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Education and Empowerment for an Uncertain World

Edited by Donald Gray, Laura Colucci-Gray and Elena Camino

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To children and granc
systems

2 Post-Normal Relationships between Science and Society

Implications for Public Engagement

Ângela Guimarães Pereira

> Science and technology are present in all of the narratives that modern societies weave about the world, as essential threads in the tapestry of social reality.
>
> (Jasanoff, 2005)

EDITORS' INTRODUCTORY NOTES

The epistemological changes that characterize modern technoscience, as described in Chapter 1, along with the growing concentration of economic power and energy, have important implications for the involvement of the public in decision-making processes concerning socioenvironmental issues. In this view, the epistemic framework of post-normal science challenges the model of Public Understanding of Science (PUS), and the thesis of the public's inability to act on scientific issues, supporting instead the launch of various efforts for democratizing science. Such an extension of participation calls for a reflection on the nature of the knowledge that is being produced and on what the criteria and processes for ensuring quality might be. Chapter 2 deals with these questions through an exploration of different models of participation and co-construction of knowledge, which refer to different perspectives on the relationships between science and society. In particular, if exclusive reliance on scientific knowledge validated by the academic community is no longer tenable, then quality in decision making is linked to the extent to which multiple subjects can be involved and participate in a process of dialog: an extended peer community that is able to balance previous power differences between science and society, and also to enable co-production of civic science.

This chapter will offer a number of examples of contexts and places for engagement, with a final reflection on the changes in the ways of learning that are required by the ongoing transformation of the relationship between the public and the scientific community.

SCIENTIFIC KNOWLEDGE AS A POWERFUL MEANS OF REPRESENTING REALITY

One of the most important challenges I have had recently has been in trying to explain to my four-year-old son some of his curiosities about the world. I now have to explain everything I have (unconsciously) taken for granted. Even if fantasy helps a great deal, most of the time my tales and metaphors are based on science. This is hardly surprising given my engineering background, and also probably because I, too, as a child, was not exposed to other types of narratives, even although I lived in Africa.

Every day we *translate*[1] scientific knowledge, or are exposed to others' translations, in our metaphorical personal world, using our own vocabulary, our referential walks of life, and apply it in our context of significance. Doctors translate illness information to their patients; parents respond to their children's questions with science tales; the press, movies, radio or TV shows convey scientific stories to their audiences; and arts often express scientific views. In regulation, as in the European environmental impact assessment (CEC 1997) and the water framework directives (CEC 2000), a nontechnical summary of the specialist reports is requested to be available to the nonspecialist public. Likewise, among specialists, exercises of *translation* are done, as, for instance, when the European Food Safety Agency writes opinions to the European Commission's Directorate General Health and Consumption (DG SANCO).

Moreover, the producers of science, generally denominated as scientists, are often seen as privileged with a power that derives from their proximity to the truth. Hence, it makes sense that their narratives become tangible and accessible to all! The US educator John Dewey claimed that young people should be inculcated with a "scientific attitude" that would help them approach the issues and problems of everyday life in a rational and logical fashion (in Dewey [1934], quoted in Gregory and Miller [2000]).

From a historical perspective, science as we know it appeared in the seventeenth century and was accompanied from day one by science popularization and science fiction. One of the first science popularization books was Galileo's "Dialogue," published in Italian in February 1632. Athanasius Kircher used the then-recent optical scientific discoveries to design spectacular public shows in Rome around 1640 and created one of the first science museums. The science-fiction novel, "Les états et empires de la lune et du soleil" by Savinien Cyrano de Bergerac (a physicist) was published in 1648.

Also, quite early public involvement in science was sought as a means of legitimation. For example, part of the mission of the Royal Society of London, which was founded in 1660, was public demonstrations of new science as part of its validation process[2]. Historians of science have pointed out the fact that prior to the days of peer-reviewed journals and elite science societies, the latest facts and theories about science were regularly

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The national history or tradition of a country has greatly influenced the actions taken to promote research and technology development (RTD) culture and public involvement in science in that country (Miller et al. 2002; Jasanoff 2005). Some historical crisis of science–society relationships has set the stage for present day attitudes, science communication styles having taken different routes in different countries. In the remainder of this chapter, I will look at the ways in which the public's involvement in policy-relevant science has been conceptualized, especially in Europe. I will also look at how, in practice, researchers view engagement of the public in the development of science. I will look into the challenges of democratizing science and how extended frameworks, such as knowledge co-production (Jasanoff 1994) and the post-normal science framework (Funtowicz and Ravetz 1990, 1991, 1992) in which the concept of extended peer review and extended peer communities have developed, can contribute to its *operationalization.* Finally, I will reflect on the implications for education and learning processes of the introduction of these extended processes for knowledge creation.

MODELS OF PUBLIC INVOLVEMENT IN SCIENCE

In this section, I concentrate on the publics' involvement in policy-relevant science in the last decades. The types of processes I am considering here relate to situations where science is used to inform a debate about a specific policy issue. In particular, I will adopt the three main phases of "public involvement" in science identified by Wilsdon and Willis (2004): a) public understanding of science; b) from "deficit to dialog" and c) engagement upstream. They also find correspondence with Callon et al. (2001) and others (see, for instance, Felt 2002) models of science and public relations.

a. PUS

The PUS (or PUST if the word *technology* is added, or yet PUSH if the humanities are considered, as in the German approaches to the issue) developments since the mid-1980s arose on the assumption that the lack of public support for science and innovation was solely due to lack of understanding or "scientific illiteracy" (Wynne et al. 2007), which was also deemed to jeopardize modern democracies. This concept corresponds to Callon's (2001) model of science and public relations called the "public education model."

The response[3] *from scientists* to growing levels of public detachment and mistrust was to embark on a mission to inform, a one-way transmission of knowledge from science to a public imagined as passive and lacking in information. It is, in practice, a pedagogical approach that relies on a "deficit model" of the public as ignorant and science as unchanging and universally comprehensible and, therefore, tries to increase the scientific knowledge of citizens. Some have even elaborated practical protocols with sound principles to engage in such an endeavor like Gregory and Miller (2000)—although many aspects of the latter are much beyond the PUS paradigm.

Many have argued against this paradigm because of its ambiguities, like Duranet al. (1996), who discussed the very expression: what is the "public," what is "understanding" and what is "science"?, and Jasanoff (2005), who argues that the "u" of understanding in PUS implies the interest of the public in scholarly issues, potentially being, in this case, a source of cross-cultural variance: failure to understand science becomes a meaningful dimension of difference among individuals and communities. Gross (1994), in his work about the rhetoric of PUS, outlines how the deficit model incorporates the metaphors of scientific *sufficiency* and public *deficiency*: "its practitioners do not try to persuade, they assume that the public is already persuaded of the value of science" and "they do not try to build trust; they assume that the public is already trusting"; hence, this model implies a passive public, which "requires a rhetoric that acts to accommodate the facts and methods of science to the publics' limited experience and cognitive capacities" (Gross 1994, 6).

