STEPS centre

Emancipating Transformations:
From controlling 'the transition'
to culturing plural radical progress

Andrew Stirling

Transformations

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Current global environmental policy reverberates with talk of a new "Anthropocene epoch" defined by "human domination", in which a "perfect storm" of catastrophic threats is forcing "the great transition" towards "planetary management". Under growing "environmental authoritarianism", democracy is increasingly seen as a "failure", a "luxury", or even "an enemy of nature". If charge is to be taken of the "control variables of the Earth", democracy must be "put on hold". So, knowledge itself is increasingly imprinted by the age-old preoccupations of incumbent power with rhetorics of control. It seems there is 'no alternative' but compliance — or irrational denial and existential doom.

Yet there are alternative ways to understand the gravity of these threats — and act against them. It can be recognised, for instance, that democratic struggle is the principal means by which knowledges of Sustainability were shaped in the first place. In this view, concentrated power and fallacies of control are more a problem than a solution. Here, history shows that the greatest ongoing forms of radical progress (like freedom from slavery, colonialism, racism and patriarchy), owe more to unruly hope-inspired political struggle, than orderly technical transitions based on fear-driven hierarchical control. Combining knowing and doing, a necessary step is the emancipation of transformation itself.

About the Author

Andy Stirling is co-director of the ESRC STEPS Centre and works on many other projects at SPRU — science and technology policy research at the University of Sussex. He's served on advisory bodies for the EU on Energy Policy, Science in Society, Collaborative Research, Sustainability and Science Governance; for the UK government on toxic substances, GM crops, public engagement and science advice; and working groups for the Royal Society, Nuffield Council and UN IHDP as well as boards for several academic journals and Greenpeace International. He's currently on the ESRC Research Committee.

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Acronyms

BBC	British Broadcasting Corporation
CEC	Commission of the European Communities
DEFRA	Department for Environment, Food and Rural Affairs
DIUS	Department for Innovation, Universities and Skills,
DTI	Department for Trade and Industry
ECF	European Climate Foundation
EREC	European Renewable Energy Council
GEA	Global Energy Assessment
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
IAEA	International Atomic Energy Authority
ICSU	International Social Science Council
IPCC	Intergovernmental Panel on Climate Change
SAC	[DEFRA]Scientific Advisory Council
SCSS	Standing Committee for the Social Sciences
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WBCSD	World Business Council for Sustainable Development
WWF	World Wide Fund for Nature

Abstract

Current global environmental policy reverberates with talk of a new '*Anthropocene epoch*' defined by '*human domination*', in which a '*perfect storm*' of catastrophic threats is forcing a singular '*great transition*' towards '*planetary management*'. Under growing '*environmental authoritarianism*', democracy is increasingly seen as a '*failure*', a '*luxury*', or even '*an enemy of nature*'. If charge is to be taken of the '*control variables of the Earth*', some say democracy must be '*put on hold*'. One way of seeing this trend, is that scientific and policy knowledges are becoming increasingly imprinted by the preoccupations of incumbent power with rhetorics of control. Under this growing political mood, it seems there is '*no alternative*' but compliance, or irrational denial and existential doom.

Yet there *are* alternative ways to address the gravity of current ecological and social imperatives. It can be recognised, for instance, that democratic struggle is the principal means by which knowledges and practices of Sustainability were shaped in the first place. In this view, concentrated power and fallacies of control are more problems than solutions. Here, history can show that the greatest ongoing forms of transformative progress (like release from colonialism, racism or patriarchy), owe more to plural knowledges and values and unruly hope-inspired agonistic contention, than to single orderly technical '*transitions*' based on formally-integrated science or fear-driven structured control.

Like other great progressive struggles of history, radical shifts in grassroots culture and anarchically-choreographed flocking behaviours in nature, the most effective modes for radical change often lie in spontaneous collective bottom-up 'culturings' of knowing and doing. These do not depend on rigidly-disciplined '*integrated science*' and monolithically-structured '*planetary management*'. Instead, real hope of radically progressive social transformation may lie more in the mutualities of caring, than in the hierarchies of control. And among the greatest obstacles to this, are ideologies of technocratic transition. Perhaps the deepest necessity lies in emancipating '*transformation*' itself?

Keywords: democracy; Sustainability; transformation; transition; nexus; Anthropocene; planetary boundaries; control; care;

1. Introduction

Under any reasonable notion of 'progress', the most compelling imperatives lie in interlinked challenges of social justice and global environmental degradation (UNESCO and ISSC 2010; UNEP 2012; UNDP 2013; UN 2013b; Griggs *et al*. 2012). But are the necessary social transformations too urgent, deep and pervasive to be reliably achieved by democratic means? Does manifest lack of progress indicate a 'failure of democracy' (Shearman and Smith 2007)? Is critical democratic discourse an obstructive or dispensable 'luxury' (Haan and Sierman 1996)? The iconically influential environmentalist James Lovelock, for instance, suggests that 'it may be necessary to put democracy on hold for a while' (Hickman 2010). Indeed, the main European Commission news website has even recently queried whether democracy is actually an 'enemy of nature?' (Euractive 2010). If the term 'democracy' is seen as a procedural euphemism, concealing ever more assertively concentrated global power and privilege, then perhaps it is (Crouch 2004; Ranciere 1999; Dean 2009; Swyngedouw 2009; Hewlett 2007). But maybe history teaches instead, that the **only** sure way to achieve real progressive social transformation is through the kinds of open, unruly political struggle that more properly deserve this name (Laclau and Mouffe 2001)? These are the questions on which this paper will focus.

In short, the argument here will lead to a general heuristic distinction between two ideal-typical forms of radical social change (Stirling 2014a; Stirling 2011b). On one hand, are what might be called societal '**transitions**', often driven by technological innovation, managed under orderly control, by incumbent structures according to tightly-disciplined frameworks for knowledge, towards a specific known (presumptively shared) end? Put simply for the sake of illustration, currently relevant examples of this kind of change might include those most closely associated with prospective global transitions to nuclear power in energy production (Nuttall 2005), planetary geoengineering in climate change strategies (Shepherd 2009; Fleming 2010; Ridgwell *et al*. 2012; Ruddiman 2005) or 'sustainable intensification' of food production using proprietary transgenic monocultures (Baulcombe *et al*. 2009).

On the other hand, there are what might be called social '**transformations**'. These entail more plural, emergent and unruly political re-alignments, involving social and technological innovations driven by diversely incommensurable knowledges, challenging incumbent structures and pursuing contending (even unknown) ends. Indeed, they may owe more to critical practice of other values, virtues or social qualities than to utilitarian pursuit of ends at all (Neill *et al*. 2008; Hulme 2014; Grant 2011; Slote 1992; Slote 2007; Wong 2006). Stylised examples might include myriad changes in distributed energy practices, involving service innovations, radical eco-efficiencies, culture change and the massively more extensive harnessing of renewable resources (Jacobson and Delucchi 2009; Jacobson and Delucchi 2011; GEA 2012; EREC 2010; ECF 2010; PWC 2010; WWF 2011; IPCC 2012). Likewise there are multiple innovations in the culture and practice of food production and use, involving ecological farming, open source breeding, local supply chains, collective ownership and greater integration with other activities (Pretty 2005; Pretty 2002; Feenstra 1997; Altieri 2012; White and Stirling 2013).

By reference to historic emancipatory struggles by oppressed classes, ethnicities, colonies, women and sexualities (Zerzan 1999), the paper will argue that, contrary to much received wisdom, it is repeatedly unruly, bottom-up 'transformations' rather than top-down structured 'transitions' (in these senses), that typically achieve the most profound (sometimes rapid) radically progressive social changes (Curran 2007; Woshinsky 2008).

So, apparent contention between different meanings and practices of Sustainability and 'democracy' are not so much problems, but crucial parts of solutions (Przeworski *et al*. 1995; Dobson 2011; Dryzek 2008; Leach 2012). Ecological viability and social justice are not competing ends to be traded off (Sagoff 2008), nor a monolithically integrated and depoliticised 'nexus' of technical imperatives (Leach

2013; Pielke 2013; Stirling 2013). What makes them seem this way, is the expedient shaping of knowledge (as well as action), by powerful interests (Leach *et al*. 2010). Just as concentrated power tends to favour controlling actions, so it also fosters knowledges that emphasise associated 'fallacies of control'. But what ecological and social justice challenges arguably actually require instead is less singular controlled 'transitions' driven by whatever are the incumbent structures in any given area, and more vibrant agonistic political mobilisations towards more open-ended and pervasive 'transformations' (Stirling 2014a; Stirling 2011b). Far from democratic struggle being an 'enemy of Nature' (Euractive 2010) then, they are more likely each other's deepest hopes.

2. Nexus, Necessity and Nudge

A starting point lies in a growing body of science warning that the world is faced with a 'perfect storm' of environmental threats (Poppy *et al*. 2014; Beddington 2009). Even if not as existential as sometimes implied for the Earth as a whole or humanity in general, there are grave implications for many communities, populations, livelihoods and kinds of societies. The resulting 'nexus' of new vulnerabilities interacts with multiple prevailing forms of insecurity and injustice (Dodds and Bartram 2014; Hoff 2011; Bizikova *et al*. 2013). As in these long-established but socially-remediable patterns, it is typically the least privileged people who remain the most vulnerable (Stirling 2014a).

This new scientifically-framed 'nexus' of threats is currently attracting unprecedentedly intense attention in global governance (UN 2013a; Hulme 2009; Jasanoff 2010). In many ways, this exceeds the consideration afforded to older, more directly politically comprehensible vulnerabilities (Swyngedouw 2010), such as poverty, inequality, violence and exploitation. The result is unusual high-level willingness to contemplate ostensibly 'radical transformation' in global practices, institutions and infrastructures for provision of food, water and energy (ECF 2010). If the rhetorics are taken at face value, possibilities are opening up for potentially 'revolutionary' types and scales of change (BIS 2011; TSB 2012). Indeed, breathless talk of 'revolution' is especially pronounced when officially accredited discourse describes the envisaged benefits of favoured technologies (Oyelaran-Oyeyinka and Rasiah 2009; Kamal 2010; Rifkin 2012; Fukuyama 2002; Drexler *et al*. 1991; Adamsky 2010). Tellingly, however, such positive references to 'revolution' remain significantly less conspicuous when these same official discourses address the possibilities for more direct social, institutional or cultural transformations. Beyond the field of technology, overt discussion of 'revolutionary' depths or scales of social change seem nowadays to be viewed implicitly as highly impolite, or repudiated as if self-evidently naïve, utopian or malign 'social engineering' (May 2010; Mouffe 1992; Schäfer *et al*. 2014; Bauman 1998). It seems the disruptive connotations of 'revolution' are exciting only when aligned and compliant with incumbent interests.

Nonetheless, such is the intensity of growing discussion of this 'nexus' of imperatives for revolutionary transformation, that serious leverage is potentially emerging for unintended collateral implications (Voss and Bornemann 2011). So, with the prospect of circumscribed *direct* forms of technological, organisational and discursive change, also arise possibilities for even more substantive and extensive *indirect* political, institutional and cultural dislocations (Tenner 1999). Yet exactly how this potential wider leverage plays out is open to modulation. The possible broader changes may act in progressive ways, challenging concentrations of privilege and power (Bauchspies *et al*. 2006). Or they may act more regressively, to further entrench some of the driving incumbent patterns (Senker and Wyatt 2000). Crucial here, is that it often remains rather nonspecific what exactly will actually constitute the widely mooted 'great transitions' (Gallopín *et al*. 1997; NEF 2011; Naberhaus 2011), 'green transformations' (Beck *et al*. 2013; Ekins *et al*. 2014) or 'transitions to Sustainability' (Smith and Raven 2012; UNDP 2000; Hendriks and Grin 2007; Rauschmayer *et al*. 2013). Such ambiguity impairs traction on the part of more marginal interests, thus weighing the dice against opportunities for more progressive struggle (Stirling 2014a).

For instance, climate-driven pressures for a transformation towards radical 'soft energy paths' (Jacobson and Delucchi 2009; Jacobson and Delucchi 2011; GEA 2012; EREC 2010; ECF 2010; PWC 2010; WWF 2011; IPCC 2012) (of a kind much proclaimed on the front covers of glossy reports), may instead be redirected more covertly towards a global transition to climate geoengineering (Shepherd 2009; Fleming 2010; Ridgwell *et al*. 2012; Ruddiman 2005). More particular visions inspired by the potential to harness distributed renewable resources (Jacobson and Delucchi 2009; Jacobson and

Delucchi 2011; GEA 2012; EREC 2010; ECF 2010; PWC 2010; WWF 2011; IPCC 2012) in ways that align with the grain of local social and ecological contexts, may yield instead a 'low carbon transition' based around centralised, standardised, highly concentrated nuclear energy infrastructures (Nuttall 2005), with all their global security implications (Solomon and Marston 1986; Jungk 1985). Likewise, imperatives for transformations towards ecologically-sensitive forms of agriculture respecting the diverse knowledges of farmers as open source innovators in different settings (Pretty 2005; Pretty 2002; Feenstra 1997; Altieri 2012), may instead be harnessed towards transitions to 'sustainable intensification' strategies promoting 'monoculture' transgenic crops, that maximise rents on intellectual property and global value chains (Baulcombe *et al*. 2009).

Choices between contending institutional and infrastructural pathways like these, each variously claimed to be 'green', are profoundly political (Leach *et al*. 2010). Yet these choices are typically discussed in much existing 'green transition' literatures in rather vague and apolitical ways (Meadowcroft 2009). There is a shared concern that thinking in 'silos' (like water, energy or food) is problematic. But it is unclear how similar dangers are to be avoided in inevitable new cross-cutting 'silos'. There are, after all, many different ways to structure 'integration'. Too much 'nexus' discourse implies that nonspecific aspirations to 'integration' somehow of themselves automatically transcend the politics of framing (Stirling 2011b). In fact, integrative frameworks are typically no less sensitive to the framing of their constituent elements, and often add many further contingencies of their own (Asselt and Rotmans 2002). In evading such issues, it is as if the key questions are simply about whether to be 'green' or not, rather than about the radically different political understandings and actions that underpin these claims. It is in this depoliticised atmosphere, that it becomes possible to pose the questions with which this paper began, over the relevance of democratic deliberation, contention and struggle, or whether 'democracy' might even be negative.

This increasingly disempowering style of debate, is reinforced by a growing climate of 'environmental authoritarianism' (Beeson 2010). Despite their more generally progressive roles (Gautney 2010; Watts 2007; Hess 2007; Jamison 2004; Steffek *et al*. 2008; Baker 2002), interventions by some prominent global NGOs can sometimes help set the mood, for instance by loudly asserting that there are 'one hundred months to save the planet' (Johnson and Simms 2008). If they are lucky, such polemics will be forgotten before they are refuted (Hulme 2010). But they are widely repeated. The result is to further polarise politics simply around compliance or rejection of particular apocalyptic assertions. Little space is left for more nuanced scepticism or challenge over all-important details. Crucially, this negative emphasis on uncompromising technical fears, suppresses roles for democratic struggle over contending positive hopes (Stirling 2013).

Growing authoritarianism is also evident in the ways many influential institutions in environmental governance are increasingly deprioritising previous hard-fought duties to be transparent, responsive and accountable to citizens and public interests (Dobson 2011), in favour of more clandestine strategies for the 'nudging' (Thaler and Sunstein 2008) of 'users' and 'consumers' (Brook Lyndhurst 2009). Much government activity is devoted to developing ever more sophisticated covert means to control (assert, educate, promote, implement) according to prior established ends, which seem ever less clearly declared (Crouch 2004). Many businesses pursue increasingly elaborate practices of public relations 'greenwash' (Moloney 2000; Mickey 2003; Mackenzie 2007; Goldacre 2009; Rowell 2004; Doorley and Garcia 2007; Delmas and Burbano 2011; Rowell 1996). And, rather than actively and openly prioritising the transforming of public interests and values, many large civil society organisations increasingly take a conservative view of established patterns, and treat these as a given in their own communication strategies (Crompton 2010; Juniper 2012; Rose 2014).

