Developing post-normal technologies for sustainability

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Abstract

The last two decades have seen the development of an array of techniques and practices aimed at promoting sustainability. For many, results have been disappointing, with charges that supposedly new organizational approaches remain embedded in managerialist, functionalist and anti-dialogic frameworks that are a significant part of the problem. The technocratic scientization of public policy is similarly viewed as ill-equipped to deal with the social, economic and ecological issues currently facing neo-liberal societies. We argue that the gap between sustainability rhetoric and sustainability practices can be reconceptualised through the practice of science as post-normal and developing the notion of post-normal sustainability technologies. Post-normal science shows why stakeholder engagement in sustainability (and other scientific) issues is critical for the legitimacy and quality of decisions and the admission of complexity in decision-making and accountability processes. Post-normal technologies are tools for achieving this participation; wherein stakeholders assume expertise and interact with those possessing more traditional forms of expertise in order to co-produce knowledge about sustainability. Recognition of ideological diversity is also central to the post-normal sustainability agenda. The values-based nature of the issues involved is articulated in a way that seeks to bring politics openly into the picture.

Keywords: sustainable development, post-normal science, sustainability technologies, active citizenship, ideological diversity, dialogic engagement

1 Introduction and Context

In sustainability research there is a strong drive to stimulate institutions to take account of knowledge-making processes within risk-laden, ideologically diverse and highly uncertain environments. This paper argues that, to achieve this, we need to develop new sets of technologies and that these can fruitfully be based on the post-normal approaches to science that have been slowly emerging since the mid-1980s (notably Ravetz, 2006, 1986; Funtowicz and Ravetz, 1993; Ravetz and Funtowicz, 1999; Luks, 1999; O'Connor, 1999; Liberatore and...
Funtowicz, 2003 and contributions in Pereira et al., 2006). We believe it is now important to revisit this body of work and to refresh its applicability to contemporary ‘wicked problems’, especially related to sustainability.

We propose that the current mismatch between the rhetoric of sustainability and actual implementation of sustainability principles can be addressed by post-normal technologies that work with the complexity and uncertainty by enlisting stakeholders with diverse perspectives and multiple capacities in the co-production of sustainability know-how. It is our view that these are vital requirements for society to tackle wicked problems such as climate change, biotechnology, distributive justice, endangered species, etc. They form a suite of technologies (in the widest sense) that are emerging as contributions to tackling the highly complex, uncertain, value-laden issues facing a resource-constrained world.

It is not accepted that post-normal science should also be interpreted as an integrative approach (e.g. PCE, 2004), that is to say, one that combines many voices and reduces them to a single, consensual view. To do so fails to recognise the irreducible plurality of perspectives and modes of understanding (O’Connor, 1999, p. 673, Table 1). Post-normal science takes concepts of stakeholder input beyond simply broadening democratic participation to new processes, open dialogue and ongoing engagement. Post-normal science is based on "assumptions of unpredictability, incomplete control, and a plurality of legitimate perspectives" (Funtowicz and Ravetz, 1993, p. 739). It is transdisciplinary, context-sensitive and committed to methodological pluralism, and concepts of agonistic participation (Luks, 1999; Haag and Kaupenjohann, 2001).

Technologies, in this context, refer to interventions for the creation and use of knowledge about sustainability, which redistribute and disburse responsibility for environmental, social and cultural stewardship onto broad-ranging groups of stakeholders, including members of the public, as agents of change. Technologies also describe ways in which individuals, organisations, actor networks and governments alike provide for themselves materially, socially and politically (e.g. through forms of self-governance). Post-normal technologies require new forums for public engagement with science and technology, alongside other stakeholders with diverse interests or stakes who may have varying levels of ‘professional’ expertise. These technologies offer alternative styles of knowing to bridge gaps between science, politics and practice.
The paper is organized as follows. In the next section we review post-normal science to set up the possibility of post-normal technologies for sustainability. We then examine several technologies we have observed emerging and against which we position the building of capability for sustainable development as a key concern. We then suggest that these interventions can best be undertaken in conjunction with a review of institutional and governance structures. Finally we indicate possible leads and cautions for future development of such technologies.

2 Post-normal science

Recognition of the inherent uncertainties and value-laden nature of scientific practice, sparked by the realities of operating in risk-laden environments, brought calls for a more participative and ideologically open approach to knowledge-making in science in the mid-1980’s. Calls for the democratization of science and scientific expertise became apparent in the traditional hard areas of science, as evidenced by the emergence of post-normal science. A core body of work has since emerged (see, e.g. Ravetz, 1986; Funtowicz and Ravetz, 1993, 1997; Luks, 1998, 1999; O'Connor, 1999; Haag and Kaupenjohann, 2001; Gallopín et al., 2001; Liberatore and Funtowicz, 2003). The phrase ‘post-normal’ implies a qualitative change in the way science and policy-making are approached and draws attention to aspects of uncertainty and values that are typically down-played or ignored in more traditional research. Post-normal science is underpinned by a complexity rather than Cartesian epistemological perspective. It takes the concepts of stakeholder input and democratic participation beyond notions of Laplacian reconciliation (with its ideal of an integrated, single and internally consistent framework) to dialogic reconciliation which allows for the coexistence of a diversity of perspectives and ways of understanding (O'Connor, 1999). It thereby opens up possibilities for more inclusive, open and ongoing engagement processes.

The notion of post-normal science was first developed in contrast with Kuhn's (1970) conception of ‘normal science’. Normal science, underpinned by positivist philosophy, sought "universal, objective and context-free knowledge" (Haag and Kaupenjohann, 2001, p. 53) and was characterised by a lack of reflection on the standpoints of researchers and social actors in wider socio-political contexts. It therefore struggles to deal with the uncertainties in
real-world organizational and public policy contexts. This is so especially in relation to sustainability issues. Sustainability now characterises the new policy context for post-normal science (Ravetz, 2006, p. 279), which is about managing complexities to do with questions of survival more than addressing uncertainties to do with technological risks (ibid., p. 283). In post-normal science "complexity is respected through its recognition of a multiplicity of legitimate perspectives... and reflexivity is realised through the extension of accepted 'facts' beyond the supposedly objective productions of traditional research" (Funtowicz and Ravetz, 1997, p. 800).

