Environmental Knowledge and Deliberative Democracy

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Introduction

In recent years deliberative democracy has spread to a remarkable pace in environment-related policy-making, affecting especially the way democracy meets scientific expertise. Science has for long time been understood as the social enterprise specialized in producing explanatory and predictive knowledge – the latter being of obvious policy relevance. This has been brought into question by the growing import and saliency of environmental threats, as a 'side effect' of techno-science (Beck 1992). The result is what is often described as a paradoxical relationship between science and society. According to the European Commission 'expectations of science and technology are getting higher and higher… [yet] advances in knowledge and technology are greeted with growing scepticism, even to the point of hostility' (European Commission 2000: 5). This statement is supported by empirical evidence. Social surveys like the Eurobarometers (e.g. 2005a; 2005b) show that, while science enjoys a positive image, it is not seen as a reply to every problem or a carrier of unquestioned, generalized benefits. Citizens are increasingly concerned with the unfair distribution of the goods and bads of innovation and the intertwining of science, politics and business; they also regard scientists as provided with too much decisional power and too little responsibilities. If modern science has developed on the basis of an 'unspoken contract' between science and society, such contract seems therefore to require some revision. 'New relationships are needed that fit the new mould of science, technology and society' (European Commission 2000: 5). To many deliberative democracy represents a sound reply.

In this chapter I reflect on the connection between environmental knowledge and public deliberation. I start by describing the distribution between cognitive abilities and disabilities implied in the 'social contract of science', suggesting that the demand for and offer of participation depends on a crisis of this alleged division of social labour, with uncertainty leading to growing policy ineffectiveness and questionableness. Coming to terms with uncertainty has become a pressing issue. Some trace it back to risk or confine it into suitable social realms; for others uncertainty blurs the traditional divide between matters of fact and matters of concern, entailing for the science-policy relationship to be thoroughly rethought. Here environmental knowledge meets deliberative democracy. I describe the basic understandings and pros and cons of public deliberation. Then I focus on some features of the application of deliberative arenas to environmental issues, namely: the role of scientific expertise, the configuration of deliberative games and the presence of institutionalised biases with respect to the treatment of uncertainty. Deliberative processes may be 'inclusive' but they usually reproduce the traditional division of labour between

production and use of environmental knowledge. This has been criticized by part of social science scholarship, committed to supporting an innovative perspective. The latter, however, raises questions of its own, that I briefly address in the conclusion.

Environmental Knowledge and the Dominant Cooperative Scheme

All societies are characterized by what Allen Buchanan (1996) calls a dominant institutional infrastructure for productive interaction or, more simply, a 'dominant cooperative scheme' (hereafter DCS). A DCS is a legitimized division of labour, the allocation of abilities and disabilities connected with socially relevant tasks or functions. A DCS expresses a solidarity system, with related delegation of assignments and distribution of rights to hold social positions, handle collective questions, accede to material and immaterial resources. Abilities and disabilities design a chessboard of communicative spaces. What for able agents is a space of discussion, for disabled ones is a black box, to which they may just address 'questions' (instances, concerns etc.) to get suitable 'answers' (issue definitions, technical solutions, policy decisions etc.).

A DCS specifies who and how is to be involved in what type of collective enterprise relevant to a given community. The emergence of a demand for participation, then, means that some aspect of the DCS – for example as regards environmental governance – is brought into question. It indicates a rift in the structure of social solidarity; a weakened legitimacy of the division of labour; a decline in the sense of belonging and the collective sharing of responsibility for decisions taken on behalf of a whole constituency; a request of more equitable arrangements. Some, formerly disabled and excluded, ask for acknowledgment and inclusion. Meeting this demand entails a distribution of power: a break in hierarchy, a reduction in the distance between or isolation of social actors. Historically, democratization consisted in the gradual extension of citizenship rights to broader constituencies, as an answer to conflicts stemming from lack of active inclusion in the political life (Dahl 1971) – that is exclusion from decision-making on the distributive rules of relevant resources and tasks. Talking of participatory policy arrangements, therefore, means referring to increased equality and connectedness of citizens in some relevant respect, vis-à-vis a former institutional set up.

Classical and contemporary sociology stresses that a core feature of the modern DCS is rationalization and functional differentiation, that is a growing specialization of tasks according to means-ends efficiency and effectiveness. A crucial aspect of this arrangement is the emergence of science, as an institution specialized in the production of knowledge about 'nature'. The independence of science implies a new way to produce and validate knowledge: no longer by means of deduction from ascertained principles governing the world order in its entirety (society and nature), but by means of testimony of material things (nature) approved by specialized peer groups (scientists as 'representatives' of society). Science deals with facts; politics and economy with values, interests, needs. As the famous dispute between Boyle and Hobbes over the air pump testifies, this represented a deep change in the social order (Shapin and Schaffer 1985). According to Max Weber (1958), such change has produced major effects on the legitimacy of political

power: no longer is the latter based on tradition or charisma but on legality and rationality, that is on the application of appropriate technical competences according to legally validated procedures. Political legitimacy becomes in this way tightly connected with effectiveness and efficiency in the control of the world: the stronger the latter, the stronger the former, and vice versa.

The idea of a 'social contract of science', famously argued by Vannevar Bush (1945) at the dawn of the post-war era and afterwards restated many times (e.g. Price 1965; European Commission 2000) can be regarded as a full-fledged, narrative expression of this division of labour. According to such narrative[1] sound science is always premised to rational, efficient policy-making. More precisely, science represents a reservoir of knowledge to answer social needs, fundamental research leading to applied research, and applied research to concrete social benefits (Pielke 2007). The result is a linear model of the science-policy relationship, according to which professional experts sanction the facts about nature (distinguishing for example full-blown, quantifiable environmental risks from hypothetical threats) and the appropriate ways to deal with them, whereas lay people and stakeholders express interests and concerns that policy-makers are expected to address and harmonize accordingly. Sound science has nothing to do with politics; at the same time – and for this very reason – 'the policymakers' maxim should be "science first"' (Forrester and Hanekamp 2006: 310). On this view, policy questions can always be reduced to quantitative risk-benefit analyses, and the basic goal is to ensure at the same time the integrity and productivity of science (Guston 2000). Crucial to this account, that recognizes a social value to fundamental research for its practical spin-offs, is the growing relevance taken by the hypothetico-deductive, prediction-focused, control-oriented model of science. Traditionally proper of physics and astronomy this model gradually spreads to sciences, like geology and biology, which were formerly grounded on an inductive, explanatory approach (Oreskes 2000).