Risk is repeatedly addressed in terms of reputation (SAC 2007). Scepticism is regarded as a pathology (Stirling 2011a). Trust is interpreted disproportionately as a desirable virtue on the part of the

powerless in favour of the powerful, rather than the other way around (Lewin and Vedung 1980; Grey and Willmott 2005). 'Participation' is undertaken more as a means to legitimation than legitimacy (Wynne 2006; Thorpe 2010; Hickey and Mohan 2004; Stirling 2008; Pellizzoni 2001). And accountability is further impaired by moves away from substantive 'thick' principles (Geertz 1973) like 'Sustainability', 'precaution', 'equity', 'justice' and 'liability', with hard-fought established bodies of practice affording agency to wider interests (Leach *et al*. 2010). Instead, emphasis moves towards more amorphous, 'thin' notions like 'responsibility', where focus merely on asserted virtue can tend to romanticise (and so reinforce) the narrower agency of incumbents (DIUS 2007; Owen *et al*. 2012; Pellizzoni 2004; Owen *et al*. 2013). So, despite the impression given by apparently benign-sounding policy language around minimising 'risk', seeking 'consensus', fostering 'trust', enabling 'participation' or promoting 'responsibility', collective capacities for open, progressive, plural, critical political discourse are increasingly undermined.

Behind this, the roots of environmental challenges are increasingly located in the 'behaviour' of ordinary people, rather than in the structures and powerful interests that so actively constrain and condition associated growing individualism, consumerism and materialism (Gallopín *et al*. 1997; Ransom and Baird 2009). The diagnosis increasingly moves away from explicitly political struggle, towards less visible psychological and communicative techniques for securing 'behaviour management' (Furedi 2009). By emphasising the centrality of supposedly undifferentiated hard-wired human nature, appreciation is further attenuated for critical argument and democratic struggle. Attention is drawn even further away from the potential for progressive political action to challenge particular incumbent interests. In this 'end of history' illusion (Hodgson 1999; Fukuyama 1992), the contrasting environmental and justice implications can be lost, even of relatively modest and proximate 'varieties of capitalism' (Hall and Siskice 2001). All too often, prospects for more diverse, creative and progressive forms of social and political transformation are conflated into a seemingly amorphous, singular – depoliticised – 'way forward' (Treasury 2004; OECD 2005; Anon 2001; WBCSD 2010; CEC 2013). Suffocated by the oppressive inevitability of 'no alternatives' rhetorics, they are thereby rendered quite simply, unimaginable (Crouch 2004; Kitschelt 2000).

The implicit expectation often seems to be, that the powers doing all the nudging and controlling, will somehow be kept benign simply by the manifest gravity of the professed environmental rationales. Yet, that the ecological threats are real and so much of the advocacy sincere, in no way diminishes the vulnerability to manipulation and diversion. The more assertive and apocalyptic the envisaged threat, the more seemingly desperately necessary the Faustian pact with power (Mulgan 2014; Norton 1991; Light and Katz 1996). And neither history nor current affairs suggest any guarantee that such bargains will be delivered (Tilly 1978; Tilly 2007). Many historic examples can be found, where sincerely progressive efforts were made to tolerate temporary concentrations of power, towards ostensible ends of radical social transformation. Yet, time and again these actually reproduce the old incumbent structures in new forms, often being even more entrenched (Amin *et al.* 1990; Arendt 1963; Skocpol 1979). When power is given the opportunity, let alone the mandate, to invoke over-riding missions to control (especially under a climate of fear), the results can be even less positive. The disarming effects of superficial appearances can make the dangers especially acute where initial motivations appear most altruistic.

The world is a big and complex place. Care should therefore be taken with simplified, especially polarised, pictures. So, the ensuing discussion will seek to unfold these arguments in more detail. But there do seem grounds for more careful scrutiny of the current moves documented here towards increasingly technical and managerial forms of 'nexus', 'nudge' and environmental authoritarianism. Crucially, however, such scrutiny does not imply questioning of the underlying ecological and social justice imperatives. The greater the respect for the diagnosis of a need for transformation, the greater the responsibility to be sure about the prescriptions of authoritarianism.

3. Anthropocene Planetary Domination

The authoritarian pressures documented above are also reflected in scientific discourse. Here, even geological history is subject to reinterpretations emphasising the theme of control. For instance, the established epoch of the Holocene is a tiny 11,700 year span, oddly tacked on to the end of the preceding 1.6 million year Pleistocene epoch (Douglas *et al*. 1996). Marking the point where Earth moved out of the last of a long series of glaciations, there is little to distinguish the Holocene from previous Pleistocene interglacials, such as to justify a new scientifically-recognised epoch (Zalasiewicz *et al*. 2011). The sustaining of relative climate stability over such brief periods, is not geologically unique (Alverson *et al*. 2003). That all previous formally recognised geological epochs extend to many tens of millions of years, compounds the anomalous exceptionalism (Smil 2002). It seems in the naming of the Holocene, that aspirations to synoptic scientific objectivity are trumped by more subjectively parochial anthropocentric concerns. For it is since the most recent 'Ice Age' that specifically human activity has most strikingly intensified, and in which the fleeting span of recorded human history has played out (Pinhasi and Stock 2011).

The relevance of all this to 'control' is many-fold. First, it arises because the subjective human exceptionalism that helps shape this scientific acceptance of an anomalously tiny Holocene epoch, is now being compounded by recent moves to add a further even more eccentrically miniscule 'Anthropocene' epoch of just a few hundred years duration (Crutzen 2002). Crucially, this is defined explicitly by reference to notional 'human control' and 'domination' (Crutzen and Schwagerl 2011; Vitousek *et al*. 1997; Steffen *et al*. 2011) variously of 'Earth's ecosystems' (Vitousek *et al*. 1997) or wider 'biological, chemical and geological processes' (Crutzen and Schwagerl 2011). So, control also becomes the central theme in a recast human history, asserting the setting of a very specific destiny of planetary domination from the time when people first 'learned how to control and manipulate fire' (Steffen *et al*. 2011). And control becomes the elaborate constitutive focus in a commanding new science (sometimes called 'geocybernetics' (Schellnhuber and Kropp 1998)) aspiring to 'tak[e] control of Nature's realm' (Crutzen and Schwagerl 2011). Thus is brought into being 'humanity as a self-conscious control force that has conquered the planet' (Schellnhuber 1999).

As in environmental authoritarianism, these relations of control are closely associated with an undifferentiated human 'we' (Lövbrand *et al*. 2009). In one sense, the aim here is positively to emphasise collective responsibility and solidarity. But a powerful effect is also to assert an imaginary singularity and homogeneity in human conditions, structures and agencies. There is an implication that the massive planetary impacts in question are exclusive (even necessary) consequences of inherently shared attributes of 'humanity', instead of far more specific, contingent (and remediable) social, economic, technological and political orders. Indeed, it is intrinsic to the explicit policy prescriptions of this 'Anthropocene domination' discourse, that there exist institutions and procedures for 'Earth systems management' under which 'humanity' might cease to exercise such impact. Although (as will be argued) issue might be taken with the underlying understandings, values and prescriptions, this aspect is at least a laudable message of hope. But the fact of the prescribed orders still being 'human', does mean that – even under this 'planetary management' perspective – the driving forces, equally of the negative impacts and the prospective positive responses, are not about 'humanity' in some undifferentiated sense. What is at issue is not humanity in general, but particular – critically distinct – economies, institutions, infrastructures and cultures. To obscure this, is to suppress the crucial politics of transformation.

There is a further point resting more directly on control. Given that 'human control' is held to be so diagnostic of the Anthropocene, it is paradoxical that much of this literature also calls urgently 'for

identification of mechanisms amenable to human control' (Ehlers and Krafft 2006). If such mechanisms are acknowledged not yet even to have been identified, one wonders how the presumptive current 'control' is already exercised? And why, if 'control' is so negative in retrospect, should it be seen so optimistically in prospect (Lövbrand *et al.* 2009)? In a similar way to some ideas around the 'crisis of capitalism' in Marxism (Milios 1995), or of grace in Christian theology (Nelson 2011), a paradoxical conjunction appears here of diagnosed inevitability and prescribed urgent action. It seems the Anthropocene is framed from the outset as much as a normative doctrine as a scientific analysis? It is a mirror in which can be seen reflected, the aspiringly self-fulfilling vision of a 'human' (or more specific?) destiny to 'control'.

This leads to a further telling feature of 'the Anthropocene'. As with 'the Nexus' more widely, it is clear that aggregate environmental impacts of diverse global economies are truly devastating. But for humans to exert unintended impacts is very different from exercising collectively intentional control. Indeed, some Anthropocene literature does acknowledge that even 'self-control of mankind' remains a speculative scenario (Faroult 2009). Serious wider questions are raised over who exactly is doing the controlling; to what ends; how enacted; and on which systems (Lövbrand *et al.* 2009)? Beyond this, there are seriously intractable questions over what might even be meant by control in the first place. As with multi-layered webs of genetic relations in genealogy, patterns of influence in the real world are embarrassingly less definitive than is routinely claimed (Neale *et al.* 2002). To reduce complex recursive patterns of causal influence to simple supposedly discrete lines of control, is as obviously a product of cultural contingency and political expediency as reducing genetic relations to linear patronymic chains (King and Jobling 2009). But the bottom line is, when has humanity as a whole even undertaken – let alone controlled, still less achieved – any single explicitly and collectively deliberate end? Rhetorics of control seem themselves, ironically 'out of control'.

Perhaps the confusion might be alleviated by redefining the problematic Anthropocene concept in terms of the manifestly massive aggregate human-mediated **impacts** on the world, rather than in asserting notional human '**control**'. Or perhaps the Holocene might be more carefully, and candidly, defined in this crucially more humble way? It certainly seems redundant to retain in geology, two such ambiguously-related instances of human exceptionalism. Whatever the resulting epoch is called, there is anyhow a case for tracing global-scale human impacts back to the very early Holocene (Zimov *et al.* 2011; Balter 2011; Glikson 2014). And the difference between a starting point a few hundred and a few thousand years ago, is well below the chronological resolution for comparable geological epochs. That this rather obvious course has not been adopted, confirms that 'Anthropocene' discourse is fulfilling a rather more particular political function. Preoccupations with 'domination' are not a coincidence. The Anthropocene storyline converts implicit subjective interest in humanity and the manifest fact of unintended impacts, into a seemingly objective validation of a political programme. Behind the loose romantic references to humanity as a whole, it is the intrinsic force of this striking rhetoric, that the authority of geological science is being invoked in favour of a far more specific and politically-located destiny to 'control'.

To be fair, a growing 'Earth systems governance' literature (Biermann 2007) is often more reflective and qualified in its treatment of the political implications of 'Anthropocene' control (Raworth 2012; Leach *et al.* 2012), referring instead to apparently less deterministic notions of 'governance' and 'stewardship' (Chapin *et al.* 2011). And the attribution here of political implications to the Anthropocene Programme certainly need not imply that this is deliberate (Galaz 2013). But substitution of more nuanced terms does little to reduce the substantive tensions (Lövbrand *et al.* 2009). Despite its more open possibilities, 'governance' is still frequently addressed in terms of integrated knowledge, formal procedures, coercive instruments and individualistic leadership. And, implying 'control in absence of overarching authority', even 'stewardship' is arguably not so much about diminished control, as diminished accountability (Anon 2013). No matter how much a

governance model might emphasise 'polycentric' co-ordination (Biermann *et al*. 2012) (rather than top-down hierarchy), if it remains subordinated to a particular agency and specific ends, then the process is equally about control. And there are few more effective means invisibly to assert iniquitous managerial control, than rhetorics of equal collaboration (Stirling 2008; Hickey and Mohan 2004). So, superficial shifts in terminology do little to alter the substantive dynamics. Indeed, misleading impressions may compound them.

It is here that preoccupations with 'planetary boundaries', further illuminate Anthropocene narratives (UN 2013a). These define the 'safe operating space', within which global governance must strive to navigate a path (Rockstrom *et al*. 2009). Despite resting on the supposed indeterminacy of 'catastrophic tipping points (Hoff and Rockstrom 2013), planetary boundaries are routinely asserted as determinate and precisely known (Rockstrom *et al*. 2009). Indeed, they are typically presented as 'non-negotiable' imperatives, raising 'absolutely no uncertainty' and brooking 'no compromise' (Rockstrom 2010). It is on this basis that 'manuals' are issued (Newton 1998) for taking charge of the 'control variables of the Earth' (Rockström *et al*. 2009) and so achieving not just governance in the loosely co-ordinated sense, but unprecedentedly ambitious forms of 'planetary management' (Faroult 2009) aimed at optimising global natural cycles (Ehlers and Krafft 2006).

What is occurring here seems not only a presumptive emphasis on control, but its assertive appropriation in particular undeclared interests. The planet as a whole is subordinated as an object under an overarching undifferentiated 'human' subject. And in this passively static position the Earth is dispossessed not only of a plurality of agencies, but even of autonomous dynamics. Yet what constitutes the notionally singular dominating human agency, is itself airbrushed of any context or constituting conditionalities, l*et* alone politics. So, in the ostensible name of re-engaging society with environmental imperatives, social diversity is (ironically) actually disembedded from Nature in even more profound ways. And, as ends are further concealed and subjugated to clamouring instrumental means, the discursive constraints on space for democratic struggle seem more restrictive even than the material boundaries.

It is perhaps by appreciating this political dimension, that the paradox may be reconciled that 'control' is viewed retrospectively as negative, but prospectively as positive. For, as in the other ideological and religious doctrines mentioned above, this is how a retrospective diagnosis of 'planetary domination' can be recruited seamlessly into a narrative prescribing prospective 'planetary management'. Of course, such pre-laden politicised implications are not unique to Earth systems governance (Stirling 2010). Other areas of policy-relevant science and 'global assessment' are also widely recognised to be similarly shaped by the cultural conditions under which they are produced (Scoones 2009). The Anthropocene narrative is just one particularly acute instance of a quite general pattern that emerges into view, only when knowledge itself is recognised as political (Felt *et al*. 2008).

So, it is not as if such dynamics are entirely avoidable (Stirling 2008). Nor is there reason for undue piety or alarm. Such political drivers in science are quite routine and tractable when realised for what they are. They are more reflective of distributed social forces, than of any individually deliberate disingenuity. And they certainly do not necessarily render the implicated science thereby invalid. In particular, these political machinations in no way detract from the need very seriously to address the implications of contemporary Earth science (albeit less hubristically) for radical shifts in technological, economic and social trajectories. Indeed it is precisely where imperatives for political transformation are taken most seriously that the lesson takes a different form. In short, science for policy holds responsibilities, not only to be accurately reflective of the objective systems it is concerned to represent (Stirling 2006). It is at least equally obliged to be reflexive about the ways these representations are conditioned by the subjective practices in which 'the science', and knowledge more generally (Jasanoff 2004), are co-produced. Without this, there are dangers that Anthropocene

rhetorics of singular agency, uncompromising leadership, non-negotiability, certainty and control will be taken much too literally. Planetary management should be careful what it wishes for.

4: Democracy, Sustainability and Emancipation

So what of the queries with which this paper began? Is democracy really an 'enemy' of transformations towards Sustainability, a 'luxury' that should be 'put on hold'? Or is it rather Sustainability that is vulnerable to longstanding powerful forces that find associated transformative emancipations so threatening? If so, maybe the real questions are about whether authoritarian appropriations by incumbent interests, can make environmentalism itself an 'enemy' of the very forms of democratic struggle that gave it birth?

In the above spirit of reflexivity, these queries require careful thought about the forces and conditions under which the answers themselves are shaped. And this is as true of general talk of 'democracy' and 'Sustainability', as of more specific concepts like 'the nexus', 'the Anthropocene' or 'planetary boundaries'. In all these areas, understandings, supposedly *informing* practice, are typically at least as much *formed* by it. In other words, knowing and doing are not so much distinct as inseparable, especially when it comes to transformation. One crucial initial reflection, then, concerns how to interpret 'democracy'. It is easy for loose usage to be misunderstood, appropriated, or strategically subverted, by specific traditions, institutions or interests (Agamben *et al*. 2011). Any wider understandings of democracy wishing to transcend such parochialisms (Sen 2005; Li 1997; Leib and He 2006) must relate at root to the general dynamics of power, as featured prominently in the discussion so far. Here, the implications are as profound for knowledge and discourse as for material practice.