Post-normal science is concerned to ensure that its methods and results are accessible to stakeholders including those who participate in quality assurance processes as part of, for example, an extended peer community (Haag and Kaupenjohann, 2001). Scientists are expected to communicate epistemic uncertainties to other stakeholders to facilitate transparent and interactive decision-making processes. This means introducing scientific material to extended peer communities as evidence and not as hard facts, as dialogue is about negotiation and not scientific demonstration (Ravetz, 2006, p.278). It requires going beyond the "mainstream" of current disciplinary and inter-disciplinary thinking that "may simply reinforce biases of the status quo" (O'Hara, 1996, p. 101). Open negotiation on complex issues helps ensure the politics surrounding sustainability are acknowledged and that various stakeholders can debate their perspectives (Funtowicz and Ravetz, 1993). It also involves accommodating the opinions of other stakeholders not previously recognised as experts, and recognising information and knowledge previously considered, perhaps, as unconstructive or irrelevant to the decision-making process.1

Strengthening knowledge diversity provides a valuable countervailing force "to the homogenizing pressures of an expanding global market" and can thus serve sustainability agendas at the local and global levels (O'Hara, 1996, p. 101). In such an approach decision-makers, stakeholders and technical advisers are viewed as working together as co-investigators – in networks of collaboration and as friendly enemies – in an open discursive community. Technical and value aspects of investigations are regarded as inextricably

1 As O'Hara (1996, p. 101) observes, the "prejudging of contributions into categories like relevant/irrelevant, educated/uneeducated, or knowledgeable/ignorant has all too often excluded contributions of women, minorities or indigenous peoples even when they have been given a place at the table".
intertwined. Though challenging for those used to more linear processes, the strength of such an approach lies in its acceptance of messiness:

While it may not be easy for all of us to cope with the messiness of an open discursive... valuation process, this messiness is where its power lies. It is the democratization of a valuation and policy process which not only integrates research and context, but offers the inclusion of numerous, vastly diverse and potentially conflicting life worlds. There is no longer only one life-world admitted, one conceptual framework shaping the valuation process, but multiple ones... this can result in an important and fruitful process of identifying a broadened, applied, and relevant research agenda (ibid., p. 102).

This approach is in marked contrast to conventional approaches where stakeholders, if they are acknowledged at all, are typically treated "as passive learners at the feet of the experts" (Funtowicz and Ravetz, 1997, p. 800). Post-normal science is concerned with fostering serious and wide-ranging discussion and debate about the "kinds of communities, characters, and cultures.... we want to help create" (Luks, 1999, p. 712 citing Throgmorton). It fosters new forms of understanding and engagement with science and technology. We argue that engagement with sustainability issues through public-private-civil partnerships (Frame and Taylor, 2005; O'Riordan, 2004), with scientists, advocates and other stakeholders, including policy-makers, is intrinsic to post-normal science and also a source of strength for self-governance of plural communities. The task of science for sustainability is, after all, “mutual learning rather than the making of blueprints” (Ravetz, 2006, p.278), as sustainability is “partly about techniques but even more about changing consciousness” (ibid., p. 279).

The current terrain of sustainability research is cluttered with a multitude of seemingly random interpretations and competing frameworks, without definable routes to implementation. It is our contention that this seemingly unordered and chaotic space becomes more navigable (though no less complex) by applying concepts of post-normality. The challenge is to develop capacities and technologies for turning complexity and uncertainty into strengths for securing progressive social and environmental change. Diez (2001) and Bebbington et al. (2007) emphasise the need to draw together people and datasets in assemblages of knowledge, often referred to as "dialogic potential”. This has to take place across local, national, regional and global scales in ways that recognise the inevitable variability in sustainability practices due to differing contexts and scales of action, but also allow for communication and accountability to go in multiple directions.
Doing sustainability is "learning by doing" and "doing through learning" that calls for different capacities and capabilities on the part of those involved (Martens, 2006). This makes sustainability a concern as much of governance (in its broadest sense) as it is of government (Adger et al., 2003; Paavola, 2006). Sustainability as a complex, experimental process benefits from the input of broad-ranging stakeholders who, together, produce knowledge about sustainability in dialogic, ad hoc and incremental ways. Sustainability issues are post-normal issues where the traditional juxtaposition of ‘hard’ facts and ‘soft’ values is overturned (Haag and Kaupenjohann, 2001, p. 53). Here the concern is to "deal with ill-defined problems... in concrete, entangled and complex economic-ecological systems, frequently involving local-global interactions, large scales, broad scopes and a high degree of uncertainty of all kinds, notably epistemic-ethical uncertainty" (ibid.)

Post-normal science, then, has begun to:

…encompass different magnitudes of scales (of time, space, and function), multiple balances (dynamics), multiple actors (interests) and multiple failures (systemic faults). [It also] has to play a major role in the integration of different styles of knowledge creation in order to bridge the gulf between science, practice, and politics (Martens, 2006, p. 36).

It reflects environmental and social concerns that are issue-driven and marked by high stakes and extreme uncertainty, where quality in relation to outcome takes precedence over expectations that a single truth - or “ethic of truth” associated with normal or positivist science (Ravetz, 2006, p. 278) - will be achieved. It engages non-scientists, but does not seek to undermine scientific expertise or the importance of scientific research. This is because “when science is involved in the policy process, it is usually not the deep theoretical obscurities that are at stake, but its relation to a real-world situation” (ibid. p, 277). Indeed much of what post-normal science will achieve will draw on the plethora of datasets, techniques and analyses already derived in the pure and applied sciences. However, it does so conscious that different disciplinary and theoretical lenses will provide "contesting parties with their own bodies of relevant, legitimated facts" which inform and are informed by different interests and normative standpoints (Sarewitz, 2004, p. 385).

Under these conditions, complexity and uncertainty become useful for leveraging the necessary interaction around the definition of sustainability issues, which leads to the co-production of sustainability knowledge. While it is difficult to achieve in practice, accommodating uncertainty as a normal part of doing science, and making it a focal point for
bringing in broad-ranging stakeholders and being responsive to multiple interests, is a powerful approach that supports sustainability policy initiatives. In this new approach uncertainty does not function as a source of unwelcome tension between scientists, policymakers and citizens. Rather, it is an aid to seeing, which generates information useful for theory building, experimentation and decision-making that may, previously, have been neglected. This co-production of sustainability knowledge is important because it disburses responsibility and accountability across numerous stakeholders. It also reinforces a more democratic governance approach, itself a key sustainability principle.\(^2\) Active dialogue can not only bring about democratic change but also "uncover barriers to change" (e.g. hidden assumptions and valuation biases) (O'Hara, 1996, p. 105).

Dialogic decision-making that works with multiple analytical perspectives is much better equipped to deal with "deep conflicts" that "include differences over the legitimate grounds for adjudicating disputes" (Baber, 2004, p. 333). Internationally there are calls for better collaborative management of natural resources that takes account of the complex nature of social–technical–environment systems (e.g. Douguet and O’Connor, 2003; Svendsen and Laberge, 2005; Dougill et al., 2006; Pahl-Wostl, 2005; Mayumi and Giampietro, 2006; Swedeen, 2006) and for recognition that science "can legitimately support... a range of competing, value-based political positions" (Sarewitz 2004, p. 386). Our proposals are cognate with these endeavours.

