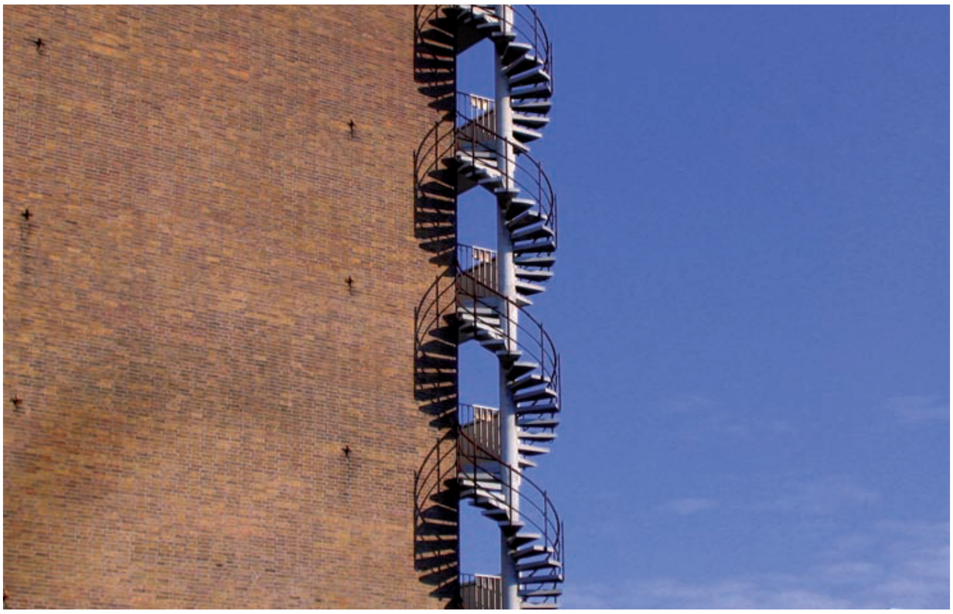
Sustainability Science: A New Mode of Science. Another Step in the Evolution of Science Paradigms

By Joachim H. Spangenberg and Martin O'Connor



Corkscrew Stairs. Photo: © Artyom Korotkov, www.sxc.hu

There is a perceptible trend towards a further fragmentation of research concerning sustainability issues: Whereas environmentally minded expert communities exhibit a strong tendency of constructing environmental issues as the core subject matter of sustainability considerations, mainstream economic thinking tends to picture financial sustainability issues as the all-encompassing concern of policy in the last instance. Scientific communities are in part constituted by an 'imperialist' reaching out of existing disciplinary paradigms, like in the debate of 'strong' vs. 'weak' sustainability which is starting from the problematic of mainstream economics, with its underlying assumptions about optimising rationality.

Towards a new concept: the evolution of science

The promotion of science for sustainable development or sustainability science requires procedures for evaluating science and technology contributions against criteria for sustainability. However, assessing the results is not enough: For all domains of science and engineering, sustainability science requires re-engineering of the fabric of science, its standard methodologies and institutions (Spangenberg, O'Connor 2006).

Significant numbers within our contemporary societies acknowledge the ambiguities of science and technology progress. Some harbour reservations about the likelihood of contributions of new science and technology to well being — or, at least, to their personal well-being, or to any notion of 'general' well-being that has pertinence to them. The perceived uneven, unfair, and un-negotiated imposition of disadvantages, damages and burdens (including future clean-up costs or enduring health problems, etc.) is, for many people, more significant than any abstract notion of a 'net benefit' to society.

In many European countries, public trust in non-transparent expert processes of technology risk and benefit assessment and regulation seems now much lower than 20 years ago. Despite the fact that this is part of a normalisation process as compared to the technology enthusiasm of the 1960s and 1970, there is a serious risk of overshoot, reflected in the decreasing number of young people willing to study for scientific or engineering professions all over Europe. Although the doubts are not always expressed in ways that are scientifically sophisticated, the point is that, if they deepen to a broad and chronic mistrust, they can contribute to a falsification of any vision of a key role for science in a 'knowledge based society'.

