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Governance: Precautionary principle and pluralism

Bernard Reber

Introduction

Governance is referred to today in almost fetishistic terms, although the origins of what is regarded as a new notion are not always recognised. In fact the term comes from the France of the Ancien Régime, where negotiation and arbitration were commonplace in the absence of a strong state monopoly. In the more distant etymological sense, the term signified a helm. In the context of environmental challenges, governance is necessary to orchestrate cooperation between states (and their bureaucracies), sometimes also including international companies, learned societies and scientific bodies – some of which are decision-makers – NGOs and even ordinary citizens who may be involved in short-term experiments of participative and deliberative democracy. Governance must metaphorically sail the stormy seas of power relations and haggling between states during bitter negotiations on particular issues, such as those of the United Nations Framework Convention on Climate Change (1992) or the Nagoya Protocol on Access and Benefit-Sharing (ABS) (2010). Often it is short-term interests that prevail, no doubt linked to internal constraints generated by the brevity of political mandates, or even the bad faith of some leaders who regard the consumption levels of their electorate as non-negotiable. We have yet to invent a way of harmonising and synchronising the different timescales of environmental evolution, industrial innovation and democratic processes.

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However, a different, equally crucial form of governance is also required at a more abstract level. Although it is rarely theorised, the *governance of spheres of knowledge* is a necessary element in any response to environmental problems. Examples of such spheres include economics, politics, law, ethics, environmental sciences and all the domains of knowledge relevant not only to an understanding of the state of the environment, but also to the anticipation, justification and implementation of long-term measures. While it is important for analysis to temporarily differentiate between these different spheres, they are closely linked in spaces of negotiation. To take an example, a speech by a head of state (political sphere) at a climate summit will include economic elements (such as the need for low cost innovation or the implementation of a carbon tax on transport), data from climatologists and scenarios from the International Panel on Climate Change (IPCC) (scientific sphere), ethical justifications (such as responsibility for future generations) and legal aspects (compensation paid to countries where plants are exploited by foreign pharmaceutical companies to develop patents). As elements of these different spheres are present in periods of

negotiation, and even more so in the implementation of new measures and their evaluation, it is necessary to understand the relationship between them. Sometimes this must be made explicit, particularly in the case of controversy, whether at the scientific or normative level.

These ideas are relevant to practical experiments involving experts, citizens and stakeholders. Conducted with mini-publics, these experiments promise a greater democratisation of the governance of environmental issues, while simultaneously providing rare opportunities to make manifest the need to theorise relations between the fields of knowledge involved. Below, I first consider the place of the ethical sphere, then the tension between innovation and responsibility, decisions taken in situations of scientific uncertainty and the structuring role of the precautionary principle in the relationship between science, politics and ethics. I shall end by considering the normative aspect of this meta-principle, notably by acknowledging the plurality of moral theories, and conclude with some lessons for the experts.

My position is that while it is often the *political* dimension that dominates, seeking only to foster *cooperation* between free, equal individuals (or states) but making no attempt to assess the effects of their actions on the external world – on the environment, for example – I do not support the monopoly of any discipline. I prefer to envisage an *interdependency* between the normative and factual spheres *pertinent to the problems to be settled*. Of course, the political sphere has advantages: it is best equipped to accommodate the others; it is used to holding together heterogeneous elements and different or even opposing interests; and it requires far less in the way of technical knowledge and skills. However, given the importance of environmental issues, the quality of the decisions to be taken means that the political sphere should not stifle the others when they are most pertinent to the discussion.

Global responsibility: experiments in reflective democracy

Clearly these questions are more than simply theoretical; they are key to the conflicting interpretations of environmental responsibility. Conflicts of this kind require innovative forms of governance to provide support and resolution. One source of enhanced legitimacy, in relation to democracy, negotiation and the management of environmental controversy, is participation. It is sometimes said that participation is should be more pluralist and inclusive. It may involve consulting ordinary citizens and indeed stakeholders. There are some innovative interdisciplinary and pluralist governance practices in which ordinary citizens and experts form mini-publics (Goodin *et al.* 2009), usually referred to in Europe by the term participatory technology assessment (PTA). The structure of the European Union (EU) encourages institutional innovation. On the one hand, the EU often compares different national solutions to the same problems, thereby diversifying the market in ideas. On the other, each state has to be able to convince the rest when new European bodies are designed.