The narrative of the social contract has a normative, rather than a descriptive, purpose: as shown by many studies, nowhere is to be found such a clear-cut division of labour. The narrative seeks to legitimize a tightening relationship between science, politics and economy stemming from a knot of matching needs: the need of money of an increasingly technology-dependent science and the need of science of increasingly innovation-dependent politics and businesses. Of course this does not mean that policy questions always require scientific insight. However, it would be naïve to take the 'scientificity' of an issue as merely depending on its intrinsic features. It is not simply because it has to do with 'nature' that environmental governance involves so much scientific expertise. Confronting ecological questions with the contested vote in Florida in the 2000 US elections (where G. W. Bush prevailed on Gore by a handful of votes), Daniel Sarewitz (2004: 397, 388) remarks that 'the vote count should have been much more amenable to scientific investigation than even the simplest environmental controversy. […] It is hard to

[1] A narrative can be described as a way to make sense of the world, giving salience to and logically connecting actors, institutions, events, discursive and material aspects of society (Franzosi 2004).

imagine a problem more suited to a strictly technical approach': finite number of system components, simple decision rules, clearly defined spatial and temporal boundaries. However 'the dispute was not resolved by addressing the technical aspects of the vote count, but by subjecting the vote count process to political and judicial mediation procedures that were legitimated by their capacity not to arrive at "truth" but to transparently negotiate among competing players. Because this system was broadly accepted as legitimate – that is people understood and agreed on the rules – its results were also broadly accepted'.

In other words, it is not the intrinsic technicality of an issue that brings scientific knowledge to the forefront. Rather, late modern society seems to rely on two different mechanisms to legitimize policy decisions. One is based on institutionalized forms of comparison of values and interests, with facts selected and interpreted according to suitable normative frames. The other overlays values and preferences with technical or factual arguments, presented as normatively neutral. Choices related to a desirable state of affairs (how the world should be) are justified by referring to data and predictions (how the world actually is and how it will be if one follows a given course of action). The demarcation between facts and values, and implicitly between science and politics, works mirror-like in the two cases. In the former facts are what is to be detected and allocated after values are specified and combined. We decide first what the matter is for us, then we look for relevant evidence. In the latter case values are what remains to be specified and allocated after facts have been detected and combined. We seek first for evidence, then we look for matters of concern to be accommodated accordingly. A good deal of discursive space is therefore filled with data, technical arguments and so on, to which only 'certified' experts have access. The choice between the two legitimizing mechanism depends on widespread beliefs, authoritative statements or narrative accounts of the character of issues. Just evoking nature or health in the public arena, for example, is usually enough for framing a question in terms of 'science first'. Availability of credible procedures for allocating values in dispute also affects choice, while technical legitimacy (recognized expertise, specialized bodies etc.) often acts as a substitute for such procedures (Sarewitz 2004). Yet it is precisely the technical path to legitimacy, and the cooperative scheme which it is grounded on, that has been questioned in the environmental field.

Risk and Uncertainty

There is actually an obvious contradiction in the linear model of the science-policy relationship. If policy presupposes science, then scientific debates become political debates, the conclusions of the former entailing answers to the latter (Pielke 2007). The more technicized becomes politics, the more politicized becomes science. This contradiction could be kept at bay as long as the disinterestedness of science worked as a major legitimating premise, and as long as science seemed provided with and effective capacity of prediction and control of bio-physical processes. Yet the first premise has been brought into question precisely by the growing intertwining of science, politics and business that the linear model sought to support and justify (Weingart 2003), while the second premise has been questioned by the increasing import of wide-ranging, long-term,

unintended and unforeseen 'side effects' of techno-science – in other words by the growing saliency of uncertainty, as a feature of environmental issues that, contrary to what the linear model assumes, cannot be reduced to quantitative risk-benefit analyses (Funtowicz and Ravetz 1993; Wynne 1992). Indeed, the increasing relevance of uncertainty for the science-policy relationship is indirectly testified by the very expansion of the theme of risk. The two terms do not represent opposed polarities but define a complex semantic field where different ways of imagining the world and techniques for governing it find their place (O'Malley 2004). For example, when Ulrich Beck (1992) talks of 'risk society', he refers both to the narrowing relevance of routines and traditions as a guidance to individual and institutional behaviour and to the difficulty of planning such behaviour according to the calculative way that established itself with Modernity.

The notion of risk spreads in the XVI-XVII centuries. Initially it refers to agent-independent threats of sailing, like storms or pirate attacks. Subsequently, risk is increasingly taken to designate events related to behavioural choices (Luhmann 1993). There may be little doubt that pivotal to this semantic drift is the emergence and strengthening of the figure of the modern rational individual: an autonomous centre of decisions who, in front of an open-ended future, plans his action according to calculations of means-ends connections. Risk, therefore, is not only a matter of decision, but of predictability of outcomes; taking risks is deciding upon the reliability of forecasts, the controllability of events. The spread of the notion, therefore, is tightly connected with the development of probability and statistics. In the XVII century knowledge and opinion – what in medieval thinking is true by necessity, thus subject to proper demonstration, and what is true by testimony, subject to mere approval by authorities or respected judges – merge into the notion of 'natural sign': evidence given by things themselves, from which generalizing inferences can be made. Within this framework probability, as 'worthiness of approval', depends on the frequency with which predictions result correct (Hacking 1975).

If by inventing risk moderns have 'learnt to transform a radically indeterminate cosmos into a manageable one, through the myth of calculability, to reduce uncertainty to the same calculable status as that of certainty itself' (Reddy 1996: 237), to handle physical and societal processes without controlling every single element of them, the limits to prediction start to be conceptualised in the 1920s. Interestingly, the epistemic, agent-centred account of risk is retained and even strengthened. Werner Heisenberg's indeterminacy principle defines uncertainty as a limit to the measurement of physical states. For the economist Frank Knight (1921) not only we are in front of uncertainty whenever we are unable to calculate the probability of an event, but this is hardly a negligible situation since profit derives precisely from those 'risks' which no insurance company will cover, nor any investment programme can calculate. Similarly, John Maynard Keynes (1921) talks of 'uncertain knowledge' and 'personal probabilities' referring to those situations, so common in economy, where no reliable probability estimates can be produced because data (be they experimental or historical, like accident or morbidity statistics) are insufficient. This idea is subsequently developed, among the others, by Leonard Savage (1954) with his notion of subjective probability, as referred –

according to a Bayesan approach – to the agent's state of knowledge, instead of the character of phenomena. It thus becomes possible to 'argue that all probabilities are subjective probabilities, because relative frequencies are only sample data of past events that influence subjective probabilities of future events' (Stewart 2000: 42). In this way frequentist probabilities turn into subjective probabilities, and aleatory uncertainty blurs with epistemic uncertainty. In other words, the possibility *for* something to happen according to 'stochastic laws of chance processes' is equated to the possibility *that* something happens according to human cognitive states, 'reasonable degrees of belief in propositions' (Hacking 1975: 12). 'Uncertainty owing to lack of knowledge is brought down to the same plane as intrinsic uncertainty due to the random nature of the event under consideration' (Dupuy and Grinbaum 2004: 10).