These issues are discussed in greater detail elsewhere (Stirling 2014b). Power is not simply about 'control or authority over others' (Anon 2013). As we have seen, it is often a more plural, multidimensional and multiscale structural phenomenon (VeneKlasen and Miller 2002; Luhmann 1995; Lukes 2005; Simon 1991; Gramsci *et al.* 1971; Bourdieu 1998; Sen 2000). But, for all the complexities, a constant common element shared across different historical and cultural settings, is that power is always about 'asymmetrically structured agency' (Stirling 2014b). Different social actors experience differing patterns of enablement and constraint in the ways they exercise their agency. And a diversity of social norms, institutions and discourses concentrate these disparate flows and contours of social and material agency in varying ways (Buss and Overton 2002; Knappett and Malafouris 2008). A reaction to this, 'democracy' in the broadest of senses can be seen, not as any formal procedural end-state, but as a complex, distributed process of never-ending **struggle** (Laclau and Mouffe 2001; Smith 2003; Marcuse 1969) for 'access by the least powerful, to the capacities for challenging power' (Stirling 2014b). Although the self-reinforcing dynamics of power doom any such success to be constantly provisional, the greater this access and the stronger the capacities for challenge, the more effective might be judged the democratic struggle (Laclau 1996), or any associated pretensions to 'democracy'.

Of course, none of this implies that any particular envisaged exercise of power is somehow necessarily inherently bad. This depends on the interests, values and aims in question. After all, the more challengingly transformative the progressive aspiration, the deeper the need for corresponding generative asymmetries in many kinds of social agency. The issue instead, is that all the diverse forms and contexts for concentrated power tend to display similar self-reinforcing tendencies. And, whatever the initial orientations, this dynamic can itself come over time to exert its own regressive effects. So, across a range of plural values and interests (and alongside the host of more specific cultural and institutional aims), this is where there arises a generally progressive role for democracy as continually adaptive struggle, challenging the self-reinforcing dynamics of power (Stirling 2014b).

Far from being in tension, then, this characterisation of democracy as struggle, displays especially strong affinities with Sustainability. This is so, both as Sustainability is currently formally defined (Voss *et al*. 2006) and as it historically came about (Brundtland 1987). After all, Sustainability was not elevated to the present highest levels of global governance by the kinds of integrated, polite, structured, ostensibly apolitical procedures currently highlighted in elite planetary management literatures (Voss *et al*. 2006; Norton 1991; Light and Katz 1996). Just as in other ongoing transformative processes of democratic struggle (Curran 2007; Woshinsky 2008) for the emancipation of oppressed classes (Thompson 1966), slaves (Davis 2014), women (Sudbury 1998; Paletschek and Pietrow-Ennker 2004; Ackelsberg 1991), ethnicities (Joseph 2006), castes (Bayly 1999; Natrajan 2011;)), workers (Rossman 2005; Kaiser 1987), peasants (Scott 1985), colonies (Fanon 1964), religions (Ruane and Todd 1996), minority cultures (Bloom and Breines 2003), sexualities (Kirsch 2000), young (Roszak 1969) and disabled people (McRuer 2006) this is driven overwhelmingly through diverse, protracted, radically-challenging and overtly-political agonistic forms of contestation of power by subaltern social movements (Mouffe 1999).

Take, for instance the development of issues around occupational hazards, resource degradation, consumer chemicals, ionising radiation, atmospheric pollution, water contamination and climate change (EEA 2013; EEA 2001). All were typically pioneered by particular suppressed communities of workers or affected people, then mobilised by wider social movements (Dryzek *et al*. 2003). Of course, the resulting political momentum was typically picked up later in various more formal ways in elite circles, often with significant incremental effect. But in each of these cases of environmental harm, it was early recognition of uncertainties that most advanced progressive causes, not assertions of 'uncompromising', 'non-negotiable' certainties (Thorpe 2010; Pellizzoni 2001). Indeed, these imperatives were at each stage strongly contested by precisely the hubristic authoritarian language now used by the kinds of mainstream, science and high-level governance institutions, which currently profess to champion Sustainability as 'planetary management'.

The same is typically true not only of the problems highlighted by Sustainability concerns, but also of the prescriptions. This can of course be seen, in the roots of many burgeoning new organisational forms, ideological sensibilities and lifestyle changes in various earlier 'countercultures' (Markoff 2006). But it is also true of more technologically mediated innovations (Willoughby 1990). For instance, wind turbines, ecological farming, super-efficient buildings, and green chemistry all also owed their pioneering origins and early development to subaltern social movements (Smith *et al*. 2013; Garud and Karnøe 2003). All were systematically marginalised, if not actively supressed, by incumbent interests in science, government and industry (Hess 2009; Peet *et al*. 2011). As potentially transformative initiatives, then, they were nurtured not so much by controlling management, as by adversarial struggle (Winner 1977). That so many of these innovations have now become central elements in prospective transformations to Sustainability, is more despite, rather than because of, 'sound scientific', 'evidence based' elite policy discourse.

It was for all these reasons that early visions of Sustainability went beyond merely highlighting environment and social justice as outcomes. Increasingly forgotten nowadays, is the intimate intertwining of environmental concerns with wider emancipatory struggle in the pioneering of the Green Movement (Bahro 1994; Bookchin 1982; Gorz 1988; Roszak 1969). By the 1980s, even the elite intergovernmental Brundtland Commission emphasised the key role for democratic struggle in their own vision of Sustainability. For Brundtland, Sustainability was inherently about achieving 'greater democracy' (Brundtland 1987: 16) through 'effective citizen participation' (Brundtland 1987: 58). This was picked up and strongly developed in the subsequent international Agenda 21 programme (UNCED 1992; Selman and Parker 1997). But this theme of democratic struggle has since become increasingly subordinated to local level implementation (Paehlke 2003). Contemporary instruments like the Millennium Development Goals (UN 2013b; UN 2000) and subsequent Sustainable Development

Goals (UNEP 2013), also sideline these crucial processes of democratic agonistic contention, amidst the clamouring instrumental concerns with metrics and outcomes (Griggs *et al*. 2012).

In conclusion, the links between democracy and Sustainability are not just contingent. At root, both are about emancipation from the concentrated power of incumbent interests (Bhaskar 2009). And this is as true of knowledge and discourse as of material practice. It is in this light, that it looks most dissonant, that contemporary high-profile debates about 'Sustainability transitions', should display such increasing preoccupations with contradictory attributes like 'integration', 'certainty', 'leadership' and 'control'. It seems that the greatest need is to emancipate understandings of transformation itself.

5: From Transition to Transformation

So much for the background in the general history and practice of Sustainability. But what has all this got to do with particular real-world prospective 'Sustainability transitions' on the ground? Even if the above account is right, does it really matter that environmental authoritarianism tends to emphasise control over accountability? What is the harm in a little over-egging of notions of Anthropocene 'planetary domination'? Might not a measure of over-assertiveness concerning the 'certainty' and 'non-negotiability' of planetary boundaries at least help galvanise attention? As has been emphasised, it is not as if existing efforts at transformation to Sustainability have hitherto been so conspicuously successful.

It is crucial to recall that the thrust of all the previously-raised concerns is not to belittle the gravity or urgency of the current nexus of imperatives around social justice and ecological disruption. The essential challenge is **how** to achieve the necessary radical technological, political, economic and cultural changes, not **whether**. Here, though, particular care needs to be taken in the light of the preceding discussion, because the shaping effects of incumbent power act on knowledge and discourse as well as more material structures (Felt *et al*. 2008). This means that neither words nor actions are always what they seem. Indeed, they can sometimes entail their apparent opposites. It also means that interventions expressly and sincerely motivated by progressive interests (in the senses defined here by reference to democratic struggle and the countering of concentrated power), may nonetheless sometimes end up being regressively counterproductive in their effects, serving beneath the concealing discourse, rather to reinforce incumbent power and suppress wider social agency. Analysis and action must get below expedient surfaces.

This is where there arises the importance of the distinction introduced at the beginning, between processes of 'transition' and 'transformation' (Stirling 2014a and 2014b). Societal transitions, it may be recalled, are mediated mainly through technological innovation implemented under structured control, presided over by incumbent interests according to tightly-disciplined knowledge, towards a particular known (presumptively shared) end. This typically emphasises integrated multidisciplinary science directed at processes of instrumental management through formal procedures in hierarchical organisations sponsored by the convening power of government (Shove and Walker 2007). Social transformations, on the other hand, are based more around wider innovations in social practices as well as technologies (Seyfang and Haxeltine 2012), driven by incommensurable, tacit and embodied knowledges, involving more diverse, emergent and unruly political re-alignments that challenge incumbent structures pursuing contending (even unknown) ends. Here there is a much stronger and more direct role for subaltern interests, social movements and civil society (Seyfang and Smith 2007), conditioning in ambiguous and less visible ways the broader normative and cultural climates in which explicitly structured procedures are set (Smith and Stirling 2007).

Of course, the utility of this distinction is heuristic (provocative and catalytic), rather than formal or definitive. The real value lies in considering implications on a concrete case by case basis, by reference to real-world examples and settings. Crucial devils will lie in details and positive or negative evaluations in the eyes of beholders. The role of technology, for instance, can in either case vary greatly (Woodhouse *et al*. 2002; Woolgar and Cooper 1999; Winner 1980; Woolgar 1993). And the point here is not to insist on particular definitions for specific words. Much existing usage of either term, often legitimately also implies the other (Grin *et al*. 2011; Driel and Schot 2013; Geels and Schot 2007). It is the contrasting connotations of the differentiated underlying processes that matter more than the words themselves. The contrast between transition and transformation is also not a dualism (Giddens 1984). Rather it is a duality (Giddens 1984), because even the concepts themselves are not

mutually exclusive, there are several ways in which each reflexively depends on (and is constituted by) the other (Stirling 2011b). Nor is it a 'dichotomy trap' (Rip 1999), in that it simply defines instead a dimension of variability for appreciating specific instances of real world dynamics (Ebrahim and Weisband 2007). The central point is rather, that if the distinction is not made (by whatever names), then governance knowledges and discourses (as well as practices) in any given sector, are vulnerable to systematic subversion by incumbent interests to channel more around expediently-controlled transition than inconveniently-emergent transformation.

Explored more thoroughly elsewhere (Stirling 2014a), there is sadly not the space here to develop examples in the requisite detail. But the point is nonetheless readily made by considering the radical implications of transformations, potentially displayed (for instance) by ecological agriculture (Pretty 2005; Pretty 2002; Feenstra 1997; Altieri 2012), zero carbon energy futures in general and renewable energy in particular (Jacobson and Delucchi 2009; Jacobson and Delucchi 2011; GEA 2012; EREC 2010; ECF 2010; PWC 2010; WWF 2011; IPCC 2012). As already touched on, these can be contrasted with characteristics of transitions towards 'sustainable intensification' based on intellectual property intensive agricultural transgenics (Baulcombe *et al.* 2009) or nuclear power (Nuttall 2005) (or even climate geoengineering (Shepherd 2009; Fleming 2010; Ridgwell *et al.* 2012; Ruddiman 2005)) as large-scale responses to climate change. These latter transitions are typically propounded by powerful incumbent interests within existing sectoral regimes (Kemp *et al.* 1998). The former possible transformations reflect knowledges, values and interests that are more marginal to the current constituting of their respectively affected regimes (Jamison 2004). Characterised, then, as a contrast between orientations for radical change driven alternatively by powerful incumbent or relatively disempowered subaltern interests, it is only the latter kinds of transformation that depend on clear roles for democratic struggle that are worthy of the understanding explicated here.

More fine-grain features of this contrast between transformation and transition can be illuminated by considering in more detail the much-proclaimed global 'renaissance' in nuclear power (Toke 2013; Nuttall 2005). Of course, when consideration is given to the actual patterns of investment and their relation to other energy technologies, the objective reality of a global nuclear renaissance is rather dubious (Dorfman 2008; Elliott 2007). But the success of this rhetoric is demonstrable (Goodfellow *et al.* 2011). Promulgated at the highest political levels and by scientific authorities ostensibly unrelated to nuclear supply chains, the effect is to condition wider knowledges and expectations in powerful ways (King 2006; King 2008; BBC 2002; DTI 2006; BBC 2007). The result in many countries, is that political pressures for green transformations in energy services and practices, driven largely by public concerns over nuclear power and sympathy for alternative transformations towards renewable energy and energy efficiency, are in fact systematically channelled by apolitical 'management' discourse, into transitions more towards nuclear power (Stirling 2014b).

Of course, general claims that nuclear power is 'green' or 'Sustainable' remain strongly criticised in any sense other than low operational carbon emissions (Elliott 2007). Nuclear waste, weapons proliferation and accident risks, and their associated authoritarian control structures, have long made nuclear an iconic target of the green movement (Dorfman 2008). The Brundtland Commission and follow-on intergovernmental processes also generally treat this technology with suspicion (Brundtland 1987). So the language of 'Sustainability transitions' is typically not used directly or explicitly of nuclear power. Although displaying many key diagnostic features of a controlled transition outlined here, initiatives explicitly identified as 'transition management' in the energy sector are typically linked in overt terms with more popular energy efficiency and renewable energy strategies (Verbong and Geels 2010; Meadowcroft 2009; Smith, Kern, *et al.* 2013). But it is precisely the central point here, that it is the attributes of power dynamics in knowledges and practices constituting transition (by contrast with transformation), that lead prospective nuclear transitions in many countries to be the perverse beneficiary of authoritarian inflections of decades of subaltern pressures that were typically

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formatively forged disproportionately in transformative opposition directly against nuclear power (Froggatt *et al*. 2013).

Further revealing examples of similar dynamics can be found in emerging global governance of climate change, arguably the principal high level arena within which issues of 'green transformation' are currently played out. Key issues arise most acutely in the concluding paragraphs of the recent summary for 'policy makers' by Working Group I of the Intergovernmental Panel on Climate Change (IPCC) (IPCC WG1 2013). That such an influential body chose (tentatively, but nonetheless momentously) to highlight a possible transition involving the diverse technologies of 'climate geoengineering', indicates the depth of the dissonance and contradiction. And assumptions adopted in the underpinning IPCC modelling exercises, further entrench these potentially self-fulfilling presumptions in favour of climate geoengineering (Bellamy 2013). So important is this for understanding the contrast being drawn here, that it is worth briefly recalling the magnitude of this disjuncture.

A 'progressive' global transformation towards genuinely "Sustainable" energy, would involve radical but entirely technically practicable, economically feasible and socially viable shifts in energy practices and services (Sovacool and Watts 2009). Although the challenges of such transformations are undoubtedly ambitious and daunting, it is clear that there exists a diversity of possible pathways through which to address them (Stirling 2009). Repeated detailed assessments show that the energy service needs of a more heavily-populated and equitable world enjoying radically higher levels of wellbeing, can be cost-effectively met (under conducive institutional conditions (Bergek and Jacobsson 2010; Neij *et al*. 2003)), entirely and solely through diverse currently-available social, organisational and technological innovations around wind, solar, biomass, hydro, ocean and geothermal power (Jacobson and Delucchi 2009; Jacobson and Delucchi 2011; GEA 2012; EREC 2010; ECF 2010; PWC 2010; WWF 2011; IPCC 2012). Crucially, these strategies offer to provide services beyond carbon reduction alone (including ambient temperature, power, mobility and industrial production) at the same time as realising other Sustainability benefits (Jacobson and Delucchi 2009; Jacobson and Delucchi 2011; GEA 2012; EREC 2010; ECF 2010; PWC 2010; WWF 2011; IPCC 2012). Yet, the impediments to an entirely renewable global energy system are not, as often claimed (Brand 2009; Lovelock 2009; Moore 2010), about intrinsic material limits on resources, technologies or economics (Kamal 2010; Sweet 2006; Scrase and MacKerron 2009; Harvey 2010; Makhijani 2007; OECD 2001; Scheer 2007; GMI 2007; Sovacool and Watts 2009; Mitchell 2010). The obstacles lie more with social and political (rather than physical or technological) obduracies, in intense resistance by incumbent interests, with sunk investments in existing energy sector infrastructures (IScrase and MacKerron 2009).