In much of the research that this concept has generated, there is little evidence that public ignorance of scientific facts correlates in any meaningful ways with collective responses to science and technology; biotechnology being simply one domain for which this observation holds true (Gross 1994; Evans and Durant 1995; Wynne 1995; Miller 2001; Jasanoff 2005).

b. From Deficit to Dialog

The UK BSE[4] "scandal" of the mid-1980s to mid-1990s is often cited as pivotal in the change of direction in the relations between science and policy making. A key moment was the publication of the 2000 House of Lords report on *Science and Society*, followed a year later by the European Commission's *Science and Society Action Plan* (European Commission 2002), as well as the European Union (EU) 5th Framework research program's "Raising Awareness of Science and Technology" activity of the late 1990s. Partly as a result of PUS failings, public perception of science worsened throughout the 1990s, and a new language of "science & society" towards dialog engagement emerged. This phase corresponds to Callon's (2001) model of science and public relations as a "public dialog and participation model."

"The GM Nation?"—see Box 2.1.—is an example of this phase in which the UK government sponsored a debate on genetically modified crops with the intention of having a wide-ranging and effective public debate, going beyond the "often polarised views in order to find out what people really

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Box 2.1 The GM Nation?

The public debate in the United Kingdom that took place during 2003 about genetically modified organisms was a unique experiment in public engagement. It involved a total of 675 public debate meetings, namely:

- 9 Foundation workshops with members of the public
- 6 National and regional conferences; small county and local-level meetings
- Focus groups (*narrow but deep* meetings)
- Material: CD-ROM, brochures incl. questionnaire
- A website where people could post comments and accompany progress of debate.

(http://www.gmnation.org.uk/)

think about GM" (Gaskel et al. 2003). It is important to note that this debate springs from a recommendation of the *Agricultural and Environment Biotechnology Commission*, which is an independent body that advises the UK government on biotechnology issues and their impact on agriculture and the environment. This debate should "establish the full spectrum of the publics views on GM and possible commercialisation of GM crops, and any conditions it might want to impose on this" (AEBC 2003). It is remarkable that the GM Nation was a governmental operation: as Jasanoff (2005) notes, in biotech times, upstream efforts to identify risks and explore ethical dilemmas were led by the science community itself. Indeed, many initiatives of public involvement in controversial issues depart from the academics or nongovernmental organizations and fewer from governmental institutions.

Horlick Jones et al. (2004) and Rowe et al. (2005) made the point that the public was concerned about lack of transparency, especially in terms of how results would be used, as well as the actual influence of the views expressed in the whole policy process, from events that had not been held early enough to influence public policy. Moreover, Wilsdon and Willis (2004) highlight that the publics involved believed that there was a genuinely open outcome at stake and that everyone believed that the government had already determined its preferred outcomes. As the government did not ascertain its position, a deep public sense of government dishonesty developed and was aggravated by the government being the sponsor of this initiative.

c. Moving Engagement Upstream

In this (current?) phase, the science community is (supposedly) embracing dialog and engagement (recognizing that many controversies had made it a nonnegotiable clause of their "license to operate"). A new term has entered the lexicon of public engagement: there has been a surge of interest in moving engagement "upstream" (e.g., The Royal Society's nanotechnology report in 2004[5]: *constructive and proactive debate about the future of nanotechnologies to be undertaken now . . .*); it focuses on establishing a two-way dialog between citizens and other actors on science and technology challenges facing society.

This phase corresponds to what Callon (2001) describes as the model "public co-production of knowledge," as far as science and public relations are concerned.

But how do researchers view public engagement in policy-relevant science at present?

MOTIVATIONS AND PLACES FOR PUBLIC INVOLVEMENT IN SCIENCE

Researchers Views about Public Engagement in Science

In this section, contemporary views of researchers with regards to public engagement in science will be reviewed. The observations herein are based on a report from the UK Royal Society published in August 2006 (Royal Society 2006) regarding the factors affecting science communication undertaken by scientists and engineers. This report is based on a survey done with UK researchers, which makes it specific to the United Kingdom in context, but (based on experiences reported elsewhere with other researcher communities) many of the observations of interest in this chapter apply to many other contexts.

In the Royal Society report of August 2006, scientists were asked to define, in their own terms, what *engaging with the nonspecialist public meant to them* (the percentage that considered the meanings are found in parentheses below):

- To explain and promote PUS (34%)
- Highlighting implications, relevance and value of science (15%)
- Giving a public lecture (13%)
- Listening to and understanding the public (13%)

Moreover, respondents considered that:

- The most important reason to engage the nonspecialist public is to ensure the public is better informed about science and technology (35%)

- The least important reason
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- The least important reason was to engage the nonspecialist public to contribute to ethical discussions about science (5%)

Yet, 69% of the respondents agreed with the statement that it is a moral duty of scientists to engage with the nonspecialist public about the social and ethical implications of their research.

The interviewees saw the following as barriers to science communication and involvement with the public:

- The need to spend more time on research (64%)
- Time taken away from research (29%)
- Scientists who engage with the public are less well regarded by other scientists (20%)
- Several researchers highlighted that public-engagement activity was seen by peers as bad for their career, "done by those who are not good enough" for an academic career, with science communication being regarded as an altruistic activity and not bringing significant funding to universities.

Reflections

As I said earlier, cultural and historical events in science and public relations shape current situations in different countries. Yet, 73% of the researchers that responded to the UK Royal Society survey had no training in communication. So one might think that lack of skills and current understanding of what a "normal" research activity is play a big part in the ways the public engagement in science is currently shaped in many countries, along with the historical context. Science communication and engagement with the public, as viewed by researchers, confirms that the great majority of respondents still adopt the one-way information paradigm. Callon's (2001) model of knowledge co-production, where citizens and concerned groups get actively involved in the process of knowledge production, is still far-off.

Several normative and regulatory documents coordinated by the European Commission, such as the report on the "democratising of expertise" (European Commission 2001) and the report on "taking knowledge society seriously" (Wynne et al. 2007) outlined the need for, and the conditions to, improving interactions between expertise, policy making and public debate, as well as new regimes of public engagement. Different motivations can be found to foster a "deeper" type of engagement that goes beyond the still entrenched paradigm that sustains the current interactions between expertise, policy making and public debate. These can be due to the inevitable, more inclusive ways in which democracies tend to develop, or because they legitimate a specific process; for some, because such interactions are a unique way to change innovation developments policy making or yet a reflexive and accountable review of current knowledge production activities (Wynne et al. 2007). While this surely has to be embedded in an extended model of governance of science for policy making, where the public is viewed as possessing relevant resources that may be relevant in a knowledge co-production (Jasanoff 1994) process, the operational framework is varied and still experimental in many cases, lacking, above all, the institutional link.

FROM PUS TO "CO-PRODUCED FACTS"

In this chapter, I am interested in situations where public involvement is pertinent in policy-relevant science. Therefore, I start to look at models of the relations between science and policy and see where in such models a more extended relation of the public with the science production and deployment could find its space. Subsequently I look at the notions of co-production, civic epistemologies and alternative contextual models that address some of the pitfalls of the PUS model and practice.