If epistemic accounts of uncertainty have long since become predominant, the latter has in the last decades extended its meaning beyond mere unpredictability of outcomes to encompass lack of insight into such very outcomes. Sources of uncertainty are manifold (Funtowicz and Ravetz 1993; Wynne 1992, 2007). For example, properties of a system may not be derivable straight from knowledge of its elements because of the intricacy of their interactions, while causal chains may be open-ended, with outcomes depending on unspecified or unpredictable intervening variables. We may not even know if we are putting the right experimental questions, because of our ignorance about the extension of non-knowledge[2]. Moreover, there may be disagreement on the selection of variables and methods of analysis, and more than one reasonable issue-framing. Think of climate change. Labour-intensive modelling is persistently unsatisfactory. Technological innovation may have a crucial yet hard to anticipate role in reducing anthropogenic impacts. The specific factors triggering irreversible change are surrounded by sheer ignorance. The relative importance of atmospheric and marine dynamics is a source of disagreement. The policy issue is framed in an ambiguous way – should temperature increments be discussed in ecological, economic or social terms? Should one focus on mitigation or adaptation? On modifying individual behaviours or institutional set ups?

To explain why the era of prediction and control has entered such a crisis various, possibly overlapping, reasons have been suggested. Some, for example, focus on the very advancement of science. 'Uncertainty in environmental controversies is a manifestation of scientific disunity (excess of objectivity; disciplinary diversity) and political conflict'

[2] Matthias Gross remarks that a major distinction can be drawn between the epistemic status of types of lack of knowledge where we know something about the unknown (or about the limits of our knowledge), and the status of what he calls 'nescience': a total lack of awareness of the shape, size or origin of what we do not know. Consciousness of nescience is by necessity retrospective: 'no one can refer to their own current nescience' (Gross 2007: 746). This is the type of uncertainty many scholars refer to by talking of the 'surprises' of the environment and techno-science. The line between other types of lack of knowledge and nescience corresponds to the line between predictive and explanatory knowledge. Many criticisms against current techno-science build on the idea that 'forcing' prediction into the territory of explanation – that is acting as if knowledge would be predictive instead of explanatory, by pretending to control all the 'relevant' variables at stake – is a recipe for unwelcome surprises.

(Sarewitz 2004: 393). It is not despite but because of the availability of sound science that we are increasingly uncertain on the knowledge suitable to address a given issue. There is too much, rather than too little, knowledge, which makes it increasingly questionable – and questioned. Different perspectives and insights can be applied to a same problem and the 'theory of everything' remains as elusive today as it was a hundred years ago – perhaps more. Moreover, 'the competition for the latest and, for that reason, presumably most convincing scientific knowledge produces [a drift] beyond the field of generally accepted knowledge to the front lines of research – where findings are still controversial, assertions are uncertain and open to attack' (Weingart 2003: 78). Others stress that uncertainty gains relevance because of the extended scope of human intermingling with nature. This idea lies for example behind Alvin Weinberg's (1972) concept of 'trans-science' and Silvio Funtowicz and Jerry Ravetz's (1993) notion of 'post-normal science'. The classic experimental method (laboratory-confined trial and error) is increasingly inapplicable because of the size of phenomena addressed, the implied decision-stakes and, frequently, the urgency of decisions. Facts become soft and values hard; cognitive uncertainties blur with ethical uncertainties. Moreover, uncertainty and decision-stakes may presuppose each other (Wynne 1992). The higher the stakes and the deeper the political controversies, the deeper the scientific uncertainties or the higher the levels of certainty required to decide. 'Uncertainty estimates are in part a measure of the psychological state of those making the estimate, which is in turn influenced by the political context within which the science is carried out' (Sarewitz 2004: 393). Climate change is again a typical case in point. Waste is another: decades of study of percolation from repositories have increased, rather than decrease, the controversy on the sufficiency of evidence for decision (Metlay 2000).

What these and many other environmental issues ultimately show is that an increase in scientific knowledge does not by itself reduce decision uncertainty. Attempts to reach a scientific closure of the space of discussion may clash with the politically controversial status of the issues, because of the normative assumptions underlying scientific assessments and the intra- and intergeneration distributional aspects of policy choices. The problem is not how much evidence is available but how evidence is evaluated – what counts as evidence, how much evidence is required to act – and by whom. Expert knowledge may collapse into a mess of competing claims on the existence, relevance and meaning of facts. Rather than help settling them, the search for technical legitimacy may worsen the intractability of conflicts (Pellizzoni 2003).

Uncertainty and the Science-Policy Relationship

As hinted, the response to conflicts on resource and task allocation has historically been to broaden participation in political power. The same question is at stake today with the politics of environment and techno-science. The answer however depends pretty much on the extent to which uncertainty is seen to affect the DCS.

A first reply is 'business as usual'. This entails downplaying the actual import of uncertainty. Giandomenico Majone (2002: 103), for example, remarks that 'if we insist that

we are "completely ignorant" as to which of the events $E_1 \ldots E_n$ will occur, it is hard to escape the conclusion that all the events are equally likely to occur'. This represents a brave attempt to fix the crack opened by Knight and others in the modern pillar of predictability and control: it is not risk to be a particular case of uncertainty (one where the possible occurrence of events is calculable); rather, uncertainty is a particular case of risk (one where probabilities are all equal). Majone and others use this argument especially to criticize precautionary policies, defending quantitative risk-benefit analysis against what they regard as an unduly expansion of a regulatory discretion aimed 'to practise protectionism, or to reclaim national autonomy in politically sensitive areas of public policy' (Majone 2002: 89-90). In other words, there may be obvious interests in politicizing scientific issues; for this reason it is important to reaffirm the soundness of the linear model of science-policy relationship. This excludes any need to revise the DCS.