But the climate geoengineering alternative now highlighted (among others (Shepherd 2012; Bracmort and Lattanzio 2013; NRC 2003)) by the IPCC (IPCC WG1 2013) is, by contrast, 'regressive' in the sense of being aligned with entrenched existing concentrations of power extending out from the energy sector. This would use an array of entirely novel (often speculative) technologies and unprecedented global institutions aimed (in most cases, solely) at assuming directly intentional 'human' 'control' over the planetary climate (Shepherd 2009; Fleming 2010; Ridgwell *et al*. 2012; Ruddiman 2005). As with other such aspirations, this requires heroic simplifications and reductions in what is notionally controlled, in this case, global average temperature (Macnaghten and Szerszynski 2013). So, even if these strategies are successful, a host of radical uncertainties, ambiguities, variabilities and collateral vulnerabilities are thereby neglected (Bellamy *et al*. 2012; Bellamy 2013). In many instances this would require economic and political investment on a scale similar to that required for direct transformation of energy infrastructures (Goes *et al*. 2011; Klepper and Rickels 2012). Even on those few occasions where 'the costs' of climate geoengineering are claimed to be lower than those associated with direct carbon emissions mitigation (Shepherd 2012; Barrett 2007), such a case is typically made in terms of

direct costs to the operator, rather than the total costs to society (MacKerron 2014). The scale of the economic externalities is potentially enormous (Sundqvist *et al*. 2004). Yet, perhaps most crucially, most forms of climate geoengineering would leave energy (or other service) needs entirely unaddressed (Bracmort and Lattanzio 2013; Morgan and Ricke 2009), thus continuing to require likely additional capital turnover that is in any case comparable in scale with that which would have been associated with the kind of renewable energy transformation with which this kind of resource commitment would compete.

Beyond this, climate geoengineering entails a further crucial transition in global governance. Whether the envisaged technologies are successful or not, the underlying explicit intentionality alone would introduce massive expansions in political aspirations, on the truly epic 'Anthropocene' scale of 'controlling the global weather' (Hoffman 2002). The scale, extent and intensity of these entirely novel forms of intractability, responsibility and accountability are of a kind and degree that is unprecedented in human history (Hulme 2012). So, when looked at dispassionately, this contrasts starkly with the far less pronounced uncertainties and ambiguities associated with foreseeable processes of substituting new innovations and practices for climate emissions mitigation within particular sectors like renewable energy transformations (Sovacool 2009). Yet it is the manifestly more speculative and uncertain alternative of climate geoengineering, that is currently gaining such striking high-level worldwide attention within and beyond the IPCC (Bellamy 2013). That a regressive transition built around climate geoengineering is asserted in some quarters to be somehow self-evidently more tractable than a progressive transformation based on renewable energy (Low *et al*. 2011; Shepherd 2012), is an indication not only of the strength of entrenched vested interests in this sector, but of their impact on wider structures, knowledges and expectations alike (Cairns and Stirling 2014; Szerszynski *et al*. 2013).

Crucially, it seems more in the energy than climate arenas, that there exist powerful incumbent interests with large sunk investments in existing material infrastructures. And it is this 'subjective' condition of knowledge production that seems to exert a greater influence on the shaping of understandings of the prospects for transformative change, than the 'objective' conditions of the implicated social, technological and environmental systems themselves. In short, there exists no current entrenched 'climate management regime' with conservative commitments to existing practices, of a kind that would insist that new ideas and practices in this sector are 'unrealistic'. So the entrenched inertia of incumbent power concentrations goes under-countered. And this conservatism is reinforced by the general propensies of wider political incumbency of many kinds, to favour rhetorics of technical control over narratives of broader social transformation. It is this fundamental political asymmetry that is arguably responsible for increasing interest in much climate change governance debate in inherently conservative (but extremely uncertain) technologically-mediated transitions over more socially radical (but technically and physically feasible) institutional transformations. The effects are clearly very practical. But the stakes could hardly be higher.

6. Control, Care and 'Knowing Doings'

These examples illuminate a general pattern of enormous importance for considering the contrasting dynamics of transition and transformation. This concerns the near-ubiquity of 'fallacies of control' (Cunha *et al*. 1999). As discussed earlier, the intentionality of 'control', makes it a very different thing to 'impact'. So also do the colloquial (and technical) connotations of 'determination', 'domination' and 'command' make 'control' quite distinct from, say, 'influence' (Anon 2013; Fischer 2010; Simons 2005; Winner 1977). That this routine elision of domination and influence constitutes a fallacy lies in the implication that social agency can be as unqualified, exclusively and comprehensively determining as suggested by the everyday meaning of 'control'.

Yet, reflecting the fantasies of linear causal genealogies mentioned earlier, exaggerations of control are well documented in various areas of psychology (Mills 1998), organisational studies (Grey and Willmott 2005; Clegg *et al*. 2006) and politics (Jessop 2003). In all these fields, deterministic understandings are widely recognised as problematic. Indeed, idealisations of control are often better understood in these areas, more as instrumental fictions necessary for assertion of privilege, than as disinterested accounts of actuality (Mintzberg and Waters 2009; Aldrich *et al*. 1976; Krackhardt 1990; Pfeffer 1992; Thornton *et al*. 1999). For all the noisy ritual, the actual maintenance of social, institutional and economic privilege arguably depends more on rhetorical surfing of uncontrollable waves of contingency – of former British Prime Minister MacMillan's apocryphal 'events, dear boy, events' (Knowles 2006) – than on the actual exercise of material control itself (Shapiro and Bedi 2007). So, it is the political expediencies of discursive claims-making and appropriation of credit for agency, rather than any substantive efficacies of associated material practices, that most explains the prevalence of control ideologies (Foucault 1984). And what is widely recognised to be true of organisations, is even more apposite in the greater complexities and indeterminacies of wider governance (Pfeffer 1992; Parry *et al*. 1997).

Recognition of this general pattern, throws further light on narratives associated with efforts at 'Anthropocene domination' through climate geoengineering. These extend expedient control discourse beyond narrowly explicitly-political domains and into broader, ostensibly independent, scientific understandings of the Earth itself. Yet, when we think about it, the weakness, contradictions and dissonance associated with this idealisation of control are obvious. Everyday experience of seeking to exercise control over even the most specific aspects of life, can teach a salutary lesson (Somov 2010). Often, the more intensely that control is conceived or enacted, the more it tends to evaporate, or itself become subordinated to circumstance (Kirkland 2004; Tzu 1955). Even the paradigmatic archetype of control – the engineered machine – displays this paradox (Leigh 2004). The more exquisite the desired fidelity of control, the greater the necessity for reciprocal compliance with conditions for tractability (Bateson 1972). This is so, even of the most simple, specific and finely-crafted tool, which typically works only if designed and operated strictly in accordance with its inherent (contingent and recalcitrant) material qualities, constraints and propensities (Pirsig 1972).

As attention extends into the wider and more open, complexities and indeterminacies of 'real-world' (especially social) settings, the limits of idealised notions of control become ever more clear (Winner 1977). Indeed, that this is a basic feature of technological dynamics, is not necessarily a negative observation, even from self-identified technophile perspectives (Kelly 1991). But the lessons are more equivocal from many of the most canonical instances of engineering 'control', for instance, in nuclear technology (Jasanoff and Kim 2009), chemicals (Cranor 2006), military systems (Alic 2007) and genomics (Ridley 1999; Levidow 1998). All these areas provide many examples of failures of control (Taleb 2007; Starbuck and Farjoun 2005; Riddle 2002; IAEA 1991; May 1989). And these limits become

even more obvious, where the systems supposedly under control are not seen as subject to deliberate design (Alexiou *et al*. 2010). Then it is not tenable even to assert claims to authorship of the controlled systems. Indeed, perhaps it is a sensitivity to the rhetorical importance of such authorial claims that helps drive Anthropocene emphasis of human control of contemporary planetary dynamics? Yet, in 'Earth systems' (as elsewhere), it remains the case that multiple alternative accountings of causality among proliferating arrays of mutually nested and reflexively co-conditioning factors, leave any particular tracing of 'control' in any given instance significantly open to contestation (Power 2000). Adding further discursive Ptolemaic epicycles does nothing to escape this general fallacy of control (Barnes 1982).

When stripped of their instrumentality, then, claimed instances of control in interactions between societies and Nature, typically decompose into far more complex conditions of diverse mutually-adapting intentionalities and (in)tractabilities (Sawyer 2005; Latour 2013). 'Subjects' and 'objects' of control are typically more ambiguous, volatile, overlapping and reflexively inter-related than suggested (Stirling 2011b). The supposed objects of control assert, and are afforded, their own countervailing agency (Latour 2005). And even the subjects of control are themselves acknowledged to be more conditioned by, than dominating of, their own contexts (Zlatev *et al*. 2008; Giere and Moffatt 2003; MacNaghten and Urry 2001; Renfrew and Scarre 1998). The knowledges ostensibly informing control are recognised to be as much shaped by, as shaping of, action (Law and Mol 2002). So, scope for problematising control moves from merely 'means' alone, through the professed overarching 'ends', to the deeper and wider relations that co-constitute and pluralise both (Porra 2010). It is in the light of these kinds of decompositions of 'control', that elaborately-integrated interdisciplinary science and monolithic hierarchically-organised programmes of 'planetary management' appear as little more than courtly etiquettes, projecting narrowly-aspired political structure into generally-imposed cosmology (Weiner 1994).

Under these circumstances, interactions are arguably better understood as mutual relations of 'care' than of dominating 'control' (Cluff and Binstock 2001; Frankfurt 2004; Bowden 1997; Hagedorn 2013; Noddings 2002; Pellizzoni 2004). And are deliberately enacted this way, knowing practices of *care* can transcend the context-free absolutes, assertive dualisms and idealised subjugations of control (Gilligan and Richards 2009), of neatly-subordinated 'scales' and 'levels'; subjects over objects; relations after categories; actions based on knowledge; effects determined by causes; ends driving means; structure over agency (or vice versa!) (Held 2005)(Slote 2007). The obdurate realities of the world remain. But in its rebalancing of relations between subjects and objects of practice, a *caring* approach accommodates better than control, the ways in which understandings and actualities are symmetrically co-produced by action (Felt *et al*. 2013). It is not only physical, but also social, materialities that shape knowledge. Embodiments of social and natural are in this sense reciprocal and recursive (Latour 2004). Likewise, it is in *caring* for the authentic autonomous propensities of 'objects', that resistance is garnered against the subjective instrumental political and disciplinary pressures noted here, to configure understandings in the most expedient ways (Kahane 2010). Thus struggling more sincerely with the imprints of power in knowledge through the more reflexive sensibilities of care (Hagedorn 2013; Felt *et al*. 2013), human and planetary processes are no longer represented or engaged with as objectified, hierarchically-categorised structures. Instead, both in understanding and action, the social and the ecological can be openly experienced more realistically: as inter-subjective, mutually-relational dances (Ho 2003).

But this *caring* disposition does share one thing in common with Anthropocene commitments. The social and planetary processes are engaged with as intensely interconnected (Graham and Roelvink 2010). Indeed, this is arguably even more so with a caring approach than in a more controlling 'Earth systems management' paradigm (Steffen, Persson, *et al*. 2011; Folke *et al*. 2011). For the intimately co-producing dynamics between the human and the natural must be cared for not just in the

'objective' domains of societies, technologies and ecological systems. Some of their most formative effects take place subjectively, in enacting the knowledge relations that shape the understandings of these systems. So the key issues lie in the depth and openness with which these epistemic politics and knowledge power relations are acknowledged, deliberated and critically challenged in action (Leach *et al.* 2005). In this way, it is perhaps the most restrictive feature of control ideologies, that the associated one-way determinacies of knowledge over action, preclude even the thought of this kind of contention. It is thus in recognising and caring for the implications of what are in reality the more complex and symmetrical entanglements between action and knowledge, that the possibilities of care – rather than control – arguably become most salient.

But what does all this mean for more specific areas of practice? In energy pathways, agricultural futures and climate change strategies (as elsewhere), care must be taken that analysis of social dynamics does not – under instrumental pressure of patronage to '*see like a state*' some particular favoured 'transition' (Scott 1998) – simply entrench and perpetuate these misleading fallacies of control. As the examples earlier in this paper suggest, such self-reinforcing channelling by incumbency can all-too-easily lead to the opposite of the envisaged transformation. Instead, what occurs can sometimes fall short even of 'transition' as defined here (which at least involves some kind of substantive change). Where existing deeply established structures persist, concealed in merely superficial novel forms of representation or discourse, a better term might be 'transduction' (Stirling 2014a).

Be that as it may, this point applies crucially as much when contemplating the exercise of nominally democratic, as of autocratic, power in 'social control' (Collingridge 1980). The difference lies not in the notional source of legitimacy, but in the contrasting materialities of social agency enacted as 'care' or 'control' (Law and Mol 2008). Building pathways to Sustainable energy is about distributed social mobilisation, more than technological innovation (Smith 2010). Ecological agriculture is about enabling cultural and environmental diversity, not imposing 'intensified' agronomic and institutional monocultures (Altieri and Nicholls 2005). And respecting the global climate is about exercising humility and responsibility in mitigating human perturbations of an acknowledged dynamic and uncertain system (Hulme 2014; Jasanoff 2003), not about assuming assertively confident control towards some assertedly 'non-negotiable', notionally static, idealised global 'optimum' (Hulme 2009).

Of course, the diverse, complex, multidimensional, fractal dynamics of power, mean that specific concrete implications of this distinction between 'controlling' and 'caring' approaches are not self-evident in any given context. Again, devils are in details and beauties in eyes of beholders. But a clear general implication of care (in these terms, as distinct from control), is active acknowledgement of the plural and political nature both of knowledges and practices of Sustainability (Ross *et al.* 2011). This follows from the explicitly normative and relational connotations of caring, *for* values, virtues and visions that (albeit still politically contestable), transcend categorical 'givers' and 'receivers' (Hulme 2014). This contrasts with the technical instrumentalism of a presumptively singular and isolated controlling agent according to their own individual ends.

So, engaged with as care rather than control, critical creativity and action may be recognised as better invested in diverse, unruly, agonistic explicitly-political interventions, than in the orderly structures and discourses which suppress them and which they themselves subvert (Rip 1987). Entwining knowledge and action in ways that are not as separate and sequential as prescribed in notions of control, a caring disposition recognises that transformative interventions are best undertaken as combining both. Doing is not necessarily predicated on knowing. And knowing is anyhow itself constituted by doing. Openly caring engagements allow each to be undertaken as more distributed and relational than commonly represented in heroic narratives of control.

None of this is new, especially where experience is conditioned by subaltern exclusions from power. For instance, more mutualistic – caring – entanglements of knowing and doing (Hagedorn 2013), are quite well established in traditional repertoires of social movements (Sen 2003). Relatively free from the instrumental mythologising of power etiquettes, the formative energy of these overtly entangled 'knowing doings', lies not in their internal purported direct controlling force, but in the combined effects with their co-implicated reflexive reactions in their wider social environments (Stirling 2011b). In this sense, dynamics enacted like care and control are not exclusive, but co-constituting. It is arguably the more liminal provenance of care, that helps lead this side of the balance to be under-documented in the expediently codified structures of academic and policy knowledge. The less tangible nature of the associated relations and relative absence of accounting institutions and procedures compound the invisibility (Power 2000). It is by these means, that dynamics of disciplinary appropriation and cliental pressures to "see like a state", pressure compliance with hegemonic discourses of control (Scott 1998). And, as has been argued, it is often as much through the discursive assertion of these fictions, as through their attempted performance, that the realities of political privilege are actually maintained. So, a key factor in effecting transition rather than transformation, may partly lie in the very 'knowing doing' that helps constitute this distinction itself.

But examples of other particular (potentially transformative), 'knowing doings' are not entirely invisible. They might include, for instance, 'Trojan horses' (Stirling 2011b). This is where an exercise in subaltern policy analysis or political action which ostensibly takes one form, actually exerts its effects in entirely different ways. Or, learning from past experience of insurgent struggle, there are various forms of 'political judo' (Popkin and Popkin 2014), where it is the very strength of incumbency that offers the principal opportunity for less powerful actors successfully to contend against it. Also relevant is the potential for 'civilising hypocrisies' (Elster 1995). This is where incumbent power is conditioned reluctantly to re-orient itself in new directions, by the incremental ratcheting of tensions between discourse and practice.