One reason for this dissatisfaction is the experience with politics legitimising itself by way of reference to regulatory procedures based on expert evaluations (such as Cost-Benefit-Analysis CBA, scientifically-based safety standards, probabilistic risk-benefit assessments, etc.). No matter how well conducted, they are insufficient for robust public and private decision-making of issues involving high risk and irreversibilities, and the public is aware of this – this inadequacy is by now demonstrated by the historical record (O'Connor 2005). A satisfactory explanation of this insufficiency is not found in assertions of the irrationality of the members of society. Governance challenges for science and technology deployments are characterised by several features that prevent a simple ,'science guides policy' equation:

- Irreducible uncertainties (unpredictability of complex systems, real yet non quantifiable risks to health, environmental damage, loss of economic opportunity);
- Plurality of social values and hence divergent concerns and justification criteria;
- High decision stakes (including commercial and military interests, risks of social disruption, and severe irreversible impacts on health of populations and/or life support systems) and long impact time-horizons.

Within this contemporary understanding, it is useful to evoke the emerging diversity of conceptual modes of the relation between science and decision-making in policy processes. The paragraphs that follow propose a sequence of modes whose emergence and criticism can be considered as a historical and cultural process of a deepening — and progressively more reflexive — understanding of the 'emergent complexities' in the process of the use of science in policy, following the categorisation suggested by Funtowicz and Strand (2007).

Models of science

1. The initial 'modern' model (perfection/ perfectibility)

Scientific facts are unproblematic to define, employed in rigorous demonstrations, they determine correct policy. In classical terms, the true entails the good; in modern terms, truth speaks to power. Being based on scientific facts, the power that is exercised is effective. There are no limits to the progress of man's control over his environment, and no limits to the material and moral progress of mankind. This is the classic 'technocratic' vision, dependent on an assumed perfection/perfectibility of science in theory and also (progressively) in practice. Of course, it took centuries for this view to emerge clearly and, even during the period of its prominence, there were mavericks within (as well as outside of) the science profession who expressed dissent with this model.

2. The Precautionary Model (uncertain and inconclusive information)

In real policy processes, it is discovered that the scientific facts are neither fully certain in themselves, nor conclusive for policy. Progress cannot be assumed to be automatic. Attempts at control over social processes, economic systems, and the environment can fail, leading sometimes to pathological situations. While adherents to this model still pay homage to the truth/validity of science in general, they may contest particular unwelcome items of information. Because of 'imperfection' in the science, there is proposed an extra element in policy decisions, precaution, which both protects and legitimises decisions. In this context it is important to note that 'precaution' has always been present as a practical, informal basis of policy formation science. What changes, in this model, is the way that precaution has been elevated to the status of a principle even when science is involved. This is important in ideological terms, as it makes a decisive break with the technocratic vision.

3. The Model of Framing (arbitrariness of choice and possible misuse)

In the absence of conclusive facts, scientific information becomes one among many inputs to a policy process, functioning as evidence in the arguments. Debate is known to be necessary, as each stakeholder has his/her own perspective and values which shape the arguments. Moreover, all such processes involve complex issues, where the situation has a plurality of phases (causes, effects, prevention, remediation, etc.), each phase being treated with its own theoretical constructions of reality (which may not be fully reconciled). There are no simple 'facts' that resolve issues in all these phases and aspects. Hence the framing of the relevant scientific problem to be investigated, even the choice of the scientific discipline to which it belongs becomes a prior policy decision. It can therefore become part of the debate among stakeholders. Different scientific disciplines themselves become competing stakeholders; whoever 'owns' the research problem will make the greatest contribution and will enjoy the greatest benefits. However, an incorrect framing of the problem (e.g., due to error, ignorance, poor judgement, and not necessarily wilful) amounts to a misuse of the tool of scientific investigation. However, because there is no conclusive scientific basis for the choice of framework, it has to be admitted that, to some extent the choice is arbitrary (or social). Acceptance of the principle of framing entails an acceptance of the arbitrariness of choice, hence of the possible misuse of science in the policy context and, moreover, of the difficulty of deciding whether or not a misuse has occurred (the judgement will itself be influenced by framing). This can lead towards 'postmodern' and 'relativist' positions. Accusations about the easy or even inevitable misuse of scientific forms and discourses (through ignorance, false consciousness or 'interests' of various sorts) can even motivate a rejection of science as a reference point for establishing quality and legitimacy in decisions (see also the 'demarcation' model, in the next paragraph).