### 3 Post-normal sustainability technologies

It is evident then that post-normal science requires widening a discourse from a core set of experts to sets of others with different skills and competencies and, accordingly, other forms of expertise. Doing sustainability requires an assemblage of different technologies and stakeholders cooperating to manage complexities and trial and error processes. This gives rise to new forms of public/private/civic engagement with science and sustainability, as well as new forms of governance, sometimes referred to as “messy governance” (Strand and Canellas-Bolta, 2006), requiring institutional reform. Sustainability science thus generates conditions for multiple accountability and responsiveness amongst stakeholders that lead to

\(^2\) This begs the question “what type of democracy”? We have elsewhere argued in favour of an agonistic approach to democratizing for sustainability (see Brown and Frame, 2007).
relevance, and legitimacy in the knowledge being produced. Stakeholders – individuals, organisations and actor networks – have to be continuously self-critical and reflective, whilst conscious of what is at stake in their relations.

In the shift from government to governance, "science is a crucial but not exclusive form of relevant knowledge" that must be reflected in new participatory forums for decision-making (Liberatore and Funtowicz, 2003, p. 149). In these forums all stakeholders become "users, critics and producers of knowledge" (ibid.). The forums hopefully allow people to be responsible and responsive participants in regulatory processes, but in ways that are experienced as compulsory and compulsive at the same time, which relates to the self-governance aspects of active citizenship. As a form of governance, it is vital to ensure that self- and co-governance are approached in ways that are genuinely dialogic and empowering (cf Bang's 2004 warnings of how it too often constitutes a "threat to democracy"). Policy approaches that rely on conditioning and "normalising" individual practices and self-discipline too often appear as unwelcome forms of social control rather than democratic interventions (Hobson, 2002). Post-normal technologies support more decentred forms of political action and provide much-needed space for less programmed and innovative "practices of freedom" (Bang, 2004).

We turn now to examples of procedures, methods and techniques that are being developed to address the inherent weaknesses in existing processes. These are based on our own research and on our reading of the literature. The list is, by its very definition, indefinitely contingent.³ At present we propose to group techniques loosely around assemblages relating, first, to multi-actor heuristics and including a wide range of techniques used in policy, accounting and evaluation; including the overall discourse relating to sustainable consumption. Our review of these broad areas leads us to question the current institutions of governance and to pose ways in which these could be restructured to provide mechanisms more likely to yield more sustainable results.

Post-normal technologies require deliberation on issues to take place in inclusive ways that permit multiple and potentially conflicting views to be aired, understood and considered outside of existing institutions. The sort of questions it asks are “what-about/what-if”

³ As Ravetz and Funtowicz (1999, p. 642) observe, development of post-normal science is likely to bring "differing interpretations... as between scholars and activists, or between reformers and radicals". True to its own presuppositions, advocates eschew "unquestioned and unquestionable frameworks" (ibid., p. 643).
questions (Ravetz, 2006, p. 277). We will discuss later the ways in which these institutions may develop to facilitate this kind of debate. For now the focus will be on the processes required and these can be assembled as types of heuristics that have a long-term component rather than solely a tactical one. As with all post-normal approaches, there will be no definitive list or fixed typology but several approaches that can be loosely bundled under the heading of participatory or collaborative approaches to learning. Carolan (2006) and Pereira et al (2006) explore various approaches to contributory, interactional and public expertise. In this paper, we seek to group these under the following contingent headings:

- Futuring
- Active citizenship
- Dialogic accountings
- Other multi-actor heuristics

**Futuring**

Under a variety of terms, futuring (or futures studies, scenario building, foresight, and so on) has been described as “the study of the present reality from the point of view of a special interest of knowledge of the future; knowledge of the future considered characteristically as knowledge of contingent events” (Mannermaa, 1986). This “very fuzzy multi-field” (Marien, 2006) has been classified in a number of ways. For example, Inayatullah’s (1990) perspectives on futures studies included a cultural-interpretative perspective with an emphasis on understanding, negotiating and acting in order to achieve a desired future. Similarly, van Asselt Marjolein and Rijkens-Klomp (2002) explored scenario analysis as a tool for "mapping out diversity" compared with "reaching consensus”; Selin (2006) examines the importance of value judgements and the role of ‘trust’ in scenarios development; and Walz et al. (2006), for example, have used participatory scenario analysis for integrated regional modelling. Van Notten et al (2002), Börjeson et al. (2006), and Bishop et al. (2007) describe various typologies (predictive, explorative, and normative) of the overall futuring field and from these only the explorative supports the need for pluralist interpretations of future occurrences as a means of supporting decision-making processes in the present. These techniques permit open discussion on contested and uncertain topics and are ideally suited to enabling discussion around the long-term temporal issues relating to sustainability. Examples of exploratory techniques include framings of multiple realities which expose the underlying and potentially irresolvable trade-offs of capitals including the need for a more dialogic
approach (Frame et al., 2005) and as an “Opening up spaces for deliberating desirable futures” (Hoijer, 2006).

As such, and very much in keeping with the other technologies discussed in this paper, clearly only some futuring techniques provide post-normal aspects or are amenable to utilisation in post-normal ways. In other words, techniques must do more than acknowledge transdisciplinary approaches and be context-sensitive. They need to wholeheartedly embrace these values through a clear commitment to methodological pluralism and adopt participatory processes that enable alternative views to be expressed in more than token ways. This is not always the case. As with the other technologies, the futures literature is littered with examples that may have shown acknowledgement of deliberative approaches but often resulted in decision-making processes that reinforce existing modalities rather than enabling new processes that may have the potential to offer longer term alternatives to seemingly intractable wicked problems. It is this ability to provide a ‘transformative’ approach (to adopt the Freirian term) that exemplifies the post-normal from ‘business-as-usual’ and the possibility of opening up new horizons. To understand this further, we turn now to some critical appreciation of techniques that fall under the general rubric of ‘futuring’.