Now is not the place fully to detail the kinds of distributed bottom-up political moves that help constitute social transformation, as distinct from transition (Stirling 2014a). The point is, that just as orientation by gridlines or fences differs from steering by compasses, these kinds of laterally transformative 'knowing doings' are not subject to the objectified categorical forces of a controlled transition. Actions are not oriented by the transcendent authority of synoptic structured grids for knowledge and practice, like controlling lines of longitude and latitude on some notionally objective and definitively-imposed map. Instead, they are steered more relationally, by the distributed spontaneously-aligning emergent interactions of myriad subjective orientations, each one centred in a polar fashion, on a different autonomously-caring subject.

It is here that the parallels between ecology and society also strike another chord. For the potential conjunction of radical and rapid realignment in social transformation is quite graphically illustrated in the abrupt shifts in direction performed every day so exquisitely (and apparently effortlessly) by the anarchistically-choreographed flocking behaviours displayed by so many other social animals. By caring equally for autonomous agency and the social collectivity within which this is embedded and constituted, flocking dispositions offer what may be more than graphic metaphor (Hildenbrandt *et al*. 2010; Hemelrijk and Hildenbrandt 2011). For similar patterns are not alien to human societies. Indeed, it is perhaps here, where the political structuring of knowledge often renders greatest blindness. Beyond the central domains of interest to power, collective autonomies of care are arguably visible in many areas of 'grassroots culture' (Zizek 1992). And comparably rapid and radical alterations of direction can also occur here, without overarching designs, integrated codifications of knowledge or power-structured programmes for action – simply by emergent lateral mutual co-ordination between autonomous subjects.

It is these dynamics of care rather than control (often agonistic), that were arguably most formative in the most impressively progressive of historical transformations mentioned earlier in this paper, in struggles for emancipating excluded classes, ethnicities, slaves, workers, colonies, women, young people and sexualities (Zerzan 1999). But it is inherent to this sensibility, that such caring dynamics must recognise themselves not to exist in isolation. It would be contradictory to deny the inevitable persistence of instances of concentrated power, with all the associated necessary fallacies of control. Indeed, there is nothing in the present analysis that precludes that this may in some degree and fashion, conditionally be contingently desirable. But the very reason for the efficacy of diverse knowing doings such as those mentioned above, is that continued presence is thereby afforded for rigid structures to serve as pivots and fulcra for more reflexive social action (Stirling 2011b; Stirling 2014b). So, whatever the intentions, what emerges in reality are messy, rumbustuous articulations of caring and controlling. And the resulting under-coherent and incommensurably structured turbulence is more like the dynamics of informal culture than the idealised formalities of policy (Jessop 2003). Therefore dynamic processes of progressive transformation might be thought of not as the controlling of determinate transitions – nor even as hubristic prescriptions to some singular normativity like that of 'care' described here – but as a more a more complex, open, multivalent and deeply plural 'culturing' (Rapport and Overing 2000; Mathews 2005) of radical social change.

7. Conclusions

This paper took its cue from growing tendencies for high profile actors in Sustainability governance debates to question (and not only implicitly), the value of 'democracy'. Emphasising multiple kinds of catastrophe, with apparently unfeasibly short periods *to* 'save the planet', active participation is seen as a threat. Acknowledging uncertainty becomes a weakness. Scepticism is a pathology, dissent an unaffordable 'luxury'. As virtues of 'responsibility' are claimed in ever narrower ways, culpabilities are increasingly externalised away from particular political structures and economic incentives, and towards 'human behaviour' in general, or humanity in an undifferentiated sense. Trust is a quality imposed by the powerful onto the powerless, not the other way around. It is in this light, that it looks like time 'to put democracy on hold' (Hickman 2010).

This chimes with emerging scientific discourses that emphasise a vision, and assert a need, for various kinds of domination and control. The Anthropocene is expressly defined to highlight these themes. Associated 'planetary boundaries' are addressed through the 'control variables' of the Earth. This is a world of 'non-negotiable' imperatives, raising 'absolutely no uncertainty', brooking 'no compromise' and requiring strong leadership. Governance is addressed not as a distributed political process, but as a more instrumentally located responsibility for 'planetary management' … 'taking control of Nature's realm'. Democracy, in this light, can become the 'enemy of nature'.

But this emerging picture is strikingly at odds with the realities both of Sustainability and democracy – and the agonistic progressive social dynamics which gave rise to both. Equally in its prioritised outcomes and its constituting processes, Sustainability has always been centrally about democratic struggle. And though the two are mutually conditioning – this is more about rudely unruly political contention **against** power, than the kinds of power-driven (and -constrained) 'integrated knowledges', 'invited engagements' (Wynne 2007) and polite policy etiquettes of 'transitions management' or 'planetary stewardship'. Just as it was arguably only in agonistic contention by social movements that high-level recognition of environmental and social justice imperatives ever came about, so too is this the best hope for sustaining them towards their promised aims.

It is this crucial lesson that current planetary management initiatives are most in danger of forgetting. Without it, there is a serious (if unintended) vulnerability to "fallacies of control". These exaggerate the efficacy of intentionally structured determinism – not because it is particularly effective in achieving radical social change, but because merely the idea helps sustain existing patterns of privilege. The prevalence of this fallacy is thus a particular example of how knowledge not only informs power, but is profoundly shaped by it. If aspirations to radical social change are to have real prospects for success, actions must be as transformative of these regressive patterns in knowledge as of more material relations. This points to engagements of care, rather than control.

In this 'caring' mode, the knowing and doing of transformation are not separate, but intimately interlinked. Neither alone is sufficient. As in the exquisite changes of direction seen in flocking behaviours in nature – and in rapid realignments in 'grassroots culture' – truly progressive social transformation is arguably only truly achieved through crucial roles by mutualistic caring dispositions, for diversity, creativity and democratic struggle, equally in knowledge and action. It is this resulting unruly horizontal interaction between contending forces of care and control that is far more like the general dynamics of grassroots culture, than the idealised vertical orderings of government, or even orderly accounts of governance more generally. Radical social change is therefore not about controlled Cartesian structures, either in knowing or doing. Instead it arises in far more incoherent, fractal, multipolar, processes emergent from myriad flocks of 'knowing doings' (like 'political judo', 'Trojan horses' and 'civilizing hypocrisies'). In the resulting turbulent flows, the cultural interplay

between loudly-proclaimed deterministic efforts at control and far less visible mutualities and agonisms of care, is best thought of not as a noun (a categorical domain of activity) but as a verb (multiple, pervasive social processes) of distributed *culturings* of radical political change (Rapport and Overing 2000; Mathews 2005).

Where instead 'Sustainability' is addressed as a determinate technical end, rather than as an emancipatory process for determining plural human and ecological ends, it betrays its own foundations (Meadowcroft 2009; Leach *et al*. 2010). Hope for genuinely progressive 'green transformations' are not about fear-driven technical compliance, but hope-inspired democratic struggle and choice. This is the challenge of 'emancipating transformation'.

References

Ackelsberg, M.A. (1991) Free Women of Spain: Anarchism and the Struggle for the Emancipation of Women, Oakland: AK Press

Adamsky, D. (2010) *The Culture of Military Innovation: the impact of cultural factors on the revolution in military affairs in Russia, the US and Israel*, Stanford: Stanford University Press

Agamben, G., Badiuo, A., Bensaid, D., Brown, W., Nancy, J., Ranciere, J., Ross, K. and Zizek, S. (2011) *Democracy in What State?,* New York: Columbia Univ Press

Aldrich, H.E., Pfeffer, J. and Aldrich, H.E. (1976) 'Environments of Organizations', *Annual Review of Sociology*, 2: 79–105

Alexiou, K., Johnson, J. and Zamenopoulos, T. (eds) (2010) *Embracing Complexity in Design*, London: Routledge

Alic, J.A. (2007) *Trillions for Military Technology: how the Pentagon innovates and why it costs so much*, New York: Palgrave MacMillan

Altieri, M.A. (2012) 'Convergence or Divide in the Movement for Sustainable and Just Agriculture', in E. Lichtfouse (ed.) *Organic Fertilisation, Soil Quality and Human Health. Sustainable Agriculture Reviews*, Dordrecht: Springer Netherlands, pp. 1–9

Altieri, M.A. and Nicholls, C.I. (2005) *Agroecology and the Search for a Truly Sustainable Agriculture*, Colonia Lomas de Virreyes: UNEP

Alverson, K.D., Bradley, R.S. and Pederson, T.F. (eds) (2003) *Palaeoclimate, Global Change and the Future*, Berlin: Springer

Amin, S., Arrighi, G., Gunder Frank, A. and Wallerstein, I. (1990) *Transforming the Revolution: social movements and the world system*, New York: Monthly Review Press

Anon (2001) 'Comparative assessment of energy options and strategies until 2025', final report of a coordinated research project 2000 – 2004 MEX / 0 / 012, Vienna: IAEA

Anon (2013) Oxford English Dictionary online, Oxford: Oxford University Press http://www.oed.com/ (19 February 2014)

Arendt, H. (1963) *On Revolution*, London: Penguin Books

Asselt, M.A. van and Rotmans, J. (2002) 'Uncertainty in Integrated Assessment Modelling: from Positivism to Pluralism, *Climatic Change*, 54: 75–105

Bahro, R. (1994) *Avoiding Social and Ecological Disaster: The Politics of World Transformation*, Bath: Gateway Books

Baker, G. (2002) *Civil Society and Democratic Theory: alternative voices*, London: Routledge

Balter, M. (2011) 'Archaeologists Say the "Anthropocene " Is Here — But It Began Long Ago', *Science*, 340.6130: 261–262

Barnes, B. (1982) *T.S. Kuhn and Social Science*, London: MacMillan

Barrett, S. (2007) 'The Incredible Economics of Geoengineering', *Environmental and Resource Economics*, 39.1: 45–54

Bateson, G. (1972) *Steps to an Ecology of Mind: collected essays in anthropology, psychiatry, evolution and epistemology*, London: Aronson

Bauchspies, W.K., Croissant, J. and Restivo, S. (2006) *Science, Technology and Society: a sociological approach*, Oxford: Oxford University Press

Baulcombe, D., Davies, B., Baulcombe, D., Crute, I., Dunwell, J., Gale, M., Jones, J., Pretty, J., Sutherland, W. and Toulmin, C. (2009) *Reaping the benefits: science and the sustainable intensification of global agriculture*, London: Royal Society

Bauman, Z. (1998) *Modernity and other Ambivalence*, London: Polity Press

Bayly, S. (1999) *Caste, Society and Politics in India from the Eighteenth Century to the Modern Age*, Cambridge: Cambridge Univ Press

BBC (2007) 'Blair defiant over nuclear plans', BBC News Channel, http://news.bbc.co.uk/1/hi/6366725.stm (20 May 2014)

BBC (2002) 'Energy review urges greener focus', BBC News, http://news.bbc.co.uk/1/hi/uk/1820244.stm (20 May 2014)

Beck, U., Blok, A., Tyfield, D. and YueYue Zhang, J. (2013) 'Cosmopolitan communities of climate risk : conceptual and empirical suggestions for a new research agenda', *Global Networks*, 1.2013: 1–21

Beddington, J. (2009) *Food, energy, water and the climate: a perfect storm of global events?*, London: Government Office for Science

Beeson, M. (2010 'The coming of environmental authoritarianism', *Environmental Politics*, 19.2: 276–294

Bellamy, R. (2013) '"Opening up" geoengineering appraisal: Deliberative Mapping of options for tackling climate change', Norwich: University of East Anglia

Bellamy, R.. Chilvers, J., Vaughan, N. E. and Lenton, T. M. (2012) 'A review of climate geoengineering appraisals', *Wiley Interdisciplinary Reviews: Climate Change*, 3.6: 597–615

Bergek, A. and Jacobsson, S. (2010) 'Are tradable green certificates a cost-efficient policy driving technical change or a rent-generating machine? Lessons from Sweden 2003-2008', *Energy Policy*, 38.3: 1255–1271

Bhaskar, R. (2009) *Scientific Realism and Human Emancipation*, London: Routledge

Biermann, F. (2007) '"Earth system governance" as a crosscutting theme of global change research', *Global Environmental Change*, 17.3-4: 326–337

Biermann, F., Abbott, K., Andersen, S., Bäckstrand, K., Bernstein, S., Betsill, M. M., Bulkeley, H., Cashore, B., Clapp, J., Folke, C., Gupta, A., Gupa, J., Haas, P. M., Jordan, A., Kanie, N., Kluvánková-Oravská, T., Lebel, L., Liveman, D., Meadowcroft., J., Mitchell, R. B., Newell, P., Oberthür. S., Olsson, L., Pattberg, P., Sánchez-Rodríguez, R., Schroeder, H., Underdal, A., Vamargo Vieira, S., Vogel, C., Young, O. R., Brock, A. and Zondervan, R. (2012) 'Transforming governance and institutions for global sustainability: key insights from the Earth System Governance Project', *Current Opinion in Environmental Sustainability*, 4.1: 51–60

BIS (Department for Business Innovation and Skills) (2011) *The Future of Food and Farming: challenges and choices for global sustainability*, London: Government Office for Science

Bizikova, L., Roy, D., Swanson, D., Venema, H.D. and McCandless, M. (2013) *The Water-Energy-Food Security Nexus: Towards a practical planning and decision support framework for landscape investment and risk management*, International Institute for Sustainable Development: Winnipeg

Bloom, A. and Breines, W. (eds) (2003) *"Takin' it to the streets": a sixties reader*, Oxford: Oxford University Press

Bookchin, M. (1982) *The Ecology of Freedom: the emergence and dissolution of hierarchy*, Palo Alto: Cheshire Books

Bourdieu, P. (1998) *Practical Reason: On the Theory of Action*, Stanford: Stanford University Press

Bowden, P. (1997) *Caring: gender-sensitive ethics*, London: Routledge

Bracmort, K. and Lattanzio, R.K. (2013) *Geoengineering: Governance and Technology Policy*, Washington: Congressional Research Service

Brand, S.(2009) *Whole Earth Discipline*, London: Penguin Books

Brook Lyndhurst (2009) 'The diffusion of environmental behaviours: the role of influential individuals in social networks, Report 1: Key findings', London: Brook Lyndhurst

Brundtland, G.H. (1987) *Report of the World Commission on Environment and Development: Our Common Future*, Oxford: Oxford University Press

Buss, S. and Overton, L. (eds) (2002) *Contours of Agency: Essays on Themes from Harry Frankfurt*, Cambridge: MIT Press

Cairns, R. and Stirling, A. (2014) '"Maintaining Planetary Systems" or "Concentrating Global Power?" High Stakes in Contending Framings of Climate Geoengineering', *Global Environmental Change* (forthcoming)

CEC (2013) Joint Declaration on The Way Forward on Renewable Energy, Brussels: Commission of the European Communities

Chapin, F.S., Power, M. E., Pickett, S. T. A., Frietag, A., Reynolds, J. A., Jackson, R. B., Lodge, D. M., Duke, C., Collins, S. L., Power, A. G. and Bartuska, A. (2011) 'Earth Stewardship: science for action to sustain the human-earth system', *Ecosphere*, 2.8: art89

Clegg, S.R., Courpasson, D. and Philips, N. (2006) *Power and Organisations*, London: Sage Publications

Cluff, L.E. and Binstock, R.H. (eds) (2001) *The Lost Art of Caring: a challenge to health professionals, families, communities, and society*, Baltimore: The Johns Hopkins University Press

Collingridge, D. (1980) *The Social Control of Technology*, Milton Keynes: Open University Press

Cranor, C.F. (2006) *Toxic Torts: science, law and the possibility of justice*, Cambridge: Cambridge University Press

Crompton, T. (2010) *Common Cause: the case for working with our cultural values*, Godalming: WWF-UK