So the problem is what kind of public policy should be devised in order to maintain the ethics of *The Imperative of Responsibility: In Search of Ethics for the Technological Age* (Jonas [1979] 1991), which, despite his boldness, Jonas left to one side, judging it too difficult. As a contribution to the assessment of controversial technologies, often described as new, such as Genetically Modified Organisms (GMOs) and certain medical technologies (pre-implantation genetic diagnosis, xenotransplantation), technology assessment agencies have developed various kinds of new procedures to involve citizens. These agencies have the task of preparing political and economic decision-makers to discuss complex scientific and technological issues and informing the public (Reber 2006). However, it became clear that technology assessment (TA) had its limitations in regard to public fears and opposition, and also to issues of legitimacy, norms, values and other aspects usually discussed by the humanities and social sciences. For some controversial technological and scientific choices, it is not enough to rely solely on the advice of experts, albeit of different opinions, provided only to political and economic decision-makers. Similarly, the resources used to popularise science among the general public do not in themselves answer certain criticisms. Mediation processes have also revealed their limitations, being orientated towards the social acceptability of, for example, new technologies and major industrial developments. While it is ultimately for political representatives to decide all these questions, these representatives themselves

have sometimes indicated that they would like to see a wider range of actors involved in debates around controversial technological subjects and environmental controversies.

Experiments have therefore been conducted on a small scale, often involving mini-publics, and linking the two worlds of science and democracy through PTA. Their different approaches (over 50 procedures) have opened up opportunities for stakeholders to express their views, using a variety of forms of communication (narration, interpretation, argumentation, reconstruction) (Ferry 1991).

This new field of bold political experimentation, which I call "socio-political experimentation", is justified by a number of justifications. There is the uncertainty among scientists, or at least the inability of science to answer certain questions concerning the risks that may be caused by controversial "new" technologies (Jonas [1979] 1991). To this we can add the differing opinions, sometimes entrenched in opposing positions, both within and between disciplines, scientific communities and interest groups. To put it another way, alongside the practical and cognitive uncertainties (Hennen 1999) there is also a normative uncertainty. These uncertainties are subject to the constraints of the plurality (de jure and de facto, or normative and factual) of practices involved in scientific and ethical assessment, so we are steering a course between precaution and pluralism.

In basing this article on these procedures, I hope to escape the confines of theory at the intersection of science with moral and political philosophy. I have not sought the philosophical protection of Minerva's owl, which takes flight only at nightfall, long after the reality of experience has faded. These PTA experiments make a crucial contribution to building the long-awaited responsible governance of the environment. Of course, although these new modes of governance and collective decision-making processes do work, they require improvement (Reber 2011), so I do not wish to overpraise them. They have their limitations, which their newness renders more acceptable. Nor do I naïvely forget the environmentalist social movements. These have created an opposition to which states (and sometimes private institutions) have sought to respond by gradually devising different experiments in PTA. Some of these movements, such as Social Ecology (Bookchin 1990), have developed useful discourse and practices. While these participative processes are important and popular as solutions to environmental problems, I think we need to move towards more structured forms of discussion, even inter-institutional governance, and away from mini-publics to international political actors. I cannot settle all these problems here, so I shall select a few more theoretical questions, including the tension between innovation and responsibility, decision-making in situations of uncertainty between the sciences, and normative decisions.

Here philosophy is a resource that is at once descriptive, contributing to the development of a moral sociology of assessment, and prescriptive as an aid in developing future organisations and institutions (on institutional design see Goodin 2003) that can provide the most effective tools for the governance that concerns us here.

Ethics: a specific sphere of knowledge for different organisations

One of the spheres to be considered is ethics. We speak of the ethics of biodiversity, for example, but ethics is not just a type of issue, or an incitement, or even an exhortation; it is a particular mode of justification, a way of solving problems through due process. It can do this on its own or, as we prefer, in collaboration with other forms of knowledge. I would add that ethical considerations are present in the background of some other spheres. For example, in economics there are normative choices that provide a framework before we proceed to calculations and various forms of objectivisation. Few economists do not bother with this justification, which is the sub-domain of normative economics. For example, how do we share the risks to which the inhabitants of an Asian country are exposed and which are largely due to the actions of consumers in North American countries? What kinds of compensation might be devised for less economically developed countries which are now reaching pollution levels similar to those produced by countries whose own growth was achieved in polluted conditions? And how can we deal with the fact that Chinese industry has a large ecological footprint at a time when European businesses are offshoring to China and Europe's massive importation of low-cost Chinese products contributes to this degradation? These problems are

considered and discussed before being subjected to the constraints of purely economic thinking and can be settled in very different ways, in the light of different ethical justifications and schematisations.