A different way to reassert the basic soundness of the DCS and the depoliticized status of scientific knowledge is by conceding the political relevance of scientific uncertainty, yet assigning its treatment to non-scientific social spheres. Two variants can be singled out. According to the first, a sharp distinction is to be made between risk assessment and risk management. The former is a science-based quantitative analysis. The latter weighs scientific insight against social and political considerations. In other words, risk assessment is an objective, value-neutral process that may (provisionally) fail to provide any definite response to policy questions. What to do in this case is not a scientific but a political issue. It is at this stage that 'inclusion' makes sense – especially if traditional ways to represent interests and concerns are met with growing scepticism and mistrust. This is for example the European Union's official position with regard to precaution. The latter is described as an approach to be applied to risk management 'when scientific uncertainty precludes a full assessment of the risk' and 'until all the necessary scientific knowledge is available' (European Commission 2000: 12, 7).

The other variant of this approach gives up any sharp distinction between risk assessment and risk management, acknowledging that 'non-scientific considerations play a distinctive up-stream role setting the framing assumptions that shape the ways in which risk assessments are constructed and conducted' (Millstone et al. 2004: 7). However the experts' task remains to bring out objective elements for evaluation; that is, to shed light on policy alternatives, distinguishing those compatible from those incompatible with data. In other words, scientific questions may be framed by political ones, yet within a given frame policy options are independent of political opinions (Pielke 2007). Here experts may perform their objective, quantitative analyses.

There is however a growing number of scholars who regard uncertainty as a permanently salient condition of knowledge production on the environment. This implies for any serious controversy that definite, agreeable distinctions between facts and values (or between policy and politics) are virtually impossible. 'The ways in which we know and represent the world (both nature and society) are inseparable from the ways we choose to live in it' (Jasanoff 2004: 2). The social and natural orders are co-produced. On one side the

very character of scientific knowledge has to be reappraised. Scientific objectivity means the presence of objects, that is something made able to object to what is said about it, by producing 'proofs', 'reliable testimonies' within an experimental framework (Stengers 1997). On the other side there is a 'continual interpenetration of political choices or commitments and the production of reliable knowledge. […] Instrumental goals, the knowledges and practices adopted for achieving them, and the applicable standards of credibility and legitimacy are all constructed together through a unitary process of ordering of the world' (Jasanoff 2005: 23). For example, in the case of the Yucca Mountain (Nevada) planned nuclear waste repository, research shows that despite repeated appeals to evidence-based policy the science used to justify choice has been influenced by politics, while the policy of site selection has been altered by the knowledge produced. A number of scientific assumptions proved controversial with further research, leading to increased complexity in the understanding of the geology of the site. This was counterbalanced by a regulatory change: from a set of independent siting criteria to an encompassing, simplified performance assessment model (MacFarlane 2003).

Yet if 'science offers a framework that is unavoidably social as well as technical since in public domains scientific knowledge embodies implicit models or assumptions about the social world' (Irwin and Wynne 1996: 2), then knowledge production is no longer to be understood as a specialized task to be entrusted to experts alone, with 'lay' actors having a say only about its policy applications – as both the risk assessment/risk management and politics/policy approaches assume. Production and use, cognitive and normative goals and assumptions, description and prescription intertwine. Knowledge production has thus to be 'democratized'. Funtowicz and Ravetz (1993) and Wynne (1992) talk for example of 'extended peer communities'. The idea is that the inclusion of all those involved in a problem-situation may improve the quality of knowledge – its fitting the bill – by affecting goal definition and evidence assessment, shedding light on the parties' stakes and assumptions about the natural and social world. Facts are to be understood in an extended sense as well, encompassing lay and local insight in its different forms. In brief, questions of values and goals are to be addressed together with questions of facts and means, with no preliminary adjudication of which is which and what pertains to whom.

Deliberative Democracy

To sum up, the need to build more inclusive policy processes is widely acknowledged, though positions differ remarkably as regards the scope of inclusion. It is no surprise, then, that many turn to deliberative democracy (hereafter DD). This expression appears around 1980, conveying the idea of a discussion between free and equal individuals. Theoretical reflections and practical experiences develop in the following years at an amazing pace. If, as Elster (1998: 1) notices, 'the idea of DD and its practical implementation are as old as democracy itself', then the legitimacy crisis of political institutions (Held 1996) and the repeated technological debacles and regulatory failures of advanced democracies (EEA 2001) may account for much of its current success.

DD differs in various respects from straightforward approaches to democracy, based on party systems and political representation. First of all, it contrasts mere aggregation of preferences (through elections or opinion surveys) with their dialogical confrontation. Elster (1995) distinguishes between two forms of dialogue, bargaining and arguing. Bargaining is based on the exchange of threats and promises, between self-interested actors. Its strength lies in credibility. Arguing is based on the exchange of reasons in search of the common good. Its strength lies in validity (propositional truth, impartiality, sincerity). This, for many, is what 'proper' DD is about. Arguments can be used strategically and the actors' true motivations are reciprocally inaccessible. Yet, compared to the classic negotiating table, a deliberative setting should at least benefit from what Elster (1998) calls the 'civilising force of hypocrisy'. If the participants are formally committed to looking for shareable reasons, then individual preferences have to be justified in non-selfish terms; private interests must be accommodated to publicly defendable principles.

Secondly, DD contrasts decisional aristocracy with inclusiveness. All those potentially affected should in principle take part in decision-making. A target of criticism are especially the neo-liberal reforms of late 1970s and 1980s and the 'public choice' school (Downs, Hayek, Riker etc.) they are based on, with its stress on elitism, technocracy and strategy – the idea that democracy is not about participation but about the selection of political leaderships; that growing complexity of issues prevents citizens and even most professional politicians from grasping the technical rationale of policy choices; that politics just consists of a struggle of competing interests, to be regulated in a market-like way.