Crouch, C. (2004) *Post Democracy*, London: Polity

Crutzen, P.J. (2002) 'Geology of mankind', *Nature*, 415(3 January): 23–4

Crutzen, P.J. and Schwagerl, C. (2011) 'Living in the Anthropocene: Toward a New Global Ethos', *Yale Environment 360*, 24 January 2011: 6–11

Cunha, M.P. e, Cunha, J.V. da and Correia, M.F. (1999) 'Scenarios for Improvisation: long range planning redeemed'. Presentation to the 15th EGOS Colloquium, Warwick, 4–6 July 1999

Curran, G. (2007) *21st Century Dissent: anarchism, anti-globalization and environmentalism*, Basingstoke: Palgrave MacMillan

Davis, D. B. (2014) *The Problem of Slavery in the Age of Emancipation*, New York: Knopf

Dean, J. (2009) *Democracy and other neoliberal fantasies: communicative capitalism and left politics*, Durham: Duke University Press

Delmas, M.A. and Burbano, V.C. (2011) 'The Drivers of Greenwashing', *California Management Review*, 54.1: 64–88

DIUS (2007) 'Rigour Respect Responsibility: a universal ethical code for scientists', Department for Innovatio, Universities and Skills, London: Government Office for Science

Dobson, A. (2011) *Sustainability Citizenship*, Weymouth: Green House

Dodds, F. and Bartram, J. (2014) 'Building Nexus Principles into the Sustainable Development Goals', declaration from the Nexus 2014: Water, Food, Climate and Energy Conference in the name of the Co-directors held at the University of North Carolina at Chapel Hill, 5–8 March 2014

Doorley, J. and Garcia, H.F. (2007), *Reputation Management: the key to successful public relations and corporate communication*, Abingdon: Taylor and Francis

Dorfman, P. (ed.) (2008) 'Nuclear Consultation: public trust in Government', Report of the Nuclear Consultation Working Group, Warwick

Douglas, I., Huggett, R. and Robinson, M. (eds) (1996) *Companion Encyclopedia of Geography, the Environment and Humankind*, London: Routledge

Drexler, E., Peterson, C. and Pergamit, G. (1991) *Unbounding the Future: the Nanotechnology Revolution*, New York: Quill

Driel, H. Van and Schot, J. (2013) 'Radical Innovation as a Multilevel Process Introducing Floating Grain Elevators in the Port of Rotterdam', *Technology and Culture*, 46.1: 51–76

Dryzek, J.S. (2008) *Democratization as Deliberative Capacity Building*, Canberra: Australian National University

Dryzek, J.S., Downs, D., Hernes, H. and Schlosberg, D. (2003) *Green States and Social Movements: environmentalism in the United States, United Kingdom, Germany and Norway,* Oxford: Oxford University Press

DTI (2006) *The Energy Challenge - Energy Review Report 2006*, London: Department for Trade and Industry

Ebrahim, A. and Weisband, E. (eds) (2007) *Global Accountabilities: participation, pluralism and public ethics*, Cambridge: Cambridge University Press

ECF (2010) *Roadmap 2050: a practical guide to a prosperous, low carbon Europe*, Brussels: European Climate Foundation

EEA (2001) *Late lessons from early warnings: the precautionary principle 1896–2000,* European Environment Agency Report No22/2001, Copenhagen: EEA

—— (2013) *Late lessons from early warnings: science, precaution, innovation*, European Environment Agency Report No1/2013, Copenhagen: EEA

Ehlers, E. and Krafft, T. (eds) (2006) *Earth System Science in the Anthropocene*, Berlin: Springer

Ekins, P., McDowall, W. and Zenghelis, D. (2014) *Greening the Recovery: the report of the UCL Green Economy Policy Commission*, London: University College London

Elliott, D. (ed.) (2007) *Nuclear or Not? Does Nuclear Power Have a Place in a Sustainable Future,* Basingstoke: Palgrave MacMillan

Elster, J. (1995) 'Strategic uses of argument' in K. Arrow, R. H. Mnookin, L. Ross, A. Tversky and R. B. Wilson (eds) *Barriers to Conflict Resolution*, New York: W. W. Norton and Company

EREC (2010) *Rethinking 2050: a 100% renewable energy vision for the European Union*, Brussels: European Renewable Energy Council

Euractiv (2010) '"Guilt card" to force green behaviour on consumers?', www.Euractiv.com (4/6/2010: 1–2)

Fanon, F. (1964) *Toward the African Revolution*, New York: Grove Press

Faroult, E. (ed.) (2009) *The World in 2025: contributions from an expert group*, Brussels: European Commission

Feenstra, G.W. (1997) 'Local Food Systems and Sustainable Communities', *American Journal of Alternative Agriculture*, 12.1: 28–36

Felt, U. and Wynne, B. (2008) *Taking European knowledge society seriously,* report of the Expert Group on Science and Governance to the Science, Economy and Society Directorate, Directorate-General for Research, European Commission, Brussels: European Commission

Felt, U., Barben, D., Irwin, A., Joly, P-B., Rip, A., Stirling, A. and Stöckelová, T. (2013) *Science in Society: caring for our futures in turbulent times*, ESF Science Policy Briefing, Strasbourg: Standing Committee for the Social Sciences

Fischer, F.M. (2010) *The Application of the Controllability Principle and Managers' Responses: a role theory perspective*, Wiesbaden: Gabler

Fleming, J.R. (2010) *Fixing the Sky: the checkered history of weather and climate control*, New York: Columbia University Press

Folke, C., Jansson, A., Rockström, J., Olsson, P., Carpenter, S. R., Chapin III, F. A., Crépin, A-S., Daily, G., Danell, K., Ebbesson, J., Elmqvist, T., Galaz, V., Moberg, F., Nilsson, M., Österbom, H., Ostrom, E., Persson, A., Peterson, G., Polasky, S., Steffen, W., Walker, B. and Westley, F. (2011 'Reconnecting to the Biosphere', *Ambio*, 40.7: 719–738

Foucault, M. (1984) The Foucault Reader (P. Rainbow (ed.)), New York: Pantheon

Frankfurt, H.G. (2004) *The Reasons of Love*, Princeton: Princeton University Press

Froggatt, A., Schneider, M., Hosokawa, K., Thomas, S., Yamaguchi, Y. and Hazemann, J. (2013) *World Nuclear Industry Status Report 2013*, Paris: World Nuclear Industry Status Report

Fukuyama, F. (1992) *The End of History and the Last Man*, New York: MacMillan

—— (2002) *Our Posthuman Future: consequences of the biotechnology revolution*, New York: Farrar, Straus and Giroux

Furedi, F. (2009) *Socialisation as behaviour management and the ascendancy of expert authority*, Amsterdam: Vossiuspers UvA

Galaz, V. (2013) 'A "Planetary Boundaries" Straw-man', *Resilience Science*, http://rs.resalliance.org/2013/04/08/a-planetary-boundaries-straw-man/ (20 May 2014)

Gallopín, G., Hammond, A., Raskin, P. and Swart, R. (1997) *Branch Points: Global Scenarios and Human Choice*, a resource paper of the Global Scenario Group, Stockholm: Stockholm Environment Institute

Garud, R. and Karnøe, P. (2003) 'Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship', *Research Policy*, 32.2: 277–300

Gautney, H. (2010) *Protest and Organisation in the Alternative Globalization Era: NGOs, social movements and political parties*, London: Palgrave MacMillan

GEA (2012) *Global Energy Assessment Toward a Sustainable Future*, Cambridge: Cambridge University Press

Geels, F.W. and Schot, J. (2007) 'Typology of sociotechnical transition pathways', *Research Policy*, 36.3: 399–417

Geertz, C. (1973) *The Interpretation of Cultures: selected essays by Clifford Geertz*, New York: Basic Books

Giddens, A. (1984) *The Constitution of Society: outline of the theory of structuration*, Cambridge: Polity Press

Giere, R.N. and Moffatt, B. (2003) 'Distributed Cognition: Where the Cognitive and the Social Merge', *Social Studies of Science*, 33.2: 301–310

Gilligan, C. and Richards, D.A.J. (2009) *The Deepening Darkness: patriarchy, resistance and democracy's future*, Cambridge: Cambridge University Press

Glikson, A.Y. (2014) *Evolution of the Atmosphere, Fire and the Anthropocene Climate Event Horizon*, Berlin: Springer

GMI (Global Markets Institute) (2007) *Alternative Energy : A Global Survey*, New York: Goldman Sachs

Goes, M., Tuana, N. and Keller, K. (2011) 'The economics (or lack thereof) of aerosol geoengineering', *Climatic Change*, 109.3–4: 719–744

Goldacre, B. (2009) *Bad Science*, London: Harper

Goodfellow, M.J., Williams, H.R. and Azapagic, A. (2011) 'Nuclear renaissance, public perception and design criteria: An exploratory review', *Energy Policy*, 39.10: 6199–6210

Gorz, A. (1988) *Critique of Economic Reason*, London: Verso

Graham, J.K.G. and Roelvink, G. (2010) 'An Economic Ethics for the Anthropocene.', *Antipode*, 41: 320–346

Gramsci, A., Hoare, Q and Smith, G. N. (eds) (1971) *Selections from the Prison Notebooks of Antonio,* New York: International Publishers

Grant, R.W. (ed.) (2011) *In Search of Goodness*, Chicago: University Chicago Press

Grey, C. and Willmott, H. (eds.) (2005) *Critical Management Studies: a reader*, Oxford: Oxford University Press

Griggs, D. Stafford-Smith, M., Gaffney, O., Rockström, J., Öhman, M. C., Shyamsundar, P., Steffen, W., Glaser, G., Kanie, N. and Noble, I. (2012) 'Sustainable development goals for people and planet', *Nature*, 495: 305–7

Grin, J., Rotmans, J. and Schot, J. (2011) 'On patterns and agency in transition dynamics: Some key insights from the KSI programme', *Environmental Innovation and Societal Transitions*, 1.1: 76–81

Haan, J. de and Sierman, C.L.J. (1996) 'New Evidence on the Relationship between Deomocracy and Economic Growth', *Public Voice*, 86.1/2: 175–198

Hagedorn, S. (2013) 'The politics of caring: the role of activism in primary care', *Advances in Nursing Science*, 17.4: 1–11

Hall, P.A. and Siskice, D. (eds.) (2001) *Varieties of Capitalism: the institutional foundations of comparative advantage*, Oxford: Oxford University Press

Harvey, L.D.D. (2010) *Carbon-Free Energy Supply*, London: Earthscan

Held, V. (2005) *The Ethics of Care: personal, political and global*, Oxford: Oxford University Press

Hemelrijk, C.K. and Hildenbrandt, H. (2011) 'Some causes of the variable shape of flocks of birds', *PloS one*, 6.8: 22479

Hendriks, C.M. and Grin, J. (2007) 'Contextualizing Reflexive Governance: the Politics of Dutch Transitions to Sustainability', *Journal of Environmental Policy and Planning*, 9.3–4: 333–350

Hess, D.J. (2007) *Alternative Pathways in Science and Industry: activism, innovation and the environment in an era of globalisation*, Cambridge: MIT Press

—— (2009) *Localist Movements in a Global Economy: sustainability, justice, and urban development in the United States*, Cambridge: MIT Press

Hewlett, N. (2007) *Badiou, Balibar, Ranciere: rethinking emancipation*, London: Continuum

Hickey, S. and Mohan, G. (eds) (2004) *Participation: from tyranny to transformation: exploring new approaches to participation in development*, Londion: Zed Books

Hickman, L. (2010) 'James Lovelock: Humans are too stupid to prevent climate change', *Guardian*, 29 March: 2–5

Hildenbrandt, H., Carere, C. and Hemelrijk, C.K. (2010) 'Self-organized aerial displays of thousands of starlings: a model', *Behavioral Ecology*, 21.6: 1349–1359

Ho, M.W. (2003) 'Dance of life: Holistic science', *Resurgence*, 1.216: 18–19

Hodgson, G.M. (1999) *Economics and Utopia: Why the learning economy is not the end of history*, London: Routledge

Hoff, H. (2011) 'The Water, Energy and Food Security Nexus: solutions for a green economy', background paper for the Bonn 2011 Nexus Conference, Stockholm

Hoff, M. and Rockstrom, J. (2013) 'Johan Rockstrom: Protecting the Earth's Systems from Catastrophic Failure', *Ensia*: 1–5, Available at: http://ensia.com/interviews/johan-rockstrom-protecting-the-earths-systems-from-catastrophic-failure (19 February 2014)

Hoffman, R.N. (2002) 'Controlling the global weather', *Bulletin of the American Meteoroloigcal Society*, 83.2: 241–248

Hulme, M. (2009) *Why We Disagree About Climate Change*, Cambridge: Cambridge University Press

—— (2010) 'Cosmopolitan Climates: Hybridity, Foresight and Meaning', *Theory, Culture and Society*, 27.2-3: 267–276

—— (2012) 'Climate change: Climate engineering through stratospheric aerosol injection', *Progress in Physical Geography*, 36.5: 694–705

—— (2014) 'Climate Change and Virtue: An Apologetic', *Open Access Humanities*, 3: 1–13

IAEA (1991) *The International Chernobyl Project: an overview - assessment of radiological consequences and evaluation of protective measures*, Vienna: International Atomic Energy Agency

IPCC (2012) *Renewable energy sources and climate change mitigation: special report of the Intergovernmental Panel on Climate Change*, Cambridge: Cambridge University Press

IPCC WG1 (2013) *Fifth Assessment Report: Summary for Policymakers*, Report of Working Group 1 of the Intergovernmental Panel of Climate change, Geneva: PPCC

Jacobson, M.Z. and Delucchi, M. (2011) 'Providing all global energy with wind, water, and solar power, Part I: Technologies, energy resources, quantities and areas of infrastructure, and materials', *Energy Policy*, 39.3: 1154–1169

Jacobson, M.Z. and Delucchi, M.A. (2009) 'A Plan to Power 100 Percent of the Planet with Renewables', *Scientific American*, Novembe: 1–5

Jamison, A. (2004) *The Making of Green Knowledge: environmental politics and cultural transformation,* Cambridge: Cambridge University Press

Jasanoff, S. (2003) 'Technologies of Humility: citizen participation in governing science', *Minerva*, 41: 223–244

—— (2010) 'A New Climate for Society', *Theory, Culture and Society*, 27.2-3: 233–253

Jasanoff, S. (ed.) (2004) *States of Knowledge: the co-production of science and social order*, London: Routledge

Jasanoff, S. and Kim, S.-H. (2009) 'Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea', *Minerva*, 47.2: 119–146

Jessop, B. (2003) 'Governance and Metagovernance: on reflexivity, requisite variety, and requisite irony, in H. P. Bang (ed.) *Governance as Social and Political Communication,* Manchester: Mancheser University Publishers, pp.101–116

Johnson, V. and Simms, A. (2008) *100 Months: Technical note*, London: NEF

Joseph, P.E. (ed.) (2006) *The Black Power Movement: rethinking the civil rights - black power era*, London: Routledge

Jungk, R. (1985) *Children of the Ashes: the people of Hiroshima after the bomb*, London: Paladin

Juniper, T. (2012) 'We shouldn't simply try to change people's values when it comes to the environment', *Independent*, Friday, 20 July: 1–20

Kahane, A. (2010) *Power and Love: a theory and practice of social change*, San Francisco: Berrett-Koehler

Kaiser, D.H. (ed.) (1987) *The Workers Revolution in Russia, 1917: the view from below*, Cambridge: Cambridge University Press

Kamal, S. (2010) *The Renewable Revolution: how we can fight climate change, prevent energy wars, revitaize the economy and transition to a sustainable future*, London: Earthscan

Kelly, K. (1991) *Out of Control: the new biology of machines, social systems and the economic world*, New York: Basic Books

Kemp, R., Schot, J. and Hoogma, R. (1998) 'Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management', *Technology Analysis and Strategic Management*, 10.2: 175–198

King, D. (2006) 'David King: Why we have no alternative to nuclear power: if there were other sources of low carbon energy I would be in favour, but there aren't', *Independent,* Thursday, 13 July: 1–4

—— (2008) Debate chaired by Quentin Cooper with Sir David King, Chris Whitty and Richard Davis and Andy Stirling. BBC Radio 4, The Material World, 16 January