Models of Science and Policy: From Expert Demonstration to Post-Normal Science

Funtowicz (2006) identified several conceptual models of the relation between science and decision making in policy processes. Funtowicz traces their evolution through a deepening appreciation of the process of the use of science in policy. Starting from the «modern model» of perfection and perfectibility—which represents a classic "technocratic" vision where there are no limits to the progress of humans' control over their environment, and no limits to the material and moral progress of mankind—Funtowicz offers an evolutionary perspective on the governance of science in policy making:

- *Precautionary model* (with uncertain and inconclusive information): arises from discovering that the scientific facts are neither fully certain in themselves nor conclusive for policy; therefore, an extra, normative element is introduced in policy decisions: *precaution*, which both protects and legitimizes decisions.
- *Framing model* (arbitrariness of choice and possible misuse): arises from the recognition that, in the absence of conclusive facts, scientific information becomes one among many inputs to a policy process, functioning as evidence in the arguments. Stakeholders' perspectives and values become relevant, and even the choice of the scientific discipline to which the "problem" belongs becomes a prior policy decision, part of the debate among those affected by the relevant issue.
- *Demarcation model* (possibility of abuse of science): arises because the scientific information and advice that are used in the policy process are created by people working in institutions with their own agendas. It recognizes that the "scientific" information and advice cannot be

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- *Extended participation:* acknowledges the difficulties of defending a monopoly of accredited expertise for the provision of scientific information and advice. "Science" (understood as the activity of technical experts) is included as one part of the "relevant knowledge" is brought in as evidence to a process. The ideal of rigorous scientific demonstration is replaced by that of open public dialog. Citizens become both critics and creators in the knowledge-production process as part of an extended peer community.

It is argued that it is within the "extended participation" model of science and policy that new relations between science and the public are usefully operated, underpinning phase 3 of public engagement in knowledge production. The "extended participation" model is both framed and operationalized within the post-normal science framework and the concept of *extended peer review*, which we address below.

Post-Normal Science and Extended Peer Review

> The insight leading to Post-Normal Science is that in the sorts of issue-driven science relating to environmental debates, typically facts are uncertain, values in dispute, stakes high, and decisions urgent [. . .] In post-normal conditions, such products the goal of achievement of truth or at least of factual knowledge may be a luxury, indeed an irrelevance. Here, the guiding principle is a more robust one, that of quality. (Funtowicz and Ravetz 1990b)

As reported in Chapter 1, in the diagram of post-normal science (reported on page 19 of this book), Funtowicz and Ravetz (1985; 1990a; 1992) represented how different types of problem-solving strategies and practice correspond to different sorts of uncertainty (namely technical, methodological and epistemological), as well as how they relate to the world of policy: *decision stakes* included "costs, benefits, and commitments of any kind by the parties involved."

The "post-normal science" framework (Funtowicz and Ravetz 1990b; 1992; 1993; *http://www.nusap.net*) and its guiding principle—quality—quires the participation of an "extended peer community" (Funtowicz Ravetz 1990b) engaged in dialog and the resolution of the issues at ...ded peer community"—see Box 2.2.—consists not merely ... of institutional accreditation, but rather all ... participate in "extended peer review" processes for

Box 2.2 "Extended Peer Communities."

"Extended Peer Communities" are increasing in number, organized for different purposes and involved in different ways and at different steps in policy-making processes. They are called "citizens juries," "focus groups," "consensus conferences," etc., with correspondingly varied powers. They may be engaged through regulated participatory processes, or they may be the initiative of specific interests or even develop into formal settings, resulting from social mobilization. But they all have one important element in common: they assess the quality of policy proposals, including a scientific element, on the basis of the science they master combined with their knowledge of the ways of the world. The contribution of relevant social actors, in this case, is not merely a matter of broader democratic participation, and their verdicts all have some degree of moral force and, hence, political influence (Funtowicz 2001).

the resolution of the issue (Funtowicz and Ravetz 1990b). Their relevance and influence will depend on the context in which they operate, the eventual aim of the involvement and the flexibility of, or instrumental use by, institutional "ears" that could benefit from their inputs.

The assessment of the *quality* of the knowledge inputs to policy issues by those "extended communities" is in many ways different from the review processes of research science, professional practice or industrial development (Funtowicz 2001). Each of those has its established means of quality assurance for the products of the work, be they peer review, professional associations or the market. However, what Funtowicz and Ravetz argued is that, for new controversial problems, the maintenance of quality depends on open dialog between all those affected.

The aim of knowledge quality assurance by "extended peer review" is precisely to open processes and products of policy-relevant science to those who can legitimately verify its relevance, fitness for purpose and applicability in societal contexts, contributing with extended insights and knowledge: "extended facts." These may include craft wisdom and community knowledge of places and their histories, as well as anecdotal evidence, neighborhood surveys, investigative journalism and leaked documents (Funtowicz 2001). Extended peer review faces several challenges, such as, for example, resistance and closure of institutional or established practice in research and policy, different conceptual and operational framings and knowledge representations and mediation (Guimarães Pereira and Funtowicz 2005).

Knowledge Co-production, "Civic Epistemologies" and Contextual approaches

This section looks at the concepts of "knowledge co-production" and "civic epistemologies" as proposed by Jasanoff (1996, 2004, 2005).

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"*Co-production* is short hand for the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it" (Jasanoff 2004, 3).

In this framework, scientific endeavor is not to be understood as "a simple reflection of the truth about nature nor an epiphenomenon of social and political interests" (Jasanoff 2004, 3). Scientific knowledge "both embeds and is embedded in social practices identities, norms, conventions, discourses, instruments and institutions—in short all building blocks of what we term the social" (2004, 3). Hence, scientific knowledge is not independent of political contexts, but *co-produced* by scientists and the society within which they are embedded (Jasanoff 1996).

As with a post-normal science framework, the co-production framework attempts to interpret and account "for complex phenomena so as to avoid the strategic deletions and omissions of most other approaches in the social sciences" (Jasanoff 1996). Hence, this framework conceptualizes the scientific endeavor as intrinsically embedded in the context where it develops and so scientific knowledge as being context-dependent, a notion that is further developed in Giampietro (2003), for whom scientific narratives and its framings are dependent on "who" initiates the process, with which purpose, perspectives and values.

The ideas of co-production of knowledge liaise with the motivations and justifications for the ways in which the publics hold, develop, represent, communicate or express and deploy knowledge. Jasanoff (2005) offered the term "civic epistemology" to refer to the culturally specific, historically and politically grounded public-knowledge ways; i.e., what she calls the "institutionalised practices" by which society members "test and deploy knowledge claims used as a basis for making collective choices" (255). Through this concept, one moves away from "*a priori* assumptions about what the publics should know or understand of science." "Moreover, it challenges the assumption that the credibility of science in contemporary political life can be taken for granted when, in fact it is a subject that needs explanation (Jasanoff *idem*), i.e. how science claims become authoritative and through which ways science inputs become legitimate in policy settings needs to be addressed.

The notion of "civic epistemologies" and the "extended peer review" earlier described explicitly recognize that the public at large shares certain values, experiences and ways of testing and handling knowledge claims. Hence, such acknowledgement requires the consideration of a relationship between the science and the public to be necessarily conceptualized on a basis that is different from what was offered to support the PUS movement.