4. The Model of Science/Policy Demarcation (possibility of abuse of science)

The scientific information and advice that are used in the policy process are created by people working in institutions with their own agendas. Experience shows that this context can affect the contents of what is offered, through the selection and shaping of data and conclusions. Although they are expressed in scientific terms, the information and advice cannot be guaranteed to be objective and neutral. Moreover, science practitioners and their funders have their own interests and values. In this view, science can (and probably will) be abused when used as evidence in the policy process. As a response to this problem, a clear demarcation between the institutions (and individuals) who provide the science, and those where it is used, is advocated as a means of protecting science from the 'political' interference that would threaten its integrity. This demarcation

Line of radio telescopes in Westerbork, Netherlands. Photo: © Herman Brinkman, www.sxc,hu

is meant to ensure that political accountability rests with policy makers and is not shifted, inappropriately, to the scientists. Designing the right form of demarcation of science and policy is therefore one of the urgent tasks of governance. This is not easy: too great a separation can result in the scientific institutions pursuing their own, internal goals, and the work becoming irrelevant to the needs of the policy process. Too little a separation can aggravate rather than resolve the risks of 'political interference' in science. One contemporary solution — the so-called 'economic model' — is to propose the mobilisation of the interests of scientists as 'suppliers' of knowledge, responding explicitly to the 'demands' of the funding marketplace (private sector, public programmes, NGO research, etc.). This reinforces the role of context in framing interests and purposes, and introduces the well known problem of possible 'market failure' (viz., the coordination effectuated by the marketplace might not correspond with the social demand, and, the 'social demand' – whatever this is – might depend in a dynamic way on the ways that knowledge is produced and used in society, etc.). In this regard, the discipline of economics has attempted to institute the science/policy demarcation model via the distinction, explicit since the first part of the 20th century, between 'positive' and 'normative' analysis. However, this attempted demarcation has always rebounded because it turns out to be very difficult — purely theoretically — to keep separate the two domains while still carrying out 'policy relevant' economic analysis.

5. The Model of Extended Participation (working deliberatively within imperfections)

Given these acknowledged complications, and 'imperfections' in the deployment of science in the policy process, it becomes ever more difficult to defend a monopoly of accredited expertise for the provision of scientific information and advice. 'Science' (understood as the activity of specialised 'technical experts') is henceforth to be included as (only) one part of the 'relevant knowledge' that is (or may be) brought in as evidence to a decision or policy process – complementing knowledge created by scientists on an equal footing. The ideal of rigorous scientific demonstration is replaced by that of open public dialogue. Citizens (as well as scientists) become both critics and creators, providers and recipients in the knowledge production process. Their contribution is not to be patronized by using, in a pejorative way, labels such as 'local', 'practical', 'ethical' or 'spiritual' knowledge (which would in turn label scientific knowledge as being neither locally nor spiritually relevant, unpractical and unethical). A plurality of co-ordinated legitimate perspectives (each with their own value-commitments and framings) is accepted. The strength and relevance of scientific evidence is amenable to assessment by citizens (and vice versa). All sides come to the dialogue ready to learn, or else the process is a sham. Through this co-production of knowledge, the extended peer community creates a (deliberative) democracy of expertise (for an application see e.g. O'Connor, Spangenberg 2008).

Choosing a model

Reflexively, we can consider the latter four models as a progression from the initial 'modern' model with its assumption of the perfect adequateness of science in the policy process. Precursors to these models can be found many decades ago, sometimes even in the 19th century. Notions of precaution, framing and demarcation came

The intersection of technology parkway and scientific drive. Photo: © Mad Jack, www.istockphoto.com

to be advocated and debated publicly during the 1970s, when 'progress' as expressed in productivity (e.g., chemically intensive agriculture, fossil and nuclear energy) and exponential economic growth started to come into question, and when the 'social responsibility' of scientists and engineers started to be advocated as a value position to be assumed rather than as a corollary of science itself (e.g. Bossel 1978). They received a boost from the international peace movement in the 1980s (e.g. INES 1991), and have visibly emerged into the policy domain notably in the last decade, for example with the proclamation of 'precaution' at Rio 1992 (United Nations 1993).