For some the appropriate place for DD is the public sphere – the informal, multiple spaces where citizens address public issues (Habermas 1992). For others DD needs proper 'deliberative arenas', that is institutionalised domains where participants meet and discuss, face to face or virtually, according to agreed rules (Cefaï 2002). A number of deliberative models have been developed to this purpose: participatory budgeting, deliberative poll, citizens' jury, consensus conference, scenario workshop, and so on. DD here is understood, rather than a philosophical ideal of democracy, as a purpose-oriented practice. More precisely, some models take DD as a sounder alternative to traditional opinion surveys, with which they share however the source of legitimacy. The latter lies in the statistical representativeness of the deliberating group – in fact, an application of science to knowledge production. The innovative aspect, then, consists in the participants' targeted information and discussion, allegedly affecting their views on the issues at stake. Deliberative processes should produce a 'mindful', 'reflective' public opinion, leading to valuable policy recommendations. Other approaches understand DD more as a problem-solving activity, to be applied either to wide-ranging issues or – more frequently – to ill-tractable local controversies. Here the reference is not so much Habermas's idea of public sphere, as John Dewey's (1927) notion of the public as a community of inquiry. In this case, more than a discursive exchange preliminary to preference expression, deliberation is seen as a practice aimed at producing a cognitive added value. Consequently, the statistical representativeness of the participants becomes less important than their ability

to express (or 'represent' in a theatrical sense of the word) a significant range of concerns and insights.

The design of deliberative arenas varies, therefore, according to the concept of deliberation. For what we may call the opinion-oriented deliberation what counts most is to ensure the 'input equality' of participants (same possibility to take part, same information, same opportunity to take the floor etc.). Ideally participants should be as similar as possible to each other, their only difference lying in the way their minds process information. The internal forum of deliberation is of paramount importance (Goodin 2000). Major attention is to be devoted to providing informational inputs free from intentional or unintentional biases, which might affect the resulting opinions. For what we may call the inquiry-oriented deliberation, on the contrary, participants should be as diversified as possible: the greater the diversity the richer the material for a joint reflection. The stress is on creating a favourable setting for collective learning and output devising (solutions to, or at least clarifications of, the terms of a question).

The deliberative opinion poll (Fishkin 1997) represents the best known example of opinion-oriented deliberative model. It uses a large statistical sample; draws on questionnaires to be filled before and after the discussion phase; provides the deliberating group with information and expert advice. An example of inquiry-oriented model is the scenario workshop (Andersen and Jäger 1999). The latter's goal is to gather insight into experiences, hurdles and visions of participants in order to single out concrete proposals on how to address an issue. No random sampling is required. Members are chosen according to their potential contribution, usually among four groups: citizens, businessmen, public administrators and experts. Citizens' jury (Jefferson Center 2004) and consensus conference (Joss and Durant 1995) share something of both the opinion- and inquiry-oriented concepts of DD. They draw on statistical sampling, pre-post deliberation polls, preliminary information and expert advice; yet a small discussion group is carved out from the sample (thus becoming a quota-sample) and the goal is to reach a consensual 'verdict' or 'position', rather than to aggregate individual opinions.

Strengths and weaknesses of DD and related models have been extensively discussed (e.g. Gastil and Levine 2005; Rosenberg 2007). It is usually maintained that public deliberation improves civicness, making people more active, informed, responsible, reflective, open to change their opinion. Moreover, by including in the policy-making those affected by decisions, DD should improve the legitimacy of policies. Also the quality of decisions can be positively affected, from both a normative viewpoint (fairness, justice) and a cognitive viewpoint (mutual learning, innovation). Inclusion, however, always represents a weak point. Participation of all those involved in an issue is confronted with problems of scale (they may be too many), identification (who they are may be unclear or controversial, depending on how the issue is defined), withdrawal (some of them may feel sceptical or uninterested; they may be short of time, money or competence; they may disagree with the agenda). As the models cited above indicate selection criteria are often applied, none of which is exempt from bias, while self-selection is hardly any better in this respect since it

privileges the most resourceful or directly involved persons. Another problem is intentional or unintentional manipulation, stemming from agenda setting, expert and information selection and group dynamics (opinion polarization, 'spiral of silence' etc.)[3]. Professional organization and facilitation of discussions help address these problems, which however can never be totally overcome[4]. A further issue is that DD may be a source of policy fragmentation. The practical efficiency and effectiveness of deliberative arenas are often linked to restricting their inclusiveness and scope, at the price of increasing their externalities. A suitable solution here and now may produce negative outcomes elsewhere and later. However, broadening the scope and inclusiveness of deliberation expands also management difficulties and manipulative opportunities. Moreover, the appropriate scale for discussing a question is seldom self-evident, becoming a frequent source of controversy – think of traffic pollution or infrastructure planning, to say nothing of global warming and the like.

Finally, deliberation outputs and policy outcomes are often loosely connected. Deliberative processes are mostly consultative rather than participatory in the full sense of the word, even when provided with a problem-solving aim. Sponsors may be strongly and even formally committed to applying the results of deliberation (Smith and Wales 2000). Yet such commitments have a political, rather than legal, value[5]. Above all, deliberators cannot become actual decision-takers without undermining the role of democratic institutions, from town councils to parliaments. It thus remains an open question to what extent and how deliberative arenas may be accommodated to the traditional institutional arrangements.

Environmental Governance and Public Deliberation

Often ill-tractable, and different from usual interest conflicts, environmental questions have managed to play a pioneering role in the development and diffusion of DD – global and local ecological and techno-scientific issues are a very frequent topic of deliberative arenas around the world. However, while a huge literature is available on the general problems of public deliberation, the peculiarities of its application to environmental policies have attracted less attention. In this section I address some relevant issues, namely: role of scientific expertise, game configuration and institutionalised biases with regard to the treatment of uncertainty.

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[3] On opinion polarization cf. Sunstein (2003). The 'spiral of silence' (Noelle-Neumann 1984) is a frequently observed phenomenon by which those who perceive their own as a minority opinion hesitate to publicly express it, causing its disappearance.

[4] The very issue-definition has an intrinsic manipulative potential, implicitly circumscribing what is to be regarded as relevant expertise and information and a sensible answer to the policy question. One thing, for example, is to talk of waste disposal or recycling; another of waste production. One thing is to reflect on the most suitable site for an incinerator; another is to reflect on whether an incinerator is actually needed.

[5] A written commitment signed by a political sponsor, as sometimes happens, has hardly any legal relevance: in modern democracies political representation cannot formally take the shape of a principal-agent relationship.

Role of scientific expertise

The typical structure of a deliberative arena on environmental issues – apart from organizers and facilitators – includes three categories of participants. One may participate as a 'stakeholder', that is someone provided with a personal and direct interest in the issue at stake (for example an entrepreneur, a property owner, a member of a local group); as a 'citizen', that is someone involved as a member of the relevant community; as an 'expert', that is someone provided with professional competence and insight[6].