Gross (1994) suggests a "contextual model" as the counterpart to the "deficit model" of PUS. In the "contextual model," he argues, scholars do not have a methodological security, as practitioners of PUS—who often use surveys and statistical analysis to justify their approaches—claim to have. The author suggests that case studies should, in this case, be considered as a social scientific method. In the "contextual model," interaction between science and its public is the basic metaphor; hence, it depicts communication as a two-way flow between science and its public. In this model it is not assumed that the public is already trusting, implying also a very active public. This model implies the rhetoric of reconstruction, where public "understanding" is the *joint creation of scientific and local knowledge; the genre is deliberative.* Ethical and political concerns are always relevant.

From PUS to "Co-Produced Facts"

Jasanoff's "co-production" framework and "civic epistemologies" help us to realize that the scientific endeavor has indeed been a collective one, for it results from an implicit or explicit interaction of "science makers" and the contexts in which they operate. This is an important recognition, since those in charge of scientific developments often assume positions of "independence," objectivity, value and passion-free and neutrality, which become arguable in the light of the thorough acknowledgment of the dependencies of science in its context.

Post-normal science and its accompanying concepts of "quality assurance" through "extended peer review" by "extended peer communities" with their "extended facts," as well as manifestations of more inclusive participation of the public in science production, such as those of the European science democratization (CEC 2001), proposals seem to be—in a way—a natural path to follow. In a previous section we argued that it is within the "extended participation" model of science and policy, as proposed by Funtowiz (2006), that new relations between science and the public may be usefully operated because it encourages (and justifies) public engagement in policy-relevant science developments. The "extended peer communities" that this model alludes to are the key concepts in this chapter that justify public engagement in science, i.e., the acknowledgment that publics are not passive recipients of knowledge inputs provided by specialists, but are able to engage in "co-production of facts."

As we have seen in the previous sections, several authors, while offering different models of the relation between the public and science production, have demonstrated the pitfalls of the "deficit model" as the means of interfacing science and society, e.g., Gross's (1994) "contextual model" as presented earlier. In contrast with the "deficit model," contextual-like models have no prior assumptions about public knowledge and view science–society relationships as a cooperative endeavor, leading to "co-produced facts." The latter could be defined as the knowledge produced as a result of partnerships among those who have relevant knowledge that helps taming a specific *problematique*, whether it is a result of shared framing, data collection, shared scope, analysis or other forms of knowledge creation.

The concepts presented earlier are all important to understand what questions the PUS paradigm does not address, making it irrelevant for collective action. For instance:

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- How knowledge is produced, communicated, legitimized and deployed for collective action;
- What are the context dependencies to be considered in a knowledge mediation process;
- What form *interfaces* between science and society might have when the objective is one of debate instead of education.

The ways PUS practice has been operating, and its more urgent question of what the public knows about science, is relevant for the sole purpose of deciding what requirements are needed to implement a strategy of knowledge mediation when dialogs with the public are desirable. Moving beyond the *reductionist* relationship between science and society that PUS implies requires rethinking the "safe spaces" for knowledge exchange in public debate, with methodological implications for implementing those debates including the knowledge communication. The next section will reflect on this.

PUBLIC ENGAGEMENT IN SCIENCE AND TECHNOLOGY

> Public engagement today can directly affect research. It has gone beyond debating controversial social impacts of applied science and technology (. . .). It now delves into research methods that are unique to the laboratory, such as somatic-cell nuclear transfer and hybrids. (Taylor 2007, 163)

A whole issue on science and policy published by *Nature* in September 2007 heralds public engagement in science and technology as an inevitable and well-grounded activity for research operation. There is a whole body of literature, mainly based on case studies, reflecting on the challenges, opportunities and motivations for the public to be engaged in the science production processes, especially when dealing with policy-relevant science. "Public engagement" is viewed with enthusiasm to implement more inclusive governance styles. The implementation of participatory activities within policy- and decision making has evolved, nowadays being the subject of regulation and becoming more formalized within existing regulatory frameworks (see, e.g., De Marchi et al. 2001). Still, oftentimes, in public engagement, the public is involved in some limited manner in the practices of policy making, in contrast with the predominant model of representative democracy, where the public is "involved" solely by voting and election mechanisms (Guimarães Pereira et al. 2005; Rowe et al. 2005). The question now seems not to be whether public involvement should occur—there is a great deal of normative argumentation for doing it. The questions now seem to be about how it should occur, at which point of the process, its impacts and in what fields is it legitimate and relevant (Joly and Rip 2007; Taylor 2007). Notwithstanding the more accommodating tendency, effective public engagement exercises are full of difficulties of theoretical (what is effectiveness in this context?), practical (how do we assess that?) and political (how can this be done in often contested terrains?) natures (Rowe et al. 2005). Elsewhere (see, e.g., De Marchi et al. 1998), a number of principles essential to ensure an effective involvement of "extended peer communities" were described. A first principle, "knowledge-sharing," refers to the necessity of recognizing and appreciating the different types of knowledge that different agents can bring into a dialog. For example, citizens exposed to a certain risk are not a tabula rasa. They derive much relevant knowledge from everyday experience, dealing with real world problems. Acknowledgment of a community's "resources" refers to all the available talents, expertise, connections, etc. of different community members, which also include social and communicational skills, as well as access to extended networks. A policy dialog facilitates the elicitation of such resources that, once discovered, can be enhanced and used in a social learning process.

Many argue that changes are necessary in the institution and culture of science to one that supports more participatory and deliberative research designs (Cortner and Moote 1999; Bellamy and Dale 2000; Funtowicz et al. 2000; Wondolleck and Yaffee 2000; Pound et al. 2003; Bellamy et al., 2004; Burgess and Clark 2006; Wynne et al. 2007). Joly and Rip (2007) sustain that public engagement in science and technology is thriving, especially in the United Kingdom, suggesting that, in a number of case studies, such involvement has been fruitful for scientists and members of the public.

In order to implement participatory activities, practitioners often assume that citizenship is given. Writers about these issues often focus on how best to involve people in policy and decision processes and less on what it means to be a citizen and how its varied attributes express in public engagement (Jasanoff 2004); in other words, also focusing on the bases for inclusion and exclusion instead of the purposes served by wider inclusion.

We would argue that these issues are not disconnected; the loose link that these processes often have with their potential institutional "ears" is, at present, the most important bottleneck of these processes. So, when examining the methodological aspects of public participation implementation, one should look at the reasons why the civic and the political worlds do not connect, examining expectations from those involved and the meanings of the involvement. Wynne et al. (2007) distinguish between invited and uninvited participation, explicit and implicit forms of participation and the private and public arenas (e.g., media debates)—see Box 2.3.—for the meanings. These are contextual aspects of involvement of the publics. They frame the ways in which such processes are conducted, both conceptually and methodologically speaking.

Although those who advocate the democratization of science and more inclusive science and governance approaches certainly have a reason to

Box 2.3 Contextual aspect

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Based on Wynne et al. (2007).

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Box 2.3 Contextual aspects in which public involvement may occur.