The governance of spheres of knowledge should make it possible to set sail on a sometimes wild and unpredictable sea pulled in different directions by different spheres of knowledge. As we steer our course, we shall be guided by the twin lights of pluralism and the precautionary principle, two concepts that can contain and structure the problem. Their advantages are tangible existence in the case of pluralism, which is increasingly commonly experienced, notably in the evaluation of ethical problems; and legal and political existence in the case of the precautionary principle, which has enjoyed sudden international recognition (for example in the UN's Rio Declaration on the Environment and Development, 1992) and features prominently among the pillars of the major European treaties, not to mention the French Constitution, which adopted it in 2005. I would add that pluralism is a key concern of UNESCO, which has also proposed some original ideas on the precautionary principle (COMEST 1995). At the more philosophical level that concerns us here, pluralism and precaution are key to conflicts in the interpretation of environmental responsibility (Chardel *et al.* 2012).

Even if the (first level) issues of practical governance – relations between states and institutions – were settled, if political decision-makers had the necessary courage and if states were agreed on the fragility of the environment and convinced of the actions to be taken, certain theoretical and practical problems would still remain in relation to the (second level) governance of the various types of relationship possible between the *descriptive* sciences (natural sciences, medicine and engineering) and their *normative* counterparts (moral philosophy, politics, law, ethics and an element of economics). In reality, the challenge of interdisciplinarity is present at the level of both what is and what should be or, to put it another way, the world of facts and that of values (or any other normative element).

These two levels can be linked in different ways. Some would argue for strict separation: this tends to be true of positivist conceptions comfortable with the division of labour – which has moreover proved its worth in our complex societies. Others admit a larger spectrum in the name of realism, preferring close interaction or forms of interdependency. I shall adopt this second position here. The primary responsibility in relation to environmental questions is a balanced realism, which partial visions would truncate. I would add that it is important to maintain a balance in the governance of both the different spheres (politics, ethics, economics, science) and the disciplines that provide them with methods and results because problems of interpretation affect spheres of knowledge, their disciplines and also their sub-disciplines (for example climatology and ecotoxicology)

A better world: innovation with responsibility

While one element of environmental ethics is conservative and seeks to protect wildernesses, ecosystems and species, it is important to acknowledge human activities, and notably those described as innovations. First, conservation poses a problem for biologists who favour a more dynamic vision of environmental systems. Second, the analyses of conservative visions of nature leave out the technological activities that human societies require for their development. So we need to include both innovation and responsibility, and indeed to talk about responsible research and innovation (RRI), to borrow a term from recent European research policy (Von Schomberg 2011).

Every inch of the planet has now been discovered, explored, mapped, attributed and documented from the different perspectives of geography and anthropology. Some parts have been the subject of highly aesthetic films shot from helicopters ruffling the treetops, such as the documentary *Home* (Arthus-Bertrand 2009), which introduced us to the most distant places on earth and became an international phenomenon. So where are these new worlds of ours? A few may find them in the stars and the poetry of black holes and anti-matter, but for all of us they lie in the future and in the transformation of the planet – our world of today – according to its "enframing" (Heidegger [1954] 1958) and ever more intricate colonisation by our technologies. In a way these are giving birth to a new world. Yet our course towards the world to come is uncertain. Announcements by engineers and industrialists of the coming of better *microworlds* are relayed by political decision-makers seeking promises of innovation; meanwhile other scientists, voluntary groups and politicians do not want to see

the coming of the promised *better world*, which they regard as dangerous, preferring the world of today or advocating another kind of world altogether.

So what of today's forms of deliberation in relation to the worlds to come, alternating between best and worst? What moral security might be sought in the relationship between knowledge and skills, and how? While knowledge may require courage, tenacity and creativity, doing something and getting involved requires even more. This is particularly true when it comes to doing the right thing. Often, we lack practical knowledge. We know how to do things but we know next to nothing about their impact and the consequences of doing them so controversial technologies, often described as "new", must now meet twin requirements. A technological solution is proposed to solve a problem or to more successfully perform a task that currently uses an older technique. This is the price of innovation. For example, the scientists working on GMOs present themselves as "improvers". But these "improvements" must meet requirements that are both scientific and ethical in nature.

Posed in this way, the question cannot be settled through the accepted form of a debate, with facts produced by scientists on one side and, on the other, ethics and indeed other disciplines such as law, whose role is to deal with the values or normative aspects of the proposed solutions. This *competition between improvements* is key to discussions about what the future will be. Many aspects of the controversy are intertwined. First, there is the comparison between the world of today and the promised world to come. These two worlds form the subject of competing and sometimes opposing descriptions, predictions and scenarios. Second, modes of problem-solving and improvement are also a matter of controversy, relating to the negative, unintended effects of improvements and to comparisons between them in order to select the best.