The role assigned to experts is a clue to the different ways of conceiving deliberation. In the scenario workshop they represent a group among the others, provided with their own views and concerns rather than a superior cognitive equipment. As a consequence, members of the different groups mix up when a concrete proposal has to be carved out, in the last phase of the process. Yet this is the exception rather than the rule. Deliberative polls, 'jury' models and most other types of deliberative processes treat experts as the cognitive interface of the deliberating group. A sharp distinction is made, in other words, between cognitive and normative capacities, between those who know and talk of objective things and those who can just talk of interest and value commitments. Experts provide information and answer the participants' questions about facts and data. In environmental controversies they are therefore assumed to have privileged access to evidence about nature, setting the frame for the discussion of cognitively disabled people.

The clash between different views of the social contract of science becomes here especially salient. Those who adopt a business as usual approach or follow the line of a neat distinction between risk assessment and risk management, or political and policy options – that is those who consign risk to objective evaluation and restrict uncertainty to the traditional social realm of value and interest conflicts – find perfectly sound the expert-lay divide in deliberative arenas. Scientific uncertainty does not necessarily affect such divide. To the extent that it is depicted as transitory and deemed to be fixed thanks to additional insight, investment and time, it may indeed enhance the role of experts (Zehr 2000), as the only entitled to set the borders of knowledge relevant to the issues at stake. A convenient diversification of expertise is usually ensured in order to avoid possible biases due to the experts' own political or ethical commitments – sometimes participants can even choose among a pool of experts those whom they trust most. In this way scientists' disagreement is depicted as marginal to the building of a robust cognitive frame. Once the influence of their own value judgements is neutralized by ensuring a balanced variety of viewpoints, the provision of a plurality of expert views adds to, rather than detract from, the solidity of the factual background which the debate has to draw on.

The expert-lay participants divide is of course contested by those who make a case for the subtle intertwining of matters of fact and matters of concern, ways to represent the world

[6] Sometimes one should rather talk of 'key informant', that is a non-professional provided with relevant information, often about particular commitments or positions vis-à-vis the issue at stake – for example, the 'viewpoint of farmers' on the location of a waste repository.

and ways to live in the world. Especially according to an inquiry-oriented approach to deliberation, an a priori distinction between cognitively able and disabled actors can prove misleading. As shown by many studies, anecdotal, synthetic, contextual lay and local knowledge can be no less relevant than the general and abstract knowledge of professional experts (Irwin 1995). Moreover, experimental data may be evaluated in different ways by expert themselves. Assessments are always somewhat biased – from a scientific, rather than merely an ethical or political viewpoint. 'As evidence builds we update our degree of certainty of harm, but at any point in time that updated degree of certainty also depends on how suspicious we were initially' (Neutra et al. 2002a: 56). For example, if we assume that only high energy radiations may have biological effects, before questioning such belief we will need a strong evidence of harm associated with exposition to low energy radiations. Another type of bias comes from the context of scientific inquiry. It has been noticed, for example, that corporate-supported clinical medical trials tend to provide new therapies with more favourable evaluations than publicly funded ones. This not so much because of corruption, but because 'a close and remunerative collaboration with a company creates goodwill [that] can subtly influence scientific judgement in ways that may be difficult to discern' (Angell 2000: 1517). As noticed long ago by the epidemiologist Austin Bradford-Hill (1965), what counts as sufficient evidence is linked to the perceived costs of being wrong and their expected distribution[7].

This sort of considerations lead critics of the DCS on knowledge production to complain that most deliberative designs reproduce the traditional divide between social abilities and disabilities, with experts assumed to deal with factual evidence and public concerns characterized as purely ethical, devoid of cognitive content (Wynne 2001). An UK's major experiment in public consultation, the *GM Nation?* debate on the commercial growing of GM crops, may be regarded as a case in point. Commentators on the critical side have pointed out, as its core features, the engagement of 'innocent' citizens (rather than 'activists', that is people provided with their own views), a focus on consensus and trust building (rather than on the reasons for dissent and mistrust) and a sharp distinction between expert and lay opinions. According to Alan Irwin (2006: 316-317), 'in giving the appearance of democracy, such talk actually diverts from a more adequate onslaught on deeper institutional and epistemic commitments […]. Little has changed: we are simply in the old nexus of technocratic aspirations with the public construed as an obstacle to progress'.

Game Configuration

From the viewpoint of the ill-tractability of many environmental controversies, the main asset of DD should be its capacity to increase the legitimacy and applicability of policy choices. The extent to which this is to be expected, however, depends on the configuration

[7] Bradford-Hill provides three examples: 'relatively slight evidence' is enough for a ban on the sale of a widely used drug for early-morning sickness in pregnant women; 'fair evidence' is required to reduce occupational hazards such as change from a probably carcinogenic to a non-carcinogenic oil; 'very strong evidence' is needed for public restrictions on smoking or diets.

of the deliberative game. If the stakes look fixed and the parties believe they can just think of themselves, then strategic behaviour is the obvious choice and the game takes a distributive configuration. If the participants think that the stakes can be broadened and that in order to fulfil their goals they need each other, then sincerity may become an asset, the game may take an integrative configuration and the creative search for shareable choices becomes a meaningful effort (Fisher et al. 1991). Distributive configurations, however, are logically dominant on integrative ones, because giving up strategic behaviour entails for any actor to see the game as integrative and to be confident that the others share this view. In theory, therefore, the usable space for deliberation – if the latter is to be something more than mere bargaining – is rather narrow[8]. In practice, the game configuration is likely to be affected by several factors.

One of them is where deliberative arenas find their place in the policy process. The closer deliberation is (felt to be) to the decision-making, the more the participants are likely to endorse a distributive configuration. There is some empirical evidence of this (Pellizzoni 2003). Experimental studies in psychology also indicate that cognitive closure is fostered by perception of bio-physical threat (Pantaleo and Wicklund 2000). Being asked to confront opinions or take decisions makes a big difference in this respect, even though the presence of fiduciary relationships may help reduce the recourse to strategic behaviour.