Wallace (2007, pp. 31–32), for example, identifies a cautionary, and highly relevant, note, namely that scenario-building is often "too socially unitary". In so doing, Wallace finds that themes of complexity, emergence, and reflection emerge, which require “an attitude that can cope with, even delight in, the transitory and unpredictable nature of events, without succumbing on the one hand to a debilitating nostalgia about what has passed, or on the other hand to an unrealistic attempt to recapture a romanticised past of transcendental or natural harmony” (ibid.). Furthermore, he draws on French philosopher Agacinski’s (2003) ethic of the ephemeral. This is not concerned with either “living for the moment” or “depriving oneself of the pleasures of the present by mourning in advance what will inevitably pass” (Agacinski, 2003, in Wallace, 2007, p. 32). Such an ethic of the ephemeral must recognise limits of human vision and the fact that these are constantly shifting, and “seek to work responsibly within them according to their unique contingencies” (Wallace, 2007, p. 32). In other words, to generate meaningful futures in a post-normal sense requires participants to have a capacity to co-create through a deepening level of awareness of various possible trade-offs and an understanding of the incomplete nature of any attempt to resolve these.
Scenario building in a post-normal sense, then, according to Wallace (2007, pp. 31–32), “should be subordinated to democratic discussion of ways of collectively orienting to the future” and be a “tool of democratic envisioning” by focusing on a social constructionist approach other than a positivist emphasis on drivers. In so doing, themes of complexity, emergence, and reflection develop. A point shared, at least in part, with Craps et al. (2004), who support the concept that differences between communities of practice (to use Wenger’s term (1998)) can be clarified using social-constructionist perspectives, such a process may not yield common ground but may well provide opportunities to deal with contradictory tensions.

To ground this notion of generating post-normal futuring in a pragmatic way requires of its facilitators a capacity to sense and co-create through a deepening level of awareness about how shifts in a group emerge and can be caused. In workshop situations this could draw on transformative learning techniques of a Freirian ilk, such as those proposed by Senge (2005), hooks (1994), or by Thomson and Bebbington (2004). Suitably facilitated, such futuring techniques are likely to enable benefits to emerge. However, this may not necessarily occur in an *a priori* predictable manner – and as such presents considerable uncertainty to risk-averse stakeholders. Furthermore, they can be resource and time intensive, subject to ‘messiness’ and may not produce organisationally convenient results. The latter often occurs as a suite of four options (frequently in a 2x2 matrix with key drivers as the axes) with polarised alternatives which can (unintentionally) guide the user to specific outcomes rather than engage with the richness and inconclusive subtleties of the essential ‘thick’ interpretation (from Adger et al., 2003, citing Geertz, 1973) where thick analysis implies the identification of connections and general patterns that are characteristic of a certain context (Geertz, 1973, pp. 25–26).

To achieve such a thick analysis requires further development in the futuring theme. Within the literature, a more distinctive post-normal form of futuring is arising – foresight knowledge and its associated assessment (Keenan et al., 2003; Von Schomberg et al., 2006; Pereira et al., 2007). In ‘fully-fledged’ foresight, the European Foundation for the Improvement of Living and Working Conditions (Keenan et al., 2003, p. 21) develops the technology as an assemblage of the following:
Planning. Here it is assumes that strategic approaches will involve qualitative as well as quantitative ones and thereby incorporate uncertainty and assume dynamic change in terms of stable structures.

Networking. This is taken as including intelligence-gathering and greater democratization and legitimacy in political processes, and

Futures studies. Here the shift from predictive approaches to more exploratory ones is assumed along with more extensive stakeholder involvement than expert-led approaches.

As with all post-normal approaches, the foresight approach specifically acknowledges that it is not intended to displace existing decision-making and planning processes but is intended to complement and inform them so as to increase their overall effectiveness.

Pereira et al. (2007) explain the post-normal aspects of foresight knowledge through a series of attributes that are by now familiar, namely that it:

- is non-verifiable since it does not give a representation of an empirical reality
- contains a high degree of uncertainty and complexity
- thematises a coherent vision of the future that includes an ‘anticipation of the unknown’
- contains an action-oriented perspective (unlike normal science, which lacks such a perspective)
- shares a hermeneutical dimension with the social sciences and the humanities whereby knowledge is subject to continuous interpretation
- is more than merely future-oriented but intent to combine normative transformability with socio-economic feasibility and scientific plausibility
- is trans-disciplinary in its approach (using the term as defined by Adger et al., 2003).

In this sense the foresight knowledge approach appears to be a post-normal maturation of that aspect of futures studies most relevant to the development of technologies in support of moves to increased sustainability. It is not, of course, by its very definition, a complete or finite process. The methodologies and instances of implementation are still at an early stage and it is likely these will need to be accompanied by other post-normal interventions if traction is to be achieved. If foresight knowledge is seen as one aspect of these, perhaps most
naturally associated with the governance dimension, then another highly relevant one is that associated with the citizen themselves.

**Active citizenship**

Citizenship is becoming increasingly important in the context of contemporary wicked problems relating to sustainability, and affects many different areas including identity, democratic participation, community empowerment and consumption. The concept of active citizenship is emerging as a way of bridging gaps between science, politics and practice, and empowering people to be responsive and responsible vis-à-vis matters of science, and sustainability. The concept enables people to be credited with multiple capacities and expertise that can support the co-production of knowledge about sustainability in dialogic forums alongside other ‘professional’ public and private experts. It is premised on lay publics being able to assume some expertise in relation to the exercise of sustainability in their own daily life contexts:

Those whose lives and livelihood depend on the solution of the problems will have a keen awareness of how the general principles are realized in their 'back yards'. They will also have 'extended facts', including anecdotes, informal surveys, and official information published by unofficial means. It may be argued that they lack theoretical knowledge and are biased by self-interest; but it can equally well be argued that the experts lack practical knowledge and have their own unselfconscious forms of bias (Funtowicz and Ravetz, 1993, p. 753).

Active citizenship is about messy governance – bringing in those who have previously being marginalized in policy formation processes and allowing for the inevitable variability in sustainability practices due to differing contexts and scales of action. However, citizenship as a critical form of political agency has often been under-emphasised in light of the prominence of consumption and consumerism.

Neo-liberal societies have tended to treat people’s consumer rights as paramount, resulting in consumption as a separate and privileged activity to citizenship (Couldry, 2004; Soper, 2004). Indeed, people’s rights and responsibilities were seen to emanate from market laws of supply and demand, including the right to demand quality (Doubleday, 2004, p. 118; Burgess, 2001); rather than from their civic responsibilities or accountabilities. This is changing. Central and local government programmes of reform are developing different ideas about citizenship – and, in particular, active citizenship – and what it means to be a citizen in order to manage the risk society. This requires different capacities and roles for individuals and
communities vis-à-vis matters of science and technology, alongside consumption choices as a way for individuals and social groups to express their beliefs, norms, political commitments and differences in a pluralist society (Cosgel and Minkler, 2004; Paavola, 2001; Seyfang 2004, 2005; see also Carter and Huby, 2005, on ethical investment consumerism). This brings the potential for social change through consumption and production activities.

