijer Discussion Paper Series No. 230, The Beijer Institute of Ecological Economics,
- Grosz E (1993) A Thousand Tiny Sexes: Feminism and Rhizomatics. *Topoi* 12(2): 167–179.
- Harman G (2009) *Prince of Networks: Bruno Latour and Metaphysics*. Melbourne: re.press.
- (2010) I am also of the opinion that materialism must be destroyed. *Environment and Planning D: Society and Space* 28: 772–790.
- ICSU (2011) Earth System Sustainability Initiative, International Council for Science, at <http://www.icsu.org/what-we-do/projects-activities/earth-system-sustainability-initiative/>, accessed 2011-10-15.
- Janssen MA and Ostrom E (2006) Resilience, vulnerability, and adaptation: A cross-cutting theme of the International Human Dimensions Programme on Global Environmental Change. *Global Environmental Change* 16(3): 237–239.
- Jasanoff S (2004) Heaven and Earth: The Politics of Environmental Images. In Jasanoff S and Martello ML (eds) *Earthly Politics: Local and Global in Environmental Governance*. Cambridge Mass.: The MIT Press, 31–52.
- Knorr-Cetina KD (1981) *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science*. Oxford, New York: Pergamon.
- Kwa C (2005) Local Ecologies and Global Science: Discourses and Strategies of the International Geosphere-Biosphere Programme. *Social Studies of Science* 35(6): 923–950.
- Latour B (1983) Give Me a Laboratory and I will Raise the World. In Mulkay M and Knorr-Cetina KD (eds) *Science Observed. Perspectives on the Social Study of Science*. London, Beverly Hills: Sage Publications Ltd., 141-170.
- (1988) *The Pasteurization of France*. Cambridge Mass, London: Harvard University Press.
- (2004) *The Politics of Nature: How to Bring the Sciences into Democracy*. Cambridge Mass, London: Harvard University Press.

- (2010) An Attempt at a 'Compositionist Manifesto'. *New Literary History* 41: 471–490.
- Latour B and Woolgar S (1979) *Laboratory Life: The Construction of Scientific Facts*. Princeton, Chichester: Princeton University Press.
- Law J (2004) *After method: Mess in social science research*. Oxon, New York: Routledge.
- (2009a) Collateral Realities, version of 29th December, at <http://www.heterogeneities.net/publications/Law2009CollateralRealities.pdf>, accessed 2010-10-15.
- (2009b) The Greer-Bush Test: On Politics in STS, version of 23rd December 2009, at <http://www.heterogeneities.net/publications/Law2009TheGreer-BushTest.pdf>, accessed 2010-08-10.
- (2010) The Materials of STS. In Hicks D and Beaudry M (eds) *The Oxford Handbook of Material Culture Studies*. Oxford: Oxford University Press, 171–186.
- Law J and Singleton V (2005) Object lessons. *Organization* 12(3): 331–355.
- Lawton J (2001) Earth System Science. *Science* 292(5524): 1965.
- Lynch M (1982) Technical Work and Critical Inquiry: Investigations in a Scientific Laboratory. *Social Studies of Science* 12(4): 499–533.
- Lynch M and Cole C (2005) Science and Technology Studies on Trial: Dilemmas of Expertise. *Social Studies of Science* 35(2): 269–311.
- N Marres and K Asdal (2011) Social Science Methods and the Performance of Environmental Change, Keynote session, at the 10th NESS, Nordic Environmental Social Sciences conference, Stockholm, Sweden, June 2011, at <http://www.stockholmresilience.su.se/seminarandevents/otherseminars/ness2011/videoarchive.4.1f74f76413071d337c380005790.html>, accessed 2011-08-15.
- Massey D (2005) *For space*. London, Thousand Oaks, New Delhi: SAGE Publications Ltd.
- Metzger J (2011) Strange spaces: A rationale for bringing art and artists into the planning process. *Planning Theory* 10(3): 213–238.
- Mol A (2002) *The Body Multiple: Ontology in Medical Practice*. Durham: Duke University Press.
- National Geographic (2011) Enter the Anthropocene – Age of Man, March, at <http://ngm.nationalgeographic.com/print/2011/03/age-of-man>, accessed 2011-06-30.
- New York Times (2011) Embracing the Anthropocene, 20 May, at <http://www.nytimes.com>, accessed 2011-06-27.
- Reid WV, Chen D, Goldfarb L, Hackmann H, Lee YT, Mokhele K, Ostrom E, Raivio K, Rockström J, Schellnhuber HJ and Whyte A (2010) Earth System Science for Global Sustainability: Grand Challenges. *Science* 330(6006): 916–917.