The way an issue is framed is of course also likely to be relevant to the perception of the deliberative game as distributive or integrative. The threshold between private and public aspects is a major point in this respect. Some participants may see the allocation of a resource (the control of a good, the power to decide on something) as out of discussion – their own business – while others may regard it as part of the problem. As already noticed, one thing is to reflect on the most suitable site for an incinerator; another is to reflect on whether an incinerator is actually needed. 'Responsible' corporations often welcome stakeholder advice on ecological initiatives, yet they are hardly willing to discuss on how much of their profit is to be spent on environmental protection.

'Focal points' (Sugden 1995) – that is salient features of the issue at stake that anyone involved is able to grasp and agree upon beforehand – are relevant as well to the game configuration. This often depends on how the agenda is set. For example, in some circumstances a future-oriented perspective may foster an integrative configuration; the opposite applies if the decision is presented as long-lasting. Not by chance are unwelcome technologies often presented as transitory solutions – pending safer or cleaner ones. Of particular interest is the so-called 'crowding-out' effect, that is the dominance of extrinsic, monetizable motivations over intrinsic, non-monetizable ones. Research (Frey 1997) shows

[8] This, at least, if one adopts a rational choice approach to human behaviour, that is if one assumes that selfish motivations are the only, or the dominant, ones. Such presumption is obviously debatable (Elster 1995; Heath 2001). However, since the presence of actors all of which provided with a selfish initial attitude represents a worst-case scenario for a 'proper' deliberation, I think that rational choice assumptions offer a good starting point for reflecting on the conditions of possibility of different deliberative configurations, including those which contradict such assumptions.

that talking of monetary compensations – for example for an hazardous plant or for the individual contribution to a collective good such as urban waste collection – leads to a distributive configuration. People are encouraged to reflect on how public and private benefits can be accommodated, rather than how the public interest may be fulfilled.

If valuable insight is already available into the factors impinging on the game configuration and on the consequent room for a 'proper' deliberation, further research is needed to provide a more robust, detailed picture. This applies especially to the role of cognitive uncertainty. It is unclear on what terms deep forms of uncertainty like those related to many environmental issues – think for example of adaptive measures to the rising level of seas, as a possible consequence of climate change – may lead to a distributive configuration, with the parties stuck to their position and using the available evidence in a strategic way, rather than to an integrative configuration, the open mindset of the parties allegedly depending in such case on their being unsure about the policies best suited to ill-defined interests[9].

Institutionalised Biases in the Treatment of Uncertainty

Uncertainty is of major relevance also from another viewpoint: the existence of institutionalised biases with regard to its treatment. If any non trivial environmental issue is confronted with significant levels of uncertainty, in deciding what to do one can make two types of errors: false positives (Type I errors, as statisticians call them) and false negatives (Type II errors). 'False positives occur when an initial finding of (unacceptable) harm later turns out to have been incorrect. False positives are risked by presuming "guilty until proven innocent". […] False negatives occur when an initial finding of no (or acceptable) harm later turns out to have been incorrect. False negatives are risked by presuming "innocent until proven guilty"' (Wiener and Rogers 2001: 321). We can reduce the probability of Type I errors (for example we take as true that some GMO has harmful environmental effects while, as we later clarify, this actually is not the case) only at the cost of increasing the probability of Type II errors (we reject the hypothesis that such GMO is harmful while, as we later ascertain, this is actually true), and the choice of different levels of significance for these errors (that is different burdens of proof) is conventional (Stewart 2000). It therefore depends on assumptions about the relevance of one or the other error, usually related to some notion of what is good and desirable. If, for example, we are concerned with the increase in environmental degradation we will likely lean towards reducing false negatives in experimental (and judicial) trials; if we are instead concerned with an over-restrictive regulatory system we will lean towards reducing false positives.

[9] The latter case corresponds to John Rawls's (1971) well-known mental experiment about the 'veil of ignorance'. According to him, insufficient information about one's own future position in society (class, social status, access to natural assets and possession of abilities etc.) leads to the search for equitable distributive rules.

Beyond the statistical lexicon, the point is that in taking decisions we may incur two different types of mistakes: rejecting something that we should have accepted or vice versa. These possibilities cannot be reduced at the same time, and there are no objective criteria for balancing them. The controversy over precaution, in this sense, can be traced back to a contrast between those who are more concerned with false positives, because they believe that being too worried about uncertainty entails 'financial losses, restricted freedoms, and the foregone health and environmental benefits of restricted technologies' (Wiener and Rogers 2002: 321), and those who are more concerned with false negatives, because they believe that current regulatory arrangements are insensitive to many environmental threats. While the former stress that sensible policy-making requires evidence of harm, the latter contend that no evidence of harm is not the same as evidence of no harm, since it may depend on insufficient or unsuitably designed research.

It is important to remark that these orientations are not so much a matter of individual preferences, as of institutionalized roles. For example, it is logical for entrepreneurs to be more concerned with Type I errors because the latter impinge on the profitability of investments, prompting them to address fictitious problems, as would be the case if they had to rearrange electric power lines in response to misleading epidemiological or experimental evidence of harm caused by electromagnetic fields. False positives are also usually of greater concern for scientists. To mistakenly find out something that does not actually exist may hamper research progress, while if something that really exists has not been detected yet, it can still be captured by further inquiry (Cranor 1993). Consequently, methodologies are often designed to reduce false positives at the cost of increasing false negatives. Think for example of the stress of experimental studies on exposure to single agents or conditions rather than mixtures, even though many biological effects have an obvious multi-causal nature. On the other hand, when research is used for environment protection purposes the implications of false negatives are more important than missing or slowing down innovation. This is the typical viewpoint of environment and health agencies or technology end users and local communities. Approaches to uncertainty, thus, have their own political constituencies (Hammond 1996) and cycles of policy adjustments may be observed as a consequence, as with the European and American oscillations in the application of precautionary policies (Pellizzoni 2009a).

Biases in the treatment of uncertainty are also embedded in specific scientific disciplines. This helps explain why, as already remarked, scientists may assess a same evidence in different ways. It is probably not by chance that geneticists and molecular biologists are overrepresented among those who stress the benefits of GMOs, while ecologists, biologists of populations, agronomists are overrepresented among those who stress their potential risks. The former are used to think in terms of direct cause-effect relations; the others in terms of complex, ill-controllable interactions. Similarly, being used to think of human history in terms of scarcity overcome through innovation, economists are often more optimistic than ecologists about technological answers to environmental problems (Sarewitz 2004). Biases in the treatment of uncertainty are also a matter of policy frameworks. The social justice framework typically adopted by NIMBY groups leads them

to focus on false negatives and justify expensive policies 'on the basis of a few credible scientists suspecting a small risk that violates the rights of even a small group of people', whereas economists, engineers and regulatory agencies usually focus on false positives because they follow an utilitarian approach, searching for the option 'that aims at producing "the most good for the most people at the least cost"' (Neutra et al., 2002b: 2).