Under active citizenship, the hybrid citizen-consumer becomes a political subject with internalised knowledge about sustainability issues such that sustainable development makes intuitive common sense, leading to a personal sense of responsibility and duty that gets expressed through self- and co-governance. The model of the “political economic person” (PEP) by Söderbaum (2001) has parallels with the notion of hybrid citizen-consumers. Söderbaum developed his notion of PEP in direct response to perspectives that assume “each individual maximizes her or his own utility, whatever that means in ethical terms” (2000a, p. 37). He claims that economic analyses could seek a much more pluralist approach and model of stakeholder relations “that allows for differences, as well as similarities, among individuals” (Söderbaum, 2000b, p. 438).

Söderbaum’s model of PEP requires the internalisation of broader, non-market related values into economic accounting and a better understanding of the social and cultural aspects of human behaviour in environment-technical-natural systems. PEP recognises that individuals, as part of their market transactions, consider ethical questions and the wider implications of their transactions for identifiable others and society at large (Söderbaum, 2000a, p. 37). It accommodates the possibility of cooperation on the basis of common interests, and considerations of trust and fairness; rather than contracts between parties with conflicting interests that characterise neoclassical economic models (Söderbaum, 2000b, p. 442). Post-normal technologies are linked to PEP and to citizen-consumers through the emphasis on plurality of knowledge, the inherently political nature of the issue of sustainable consumption, and the expertise attributed to individual citizens and consumers. In other words, post-normal science helps “shape a new ‘science of, by and for the people’” (Ravetz, 2006, p. 277).

The idea of sustainable consumption provides a ‘communicative’ role for consumption that is a way of inviting others “to alter their levels and patterns of consumption” (Paavola, 2001, p. 245). It assists in the signalling of sustainability ‘personas’ to others, including the intensity
of one's commitments (Cosgel and Minkler, 2004), and the forging of collective identities through social networks. Ethically informed consumer choices can potentially have significant audience effects, in terms of influencing production. However, again ideological diversity makes this a contestable process. Value pluralism recognises that “different individuals may choose to be informed and act upon different sets of values in essentially the same choice situation, and arrive at either similar or different choices” (Paavola, 2001, p. 232; see also Anderson, 1993). Conflicts arise at both the intra and inter-personal level. For example, individual consumption decisions might vary widely based on whether one takes a utilitarian or deontological approach. Social marketers may, in turn, tap into different submarkets through cause-related advertising. Similarly, ethical investment funds pitch their portfolios based on varying criteria (e.g. screening on negative or positive basis) and value orderings (Carter and Huby, 2005). Labour unions, environmentalists and religious groups, for example, might all stress different aspects of sustainability.

Sustainable consumption is thus a contested concept, subject to diverse ideological interpretations (Seyfang, 2004, 2005). For many the focus is on eco-efficiency and ‘greener’ products, with economic growth through the consumption of ‘fully-costed’ goods regarded as compatible with sustainability. In some cases, this is also viewed as requiring a concern for eco-justice and ethical trading initiatives. The emphasis is on ‘getting the prices right’ based on a range of market-based measures (e.g. polluter pays, eco-labelling, procurement policies, green taxes). Some are content to rely on voluntarist industry initiatives, while others see government regulation as essential (e.g. to ensure credible consumer information on social and environmental impacts) (Seyfang, 2004, 2005).

For others, sustainable consumption is not simply about consuming more efficiently-produced or ethical goods. A far more radical approach to redefining wealth and progress is required to achieve “a wholesale rethinking of affluent lifestyles and material consumption per se” (Seyfang 2005, p. 292). Ecological citizenship calls for “an absolute reduction in consumption to reduce the size of ecological footprints, and quite different social institutions to facilitate those choices” (ibid., p. 297). For this group, the extent to which self-reflexive

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4 Cosgel and Minkler’s (2004) work is concerned with the issue of religious identity and consumption. The PEP concept recognizes that religion may, in turn, form an important part of how one frames sustainability issues.

5 See Paavola, 2001, pp. 231–236 for illustrative examples. Note also that this incorporates a broader, more hermeneutic understanding of “rationality” than the approach taken in neo-classical economics.
consumers can progress sustainability concerns by voting with their wallets is severely limited. Seyfang (2005, p. 297) charges that it is a “category error” to pit atomised consumers against global institutions. The broader structural context means markets rarely offer real consumer choice. Barriers to a “citizenship of the market” include affordability, availability and convenience of sustainable products, individuals feeling powerless to make a difference, disenchantment with corporate marketing and governments, and preferences for goods that are not available (ibid., p. 296). Choices are shaped and constrained by institutions and political arrangements, with consumers “effectively locked in to particular consumption patterns by the overarching social structures of market, business, working patterns, urban planning and development” (ibid., p. 297; see also Sanne, 2002).

The idea of citizenship through consumption is also viewed as at risk of reinforcing neo-classical ideology. Concepts of consumer choice and sovereignty convey the message that “freedom and consumption are inextricably linked” (Hobson, 2002, p. 100). Burgess (2001, p. 106) is sceptical of an approach that encourages workers to regard themselves as consumers and spend their time shopping rather than attending trades union meetings. He calls for more emphasis on how "consumer culture has itself been socially and politically created" and "how consumption has actively been placed at the centre of contemporary life" (ibid., p. 102). To this end he illustrates how the idea of a market-led democracy has been promoted to give "an appearance of accountability" as markets have been deregulated (ibid., p. 93). The dominance of eco-modernist cost-benefit and risk management approaches are similarly viewed as having marginalized more critical discourses that problematize over-consumptive lifestyles and capitalist institutions (Oels, 2005). Consumption needs to be politicized in other ways, for example, by strengthening input from more egalitarian and less materialistic cultures and transforming power relations and recreating institutions "to enable radically different lifestyles" (Seyfang, 2005, p. 298).

While eco-modernist approaches may seem trivial to some, they can be "a useful first step along the path to greater reflection and awareness of sustainability issues and their relationship to individual behaviour" (Seyfang, 2005, p. 302). Similarly, while initiatives which focus on more localised and decentralised economics may seem utopian they can provide valuable exemplars which the mainstream can learn from. Growing interest in, and acceptance of, national accounting mechanisms that focus on ‘quality of life’ as opposed to traditional measures of GDP as indicators of wealth and progress provide one example of
how ideas once seen as ‘on the fringe’ can become influential over time (Ness et al., 2006). This reinforces the importance of diversity in social institutions that open ‘policy space’ for new approaches (e.g. local exchange trading schemes). Though initially small in scale, more radical community-based initiatives can be "important carriers of pluralistic visions" that could "grow and thrive if surrounding social conditions and social institutions... were more favourable" (Seyfang, 2005, p. 303).