King, T.E. and Jobling, M.A. (2009) 'What's in a name? Y chromosomes, surnames and the genetic genealogy revolution', *Trends in Genetics*, 25.8: 351–360

Kirkland, R. (2004) *Taoism: the enduring tradition*, London: Routledge

Kirsch, M.H. (2000) *Queer Theory and Social Change*, London: Routledge

Kitschelt, H. (2000) 'Citizens , politicians , and party cartellization : Political representation and state failure in post-industrial democracies', *European Journal of Political Research*, 37: 149–179

Klepper, G. and Rickels, W. (2012) 'The real economics of climate engineering', *Economics Research International,* 2012: 0316564 http://dx.doi.org/10.1155/2012/316564

Knappett, C. and Malafouris, L. (eds) (2008) *Material Agency: towards a non-anthropocentric approach*, Berlin: Springer

Knowles, E.M. (2006) *What they didn't say: a book of misquotations*, Oxford: Oxford University Press

Krackhardt, D. (1990) 'Assessing the Political Landscape: Structure, Cognition, and Power in Organizations', *Administrative Science Quarterly*, 35.2: 342–369

Laclau, E. (1996) *Emancipation(s)*, London: Verso

Laclau, E. and Mouffe, C. (2001) *Hegemony and Socialist Strategy: towards a radical democratic politics*, London: Verso

Latour, B. (2004) *Politics of nature : how to bring the sciences into democracy*, Cambridge: Harvard University Press

⸻ (2005) *Reassembling the Social - an Introduction to Actor-Network-Theory*, Oxford: Oxford University Press

⸻ (2013) 'Facing Gaia. Six lectures on the political theology of nature', Gifford Lectures on Natural Religion, 18–28 February 2013, Edinburgh: Edinburgh University

Law, J. and Mol, A. (2002) Complexities: Social Studies of Knowledge Practice, Durham: Duke University Press

Law, J. and Mol, A. (2008) 'The Actor-Enacted: Cumbrian Sheep', in C. Knappett and L. Malafouris, (eds) *Material Agency: towards a non-anthropocentric approach*, Berlin: Springer

Leach, M. (2012) 'Sustainability, Development, Social Justice: Towards a New Politics of Innovation', in J.-C. Bolay, A. Schmid, G. Tejeda and E. Hazboun (eds) *Technologies and Innovations for Development*, Paris: Springer, pp. 19–30

⸻ (2013) 'Democracy in the Anthropocene? Science and Sustainable Development Goals at the UN', *Huffington Post* (27 March 2013)

Leach, M., Scoones, I. and Wynne, B. (2005) *Science and Citizens: globalization and the challenge of engagement*, London: Zed Books

Leach, M., Scoones, I. and Stirling, A. (2010) *Dynamic Sustainabilities: technology, environment, social justice*, London: Routledge

Leach, M., Rockström, J., Raskin, P., Scoones, I., Stirling, A. C., Smith, A., Thompson, J., Millstone, E., Ely, A., Arod, E., Folke, C. and Olsson, P. (2012) 'Transforming Innovation for Sustainability', *Ecology and Society*, 17.2: 11

Leib, E.J. and He, B. (eds) (2006) *The Search for Deliberative Democray in China*, New York: Palgrave MacMillan

Leigh, J.R. (2004) *Control Theory*, Stevenage: Institute of Electrical Engineers

Levidow, L. (1998) 'Democratizing technology - or technologizing democracy? Regulating agricultural biotechnology in Europe', *Technology in Society*, 20.2: 211–226

Lewin, L. and Vedung, E. (eds) (1980) *Politics as Rational Action: essays in public choice and policy analysis*, Dordrecht: Reidel

Li, C. (1997) 'Confucian value and democratic value', *The Journal of Value Inquiry*, 31: 183–193

Light, A. and Katz, E. (eds) (1996) *Environmental Pragmatism*, London: Routledge

Lövbrand, E., Stripple, J. and Wiman, B. (2009) 'Earth System governmentality', *Global Environmental Change*, 19.1: 7–13

Lovelock, J. (2009) *The Vanishing Face of Gaia: a final warning*, New York: Basic Books

Low, S., Gosh, A., Chen, J., Wu, R. and Blackstock, J. J. (2011) International Governance of Solar Geoengineering: Assessing the Utility and Limits of Existing International Environmental Institutions, Washington; Centre for International Governance Innovation (Waterloo), Council on Energy, Environment and Water (New Delhi); Environmental Defence Fund (Washington)

Luhmann, N. (1995) *Social Systems*, Stanford: Stanford University Press

Lukes, S. (2005) *Power: a radical view*, Basingstoke: Palgrave MacMillan

Mackenzie, M.A. (2007) *Courting the Media: Public Relations for the Accused and the Accuser*, Westport: Praeger

MacKerron, G. (2014) *Costs and economics of geoengineering*, Brighton: University of Sussex

Macnaghten, P. and Szerszynski, B. (2013) 'Living the global social experiment: An analysis of public discourse on solar radiation management and its implications for governance', *Global Environmental Change*, 23.2: 465–474

MacNaghten, P. and Urry, J. (eds.) (2001) *Bodies of Nature*, London: Sage

Makhijani, A. (2007) *Carbon-Free and nuclear-free: a roadmap for US energy policy*, Takoma Park: IEER Press

Marcuse, H. (1969) *An Essay on Liberation*, Boston: Beacon Press

Markoff, J. (2006) *What the Dormouse Said: how the 60s counterculture shaped the personal computer industry*, London: Penguin Books

Mathews, F. (2005) *Reinhabiting Reality: towards a recovery of culture*, New York: State University of New York Press

May, J. (1989) *The Greenpeace Book of the Nuclear Age: the hidden history, the human cost*, Amsterdam: Greenpeace International

May, T. (2010) *Contemporary Political Movements and the Thought of Jacques Rancière: equality in action*, Edinburgh: Edinburgh University Press

McRuer, R. (2006) *Crip Theory: culltural signs of queerness and disability*, New York: New York University Press

Meadowcroft, J. (2009) 'What about the politics? Sustainable development, transition management, and long term energy transitions', *Policy Sciences*, 42.4: 323–340

Mickey, T.J. (2003) *Deconstructing Public Relations: public relations criticism*, Mahwah: Lawrence Erlbaum

Milios, J. (1995) 'Marxist Theory and Marxism as a Mass Ideology The Effects of the Collapse of "Really Existing Socialism" on West European Marxism', *Rethinking Marxism: A Journal of Economics, Culture and Society*, 8.4: 37–41

Mills, J. A. (1998) *Control: a history of behavioural psychology*, New York: New York University Press

Mintzberg, H. and Waters, J. A. (2009) 'Of Strategies, Deliberate and Emergent', Strategic Management Journal, 6.3: 257–272

Mitchell, C. (2010) *The Political Economy of Sustainable Energy*, London: Palgrave MacMillan

Moloney, K. (2000) *Rethinking Public Relations: the spin and the substance*, London: Routledge

Moore, P.A. (2010) *Confessions of a Greenpeace Dropout: The Making of a Sensible Environmentalist*, Vancouver: Beatty Street Publishing

Morgan, M.G. and Ricke, K. (2009) *Cooling the Earth Through Solar Radiation Management: The need for research and an approach to its governance*, Geneva: International Risk Governance Council

Mouffe, C. (1999) 'Deliberative Democracy or Agonistic Pluralism', *Social Research*, 66.3: 745–758

Mouffe, C. (ed.) (1992) *Dimensions of Radical Democracy: Pluralism, Citizenship, Community*, London: Verso

Mulgan, G. (2014) *The radical's dilemma: an overview of the practice and prospects of Social and Public Labs*, NESTA Working Paper, posted at http://www.nesta.org.uk/sites/default/files/social_and_public_labs_-_and_the_radicals_dilemma.pdf

Naberhaus, M. (2011) *Effective strategies for the great transition: five leverage points for civil society organisations*, SmartCSOs Report, London

Natrajan, B. (2011) *The Culturalization of Caste in India: Identity and Inequality in a Multicultural Age*, London: Routledge

Neale, M.C., Neale, B.M. and Sullivan, P.F. (2002) 'Nonpaternity in Linkage Studies of Extremely Discordant Sib Pairs', *American Journal of Human Genetics*, 70: 526–529

NEF, 2011. *The great transition: a tale of how it turned out right*, London: New Economics Foundation

Neij, L., Anderson, P. D., Durstewitz, M., Helby, P., Hoppe-Kilpper, M. and Morthorst, P. E. (2003) *Experience Curves: A Tool for Energy Policy Assessment*, IMES/EESS Report No 40, Department of Technology and Society, Lund: KFS AB

Neill, J. O., Holland, A. and Light, A. (2008) *Environmental Values*, London: Routledge

Nelson, D.R. (2011) *Sin: a guide for the perplexed*, London: T and T Clark

Newton, P. (1998) 'A manual for planetary management', *Nature*, 741: 1998

Noddings, N. (2002) *Starting at Home: caring and social policy*, Berkeley: University of California Press

Norton, B.G. (1991) *Toward Unity Among Environmentalists*, Oxford: Oxford University Press

NRC (2003) *Critical Issues in Weather Modification Research*, Washington: National Research Council

Nuttall, W.J. (2005) *Nuclear Renaisance: Technologies and Policies for the Future of Nuclear Power*, Bristol: Institute of Physics Publishing

OECD (2001) *Toward a Sustainable Energy Future*, Paris: Organisation for Economic Cooperation and Development

—— (2005) *Society at a Glance 2005: OECD social indicators*, Paris: Organisation for Economic Cooperation and Development

Owen, R., Bessant, J. and Heintz, M. (eds.) (2013) *Responsible Innovation: managing the responsible emergence of science and innovation in society*, Chichester: Wiley

Owen, R., Macnaghten, P. and Stilgoe, J. (2012) 'Responsible research and innovation: From science in society to science for society, with society', *Science and Public Policy*, 39.6: 751–760

Oyelaran-Oyeyinka, B. and Rasiah, R. (2009) *Uneven Paths of Development: innovation and learning in Asia and Africa*, Cheltenham: Edward Elgar

Paehlke, R.C. (2003) *Democracy's Dilemma: environment, social equity and the global economy*, Cambridge: MIT Press

Paletschek, S. and Pietrow-Ennker, B. (eds) (2004) *Women's Emancipation Movements in the Nineteenth Century: a European Perspective*, Standford: Stanford University Press

Parry, R., Hood, C. and James, O. (1997) 'Reinventing the Treasury: Economic Rationalism or an Econocrat's Fallacy of Control?', *Public Administration*, 75.3: 395–415

Peet, R., Robbins, P. and Watts, M.J. (eds) (2011) *Global Political Ecology*, London: Routledge

Pellizzoni, L. (2001) 'The myth of the best argument: power, deliberation and reason', *The British Journal of Sociology*, 52.1: 59–86

—— (2004) 'Responsibility and Environmental Governance', *Environmental Politics*, 13.3: 541–565

Pfeffer, J. (1992) 'Understanding Power in Organizations' in J. Pfeffer *Managing with Power: politics and influence in organizations,* Boston: Harvard Business School Press, pp.337–347

Pielke, R. (2013) *Planetary Boundaries as Power Grab*, Roger Peilke Jnr's blog, Science Innovation, Politics, http://rogerpielkejr.blogspot.co.uk/2013/04/planetary-boundries-as-power-grab.html

Pinhasi, R. and Stock, J.T. (eds) (2011) *Human Bioarchaeology of the Transition to Agriculture*, Chichester: Wiley Blackwell

Pirsig, R.M. (1972) *Zen and the Art of Motorcycle Maintenance - an inquiry into values*, New York: Bantam

Popkin, S.L. and Popkin, S.L. (2014) 'Pacification: Politics and the Village', *Asian Survey*, 10.8: 662–671

Poppy, G.M., Chiotha, S., Eigenbrod, F., Harvey, C. A., Honzák, M., Hudson, M. D., Jarvis, A., Madise, N. J., Schreckenberg, K., Shackleton, C. M., Villa, F. and Dawson, T. P. (2014) 'Food security in a perfect storm : using the ecosystem services framework to increase understanding', *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 369

Porra, J. (2010) 'Group-level evolution and information systems: what can we learn from animal colonies in nature' in N. Kock (ed.) *Evolutionary Psychology and Information Systems Research. Integrated Series in Information Systems*. Boston: Springer, pp. 39–60

Power, M. (2000) 'The Audit Society - Second Thoughts', *International Journal of Accounting*, 119: 111–119

Pretty, J. (2002) *Agri-Culture: reconnecting people, land and nature*, London: Earthscan

Pretty, J.(ed.) (2005) *The Earthscan Reader in Sustainable Agriculture*, London: Earthscan

Przeworski, A., Pereira, L. C. B., Bruszt, L., Choi, J. J., Comisson, E. T., Cui, Z., di Tella, T., Hankiss, E., Kolarska-Bobińska, L., Laitin, D., Maravall, J. M., Migranyan, A., O'Donnell, G., Ozbudun, E., Roemer, J. E., Schmitter, P. C., Stallings, B., Stepan, A., Weffort, F. and Wiatr, J. J. (1995) *Sustainable Democracy*, Cambridge: Cambridge University Press

PWC (2010) *100% renewable electricity: A roadmap to 2050 for Europe and North Africa*, London: PricewaterhouseCoopers

Ranciere, J. (1999) *Disagreement: Politics and Philosophy*, Minneapolis: University of Minnesota Press

Ransom, D. and Baird, V. (eds) (2009) *People First Economics*, Oxford: Oxfam

Rapport, N. and Overing, J. (2000) *Social and Cultural Anthropology: The Key Concepts*, London: Routledge

Rauschmayer, F., Bauler, T. and Schäpke, N. (2013) *Towards a Governance of Sustainability Transitions: giving place to individuals*, Leipzig, http://www.incontext-fp7.eu/download

Raworth, K. (2012) *A safe and just space for humanity: can we live within the doughnut?*, Oxfam Discussion Paper, Oxford: Oxfam

Renfrew, C. and Scarre, C. (eds) (1998) *Cognition and Material Culture: the archaeology of symbolic storage*, Oxford: Oxbow

Riddle, J. (2002) *Bhopal*, New York: Chelsea House Publishers

Ridgwell, A., Freeman, C. and Lampitt, R. (2012) 'Geoengineering: taking control of our planet's climate', in *Science Sees Further* (pp.22–23), London: The Royal Society

Ridley, M. (1999) *Genome: the autobiography of a specieis in 23 chapters*, London: Harper Collins

Rifkin, J. (2012) 'The Third Industrial Revolution: how the internet, green electricity, and 3-D printing are ushering in a sustainable era of distributed capitalism', *World Finance Review*, April 2012: 8–12

Rip, A. (1987) 'Controversies as Informal Technology Assessment', *Knowledge: Creation, Diffusion, Utilization*, 8.2: 349–371

—— (1999) 'Constructive Technology Assessment' in A. Stirling (ed.) *On Science and Precaution in the Management of Technological Risk - Volume II: CaseStudies*, Sevilla: Institute for Prospective Technological Studies

Rockstrom, J. (2010) 'Let the environment guide our development' TED, http://www.ted.com/talks/johan_rockstrom_let_the_environment_guide_our_development.html (19 February 2014)

Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin III, F. S., Lambin, E., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlbert, L., Corell, R. W., Fabry, V. J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P. and Foley, J. (2009) 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity', *Ecology and Society,* 14.2: 32

Rose, C. (2014) *Beyond Class: The Motivational Values And Political Affinities of British Voters*, London, http://www.cultdyn.co.uk/ART067736u/Beyond-Class.pdf

Ross, A., Pickering Sherman, K., Snodgrass, J. G., Delcore, H. D., and Sherman, R. (2011) *Indigenous Peoples and the Collaborative Stewardship of Nature: knowledge binds and institutional conflicts*, Walnut Creek: Left Coast Press

Rossman, J. (2005) *Worker Resistance under Stalin: class and revolution on the shop floor*, Cambridge: Harvard University Press

Roszak, T. (1969) *The Making of a Counter Culture: reflections on the technocratic society and its youthful opposition*, Garden City: Doubleday

Rowell, A. (2004) *Don't worry [it's safe to eat]: the true story of GM food, BSE and foot and mouth*, London: Earthscan