The new worlds opened up by the intrusion of these technologies, their rejection or modification (the "constructive technology assessment" – see Rip *et al.* 1995), are the subject of controversies between possible worlds (futuribles). Sometimes it is the possibility of their realisation itself that is questioned. These controversies concern the following three points at least:

(1) the *choice* (deterministic and certain) between desired worlds and those to be avoided;
(2) the *possibility* that a particular predicted state of the world (better or catastrophic) will occur according to probabilities and predictions, following an event such as an accident (from the catastrophist perspective);
(3) the *hierarchisation* or classification *of worlds* to find the best order, making the largest number compatible with each other and ensuring the least degree of irreversibility for the greatest number of worlds, including our shared world of today.

These three types of difficult problem are interconnected and influence each other. The specialist field of risk assessment deals mainly with the second aspect and has trouble responding. Some new technologies mean that there is an urgent need for an ethics of the future and a new political science that can deal with these difficulties. The three types of questions appear in snatches and heterogeneously in the context of PTA.

How have we got to this point? What happened between the New World of the Great Discoveries in the sixteenth century and the innovations that were supposed to lead to better worlds, which are sometimes challenged both as technologies and in terms of the worlds they herald? The status of notions of progress, newness and innovation can no longer go unquestioned. Innovation, which is still often implicitly seen as a factor in the health of the economy, job market and in well-being, and even as a spur in some research fields, no longer automatically commands support. For example, some scientists, proud of new skills such as transgenesis, which makes it possible to produce GMOs, find themselves in conflict with groups of crop saboteurs, who claim to act on the basis of ethics and values of good citizenship and destroy their field trials, even though these are guarded by the police. In so doing, the saboteurs stop experiments conducted to better understand GM phenomena in situ. These problems also have repercussions on the quarrel over the legitimacy of territories over these types of issues. Orders made by local authorities, ostensibly in the name of the precautionary principle, prohibiting these trials as long as they have not been scientifically proven to be harmless, are rendered nul and void by the French courts. At the same time, all the Swiss cantons have banned the use of animal and plant GMOs in response to public pressure (Reber 2011). The technological

improvements and advances on which innovations are based are now regarded with suspicion: innovation is on trial and arouses passionate resistance; the "better" that is proclaimed may conceal something worse. To borrow the words of Hans Jonas, one of the very few philosophers to have made an impression with his *The Imperative of Responsibility. In Search of an Ethics for the Technological Age*, technological "meliorism" could be dangerous. As Jonas ([1979] 1991, p.101) writes, "The promise of modern technology has become a menace, that is, that technology is intrinsically menacing".

This technological civilisation has become a virgin territory for ethics, or rather a territory to be explored in order to go beyond an ethics of relations between people sharing the same space-time, unmediated by technologies. Our discussions must also take account of intertwined socio-technological relations over long timescales, in what Jonas referred to as a "creeping apocalypse" (Jonas [1988] 1992, p.101).

The issue of the consequences of technological innovations for society and for the environment is not new. Jonas expressed concerns about the overturning of the order of theory and practice over 50 years ago. We know how to do things that have implications of which we are largely ignorant. This turn of affairs radicalises philosophical undertakings that had already indicated the difficulty of making assessments on too large a scale, in relation to excessively long chains of cause and effect and probabilities that are difficult, if not impossible, to determine. I think of Hume ([1740] 1983, Book III, pp.141–267). The same is true of Mill's chains of argument – used as an epigraph by Boudon (1995); Mill states, "On every subject on which difference of opinion is possible, the truth depends on a balance to be struck between two sets of conflicting reasons." Even Kant, the philosopher of limits, still seems too optimistic with his three famous questions: "What can I hope for?", "What ought I to do?" and "What can I know?" He would find it hard to deal with the question of GMOs.

So should we settle for a minimal ethics, which Jonas would have described as "woolly"? Should we simply look to the legal sphere and "biodegradable" laws that can remain in step with technological developments and not hinder new possibilities? Is technology the fate of politics, as Jonas thinks? Should politics move forward as directed by lobby groups in favour or against this or that technology? Can we devise a form of civic or civilised public debate?