- **Invited/uninvited** participation concerns the legitimacy of societal voices and how they are determined in relation to the framework where they operate;
- **Explicit or implicit** participation tries to capture the fact that the public can be absent presences in the sense that proxies might be used to integrate the publics' views in policy making processes, such as survey results or similar tools, or by more informal processes.
- **Private and public arenas** set also the context in which public engagement is framed; one around a vision of citizens as individuals, and the other around the public as represented through *stakeholders*[6].

Based on Wynne et al. (2007).

cheer the evolution it has taken over the last decades, we are still far from an extended model of science and policy.

Places of Engagement in Science and Technology

As we said earlier, public involvement methodologies are now beyond experimentation. There is an immense body of literature on participatory methodologies (see, for instance, Morgan 1998; Glicken 1999; IAP2 2000; Frewer et al. 2001; Van Asselt et al. 2001; Peals 2003; Slocum 2003; Involve 2005) that aims at *operationalizing* public involvement, discussing their appropriateness and conditions for implementation. Having said that, there is space to discuss whether those methods, taken from social research, are the appropriate interfaces between the public and institutions involved in the science–policy cycles. Although the argument for lack of connectedness between participatory initiatives and institutions is grounded on stands of political and cultural nature, there is no evidence that the methodologies chosen are not playing a hindering role as well. For instance, a recurrent argumentation about using qualitative methodologies in social research is the issue of *representativeness*, which links closely with the methodologies chosen and social–political context.

In the European Union (EU), two-thirds of Member State Governments now either have, or are developing, mechanisms of involving the general public in issues concerning scientific and technological developments (Austria, Denmark, Finland, France, Greece, Germany, Ireland, The Netherlands, Sweden and United Kingdom [Miller et al. 2002]). Denmark currently has the most extensive toolkit of participatory instruments, organized through the *Danish Teknologirådet* (http://www.tekno.dk/)—the Danish Board of Technology. Denmark was also the EU country that pioneered Scientific Ethical Committees to approve research procedures, such as medical trials. In fact, this Board, which informs parliamentary deliberations and decisions with well-crafted forms of direct elicitation of relevant public concerns, meanings and attitudes, is one of the exceptions to the otherwise overall realization that many participatory initiatives do not have a priori practical connections with real institutional policy processes.

Science shops (see, for instance, Mulder et al. 2006; http://www.scienceshops.org/) are another way of empowering citizens, providing them with independent scientific and technological advice as required for local issues, in particular. A science shop is a "unit that provides independent, participatory research support in response to concerns experienced by civil society" (Mulder 2006, 279). Most science shops are linked to universities and use the work of students under appropriate supervision to respond to civil society's (mostly nongovernmental organizations) needs.

Interactive webpages of leading scientific organizations offer opportunities to the general public to get involved in discussions about future directions of science; see, for instance, CNRS (http://www.cnrs.fr/), UK Royal Society (http://www.royalsoc.ac.uk/), etc.

These initiatives may seem to be at the forefront, but what remains unclear, however, is to what extent there is a culture of government acting on the findings of such activities.

Doing it with ICT

In the last decades, we have been addressing throughout our research projects the use of information and communication technologies (ICT) both to promote spaces for interaction among the publics concerned and the communication of science for public debate of policy-relevant scientific developments (see, for instance, De Marchi et al. 1998; Guimarães Pereira and O'Connor 1999; Guimarães Pereira et al. 2001, "ICT Tools" 2003, "TIDDD" 2003, 2005, 2006; O'Connor 1998, 2006; Rosa et al. 2008; De Sousa et al. 2008).

I illustrate the usage of ICT for public debate of policy-relevant science with a project called GOUVERNe[7], which aimed at the development and pilot implementation of a user-based, scientifically validated process and informatics product for the improved governance of groundwater resources. In this project, our activities consisted of organizing and mediating the available knowledge about two groundwater resources case studies in Europe (see Guimarães Pereira et al., "ICT Tools" 2003; "TIDDD"2003).

The methodology deployed was based on the concept of *quality assurance by extended peer review* as a normative procedure to construct the knowledge base upon which a debate about water governance options could start in both case studies among the relevant social actors. What we called the "GOUVERNe process" was strongly based on transdisciplinary principles, combining hybrid methodologies and integrating social research methods with evaluation tools, such as multicriteria evaluation.

The GOUVERNe Process

Knowledge scrutiny in the GOUVERNe process was strongly based on social research. That was the means to ensure that knowledge other than scientific–technical was available in the knowledge base to debate on possible futures for groundwater resources and the associated river basins of the two case studies (in France and Greece).

The involvement of relevant social actors was done from the very first framing step, which ensured that, early in the process, their perspective, concerns and ways of representing the issues were accounted for. The research framing acknowledged and shared by the relevant community helps to avoid the so-called Type III error, of addressing the wrong problem, and enhances the scoping phase (i.e., focuses the work of collecting relevant information). The extended involvement also means that the issues addressed are shared and are dealt at the appropriate depth.

Clearly, if the experts involved in the process are the only "digesters" of the available knowledge (even if the process is *inclusionary*), their research framing and representation will be paramount. This is why the quality check by the relevant community throughout the whole process is essential for compliance and effectiveness, and why the process of creating socially robust knowledge (Gibbons 1999) is a continuous *inclusionary* process of those concerned. In GOUVERNe, engagement of relevant social actors was done at several steps of the process.

What emerged from the processes of knowledge scrutiny is that activities and options explored together by those concerned had great advantages in terms of enhancing the final process of dialog compared with those activities structured solely by "experts": what becomes available as a knowledge base to support the ongoing dialogs is perceived as *co-produced facts,* issues becoming more easily appropriated by all those engaged.

One of the main research issues of this process was how to *articulate* different values and perspectives, as well as different representations of knowledge that may be presented through alternative narratives (language, framing, scales of measurement, numerical models, etc). GOUVERNe is about knowledge integration while trying to keep diversity, which, in the interpretation of the researchers, was the creation of a space: where different types of knowledge articulated in different sets of semantic rules, with different codes, different scales of evaluation, etc., could be represented through several formats implying various degrees of specialization; where no a priori "integrative methodology" was applied as the means of sharing knowledge, the integration being made through dialog and interactions.

This entails the effort to produce a sort of "knowledge platform" that is accessible to all those involved and promotes conviviality of different *knowledges*, including tools that help with the process evaluation, capturing plurality and diversity and avoiding the pitfall of reducing them to something plausible but meaningless. This was explored through the use of ICT and, in particular, multimedia knowledge representation.

Building Spaces for Conviviality: The TIDDD Concept

A major development within the GOUVERNe process was the realization, design and prototype implementation of a new concept tool: TIDDD (Tools to Inform Debates, Dialogs and Deliberations) deploying new ICT. The main characteristics of this tool can be defined as "tools that inform and mediate processes of debate, dialog or deliberation which involve social actors of a governance, policy or decision process." Mediation of knowledge in this case entails organization, communication and exchange of a plurality of sources and types of knowledge (Guimarães Pereira et al., "TIDDD" 2003). In the case of GOUVERNe, there was a great deal of disciplinary knowledge, such as climate, geological and hydrological, as well as socioeconomical, regulatory, etc. Scenario drivers to debate about future options were devised together with the social actors. Hence, as some modeling tools were used to characterize possible futures, there had to be some work on "translating" that information in order to use it as input for the models. TIDDD's aim is the creation of convivial contexts of exploration and "discovery," where representations of knowledge come from different actors in the form of consistent narratives, aided by a multiplicity of supporting materials, namely multimedia formats, metaphors, etc. In TIDDD, some pieces of information were represented through different media in order to reach different people involved. TIDDD can integrate other sources and types of knowledge that may emerge during the process, which is done through the available multicriteria evaluation tool.