- Rockström J (2011) The social challenge of tipping towards sustainability, Keynote and welcome address at the 10th NESS, Nordic Environmental Social Sciences conference, Stockholm, Sweden, June 2011, at <http://www.stockholmresilience.su.se/seminarandevents/otherseminars/ness2011/videoarchive.4.1f74f76413071d337c380005790.html>, accessed 2011-06-30.
- Rockström J, Steffen W, Noone K, Persson A, Chapin, F. Stuart, Lambin EF, Lenton TM, Scheffer M, Folke C, Schellnhuber HJ, Nykvist B, de W, Cynthia A., Hughes T, van dL, Sander, Rodhe H, Sorlin S, Snyder PK, Costanza R, Svedin U, Falkenmark M, Karlberg L, Corell RW, Fabry VJ, Hansen J, Walker B, Liverman D, Richardson K, Crutzen P and Foley JA (2009) A safe operating space for humanity. *Nature* 461(7263): 472–475.
- Ross A (1996) Introduction. *Social Text* 14(1/2): 1–13.
- Royoux JC and Sloterdijk P (2005) Foreword to the theory of spheres. In Ohanian M and Royoux JC (eds) *Cosmograms*. New York: Lukas & Sternberg, 223–240.
- Schneider SH (2004) Abrupt non-linear climate change, irreversibility and surprise. *Global Environmental Change* 14: 245–258.
- Scott JC (1998) Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed. New Haven, London: Yale University Press.
- Serres M (1992) The Natural Contract. *Critical Inquiry* 19(1): 1–21.
- Shove E (2010a) Beyond the ABC: climate change policy and theories of social change. *Environment and Planning A* 42: 1273–1285.
- (2010b) The relevance of social science on sustainability, Presentation at the FORMAS Seminar Mobilising Swedish Social Science Research on Sustainability, 2010-09-22,
- Sokal A and Bricmont J (1998) Fashionable Nonsense: Postmodern Intellectuals' Abuse of Science. New York: Picador.
- SRC (2009) Tipping towards the unknown, Stockholm Resilience Centre, at <http://www.stockholmresilience.org/research/researchnews/tippingtowardstheunknown.5.7cf9c5aa121e17bab42800021543.html>, accessed 2011-07-03.
- Star SL (1988) Introduction: The Sociology of Science and Technology. *Social Problems* 35(3): 197–205.
- Steffen W, Crutzen PJ and McNeill JR (2007) The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature. *Ambio* 36(8): 614–621.
- Steffen W, Sanderson A, Tyson PD, Jäger J, Matson PA, Moore III B, Oldfield F, Richardson K, Schellnhuber HJ, Turner BL and Wasson RJ (2004) *Global Change and the Earth System: A Planet Under Pressure*. Berlin, Heidelberg: Springer Verlag.

- Stengers I (2005) The cosmopolitical proposal. In Latour B and Weibel P (eds) *Making Things Public – Atmospheres of Democracy*. Karlsruhe: Engelhardt & Bauer, 994–1003.
- (2010a) *Cosmopolitics I*. Minneapolis: University of Minnesota Press.
- (2010b) *Cosmopolitics II*. Minneapolis: University of Minnesota Press.
- (2010c) Including Nonhumans in Political Theory: Opening Pandora's Box? In Braun B and Whatmore SJ (eds) *Political Matter: Technoscience, Democracy, and Public Life*. Minneapolis: University of Minnesota Press, 3–34.
- The Economist (2011) A man-made world: The Anthropocene, The Economist, 26 May, at <http://www.economist.com/node/18741749>, accessed 2011-06-27.
- Traweek S (1992) *Beamtimes and Lifetimes: The World of High Energy Physicists*. Cambridge Mass, London: Harvard University Press.
- van Tuinen S (2009) Air conditioning spaceship earth: Peter Sloterdijk's ethico-aesthetic paradigm. *Environment and Planning D: Society and Space* 27(1): 105–118.
- Zalasiewicz J, Williams M, Haywood A and Ellis M (2011) The Anthropocene: a new epoch of geological time? *Philosophical Transactions of the Royal Society* 369(1938): 835–841.