We do not have to give in to fear, or to the heuristics of fear, and can seek to nuance Jonas's dramatic, apocalyptic tone. However, his remarks on the insufficiencies of traditional ethics and what he calls "woolly" ethics are well founded in relation to the threats he perceives. The philosophies of Aristotle, Kant, Heidegger and Lévinas are also astutely criticized in Peter Kemp's (1991) more recent book on the ethics of technology, *Det uerstattelige. En teknologi-etik.* These ethics apply to intersubjective relations between contemporaries, often really present to each other, in small actions on a small scale and with limited effects, unmediated by technological devices. I would add that they do not recognise socio-technological relations and their variations. Furthermore, today's technologies are different (Saint-Sernin 2007); they are the fruit of teamwork and have even more ramifications when scientific discoveries give rise to innovations. In his history of the relationship between technology, power, knowledge and responsibility, Gilbert Simondon, the original thinker on technologies (Reber 2008), is more optimistic than Jonas. He sees molecular biology as a revolution in the primary sense of the word. It is a danger because it can manipulate not just nature, but also people. His discussion of the thesis advanced by Jonas in *The Imperative of Responsibility* highlights problems that remain pertinent, such as the need for an ethics of technology orientated towards the future and thus able to take account of things that have not yet happened, when technology is subject to conflicting judgments – better for some, apocalyptic for others. However, he makes our task more difficult because he claims that scientists regard all futurology as impossible. So can we do nothing but simply give way to an enlightened catastrophism, as suggested far more recently by Jean-Pierre Dupuy (2001), in his critique of the precautionary principle partly inspired by Jonas? I think not.

In practice, critiques of the precautionary principle have often been based on caricature. So I propose to use its most complete formulations, validated by legitimate bodies at the end of long negotiations. One example is the document of 2 February 2000 produced by the European Commission, Communication from the Commission on the Precautionary Principle (COM 2000). This can provide a basis to pursue Jonas's thinking, even if

he does not use the term precautionary principle but speaks instead of a principle of responsibility. The precautionary principle notably makes it possible to consider the political aspect, which Jonas regarded as too difficult to take on. Some have seen Jonas as an anti-democrat. Marie-Hélène Parizeau (1996, p.539) writes: "At the political level, his choices are on the side of a government of the wise rather than democracy."

So at best, Jonas would turn to wise men, whom he saw as the only ones capable of taking the necessary decisions, unlike politicians who are subject to the rules of democracy and have a "short life-expectancy" corresponding to their mandates. We could add that voter choices are often made for short-term reasons.

So we shall see how the precautionary principle can bring both scientific and normative assessment to bear on controversial questions relating to such things as technology and climate change; and try to see how it can make interdisciplinary governance possible.

The precautionary principle as a mode of governance in situations of scientific uncertainty

I intend here to propose the precautionary principle as an appropriate framework in which to conduct a PTA and to produce high quality results. This principle more or less exhaustively includes and combines assessments of a scientific, ethical and political nature. It has become a meta-norm, intended to provide a framework for certain political decisions regarding scientific and technological choices when there is great scientific uncertainty and too little knowledge of the phenomena to establish probable outcomes. This principle means that scientific uncertainty does not have to paralyse action. It should normally be applied in specific circumstances, notably where there is high uncertainty due to the limits of scientific knowledge in assessing risks that could cause serious or irreversible damage.

While this principle has rapidly become a key factor in managing certain public scientific controversies, it remains subject to disputes over interpretation. Its importance, its newness and this instability have led to the need for clarifications. A former French Prime Minister, Lionel Jospin, commissioned a report on its interpretation (Kourilsky and Viney 2000). The principle became particularly well known due to its insertion in principle 15 of the 1992 Rio Declaration, which stipulates that:

> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

A few months earlier, in February 1992, the European Maastricht Treaty had introduced the precautionary principle as one of the main principles underpinning European Union policy in the environmental domain.

It is unusual for a principle to come to international prominence so quickly, shaking up the different spheres of politics, science and even ethics. However, it has had some detractors. In the 1990s it generated disputes between Europe and the United States at the World Trade Organization. The Americans even suspected the Europeans of obscurantism. In France too, intellectuals and political advisers such as Jacques Attali (2007) called it "out-dated and hot air".

Within the domain of philosophy, well-respected thinkers have adopted sometimes diametrically opposed positions in its regard – I am thinking, for example, of the disagreement played out in the books by Cass R. Sunstein (2005) and Jean-Pierre Dupuy (2001). Sunstein adopts a non-catastrophist approach, while Dupuy takes the opposite view, observing that we should act as though catastrophe were a certainty. It is a shame that the European texts are not cited in these disputes. By way of illustration, let us take the oft-cited and stimulating essay by Stephen Gardiner of the University of Washington in "A Core Precautionary Principle". Gardiner begins with the statement: "[T]he Precautionary Principle still has neither a commonly accepted definition nor a set of criteria to guide its implementation ... no one is quite sure ... how it might be implemented" (Gardiner 2006, p.33). Unsurprisingly, his bibliography is deafeningly silent on the implementation of the

principle in the aforementioned European COM 2000. However, Gardiner's strategy is unusual, since he proposes a Rawlsian version of the precautionary principle that exploits its maximin (maximisation of the course of action that produces the fewest undesirable effects).