Quality assurance through extended peer review of TIDDD contents and design is one of the basic principles of this tool, since its main aim is to provide *socially robust knowledge* in contexts of societal debates and even scientific controversy. This is achieved through upstream engagement of the relevant community in the implementation of the knowledge base available in TIDDD, where the social actors check all developments and ensure that contents and design are suitable to start the debate on groundwater resources futures.

ICT for Public Debate

TIDDD-like tools were conceived as interfaces of mediation between policy spheres and other sectors of the society. This mediation is done with the help of *specialists*, but what comes out of the GOUVERNe process is that

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a new class of expertise is emerging, *specializing* in creating contexts for co-production of knowledge, in mediation of different types of knowledge, perspectives and values, and eventually *specialists* in making scattered, non-organized (for the minds of the experts!) pieces of relevant knowledge intelligible to the organized and oftentimes poorly flexible institutions: in a sense *transdisciplinary specialists* (Guimarães Pereira and Funtowicz 2005).

Involvement of the public in science and technology is about conviviality of different *knowledges*. It is hoped that TIDDD-like tools can help creating the "safe spaces" where "co-produced facts" can emerge.

"We have to Learn to Think in a New Way"

In the last sections of this chapter, we have first given a short historical perspective of how the public has been engaging with science, while also alluding to the fact that historical and contextual aspects of these relations still influence the ways in which the public relates to science today; science is, after all, a co-produced endeavor. Looking at more recent phases of how public involvement in science is conceived and fostered, and the still-prevalent "public understanding of science" paradigm, one can see that this recognition is just an implicit one. The recent survey of researchers and engineers done in the United Kingdom depicts actual ways in which many of them see their involvement with the public; i.e., such relationships are still embroidered within the latter mentality, concepts and practice. Hence, looking at frameworks and models of science and policy and science and society, explanations for the current state of affairs can be found, and, unsurprisingly, that PUS still shapes those relationships. Within such models and frameworks, calls for making explicit a relationship between science and its "interlocutors" based on cooperation and partnerships has been afoot for sometime. Whatever one calls this relationship ("extended," "co-production," "contextual," etc.) of the public having legitimacy to engage in the production of science, we are essentially saying that research has to be done in a different way. While discussing the *operationalization* of this engagement, we identify issues of political, institutional, organizational, cultural, civic, methodological, etc., that are at the basis of full embedment of public engagement in research practice, when such research is relevant for policy making. While exploring the usage of ICT, its is also noted that despite their potential both as connecting different *knowledges* and their "producers" and as a "safe" space for co-production of facts, we realize that ICT may challenge, but will not solve, the established research practices if changes in the researchers' mentalities and attitudes, and research culture in science–society relationships, do not occur.

And this leads to the title of this section: "We have to learn to think in a new way." In a recent workshop on "Moving Worldviews", Prof. Dürr from the Max Plank Institute challenged the ways the majority of universities still operate (Dürr 2005). Academics, especially those in technology studies, often leave the university thinking that they now possess the crafts and are now skilled to solve the problems of the world! They are now part of the "rationality crew" that will develop arguments and evidence to inspire and justify the ways in which the world operates. Often, this translates into a great deal of (perhaps unconscious) arrogance toward other *knowledges* and toward less-specialized fellow humans. This sort of "arrogance" is indoctrinated in staff and students at the universities as a means of protection, but it is also essentially a "way of being"—in Portuguese, we would say a *forma de estar*. Very early, the mission-to-be taught to "universitaires" is also a didactic one, of *training, educating* others.

Instead, more than ever, the approach is of humility—humility about both the limits of scientific knowledge and about when to stop *scientisizing* all *problematiques*. Jasanoff (2007) proposes that "technologies[8] of humility" are necessary to reflect on the sources of ambiguity, indeterminacy and complexity, and to accommodate dissent as Leach (2007) suggests. I am unsure about the use of the word "technologies" here. Rather, I view humility as primarily a guiding concept, which shall then guide a change of mentalities; in public engagement this is a shift towards *conviviality*.

This change would encompass the embedding of "technologies of engagement" as a natural step in research practice. The relationships of *specialists* with the public would go from a didactic mission to an engagement one. This will have to go hand in hand with learning how to establish dialogs, knowledge mediation, "integration of *knowledges*" and other "technologies" to make the "engagement" paradigm operational.

NOTES

1. The word *translation* is probably not the most appropriate since there is a great deal of "interpretation" in an activity of communication, which goes beyond the seeking of adequate vocabulary and tries to keep to the original semantics.
2. See, for instance, S. Miller, P. Caro, V. Koulaidis, W. Staveloz and R. Vargas. Report from the Expert Group Benchmarking the Promotion of RTD Culture and Public Understanding of Science (European Commission, 2002).
3. One of the most authoritative statements on PUS comes from the reports of the UK Royal Society, on *Public Understanding of Science*, published in 1985.
4. Bovine spongiform encephalopathy—commonly known as "mad cow disease."
5. The Royal Society and The Royal Academy of Engineering. Nanoscience and Nanotechnologies: Opportunities and Uncertainties (July 2004).
6. Wynne et al. (2007) alert to the extensive use of the stakeholder model as an ideal form of societal participation, which excludes a broader vision of citizenship. The term *stakeholder involvement* implies that the issues "at stake" are already agreed. Citizen involvement, on the other hand, carries no such presumption, and thus more readily accommodates diversities of "local" cultures with different preoccupations and concerns, meanings and worldviews.

7. Project no. EVK1-1999-000
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http://kam.jrc.it/gouverne.
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BIBLIOGRAPHY

AEBC. 2003. GM Nation? The findin
Available online at http://www.
final.pdf (last accessed July 14, 20

Bellamy, J.A., and A.P. Dale. 2000. *E*
Resource Use Planning Project:
LWRRDC, Project CTC13, CSIR
ber 2000. Available online at http:

Bellamy, J., B. Bishop, and A. Brow
tion: Process and Impact. OBP P
Ecosystems, Brisbane.

Burgess, J., and J. Clark. 2006. Eva
strategies in environmental govern
ety, ed. Â. Guimarães Pereira, S.
field, UK: Greenleaf Publishers.

Callon, M., P. Lascoumes, and Y. B
Essai sur la démocratie technique.

CEC (Commission of the European C
EC of March 3, 1997 amending D
effects of certain public and privat
nal OJ L 327, March 14, 1997.

———. 2000. Directive 2000/60/EC
cil establishing a framework for th
icy. *Official Journal (OJ L 327)*, D

———. 2001a. Democratising exper
tems. Document of 2/07/2001. A
nance/areas/group2/report_en.pdf

———. 2001b. European Governance
July 25, 2001. Available online at
com/2001/com2001_0428en01.pd

Cortner, H.J., and M.A. Moote 19
Washington, DC: Island Press.