Each model in the sequence is designed to resolve a particular type of problem. In any real situation they may coexist, and (depending on the type of problem addressed) may be complementary or in conflict. Rather obviously, modern scientists should be no less familiar with the different models to make a deliberate and well-informed choice when being confronted with a problem than policy-makers or administrators, in particular as dealing with the 'risks of modernity' (Häfele 1974) more often than not cannot be adequately complemented when relying only on the first two models. Although each model has emerged in a historical process, in relation to specific issues, currently all four coexist (without there always being a clear divide). An example is the insistence on 'science based policy' and (even more ambiguous) 'knowledge based society' (European Commission 2002). Advocacy of a science based policy process (etc.) is correlated with the spread of doubt about the adequacy or even the possibility of grounding policy in science. It is perhaps a question of 'saving science'; but from what danger (and, hence, what model of science/policy/society is put forward as a basis for the salvage job?). Unfortunately, the first two models still dominate the academic education of future researchers and decision makers in Europe, thus posing a threat not only to future RTD capabilities and effectiveness, but also to the adequate and effective use of science by politics and business.

Concerning the first three models, the 'imperfections' can be seen to form a sequence of increasing severity, admitting incompleteness, misuse and abuse. There is still the desire, in each case, that the link between science and policy remain, once appropriate precautions are taken, direct and unmediated. In the successive models, we see that (1) policy is modified by precaution, (2) problems are framed by stakeholders, and (3) scientists are protected from political interference. But the core activity of the modem model, the experts' (desire for) "truth speaking to the politicians'" (need for) power, is unchanged.

By comparison, the final model — that of quality assurance through extended participation — proposes a fundamental change to the status accorded to science in relation to other forms of wisdom and, as such, to the form of societal governance that is envisaged. This corresponds to the perspective of a 'post-normal science' as defined and described by Silvio Funtowicz and Jerome Ravetz (Funtowicz, Ravetz 1993). This is also the kind of science needed for most of the new challenges emerging from problems of sustainable development, as argued in the following section.

In the modem tradition, the search for effective solutions on a technical plane was conceived as a separate task from the political and social aspects of decision and implementation. The proposal of 'post-normal science' is to adopt a more pluralistic, participatory and democratic view of the knowledge base for policy actions. Dealing with contemporary knowledge problems requires opening the analytical and formal decision-making processes to broader categories of facts and actors than those traditionally legitimated.

On the one hand, the old distinction between hard facts and soft values is being replaced by a 'soft facts/ hard values' framework – admitting the complexity of emergent system properties (and hence uncertainties, etc.) and admitting the plurality of quality and legitimating criteria (e.g., there are different definitions of the problem, different ways of selecting and conceiving its relevant aspects, as well as different goal definitions, depending on cultural factors and not only on conflict of interests).

On the other hand, the distinction between experts and non-experts is losing its classical status. In a sense, when facing a 'post-normal' problem, all stakeholders are experts – in different ways, from different points of view, and with regard to different aspects of the problem. So, it is necessary to extend the number and type of actors, both individual and collective, legitimated to intervene in the definition of the problems as well as the selection and implementation of the connected policies. This extension does not just fulfil the requirements of democratic decision making; it also improves the quality of decisions. The way of conducting a decision process influences dramatically its results. The dialogue between different actors is essential for quality, credibility, legitimacy and hence prospects of success of policy implementation.

Implementing this deliberative model emerges, for those persuaded of the weight of the foregoing arguments, as a great challenge of our time; for without this, it seems highly plausible that 'the consent of the governed' (and hence social cohesion) in science-related policy issues will not be maintained. But of course, this 'post-normal science' model makes its own distinctive propositions about knowledge, nature and political processes. It therefore has its own distinctive points of weakness, contradictions and pitfalls, whose study — as a reflexive move — becomes an equally urgent task.