One final interpretative difficulty is due to the fact that contained within this principle are several others, so emphasis is often placed on one aspect of what must be described as a meta-principle. Some authors focus on the nature of the risks, others on a comparison of the hypotheses concerning those risks, others on whether the most catastrophic scenarios should be taken seriously, others on looking at alternative solutions to (new) developments that might cause serious and/or irreversible damage and others still on the measures to be taken, these being only a few of the possibilities. Within these choices themselves, we can see possible nuances; this is true of the choice of levels of precaution in the measures to be taken, where some very sensibly speak of a continuum in which the different possible decisions corresponding to different levels of precaution can be located (Myers and Raffensperger 2006).

The originality of the precautionary principle in relation to prevention is that the facts are not established with certainty, but there is a strong presumption that serious and/or irreversible damage will be caused. This then removes the need to delay action until comprehensive scientific evidence has been provided or, more precisely, makes it possible to carry out complementary research and ask the question of whether or not to act. Looking more closely at how scientific facts are established, we find different types of well-documented uncertainty in the European Commission's COM 2000 cited above. The recognition of these uncertainties and their more or less optimistic or pessimistic management lead back to the hypotheses concerning the phenomena in question. However, this communication proves very unbalanced when we compare its highly detailed scientific element with its normative aspect, grounded only in the need for a high level of protection for societies and the environment (through the European treaties such as Maastricht), and social acceptability. So let us look at the various solutions proposed for decision-making in situations of uncertainty.

Political decisions in situations of scientific uncertainty

We can identify several possible paths for decision-making in situations of scientific uncertainty, when there are risks of causing serious and/or irreversible damage. To return to the dispute between worlds mentioned above, if we are to compare worlds modified by technologies, we must also be able to predict the effects of those technologies. These effects can be seen as causes of damage or can simply be regarded as very likely to cause damage. "This raises the question of how we can arm assessments for these decisions when it is not possible to attribute probability to predictions due to insufficient and imprecise data, or to the complexity of relations through which the phenomena in question can be understood", to borrow the words of Morgan and Henrion (1998). Based on the state of the art, I propose the following typology of political decision-making in situations of scientific uncertainty. Decisions may be taken:

1. using a *criterion of utility*, which bases decisions on the values of their inferred effects. These can be calculated using a cost-benefits or risks/benefits analysis. These calculations can themselves be made using five different approaches:
   - 1.1 using a determinist approach;
   - 1.2 using a probabilistic approach, notably when uncertainty is integrated into the assessment;
   - 1.3 according to a criterion of efficiency, based on economic (or other) considerations, in an attempt to find solutions that can meet the objectives at the lowest possible cost;
   - 1.4 according to a criterion of cost limitation, seeking to maximise the reduction of risk in the light of budgetary constraints. Here we can speak of the theory of the maximisation of multi-attribute utility, which seeks to specify the utility function in order to assess results according to all major attributes, including risks and uncertainties;

– 1.5 seeking to minimise the possibility of the worst possible results and to maximise the possibility of the best possible results.

2. According to criteria based on *law*, to which we can add certain *principles*, which are not primarily concerned with results but with decision-making processes. Here again the conceptions fall into four main types:

   – 2.1 zero risk, independent of benefits and costs, which thus strictly excludes taking the risk in question;
   – 2.2 limited or contained risk, taking a specific level as harmful or an imprudent exposure to danger;
   – 2.3 approved compensation, enabling (consent to) risks by people who voluntarily give their consent and receive compensation for any disruption or losses incurred;
   – 2.4 an approved process guaranteeing that all parties involved follow an identified set of procedures.

3. Technological criteria of the same order as the criterion for cost/efficiency assessment, but in order to select the best available technology for regulating and reducing environmental risks.
4. Hybrid criteria containing criteria of types 1 and 2.

I shall end with a few remarks about this typology. First, the calculation of the utilities of the different choices may be determinist, probabilistic or impossible. In the latter case we can turn to procedures and rights. While these approaches to taking political decisions in situations of scientific uncertainty are in common use, the precautionary principle proposes to treat the third case without necessarily relying on rights. However, it does oblige respect for a transparent procedure that guarantees a good scientific assessment. Second, criterion 1.5, consisting of minimising the possibility of the worst possible results and maximising those for the best possible results, is a forerunner of the precautionary principle. Third, I would note that there are different combinations according to the choice of calculation, compensation or procedure. Fourth, these decision-making models combine different types of considerations and fields, including economics, law, risk assessment and technologies. In addition to those just mentioned, each discipline may gain ascendancy over the others more easily according to the criteria chosen. For example, type 2 gives the primary role to the law and types 1, 3 and 4 to the natural sciences and engineering. The same can be said of the precautionary principle. From one disciplinary perspective to the next, there may be a focus on the different aspects presented in the preceding section. For example, if the emphasis is placed on scientific uncertainties, the natural sciences and engineering will dominate; if it is on the proportionate measures to be taken, economics and law will be primary. I think, on the contrary, that arbitrary asymmetries should be avoided and all relevant disciplines should be included.