In summary then, the concept of active citizenship, as a post-normal technology, can be a means by which consumption and consumer roles are politicized and critiqued. Active citizenship should be as much about consumption through citizenship as it is about citizenship through consumption, requiring evaluation (and continual re-evaluation) of what it means to be a citizen and consumer in contemporary society, and creating participatory processes and institutions that go beyond token understandings of democratic participation, dialogue and engagement.

**Dialogic accountings**

Possibilities for ‘accountings’ that foster democracy and facilitate more participatory forms of social organization have been proposed (Bebbington et al., 2007; Brown and Frame, 2007; Brown and Fraser, 2006) through theoretical and operational development of more dialogic accounting technologies. These draw on agonistic political theory to argue for an approach that respects difference and takes interpretive and ideological conflicts seriously. To this end, key principles for a critical dialogic approach utilize standpoint epistemology (Harding, 2004; Longinio, 2001) and the work of Peter Söderbaum (1982, 1999, 2000a, b, 2004, 2006, 2007) to develop the concept of positional analysis. Dialogic engagement principles underpin such an approach and show how such a model can be implemented (Bebbington et al., 2007). This requires reworking "calculation and democracy" (Power, 1992, p. 492) and a move from monologism to dialogism to develop a critical pluralist framework.

There is recognition that the complexity of sustainable development – both in terms of scientific uncertainty and ideological diversity – requires a multi-dimensional approach (e.g. a plurality of decision criteria). Furthermore, origins of sustainability assessment models
(SAMs) as a social and environmental accounting technology is more readily recognised as being polyvocal (Bebbington et al., 2007, O’Connor 2000, 2002, 2004, 2006a). Issues of subjectivity/objectivity become less of an issue, as SAMs are part of a plural interaction. As such, they are much less prone to perceptions as an objective, neutral and complete tool. The perceived non-positivist weakness of social and environmental accounting (as illustrated by scepticism in traditional accounting and neoclassical economic circles) creates strength in SAM through its explicit social constructionist epistemology.

Boyce (2000) addresses the issue of accounting as a social technology – "a form of social power" (p. 27) that may perform an enabling or constraining function. Accountants may help construct environmental and social visibilities that facilitate dialogue and debate through the provision of a broad range of non-financial as well as financial performance indicators. Or they may contribute ideologically to the "invisibility of bads" (p. 28), by ignoring or downplaying non-economic impacts:

[Social and environmental accounts] may serve either as a tool for broadening public discourse, debate, and decision making (away from an exclusive focus on financial and economic factors), or as a legitimating device to create an appearance of broader accounting and thereby facilitate the de facto dominance of financial and economic factors (p. 29, emphasis in original).

Accounting, according to, inter alia, Bebbington et al. (2007), and Boyce (2000), could have a major role in enhancing and developing accountability in a participatory democracy through promoting open and transparent decision-making by making visible costs and benefits at various levels, and exposing the standpoints and priorities of interested stakeholders. Boyce cautions against models aimed at bringing decisive closure because sustainability is a contestable concept and so social and environmental accounting should not intend to produce incontrovertible reports. Social worth may be judged not in terms of expert production of ‘the right answer’ but in the raising of questions and issues for discussion. Such accountings are not concerned with the representation of 'infallible truth' but in its creation of a range of environmental and social visibilities and exposure of values and priorities that become inputs to wider democratic processes of discourse and decision making (Boyce 2000, p. 53).

Rather than simple information provision, the accounting profession needs to develop models to present information to "prevent premature closure on issues" and "which infuse debate and dialogue, facilitating genuine and informed citizen participation in decision-making processes" (ibid., p. 55). In doing so, they might also help make power relations more transparent. The involvement of accountants thus helps "to make existing pluralistic
structures operative" and opens the way for new forms of accounting to be used "to promote radical democratic change within a pluralistic framework" (ibid. p. 54).

Accounting’s challenge "is to develop forms of practice that emphasize how accounting statements and insights should be regarded and used as elements of a conversation or dialogue, rather than as foundational claims asserting a particular kind of objectivity or 'truth'" (Morgan 1988, p. 484, emphasis in original). Dialogic accounting also aims to highlight the inherently contestable nature of much traditional accounting practice (O'Leary, 1985). Consistent with the aims of post-normal science, the aim is to provide broad-based understandings and multi-dimensional insights that can be used as platforms for action by a wide range of social actors.

Other multi-actor heuristics, communities' engagement(s) and public administration(s)

As society develops responses to climate change issues and the wider sustainability discourse, new technologies will be developed to assist in the process. Many of these build on participatory approaches in various guises (e.g. Chambers, 1994; Craps et al., 2004) developed in specific disciplines such as international development (e.g. participatory appraisal techniques; project management (logical frameworks), action research, etc.) in addition to the futuring, assessment and accounting approaches described above. However, such approaches can be “subverted through competing narratives that are presented in positivist terms” (Boxelaar, 2006, p. 118). It is insightful, therefore, to identify instances where the issues at stake in multi-actor initiatives arise from a social constructionist perspective. In turn this points to the need, as we will discuss later, for bridging organisations that foster convergence and divergence – so-called ‘boundary organisations’. These examples have emerged in a range of situations and are discussed over a wide literature, including examples quite specifically connected to post-normal science in, for example, Pereira et al 2006.

Some examples of these are summarized here with leads into relevant literatures:

- **Deliberative Sustainability Assessment** Techniques for integrated assessment or what O’Connor (2000, 2006, 2007) refers to as Deliberative Sustainability Assessment, namely multiple scales, multiple stakeholders, multidisciplinarity and multiple bottom
lines; have been reviewed by van Asselt Marjolein and Rijkens-Klomp (2002), and by O’Connor (2000, 2006, 2007). One such tool has been made the basis of the KerBabe™ Deliberation Matrix (O’Connor, 2004), which enables a transparent presentation of the process and outcomes of judgements offered by each category of stakeholders, for each of the options or scenarios under evaluation, with reference to a spectrum of governance or quality-performance issues. This move towards deliberative assessment is a generally ad hoc approach towards monitoring and evaluation in both policy making and implementation. If the form of deliberative assessment is interpreted in an agonistic manner then the processes can be seen as genuinely post-normal. However, few institutional arrangements advocate for such interventions. One avenue which could offer considerable traction, as noted above, is the accounting profession and its institutional discourse.