To sum up, a typical problem of deliberative arenas is that they gather people provided with different orientations about uncertainty. This may obviously undermine the joint search for, and assessment of, policy options, leading to diffidence and distrust and to a distributive game configuration. Though systematic research is needed in this respect, a connection is to be expected in most cases between inclusiveness of an arena and number of participants with no direct access to the benefits of a policy, with consequent attention to its distributive trade offs and prevalent concern for Type II errors. Similarly, since a false negative can be read as an externality (in the sense that the effects of decisions are different from, or additional to, those foreseen and included in the deliberators' window of concern), it is reasonable to expect that the broader is the agenda – and especially the greater is the attention to externalities – the stronger will be the focus on Type II errors.

On the other side, those who are more concerned with Type I errors are likely to find more sensible a tightening of the scope of inclusion, or of the agenda, or both. This finds support in a widespread prejudice adverse to assigning regulatory and policy priority to false negatives (Freudenburg et al. 2008), as a consequence of cultural biases and organized interests pressures in favour of innovation and growth. Since the advantages of the latter are assumed to be unquestioned and generalized, so its unforeseen costs have to be. Such costs cannot be borne by the innovator because they may exceed any budgetary preventive measure, deterring advancement. If 'technological innovation has given rise to increasingly complicated product design and manufacturing processes, the long-term effects of which cannot be foreseen with certainty' (European Commission 1999: 22), even the damaged citizens ultimately benefit from innovation. Examples of this approach can be found in the Directive 85/374/EEC on product liability and the Directive 2004/35/CE on environmental liability. Producers and operators are not held liable if they show that, according to scientific and technical knowledge at the relevant time (commercialization of a product, emission release etc.), they had no possibility to detect problems. This prejudice favourable to growth and innovation not only leads policymakers, companies and scientists to frequently downplaying Type II errors – with consequent dismissal of early warnings and regulatory failures, as with asbestos, BSE and many other cases (EEA 2001) – but also to take environment and health issues as a matter of risk reduction, whereas the public may be more concerned with the broader impacts and justifications of innovation (Felt and Wynne 2007). The likely result is a dialogue of the deaf, and policy decisions affected by what is sometimes called 'Type III errors' (Schwartz and Carpenter 1999): providing sound answers to the wrong questions. Institutionalised biases in the treatment of uncertainty represent therefore a constant threat to the application and fruitfulness of deliberative processes.

Conclusion

Promises and perils, strengths and weaknesses of DD are extensively discussed. Drawing on a fast developing literature in political theory, environmental sociology and sociology of scientific knowledge I have reflected on why public deliberation has been often applied to environmental questions and what are the basic challenges it encounters in this field. The attractiveness of deliberative arenas can be explained in the light of the legitimacy crisis of traditional policy processes; a crisis where the saliency of uncertainty plays a major role and which brings into question the dominant division of labour on the production and application of environmental knowledge. DD represents a participatory, inclusive reply to this crisis, yet in many cases its actual import is debatable. The possibility of 'proper' deliberations, that is something more than mere negotiations, is limited by many factors. There are systematic mismatches in the way those who gather round a deliberating table address uncertainty. There are strong motivations to hold as much as possible the traditional divide in knowledge production, affecting the design and practice of deliberative processes.

Radical criticisms of the DCS focus precisely on deconstructing the boundaries between production and policy application of knowledge by showing how uncertainty makes such boundaries increasingly debatable, the search for facts and truths being mixed up with normative commitments that cannot anymore be disclaimed or taken for granted. The assumption here is that, if the production of knowledge is increasingly crucial to politics and economy, then 'democratizing' the former will crucially help democratize the latter. The task then is to remove strong yet well identified obstacles to truly equitable deliberations; to overcome those forces that, by defending the existing cognitive order, protect a social order affected by unacceptable privileges and inequalities.

Yet one should reflect carefully on the implications of the growing saliency of uncertainty. As regards climate change, for example, the lack of unquestioned certainties, the inevitable scientific discords, have been used in the policy arena as arguments for shelving or postponing stricter measures (Freudenburg et al. 2008). More in general, one should reflect on the possible effects of dismantling the institutionalised separation between production and policy uses of knowledge. Its breakdown might lead to decreased, rather than increased, openness to public scrutiny. Exposing to debate and negotiation any cognitive standpoint may undermine, rather than strengthen, 'weaker' interests and insights. The more is knowledge maintained to be positional, the less distinguishable is it from power and, consequently, the more is power able to label any form of knowledge-based dissent as a minority partisan stance – to be conveniently dismissed according to the rules of democracy (deliberative arenas included) or of the market. Such drift is already noticeable in the bioscience field, where what was once regarded as a non-proprietary discovery is increasingly described as a patentable invention. The result is not an expansion of the public review of innovation, but of the private appropriation of the biophysical world (Pellizzoni 2009b).

Not by chance some scholar has begun to express concern for the use of scientific uncertainty or of the narrative of the manufactured character of things as a weapon in the struggle for power and money (Latour 2004). The scope of deliberative arenas may therefore be undermined not only by persistent appeals to hard facts as the preserve of qualified actors but also, and perhaps above all, by the broadening acknowledgement of the manufactured, proprietary character of biological matters. Public scrutiny of knowledge production may decline not so much because it is beyond cognitive reach, but because it is beyond legal reach.

Deliberative democracy can hardly represent by itself an answer to these problems. Its potentialities may flourish not only as a result of procedural refinements, but of broader social reforms. Something is moving in this respect. For example the idea of 'public domain' (Boyle 2003), as a space encompassing intellectual goods on which no proprietary rights can be exerted, is of major relevance and its applications (mostly in the ICT field) promising. Prospects for a 'democratization' of knowledge production and use are however uncertain, being confronted with powerful political, economic and scientific interests and ideologies, for which the defence of the traditional narrative of science and politics is premised on the pursuit of their own goals and visions of society. In this sense the conditions of success of deliberative democracy in the environmental field cannot be measured only in terms of intellectual elaboration and practical experience, as in terms of emergence of social forces capable to impart a major swing to the current tangle of techno-science and neo-liberal political economy.

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