De Marchi, B., S. Funtowicz, C. Goug
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7. Project no. EVK1-1999-00032: A Shared Cost Action financed by DG RTD, under FP 5. GOUVERNe stands for Guidelines for the Organisation, Use and Validation of information systems for Evaluating aquifer Resources and Needs. Online. Available at: http://neptune.c3ed.uvsq.fr/gouverne/ and http://kam.jrc.it/gouverne.
8. Technologies are inherently human artifacts, and here we would like to stress the importance of changing the nature of the human "posture"; in this case, the attitude of specialists toward nonspecialists and toward problem solving.

BIBLIOGRAPHY

AEBC. 2003. GM Nation? The findings of the Public Debate. Report of the AEBC. Available online at http://www.aebc.gov.uk/aebc/reports/gm_nation_report_final.pdf (last accessed July 14, 2008).

Bellamy, J.A., and A.P. Dale. 2000. *Evaluation of the Central Highlands Regional Resource Use Planning Project: A synthesis of findings.* Final Report to LWRRDC, Project CTC13, CSIRO Sustainable Ecosystems, Brisbane, November 2000. Available online at http://irum.sl.csiro.au/

Bellamy, J., B. Bishop, and A. Browne. 2004. *Ord Bonaparte Program Evaluation: Process and Impact.* OBP Project 1.3, Final Report, CSIRO Sustainable Ecosystems, Brisbane.

Burgess, J., and J. Clark. 2006. Evaluating public and stakeholder engagement strategies in environmental governance. In *Interfaces between science and society*, ed. Â. Guimarães Pereira, S. Guedes Vaz, and S. Tognetti, 225–52. Sheffield, UK: Greenleaf Publishers.

Callon, M., P. Lascoumes, and Y. Barthe. 2001. *Agir dans un monde incertain. Essai sur la démocratie technique.* Paris: Le Seuil.

CEC (Commission of the European Communities). 1997. Council Directive 97/11/EC of March 3, 1997 amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment. *Official Journal OJ L 327*, March 14, 1997.

———. 2000. Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the community action in the field of water policy. *Official Journal (OJ L 327)*, December 22, 2000.

———. 2001a. Democratising expertise and establishing scientific reference systems. Document of 2/07/2001. Available online at http://ec.europa.eu/governance/areas/group2/report_en.pdf (last accessed July 14, 2008).

———. 2001b. European Governance: A White Paper; Com (2001) 428, Brussels, July 25, 2001. Available online at http://eur-lex.europa.eu/LexUriServ/site/en/com/2001/com2001_0428en01.pdf (last accessed July 14, 2008).

Cortner, H.J., and M.A. Moote 1999. *The politics of ecosystem management.* Washington, DC: Island Press.

De Marchi, B., S. Funtowicz, C. Gough, Â. Guimarães Pereira, and E. Rota. 1998. *The ULYSSES Voyage: The ULYSSES Project at the JRC.* European Commission, EUR 17760 EN.

De Marchi, B., S. Funtowicz, and Â. Guimarães Pereira. 2001. From the right to be informed to the right to participate: Responding to the evolution of the European legislation with ICT. *International Journal of Environment and Pollution* 15(1): 1–21.

Duran, J., A. Hansen, and M. Bauer. 1996. Public understanding of the new genetics. In *The trouble helix—Social and psychological implications of the new human genetics*, ed. T. Marteau and M. Richards. Cambridge: Cambridge Univ. Press.

Dürr, H-P (2005) *We have to learn to think in a new way*. Paper presented at the *Moving Worldviews* workshop, The Netherlands, Soesterberg, 28-30 November 2005. Available on-line at: http://www.movingworlds.net/Downloads/Papers/ Dürr.pdf. Last accessed 14th May 2009.

Evans, G., and J. Durant. 1995. The relationship between knowledge and attitudes in the public understanding of science in Britain. *Public Understanding of Science* 4(1): 57–74.

Felt, U. 2002. Sciences, science studies and their publics: speculating on future relations. In *Social studies of science and technology: Looking back, ahead. Yearbook of the sociology of sciences*, ed. H. Nowotny and B. Joerges, 11–31. Dordrecht, The Netherlands: Reidel.

Frewer, C., G. Rowe, R. Marsh, and C. Reynolds. 2001. *Public Participation Methods: Evolving and Operationalising an Evaluation Framework*. Report prepared for the Department of Health and Health and Safety Executive, Institute of Food Research, Norwich, CT.

Funtowicz, S. 2001. Peer review and quality control. In *International encyclopaedia of the social and behavioural sciences*. Elsevier. 11,179–83.

Funtowicz, S. O. 2006. Why knowledge assessment? In *Interfaces between science and society*, ed. Â. Guimarães Pereira, , S. Guedes Vaz, and S. Tognetti, 138–45. Sheffield, UK: Greenleaf Publishers.

Funtowicz, S. O., and J. R. Ravetz. 1985. Three types of risk assessment: A methodological analysis. In *Risk analysis in the private sector*, ed. C. Wipple and V. Covello, 217–31. New York: Plenum.

———. 1990a. A new scientific methodology for global environmental issues. In *Ecological economics—The science and management of sustainability*, ed. R. Costanza, 137–52. New York: Columbia Univ. Press.

———. 1990b. *Uncertainty and quality in science for policy*. Dordrecht, The Netherlands: Kluwer Academic Press.

———. 1992. Three types of risk assessment and the emergence of post-normal science. In *Social theories of risk*, ed. S. Krimsky and D. Golding, 251–73.Westport, CT: Praeger.

———. 1993. Science for the post-normal age. *Futures* 25(7): 739–55.

Gaskel, G., N. Allum, M. Bauer, J. Jackson, S. Howard, and N. Lindsey. 2003. *Ambivalent GM Nation? Public Attitudes to Biotechnology in the UK, 1991–2002*. Life Science in European Society Report: London School of Economics and Political Science.

Giampietro, M. 2003. *Multi-scale integrated analysis of agroecosystems*. CRC Press.

Gibbons, M. 1999. Science's new social contract with society. *Nature* 402: C81–4.

Glicken, J. 1999. Effective public involvement in public decisions. *Science Communication* 20(3): 298–327.

Gregory, J., and S. Miller. 2000. *Science in public, communication, culture and credibility*. Cambridge, MA: Basic Books.

Gross, A. G. 1994. The roles of rethoric in the public understanding of science. *Public Understanding of Science* 3: 3–23.

Guimarães Pereira, Â., S. Corral Quintana, S. Funtowicz, G. Gallopín, B. De Marchi, and B. Maltoni. 2001. *VISIONS—adventures into the future*. European Commission, Joint Research Centre, Ispra, Italy: EUR 19926 EN.

Guimarães Pereira, Â., and M. O'Connor. 1999. Information and communication technology and the popular appropriation of sustainability problems. *International Journal of Sustainable Development* 2(3): 411–24.