• **Knowledge Quality Assessment** New multi-dimensional and reflexive approaches to enable analysis and diagnosis of uncertainty in complex policy issues have arisen from post-normal science. These include the NUSAP notational system that attempts to include both quantitative and qualitative dimensions of uncertainty in a standardised and explanatory manner using the five qualifiers of the NUSAP acronym (numeral, unit, spread, assessment and pedigree) as discussed at by Ravetz and Funtowicz (1990) at www.nusap.net and reviewed by van de Sluijs (2006); and by Strand and Canellas-Bolta, (2006). The assessors of the knowledge quality are the extended peer communities.

• **Extended peer communities** Increasing numbers of initiatives involve wider groups of people in decision-making and policy implementation around sustainability issues (Funtowicz, 2006). These include people without formal institutional accreditation but with a desire to participate in attempts to resolve an issue. As such they are called citizens’ juries (Ward et al., 2003), deliberative stakeholder consultations (Opinion Leader Research, 2006), and so on. As several disciplines may be represented combined with two or more layers of ambiguity then issues about fitness for purpose arise that lead, as elsewhere, to considerations of authority and influence from multiple sources. However, participation is “not only ethically correct and politically expedient. It is the only way to reveal the richness and variety of the relevant knowledges and for quality, eventually to emerge” (Funtowicz, 2006, p. 145). Increasingly such extended peer communities operate in the virtual space, through...
social marketing campaigns or, as in some countries, in science shops. Indeed, there are specific examples from with the PNS world, e.g. the Post-normal Times (www.postnormaltimes.net) is:

dedicated to improving the quality of public participation in science-based policy decisions related to the conundrums presented by problems of environmentally sustainable development, by providing multiple and constructive perspectives on complex and controversial science and policy issues. A central focus will be on justifications provided for controversial high-stakes decisions that pertain to complex problems such as climate change, in which the disadvantages of making trade-offs fall disproportionately on those excluded from the decision-making process.

- **Information and Communication Technologies (ICTs) and Virtual Communities** The development of globalized communities of mutual interest via the internet is already impacting on social constructions of democracy. For example, as discussed earlier, citizen-consumers can be held to account if information systems make the environmental impacts of individual consumer choices transparent (Spaargaren and van Vliet 2003), Berkhout and Hertin 2004) with websites that enable individuals to calculate personal carbon emissions or assess energy efficiency potentials of their household. In time, property rights may, for example, be allocated through household carbon budgets supporting informational and economic incentives to induce behaviour changes. Further to this, O’Connor (2006b) explores the use of ICT for resolving collective problems of governance of common environmental and natural resource issues and outlines future possibilities.

- **Science shops** These are “units that provide independent, participatory research support in response to concerns experienced by civil society” (Mulder et al. (2006) where the term science is used in its broadest sense to combine social and human sciences with the natural, physical and technological sciences. The use of these science-society interfaces in Denmark, Germany, the Netherlands and Romania has been reviewed by Mulder et al. (2006).

- **Integrated approaches to resource management** There are now integrated approaches to large-scale ecosystem management (e.g. Integrated Catchment Management, Integrated Coastal Management, Bio-regionalism), which involve learning approaches to help deal with ongoing uncertainty and system change, and emphasise participation to support dialogue and understanding among multiple social perspectives (Lee 1993; Allen and Kilvington 2005).
The development of these practices of post-normal techniques is, to use the term from Deleuze and Guattari, ‘rhizomatic’, that is, pathways are not obvious or necessarily transparent; engagement and take-up of new ideas and processes is unlikely to take place in linear ordered ways but through uncertain and unpredictable pathways. It may be that this is an inherent component of a post-normal approach and, potentially, part of its strength. Such PNS technologies may increase with time but in the absence of institutional reforms to create appropriate dialogic spaces, development is likely to remain spasmodic.

4 Institutional reforms

By accommodating an assemblage of post-normal technologies with emergent properties, existing arrangements and structures are more obviously insufficient for the complexities of sustainability. Like orthodox science, they are, in themselves, fit for purpose, but the institutions articulating that purpose are found wanting faced with contemporary dilemmas. One response to this is to present sustainability in an aspirational sense and reshape institutions and accountability accordingly.

For many stakeholders, sustainability is indeed a utopian ideal; and consensus on what is and what is not sustainability cannot (and never will) be universally agreed (for recent reviews of different perspectives, see Hadorn et al., 2005; Castro, 2004; Hopwood et al., 2005). It is often easier to understand what sustainability is not, but achieving sustainability requires recognition of ideological diversity and socio-political processes:

There is no avoiding the policy questions of costs for whom, benefits for whom, dangers borne by whom, and when and where? In other words, whose perceptions and principles are going to prevail, whose interests are to count more, and whose less? Here scientific practice, including the prioritizing of research and dissemination of results, is necessarily entwined with wider political processes (Funtowicz, O'Connor and Ravetz cited in Luks, 1999, p. 714).

Sustainability knowledge gets played out in localities where ambiguities and contradictions are exposed in local settings, and meanings vary according to local idiosyncrasies and the particular set of stakeholders involved. In other words, dominant meanings are often "punctured by different ‘evaluative contexts’" (Barnett, 2002: 316).
Pepper (2005) examines the ways in which utopianism permeates both radical and reformist environmentalism. Utopianism has created “ecotopia”, the radical environmentalist’s utopia that has evolved from writing and action over the past half century. Ecotopianism’s "transgressive" potential in assisting change towards an ecological society is examined, and judged to be limited by idealism and unrealistic assessments of existing socio-economic dynamics. Reformist environmentalism is also considered; it is argued that this, too, can rest on unrealistic premises, reflecting liberal-capitalist utopian fantasies.

Post-normal science addressing sustainability concerns calls for institutional arrangements that are highly adaptable, creative and able to make transparent to stakeholders their underlying values and assumptions (both collective and personal). These institutional arrangements help identify previously unanticipated dimensions, including the social construction of knowledge and concepts of stakeholder participation, and lead to increased information sharing and interactive policy and management decision-making across stakeholders and sectors.

Sustainable technologies are about building awareness of what is at stake environmentally, socially and politically, and addressing issues based on differences. It is as much a task of building awareness of dilemmas, as it is about achieving outcomes. Technologies for doing sustainability involve finding appropriate concessions or compromises between the different stakeholders. These are technologies that function to redistribute and disburse responsibility for social and environmental care onto broad-ranging stakeholders as agents of change, and which make traditional forms of expertise both contestable and contested. As Dean (1999, p. 33) notes: “Government is a fundamentally utopian activity. It presupposes a better world, society, way of doing things or way of living”. However, under neo-liberal conditions, government becomes a focus, "not for the concentration of power... but for power sharing and negotiated decision making" (Lockie, 2006, p. 28). And what is a better world or way of living is contingent upon whom or what is embroiled in governing processes.