Ethical pluralism for a balanced precautionary principle

Having clarified the various types of relations between scientific uncertainty and political decisions, I now propose to further develop the normative element implied in the precautionary principle. While the European Commission's Communication recognises that decision-makers face the dilemma of whether to act or not (COM 2000), posing this very "Hamletian" question does nothing to solve the problem. From the point of view of soliciting disciplines, the precautionary principle as proposed is marked by the strong, highly developed presence of the natural sciences and engineering. Where the humanities and social sciences are concerned, to a lesser degree we must settle for the vague notion of the social acceptability of risk, and of the high level of security to be ensured. At this level, the decision-makers are very much alone. Could we not start by "arming" the political aspect of assessment, taking care to develop the ethical aspect?

Given the variety of elements in moral and ethical life related to the pluralism of ethical theories, it is no surprise that in relation to a principle that must deal with so many uncertainties, different options can present themselves to the thinker or decision-maker. So alongside the problem of the interpretation of environmental responsibility in general and the precautionary principle in particular, we find that of the management of plurality. This is because our societies are increasingly characterised by plurality, not only for cultural reasons, but also because of the great specialisation of knowledge.

As I have shown in *La démocratie génétiquement modifiée* (Reber 2011), this plurality directly affects quality criteria in the secondary assessment of PTA experiments, and more broadly of public debates and those between experts concerning environmental assessment. These criteriologies (Reber 2005) vaguely mention the term "pluralism". Often it is rendered equivalent to "plurality" rather than the normative term "pluralism", which proposes a particular management of plurality (Reber 2005). Plurality is a matter of facts, whereas pluralism is normative and indicates a type of approach, which can be contrasted with relativism on the one hand and monism on the other. Relativism refuses to discuss normative dimensions in themselves, explaining differences in terms of affiliations (religious, cultural, ideological, historical) sources of cognitive bias. Monism requires a single value (or value system) to dominate. While excessive plurality or radical pluralism can threaten social stability, at different levels both are also guarantees of a democratic society. With the current criteria for the quality of debates in PTA, the question of ethics remains as yet underdeveloped. On the one hand, values are not enough to settle moral and ethical questions, either in debates, or in relation to ethical theory and meta-ethics. Furthermore, moral values are hard to grasp. They are subject to distinctions, fragmentation and refinement (Scheler [1916] 1955), not to mention the difficult question of the relationship between actions and values, for example, and whether or not values can motivate action. On the other hand, in a justificatory context such as PTA, it is hard to see how we can do without turning for support to the great wealth of ethical theories, and thus to the pluralism of ethical theories. While they do not always ultimately enable us to make decisions, and while they can be secondary in relation to the moral insights of citizens and experts, they have the great advantage of making it possible to objectivise and justify judgements and to render them more convincing. I do not think that it is always possible to come to a final decision, but nor do I think that we should settle for relativism in this regard. We need to be able to couple an ethical pluralism of values and theories with cognitive and epistemic pluralism

Moral philosophy is a field of knowledge that can inform tensions of this kind, always on condition that it works with competing ethical theories, permitting a broader ethical pluralism than that of values alone (Reber 2006), and more generally with the question of the difficulty of judgment.

On this particular point, the typology based on Morgan and Henrion is interesting from the point of view of ethical theories for we can easily recognise forms of consequentialism in the case of models based on utility (1), and forms of deontologism in models based on rights (2), to which I added principles. So ethical theories help to structure decision-making in situations of uncertainty. True, they are more abstract and disciplines other than moral philosophy take a more practical approach to these problems.

From the point of view of ethical theories, the precautionary principle is fundamentally consequentialist. For example, it stipulates that an assessment of the possible consequences of a lack of action must be considered. However, because of the competition from other ethical theories, I see a limit to this arbitrary choice of a single ethical theory. This can already be seen in terms of common practices of decision-making in situations of uncertainty, which may choose criteria of utility or procedural criteria based on rights or principles. Let us take the very controversial case of asbestos (Reber and Sato 2009) in the distant period when scientific data had not yet reached preventative levels. In practice, the gulf between the different scientific hypotheses made it impossible for decision-makers and experts to establish effective, reliable probabilities that could inform risk-benefit assessments. It was even harder to deduce consequences, including those for the distant future and in the social domain. One might have thought that the solution established by the legal route (deontologism) could have avoided many deaths and what was called one of the greatest health scandals of the contemporary world. Conversely, in other situations risk-benefit assessments are better suited to responding than deontological approaches.