Guimarães Pereira, Â., J.D. Rinaudo, P. Jeffrey, J. Blasques, S. Corral Quintana, N. Courtois, S. Funtowicz, and V. Petit. 2003. ICT tools to support public participation in water resources governance & planning: Experiences from the design

and testing of a multi-media platfor
Policy and Management 5(3): 395–4
Guimarães Pereira, Â., J. Blasques, S. C
TIDDD—Tools To Inform Debates
VERNe Project at the JRC. European
Guimarães Pereira, Â., and T. de Sous
styles and Climate. European Comm
EUR 21869 EN.
Guimarães Pereira, Â., and S. Funtowi
peer review: Tools to inform debates,
abschätzung—Theorie und Praxis 2(
Horlick-Jones, T., J. Walls, G. Rowe, N.F.
2004. "A deliberative future? An in
Public debate about the possible con
UK, 2003." Understanding Risk wo
Environmental Risk. 1–182.
Involve. 2005. "People and Participati
of Decision-Making." London: In
able online at http://www.in
viewSection&intSectionID=400 (last
IAP2. 2000. "Spectrum of Public Pa
www.iap2.org/associations/4748/fil
2008).
Jasanoff, S. 2004. The idiom of co-proc
production of science and social orde
———. 2005. *Designs on nature: Science*
States. Princeton, NJ: Princeton Univ.
———. 2007. Technologies of humility.
Joly, J.-B., and A. Rip. 2007. A timely ha
Miller, S. 2001. Public understanding of
standing of Science 10(1): 115–20.
Morgan, D. L. 1998. *The focus group gu*
Mulder, Henk A. J., M.S. Jorgensen, L.
2006. Science shops as science–society
and society, ed. Â. Guimarães Pereira.
Sheffield, UK: Greenleaf Publishers.
Peals. 2003. *Teach yourself citizen jurie*
group. Univ. of Newcastle.
Pound, B., S. Snapp, C. McDougall, a
resources for sustainable livelihood.
don: Earthscan Publications.
Rowe, G., T. Horlick-Jones, J. Walls, N
ing public engagement: reflections o
Public debate about transgenic crop
331–52.
Royal Society. 2006. "Survey of Factors
entists and Engineers." Available onl
loaddoc.asp?id=3052
Slocum, N. 2003. *Participatory Methods*
published by King Baudouin Foundat
Technology Assessment with United
http://www.kbs-frb.be or http://www.
Taylor, P. L. 2007. Rules of engagement.

and testing of a multi-media platform. *Journal of Environmental Assessment Policy and Management* 5(3): 395–420.

Guimarães Pereira, Â., J. Blasques, S. Corral Quintana, and S. Funtowicz, S. 2003. *TIDDD—Tools To Inform Debates Dialogues & Deliberations. The GOUVERNe Project at the JRC.* European Commission, Ispra, Italy: EUR 21880 EN.

Guimarães Pereira, Â., and T. de Sousa Pedrosa. 2005. V GAS©—Energy, Lifestyles and Climate. European Commission, Joint Research Centre, Ispra, Italy: EUR 21869 EN.

Guimarães Pereira, Â., and S. Funtowicz. 2005. Quality assurance by extended peer review: Tools to inform debates, dialogues & deliberations. *Technikfolgenabschätzung—Theorie und Praxis* 2(14):

Horlick-Jones, T., J. Walls, G. Rowe, N.F. Pidgeon, W. Poortinga, and T. O'Riordan. 2004. "A deliberative future? An independent evaluation of the GM Nation? Public debate about the possible commercialisation of transgenic crops in the UK, 2003." Understanding Risk working paper 04–02). Norwich: Centre for Environmental Risk. 1–182.

Involve. 2005. "People and Participation: How to Put Citizens at the Heart of Decision-Making." London: Involve and Together We Can. Available online at http://www.involve.org.uk/index.cfm?fuseaction=main.viewSection&intSectionID=400 (last accessed August 3, 2008):

IAP2. 2000. "Spectrum of Public Participation." Available online at http://www.iap2.org/associations/4748/files/spectrum.pdf (last accessed March 3, 2008).

Jasanoff, S. 2004. The idiom of co-production. In *States of knowledge: The co-production of science and social order*, ed. S. Jasanoff. New York: Routledge.

———. 2005. *Designs on nature: Science and democracy in Europe and the United States.* Princeton, NJ: Princeton Univ. Press.

———. 2007. Technologies of humility. *Nature* 450: 33.

Joly, J.-B., and A. Rip. 2007. A timely harvest. *Nature* 450: 174.

Miller, S. 2001. Public understanding of science at the crossroads. *Public Understanding of Science* 10(1): 115–20.

Morgan, D. L. 1998. *The focus group guidebook.* London: Sage Publications.

Mulder, Henk A. J., M.S. Jorgensen, L. Pricope, N. Steinhaus, and A. Valentin. 2006. Science shops as science–society interfaces. In *Interfaces between science and society*, ed. Â. Guimarães Pereira, S. Guedes Vaz, and S. Tognetti, 278–96. Sheffield, UK: Greenleaf Publishers.

Peals. 2003. *Teach yourself citizen juries. A handbook by the DIY jury steering group.* Univ. of Newcastle.

Pound, B., S. Snapp, C. McDougall, and A. Braun. 2003. *Managing Natural resources for sustainable livelihood. Uniting science and participation.* London: Earthscan Publications.

Rowe, G., T. Horlick-Jones, J. Walls, N. Pidgeon. 2005. Difficulties in evaluating public engagement: reflections on an evaluation of the UK GM Nation? Public debate about transgenic crops. *Public Understanding of Science* 14: 331–52.

Royal Society. 2006. "Survey of Factors Affecting Science Communication by Scientists and Engineers." Available online at http://www.royalsoc.ac.uk/downloaddoc.asp?id=3052

Slocum, N. 2003. *Participatory Methods Toolkit, A Practitioner's Manual.* Report published by King Baudouin Foundation & Flemish Institute for Science and Technology Assessment with United Nations University. Available online at http://www.kbs-frb.be or http://www.viwta.be

Taylor, P. L. 2007. Rules of engagement. *Nature* 450(8): 163–4.

Van Asselt, M.B.A., J. Mellors, N. Rijkens-Klomp, S.C.H. Greeuw, K.P.G. Molendijk, P.J. Beers, and P. van Notten. 2001. *Building Blocks for Participation in Integrated Assessment: A Review of Participatory Methods.* ICIS report I01-E003, Maastricht, The Netherlands.
Wilsdon, J., and R. Willis. 2004. *See-through science: Why public engagement needs to move upstream.* London: DEMOS.
Wondolleck, J.M. and S.L. Yaffee. 2000. *Making collaboration work: Lessons from innovation in natural resource management.* Washington, D.C.: Island Press
Wynne, B. 1995. Public understanding of science. In *Handbook of science and technology studies*, ed. S. Jasanoff, G.E. Markle, J.C. Petersen, and T. Pinch, 361–88. Thousand Oaks, CA: SAGE.
Wynne, B., U. Felt, M. Callon, M.E. Gonçalves, S. Jasanoff, M. Jepsen, Joly, P.-B., et al. 2007. Taking European Knowledge Society Seriously. European Commission: EUR 22700 EN.

3 Active Citizens

The Controversy in the Susa Valle

Luca Giunti and El

EDITORS' INTRODUCTORY N

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