The development of dialogic forums therefore requires institutional reform. This reform will take place around concepts of equity and justice within and across generations, geographical spaces and social groups, as well as notions of ecological integrity and quality of life, for example (Sneddon, 2006, p. 264). One aspect of institutional reform is the emergence and development of boundary organisations as originally proposed by Brown (1991) and
developed further by, *inter alia*, Guston (2001). Another aspect is building awareness of how institutions and other stakeholders function as part of wider socio-political networks.

Boundary organisations are necessary to focus on process management of particular sustainability issues, although they depend on the relationships (or linkages) between stakeholders (Guston 2001). The role(s) performed by communicators, translators, mediators, etc., to equip diverse stakeholders with requisite skills for negotiation and co-investigation depends on which problem or issue is at stake and what set(s) of stakeholders are involved. These processes occur in multiple directions vis-à-vis several stakeholders. The phrase ‘boundary organization’ carries the risk of reproducing conventional power relations and notions of authoritative core sets of experts (Craps et al., 2004). A different language may be needed to better encapsulate the sort of work these in-between organisations (or particular individuals within those organisations) would do; that is, how they go about empowering themselves and others in dialogic forums in ways that do not presuppose conventional ways of ordering their relations and interpreting their respective interests. Giroux's (1992) concept of "border-crossers", Brown's (1991, 1993) work on bridging organisations and participatory action research and Carolan (2006) on "interactional expertise" are all helpful here.

In dialogic forums, concessions or compromises on sustainability issues will always have to be made. This may mean one stakeholder (or interest) pulling back to give the necessary conditions for another stakeholder or set of stakeholders to act. With sustainability science there is an inherent issue of dialogic reconciliation and respect to do with building relationships with others who have competing or opposing interests. This is a meta-position that people take up in different ways and which expresses their stakeholder interests in a non-essentialist way. It involves a hospitality ethic and agonistic respect, which admits tensions and antagonisms (O'Connor, 1999, p. 673; Connolly, 2003; see also O'Hara, 1996 on the development of discursive ethics) and is sensitive to the complex and dynamic nature of social relations. It calls for care in fostering "diverging and converging interactions" in a way that recognises opportunities for collaboration, without losing sight of diverse interests and frames (Craps et al., 2004, p. 385).

Only through institutional reform can the capacity and capability be created for participatory decision-making, improved knowledge management and new institutional mechanisms that
deliver innovation and sustainability. Managing complex and shifting social, economic and environmental issues requires thinking in post-normal terms and utilising post-normal technologies. It also requires focusing on improving understanding of future governance and governing processes and governments and institutions to become much more critically reflexive, learning organisations.

A creative and socially robust approach to understanding sustainability issues is of long-term importance. Robustness lies in the capacity to address matters of central importance to stakeholders, in ways that empower them to make their own choices and to experience sustainability in their own terms; that is, to add meaning in accordance with their particular circumstances, interests and existing knowledge and identify as co-investigators in the decision-making process.

5 Critical future issues

Sustainability science is demand-driven, participant-oriented, subjective, exploratory and uncertain. It requires post-normal technologies that perform as "heuristic instruments", that is, ones which “aid in the acquisition of better insight into complex problems of sustainability” (Martens, 2006, p. 38). To achieve such insight requires research of many kinds responsive to diverse value framings, and including attention to both fundamental and applied research categories (Sarewitz, 2004). For successful implementation, it requires a shift from the positivist conception of objective, value-free knowledge to a constructivist theory of knowledge. Examples of insightful case study accounts of the difficulties in progressing dialogic approaches in contexts still dominated by positivist, technocratic tools and perspectives are given by Boxelaar et al. (2006) and Callaghan and Wistow (2006).

Sneddon et al. (2006) observe that moving the sustainability debate beyond "its post-Bruntland quagmire" depends on the willingness of researchers and practitioners to work with a multiplicity of perspectives:

... Our Common Future marked, anchored, and guided the rise of a remarkable political debate, indeed a whole new political discourse across contesting interests, from grounded practitioners to philosophical academics, from indigenous peoples to multinational corporations. Sustainability may yet be possible if sufficient numbers of scholars, practitioners and political actors embrace a plurality of approaches to and perspectives on sustainability, accept multiple interpretations and practices associated with an evolving concept of "development", and support a further opening up of local-to-global public spaces to debate and enact a politics of sustainability (p. 254).
Major institutional reorientation is needed at the policy level to ensure responsiveness to local demand and context. At the programme level, such reform would mean detailed outlines for action can no longer be drawn up at the outset since problem-solving is based on partnerships, co-operation and conflict. These programmes are designed to be responsive to changing stakeholder needs, so one challenge noted by reviewers is to develop participatory and systems-based monitoring and evaluative processes to allow for feedback loops, ongoing and less programmed approaches to learning (Allen, 1997). In the absence of this, notions of "democratic participation" are likely to remain little more than token gestures (Callaghan and Wistow, 2006; Quaghebeur et al., 2004).

Critical issues for the way ahead arise from the multiple interventions or technologies for achieving sustainability. These issues implicate democratic leadership as a key driver, especially in the long-term; new manifestations of governance, and adaptive learning and post-normal science as integral mechanisms for institutional reform. They require dialogic forums that are inclusive, participatory, mobile, and post-disciplinary. There are, at present, insufficient boundary organisations to provide the sorts of facilitators or negotiators needed to broker relations between diverse stakeholders and promote open dialogue. All this requires:

- More rigorous and explicit frameworks that incorporate different forms of knowledge and expertise possessed by diverse stakeholders in policy and management processes.
- Highly innovative procedures for building on current best practice for dialogic engagement, which involve skills and attributes that may well challenge government actors and are currently largely non-existent.
- Cutting edge research that continues to provide dialogic tools and processes for doing sustainability science, and producing practical, real world solutions to shifting problems, which are also a product of those tools and processes.
- New forums for public engagement with science and technology that achieve public or civic expertise on sustainability through institutional reform.
- ‘Conversations’ amongst diverse stakeholders to foster different networks (and real partnerships) and produce new institutions.
- Different jargon based on different aids to seeing, and different ways of doing, in the fields of accounting, economics and law which are increasingly made trans- or post-disciplinary.
These developments depart from normal science approaches, conventional notions of growth and progress predicated on linear understandings, and entrenched power relations. They produce different accountabilities and emphases on individual and organizational responsibilities and different ways of knowing. And they require different notions of performance, quality, conflict and expertise.

References