The extended peer community as a key constituency in the process of knowledge generation is not a development specific to the scientific system, but rather a reflection of overall societal trends in this subsystem (as always, expressed in terms and categories of the subsystem). The larger societal question of the constituent agency underlying the transformations of modernity as the societal equivalent to knowledge generation in the science system has disappeared in its old, incurably naive form of asking for a subject of historical transformation. Instead it has reappeared in the form of the postulate of applying the discourse of modernity to itself, envisaging a historical process by which subjects of critical praxis could be constituted. This approach has been formalised in the category of reflexivity introduced by Giddens and Beck – which has, however, tended to disregard the concrete specificities of historical interest constructions and interest conflicts (a temptation some innovative approaches in science have not escaped as well, and for similar reasons). This has made clear that reflexivity (Beck 1996, Giddens 1996) is not so much an answer to the problems of historical agency, but a new, extended way of asking the question, in science as in society at large: Opening it for the diversity of perspectives and constructions, while continuing to enquire into the material specifics of conflicts and compromise in all areas touched by sustainability strategies.

Dr. Joachim Spangenberg is Vice Chairman of the Sustainable Europe Research Institute Germany e.V. (SERI),
Contact: Joachim.Spangenberg@gmx.de

Prof. Dr. Martin O'Connor is the Scientific Director of REEDS (Laboratoire de Recherche en Economie-Ecologie, Eco-innovation et ingénierie du Développement Durable)at the University of Versailles, France www2.uvsq.fr

Article from page 15 continued

References

Beck, U., 1996. Das Zeitalter der Nebenfolgen und die Politisierung der Moderne. In: Beck, U., Giddens, A., Lash, S. (Eds), Reflexive Modernisierung - Eine Kontroverse. Suhrkamp, Frankfurt/Main, pp. 19 -112

Bossel, H. (1978). Bürgerinitiativen entwerfen die Zukunft - neue Leitbilder, neue Werte, 30 Szenarien. Frankfurt/Main, Fischer Verlag.

European Commission (2002). The Lisbon Strategy - Making Change Happen. Commission Staff Working Paper in support of the Report from the Commission to the Spring European Council in Barcelona. Brussels: 28.

Funtowicz, S. O., Ravetz, J. R., 1993. Science for the post-normal age. Futures 25, 739 - 755.

Funtowicz, S. O., Strand, Roger (2007). Models of Science and Policy. In: Biosafety First: Holistic Approaches to Risk and Uncertainty in Genetic Engineering and Genetically Modified Organisms. T. Traavik, Lim, L.C. (Eds) Trondheim, Tapir Academic Press

Giddens, A., 1996. Risiko, Vertrauen und Reflexivität. In: Beck, U., Giddens, A., Lash, S. (Eds), Reflexive Modernisierung - Eine Kontroverse. Suhrkamp, Frankfurt, pp. 316 - 337

Häfele, W. (1974). „Hypotheticality and the new Challenges, The Pathfinder Role of Nuclear Energy." Minerva 1974(3): 303-322.

INES International Network of Engineers and Scientists for Global Responsibility (1991). Appeal to Reason. Founding statement, INES, Berlin

O'Connor, M. (2005). La médiation des connaisances sur l'interface science - société. PASARELAS Conference Développement Économique, Environnement, Espace. July 4-10, 2005, Universita di Corsica, Corte, Corse, France.

O'Connor, M., Spangenberg, J. H. (2008). „A Methodology for CSR Reporting: Assuring a representative diversity of indicators across stakeholders, scales, sites and performance issues." Journal of Cleaner Production 16(13): 1399-1415.

Spangenberg, J. H., O'Connor, Martin (2006). La ciencia de la sostenibilidad en el espacio de investigación Europeo: descripciones, definiciones y retos. In J.-C. Riechman (ed), Perdurar en un planeta habitable. Ciencia, technología y sostenibilidad. Barcelona, Icaria: 149-184.

United Nations (1993). Documents adopted by the Conference, The Rio Declaration. UN sales No. E.93.I.8. New York, United Nations.