Rowell, A. (1996) *Green Backlash: Global Subversion of the Environment Movement*, London: Routledge

Ruane, J. and Todd, J. (1996) *The Dynamics of Conflict in Northern ireland: power, conflict and emancipation*, Cambridge: Cambridge Univ Press

Ruddiman, W.F. (2005) *Plows, Plagues and petroleum: how humans took control of climate*, Princeton: Princeton University Press

SAC (2007) *Review of DEFRAs Ability to Compare Risks Across Different Policy Areas*, London: DEFRA Scientific Advisory Council

Sagoff, M. (2008) *The Economy of the Earth: philosophy, law and the environment*, Cambridge: Cambridge University Press

Sawyer, R.K. (2005) *Social Emergence: societies as complex systems*, Cambridge: Cambridge University Press

Schäfer, S., Steizer, H., Mass, A. and Lawrence, M. G. (2014) 'Earth's Future in the Anthropocene: Technological Interventions between Piecemeal and Utopian Social Engineering', *Earth's Future,* 2.4: 239–243

Scheer, H.(2007) *Energy Autonomy: the economic, social and technological case for renewable energy*, London: Earthscan

Schellnhuber, H. and Kropp, J. (1998) 'Geocybernetics : Controlling a Complex Dynamical System Under Uncertainty', *Naturwissenschaften*, 85: 411–425

Schellnhuber, H.J. (1999) '"Earth system" analysis and the second Copernican revolution', *Nature*, 402: C19–C23

Scoones, I. (2009) 'The politics of global assessments: the case of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD)', *Journal of Peasant Studies*, 36.3: 547–571

Scott, J.C. (1985) *Weapons of the Weak: everyday forms of peasant resistance*, New Haven: Yale University Press

—— (1998) *Seeing Like a State: how certain schemes to improve the human condition have failed*, New Haven: Yale University Press

Scrase, I. and MacKerron, G. (eds) (2009) *Energy for the Future: A New Agenda*, London: Palgrave Macmillan

Selman, P. and Parker, J. (1997) 'Citizenship, civicness and social capital in local agenda 21', *Local Environment*, 2.2: 171–184

Sen, A. (2000) *Development as Freedom*, New York: Knopf

—— (2005) *The Argumentative Indian: writings on Indian history, culture and identity*, New York: Farrar, Straus and Giroux

Sen, R. (2003) *Stir It Up: Lessons in Community Organizing and Advocacy*, San Francisco: Wiley

Senker, P. and Wyatt, S. (eds) (2000) *Technology and Inequality*, London: Routledge

Seyfang, G. and Haxeltine, A. (2012) 'Growing grassroots innovations: exploring the role of community-based initiatives in governing sustainable energy transitions', *Environment and Planning C: Government and Policy*, 30.3: 381–400

Seyfang, G. and Smith, A. (2007) 'Grassroots innovations for sustainable development: Towards a new research and policy agenda', *Environmental Politics*, 16.4: 584–603

Shapiro, I. and Bedi, S. (eds) (2007) *Political Contingency: studying the unexpected, the accidental and the unforeseen*, New York: New York University Press

Shearman, D. and Smith, J.W. (2007) *Challenge and the Failure of Democracy*, Wesport: Praeger

Shepherd, J. (ed.) (2009) *Geoengineering the climate: science, governance and uncertainty*, London: The Royal Society

Shepherd, J.G. (2012) 'Geoengineering the climate: an overview and update', *Philosophical transactions of The Royal Society. Series A, Mathematical, physical, and engineering sciences*, 370.1974: 4166–75

Shove, E. and Walker, G. (2007) 'CAUTION! Transitions ahead: politics, practice, and sustainable transition management', *Environment and Planning A*, 39.4: 763–770

Simon, R. (ed.) (1991) *Gramsci's Political Thought: an introduction*, London: Lawrence and Wishart

Simons, R. (2005) *Levers of organization design: How managers use accountability systems for greater performance and commitment*, Boston: Harvard Business School Press

Skocpol, T. (1979) *States and Social Revolutions: a comparative analysis of France, Russia and China*, Cambridge: Cambridge University Press

Slote, M. (1992) *From Morality to Virtue*, Oxford: Oxford University Press

—— (2007) *The Ethics of Care and Empathy*, Oxford: Routledge

Smil, V. (2002) *The Earth's biosphere: evolution, dynamics and change*, Cambridge: MIT Press

Smith, A. (2010) 'Civil Society in Sustainable Energy Transitions' in G. Verbong and D. Loorbach, (eds) *Governing the Energy Transition: reality, illusion, or necessity,* New York: Routledge, pp.1–31

Smith, A., Kern, F., Raven, R. and Verhees, B. (2013) 'Spaces for sustainable innovation: Solar photovoltaic electricity in the UK', *Technological Forecasting and Social Change*, 81: 115–130

Smith, A., Fressoli, M. and Thomas, H. (2013) 'Grassroots innovation movements: challenges and contributions'*, Journal of Cleaner Production*, XXX(2013): 1–11

Smith, A. and Raven, R. (2012) 'What is protective space? Reconsidering niches in transitions to sustainability', *Research Policy*, 41,6: 1025–1036

Smith, A. and Stirling, A. (2007) 'Moving Outside or Inside? Objectification and Reflexivity in the Governance of Socio-Technical Systems', *Journal of Environmental Policy and Planning*, 9.3-4: 351–373

Smith, G. (2003) *Deliberative Democracy and the Environment*, Abingdon: Taylor and Francis

Solomon, F. and Marston, R.Q. (eds) (1986) *The Medical Implications of Nuclear War*, Washington: National Academies Press

Somov, P. (2010) *Present Perfect: A Mindfulness Approach to Letting Go of Perfectionism and the Need for Control*, Oakland: New Harbinger Publications

Sovacool, B. and Watts, C. (2009) 'Going Completely Renewable: Is It Possible (Let alone Desirable)?', *The Electricity Journal*, 22.4: 95–111

Sovacool, B.K. (2009) 'Rejecting renewables: The socio-technical impediments to renewable electricity in the United States', *Energy Policy*, 37.11: 4500–4513

Starbuck, W H. and Farjoun, M. (eds) (2005) *Organization at the Limit: lessons from the Columbia disaster,* Oxford: Blackwell

Steffek, J., Kissling, C. and Nanz, P. (eds) (2008) *Civil Society Participation in European and Global Governance: a cure for the democratic deficit?*, Basingstoke: Palgrave MacMillan

Steffen, W., Grinevald, J., et al., 2011. The Anthropocene: conceptual and historical perspectives. Philosophical transactions. Series A, Mathematical, physical, and engineering sciences, 369(1938), pp.842–67.

Steffen, W., Persson, Å., Deutsch, L., Zalasiewicz, J., Williams, M., Richardson, K., Crumley, C., Crutzen, P., Folke, C., Gordon, L., Molina, M., Ramanathan, V., Rockström, J., Scheffer, M., Schellnhuber, H. J. and Svedin, U. (2011) 'The Anthropocene: From Global Change to Planetary Stewardship', *Ambio*, 40.7: 739–761

Stirling, A. (2006) 'Precaution, Foresight and Sustainability: reflection and reflexivity in the governance of science and technology chapter' in J.-P. Voss and R. Kemp, (eds) *Reflexive Governance for Sustainable Development,* Cheltenham: Edward Elgar, pp.225–272

—— (2008) '"Opening Up" and "Closing Down": Power, Participation, and Pluralism in the Social Appraisal of Technology', *Science, Technology and Human Values*, 23.2: 262–294

—— (2009) 'Afterword: The Challenge of Choice' in I. Scrase and G. MacKerron, (eds) *Energy for the Future: a new agenda*, London: Palgrave, pp.251–260

—— (2010) 'Keep it complex', *Nature*, 468: 1029–1031

—— (2011a) 'Intolerance: retain healthy scepticism', *Nature*, 471.7338: 305

—— (2011b) 'Pluralising progress: From integrative transitions to transformative diversity', *Environmental Innovation and Societal Transitions*, 1.1: 82–88

—— (2013) 'The greens are far from "finished"', *Guardian Political Science*, http://www.theguardian.com/science/political-science/2013/jul/30/greens-science-policy

—— (2014a) 'From Sustainability to Transformation: dynamics and diversity in reflexive governance of vulnerability' in A. Hommels, J. Mesman and W. E. Bijker (eds) *Vulnerability in Technological Cultures: new directions in research and governance,* Cambridge: MIT Press, pp.1–61

—— (2014b) 'Transforming power: Social science and the politics of energy choices', *Energy Research and Social Science*, 2 March 2014 (in press)

Sudbury, J. (1998) *Other Kinds of Dreams: black women's organisations and the politics of transformation*, London: Routledge

Sundqvist, T., Stirling, A. and Soderholm, P. (2004) *Electric power generation: valuation of environmental costs*, Luleå: Luleå University of Technology

Sweet, W. (2006) *Kicking the Carbon Habit: global warming and the case for renewable and nuclear energy*, New York: Columbia Univ Press

Swyngedouw, E. (2010) 'Apocalypse Forever?: Post-political Populism and the Spectre of Climate Change', *Theory, Culture and Society*, 27.2-3: 213–232

Swyngedouw, E. (2009) 'The Antinomies of the Postpolitical City : In Search of a Democratic Politics of Environmental Production', *International Journal of Urban and Regional Research*, 33(September): 601–20

Szerszynski, B., Kearnes, M., Macnaghten, P., Owen, R. and Stilgoe, J. 2013. 'Why solar radiation management geoengineering and democracy won't mix', *Environment and Planning A*, 45.12: 2809–2816

Taleb, N.N. (2007) *The Black Swan: The Impact of the Highly Improbable*, New York: Random House

Tenner, E. (1999) *Why Things Bite Back: technology and the revenge of unintended consequences*, New York: Vintage

Thaler, R.H. and Sunstein, C.R. (2008) *Nudge: improving decisions about health, wealth, and happiness*, New Haven: Yale University Press

Thompson, E. P. (1966) *The Making of the English Working Class*, New York: Knopf

Thornton, P.H., Ocasio, W. and Thornton, P.H. (1999) 'Institutional Logics and the Historical Contingency of Power in Organizations: Executive Succession in the Higher Education Publishing Industry 1958-1990', *American Journal of Sociology*, 105.3: 801–843

Thorpe, C. (2010) 'Participation as Post-Fordist Politics: Demos, New Labour, and Science Policy', *Minerva*, 48.4:389–411.

Tilly, C. (2007) *Democracy*, Cambridge: Cambridge University Press

Tilly, C. (1978) *From Mobilization to Revolution*, New York: Random House

Toke, D. (2013) 'Climate change and the nuclear securitisation of UK energy policy', *Environmental Politics*, 22.4: 553–570

Treasury (2004) Chapter 5 in *Science and Innovation Investment Framework 2004 – 2014*, London: H M Treasury, Department for Education and Skills and Department for Trade and Indusry, http://news.bbc.co.uk/nol/shared/bsp/hi/pdfs/science_innovation_120704.pdf (21 May 2014)

TSB (Technology Strategy Board) (2012) *A Synthetic Biology Roadmap for the UK*, London: UK Synthetic Biology Roadmap Strategy Board

Tzu, L. (1955) *Tao te Ching*, New York: Signet

UN (2000) *We, the Peoples: the role of the United Nations in the 21st Century*, New York: United Nations

—— (2013a) *Statement on Planetary Boundaries*, Bonn: United Nations

—— (2013b) *The Millennium Development Goals Report 2013*, New York: United Nations

UNCED (1992) *Agenda 21*, New York: United Nations Conference on Environment and Development

UNDP (2000) *World Energy Assessment: Energy and the challenge of sustainability*, New York: United Nations Development Programme

—— (2013) *Human Development Report 2013 - the Rise of the South: human progress in a diverse world*, New York: United Nations Development Programme

UNEP (2012) *21 Issues for the 21 Century: Results of the UNEP Foresight Process on Emerging Environmental Issues*, Nairobi: United Nations Environment Programme

UNEP (2013) Embedding the Environment in Sustainable Development Goals, Nairobi: United Nations Environment Programme

UNESCO and ISSC (2010) *World Social Science Report 2010 - knowledge divides*, Paris: UNESCO Publishing

VeneKlasen, L. and Miller, V. (2002) *A New Weave of Power, People and Politics*, Oklahoma City: Practical Action Publishing

Verbong, G.P.J. and Geels, F.W. (2010) 'Exploring sustainability transitions in the electricity sector with socio-technical pathways', *Technological Forecasting and Social Change,* 77.8: 1214–1221

Vitousek, P.M., Mooney, H. A., Lubchenco, J. and Melillo, J. M. (1997) 'Human Domination of Earth's Ecosystems', *Science*, 277.5325: 494–499

Voss, J., Bauknecht, D. and Kemp, R. (eds) (2006) *Reflexive Governance for Sustainable Development*, Cheltenham: Edward Elgar

Voss, J.-P. and Bornemann, B. (2011) 'The Politics of Reflexive Governance: Challenges for Designing Adaptive Management and Transition Management', *Ecology and Society*, 16.2: 9

Watts, D. (2007) *Pressure Groups*, Edinburgh: Edinburgh University Press

WBCSD (2010) *Vision 2050*, Geneva: World Business Council for Sustainable Development

Weiner, J.F. (1994) 'Myth and Metaphor' in T. Ingold, (ed.) *Companion Encyclopedia of Anthropology: humanity, culture and social life*, London: Routledge

White, R. and Stirling, A. (2013) 'Sustaining trajectories towards Sustainability: Dynamics and diversity in UK communal growing activities', *Global Environmental Change*, 23.5: 838–846

Willoughby, K.W. (1990) *Technology Choice: a critique of the appropriate technology movement*, Colorado: Westview

Winner, L. (1977) *Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought*, Cambridge: MIT Press

——— (1980) 'Do Artifacts Have Politics?', *Daedelus*, 109.1: 121–136

Wong, D.B. (2006) *Natural Moralities: a defense of pluralistic relativism*, Oxford: Oxford University Press

Woodhouse, E., Hess, D., Breymen, S. and Martin, B. (2002) 'Science Studies and Activism: Possibilities and Problems for Reconstructivist Agendas', *Social Studies of Science*, 32.2: 297–319

Woolgar, S. (1993) 'What's at Stake in the Sociology of Technology? A Reply to Pinch and to Winner', *Science, Technology and Human Values*, 18.4: 523

Woolgar, S. and Cooper, G.(1999) 'Do Artefacts Have Ambivalence? Moses' Bridges, Winner's Bridges and other Urban Legends', Social Studies of Science, 29.3: 433–449

Woshinsky, O.H. (2008) *Explaining Politics: Culture, Institutions, and Political Behavior*, London: Routledge

WWF (2011) *The Energy Report: 100% renewable energy by 2050*, Gland: World Wide Fund for Nature

Wynne, B. (2006) 'Public engagement as a means of restoring public trust in science—Hitting the notes, but missing the music?', *Community Genetics*, 9: 211–220

Wynne, B. (2007) 'Public Participation in Science and Technology: Performing and Obscuring a Political–Conceptual Category Mistake', East Asian Science, Technology and Society: an International Journal, 1.1: 99–110

Zalasiewicz, J., Williams, M., Haywood, A. and Ellis, M. (2011) 'The Anthropocene: a new epoch of geological time?', *Philosophical transactions of The Royal Society, Series A, Mathematical, physical, and engineering sciences*, 369.1938: 835–41

Zerzan, J. (ed.) (1999) *Against Civilization: readings and reflections*, Los Angeles: Feral House

Zimov, A.S.A., Chuprynin, V. I., Oreshko, A. P., Chapin III, F. S., Reynolds, J. F. and Chapin M. C. (2011) 'Steppe-Tundra Transition: A Herbivore-Driven Biome Shift at the End of the Pleistocene', *The American Naturalist*, 146.5: 765–794

Zizek, S. (1992) *Looking Awry: an introduction to Jacques Lacan through popular culture*, Cambridge Mass: MIT Press

Zlatev, J., Racine, T. P., Sinha, C. and Itkonen, E. (2008) *The Shared Mind: perspectives on intersubjectivity*, Amsterdam: John Benjamins Publishing Company