All ethical theories should be considered in decision-making. We are in a circle of continuity with scientific data on the one hand and ethical assessments on the other. These assessments question the options suggested by the data from several points of view, such as their consequences and more universal principles. I would add that ethical assessment takes account of a range of entities, including states of the world, people, procedures and technologies.

On both the scientific and normative sides, there is an issue of different degrees of plausibility. The high level of protection sought for the inhabitants of the European Union, with recourse to the precautionary principle, should not become a single, monist value crushing the delicate process of deliberation. On this point, the EU judge uses the precautionary principle as a guide in creating a balance between considerations of different orders relating to the health of individuals, the economic effects, protection against environmental consequences and free enterprise and the free circulation of goods. We must maintain a balance between the principles that constitute this meta-principle, which also includes the principle of proportionality. I think, therefore, that we should not simply weigh up all these principles and considerations, but approach them in a balanced fashion.

Conclusion: the environment needs experts in pluralism and dissonance

The most frequent hypothesis adopted in designing PTA is that of the mutual complementarity of fields of knowledge so the approach is often implicitly syncretist, based on the view that it is possible explore all facets of the problem. This kind of syncretism is not pluralism. True, attempts are made to call in all the experts who can shed light on the different aspects of the problem. However, if everything was so good in the best of all possible worlds, it would not have been necessary to call in experts and citizens to assess a technology or an environmental problem. This is not simply a problem of the fragmented nature of knowledge, but of controversy. The controversy is first of all internal to disciplines (intra-disciplinary pluralism), with their unresolved disagreements and positions adopted in relation to uncertainties, enabling citizens to assess answers given in cases of conflict.

Epistemic interdisciplinary pluralism (interdisciplinary pluralism) can be weak if there is a juxtaposition of separate disciplines, and strong where the boundaries between disciplines are porous and translation occurs between them. Depending on the questions posed, we may have cooperation between disciplines *but* also in some cases tensions and indeed conflicts.

The precautionary principle not only has the advantage of presiding over the balance to be maintained between several dimensions or values, it also structures and makes operational a fundamental difference between the approach of experts and that of academic researchers. The role of experts is to enlighten decision-makers and they must examine the facts in the light of *all* available explanations, including those that are minority views, while researchers choose to explore the most convincing path both in terms of hypotheses and at each stage of research. This is also true in relation to normative options. Often, sadly, there are more academics than experts in the sense given above, and indeed experts who express their opinions outside their field of expertise. A proposition not yet explored would be to have experts in the field who are actively involved in debates and question the various academic researchers invited, making them justify their positions and the solidity of their disagreements.

The precautionary principle would make it possible to guarantee these two forms of pluralism, the epistemic (intra- and interdisciplinary) and the normative, within PTA and later in inter-institutional and international relations. With the distinction between experts and academic researchers, where interdisciplinary epistemic pluralism is concerned, we encounter problems of the arbitration of disputes between faculties or disciplines. Given the small number of people capable of managing such a broad pluralism, it can be more certainly ensured by means of procedural requirements since, depending on the questions asked, there are sometimes tensions between disciplines.

Whatever the disciplines and their boundaries or the crossing of boundaries between them, the world is beyond the bounds of knowledge. It cannot be reduced to its epistemology and the knowledge we have of it, even in cases of dissonance. Moreover, the term cognitive dissonance, borrowed from music, seems not to take account of contemporary music, which plays on dissonance. Rather than always seeking agreement (or deliberative disagreement) or consensus, in PTA it is sometimes possible to imagine an acceptance of dissonance (Rescher 1993). Here there is an analogy between the supporters of a static, conservationist approach to the environment and those on the site of dynamism and meta-stability. We could come to terms with limited differences in political life and in the encounter between different spheres

of knowledge, with a pluralist recognition of the different positions, when choices are sensible and not unimportant (relativist). Open minds are not empty. A recognition of ethical and epistemic pluralism enables citizens and experts from different epistemic communities to put their theories to the test, sometimes to reach consensus, but also to revise their positions or beliefs. On this point, I propose aiming for a pluralism that resists pressures to reach a consensus at any price, which in practice requires citizens to produce a joint final report in too short a time. This pluralism could be based on four criteria: recognition of legitimate diversity, limited dissonance, an acceptance of difference and respect for the autonomy of others and/or their disciplines. This might make it possible to cope with disagreement in cases where consensus is not possible. This pluralist, non-relativist position would have the advantage of revealing the different reasonable positions on a particular point of scientific controversy, without settling for a mean, a lower common denominator or, worse still, a vote.

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