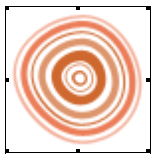

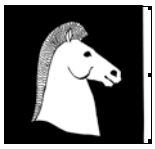

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The Precautionary Principle in Contemporary Environmental Politics

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ABSTRACT: In its restless metamorphosis, the environmental movement captures ideas and transforms them into principles, guidelines and points of leverage. Sustainability is one such idea, now being reinterpreted in the aftermath of the 1992 Rio Conference. So too is the precautionary principle. Like sustainability, the precautionary principle is neither a well defined principle nor a stable concept. It has become the repository for a jumble of adventurous beliefs that challenge the status quo of political power, ideology and civil rights. Neither concept has much coherence other than it is captured by the spirit that is challenging the authority of science, the hegemony of cost-benefit analysis, the powerlessness of victims of environmental abuse, and the unimplemented ethics of intrinsic natural rights and inter-generational equity. It is because the mood of the times needs an organising idea that the precautionary principle is getting a fair wind. However, unless its advocates sharpen up their understanding of the term, the precautionary principle may not establish the influence it deserves. Its future looks promising but it is not assured.

KEYWORDS: Precaution, precautionary principle, environmentalism, sustainability, environmental ethics.

THE PRECAUTIONARY PRINCIPLE IN CONTEXT

The environmental movement is both predatory and transforming. Over the past couple of decades, environmentalism has locked into other social movements such as rights to know and freedom of information; civil liberties in respect of health, freedom from oppression and the protection of indigenous cultural traditions; consumer power over companies or nations behaving against the rights of nature; feminism and gender issues generally but most particularly as these apply to the concerns of women over their health, their welfare and their own choice of giving birth; and to peace, security and the uneasy relationship

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between resource deprivation and civil strife. Because of this, environmentalism will never die. It will, however, metamorphose, and the political mechanisms through which it is articulated will change with the rise and fall of the 'issue-attention cycle' (Downs, 1972). These relationships are captured in O'Riordan (1976), Pepper (1984), O'Riordan (1991a), Eckersley (1992), Mies and Shiva (1993) and most recently by Sachs (1993).

In this journal Norton (1992) and Redclift (1993) have shown how sustainability has also become enmeshed in the environmental debate, unsuccessfully attempting to straddle the gaping divide between technical interpretations of replenishability and restoration, and more fundamental ethical responsibilities for protecting the intrinsic life support processes of an organic Earth and the well-being interests of future generations. To avoid the sustainability concept becoming meaningless, Norton (1992: 98) calls for

> ... a set of principles, derivable from a core idea of sustainability, but sufficiently specific to provide significant guidance in day to day decisions and in policy choices affecting the environment.

Precaution could be one such principle, for it provides an intuitively simple guide to humans on how to intervene in environmental systems in a manner that is less damaging (Jordan and O'Riordan, 1995; O'Riordan, 1993). Admittedly, precaution lacks a specific definition and, as yet, it cannot prescribe specific actions or solve the kind of moral, ethical and economic dilemmas which are part and parcel of the modern environmental condition. None the less, the precautionary principle has much efficacy because it captures an underlying misgiving over the growing technicalities of environmental management at the expense of ethics, environmental rights in the face of vulnerability, and the facilitative manipulation of cost-benefit analysis. Paradoxically, as precaution becomes increasingly integrated into modern environmentalism it may well run the risk of following the dangerously successful pathway pioneered by sustainability some time ago. We say 'dangerously successful' because it is precisely the uncritical accumulation of meanings, often contradictory and impractical, that have characterised the success of the sustainability notion in recent years.

The same could be said to apply to the precautionary principle. To date, precaution provides few, if any operable guidelines for policy makers nor does it constitute a rigorous analytical schema. Yet, it is accepted by many national governments and supra-national entities, such as the United Nations and the European Union for example, as a guiding principle of policy making. But at its core, the precautionary principle provides a direct challenge to many of the unstated assumptions and what Redclift (1992: 40) terms the 'prior commitments' of modern (and particularly 'Western') societies. These 'commitments' influence the manner in which humans value their environments, conduct their day to day affairs and organise economic production. In a nutshell, precaution

challenges the established scientific method; it tests the application of cost benefit analysis in the those areas where it is undoubtedly weakest (i.e. situations where environmental damage may be irreversible or potentially catastrophic); it calls for changes to established legal principles and practices such as liability, compensation and burden of proof; it challenges politicians to begin thinking through longer time frames than the next election or economic recession. Precaution cuts across disciplinary boundaries and it raises issues about the quality of life for future generations. It is profoundly radical and potentially very unpopular. Its success, ironically lies in its expanding novelty and scope for extended interpretation. In this article we attempt to offer a way forward, recognising that precaution will remain politically potent so long as it continues to be tantalisingly ill-defined and imperfectly translatable into codes of conduct, whilst capturing the emotions of misgiving and guilt.

INTERPRETING THE PRECAUTIONARY PRINCIPLE

The precautionary principle emerged during the 1970s in the former West Germany at a time when social democratic planning was in vogue (Weale et al., 1991). At the core of early conceptions of precaution (or *vorsorge*) was the belief that the state should seek to avoid environmental damage by careful forward planning. The word *vorsorge* means 'foresight' or taking care, although it also incorporates notions of good husbandry and 'best practice' in environmental management even in the absence of risk (von Moltke, 1988). The *vorsorgeprinzip* (precautionary principle) was used by the German government to justify the implementation of vigorous policies to tackle acid rain, global warming and pollution of the North Sea in the mid- to late-1980s. In the process of standard setting, *vorsorge* translates into a requirement, placed on operators of industrial processes, to adopt the very best available abatement technology in order to minimise polluting emissions at source. For Hajer (1992) and Weale (1993), *vorsorge* is symptomatic of a general policy orientation, labelled variously as 'ecological modernisation'. This is still a vague notion, but it suggests a compatibility between the evolution of a post-industrialist value drift , and the opportunities afforded by information technology and an increasingly flexible industrial culture towards a more inherent compatibility of high environmental quality with economic growth. High environmental standards in Germany, for example, have encouraged the development of a discrete 'eco-industrial' sector which employs 320,000 people (OECD, 1992). For the Germans, then, precaution is viewed as a positive facilitator of economic growth rather than a brake upon it.

Since then, the precautionary principle has flourished and it is now to be found in many international statements of policy, in the texts of international

conventions and protocols, and in national strategies for implementing sustainable development (see Freestone, 1991, and Cameron and Wade-Gery, 1992, for useful reviews). However, the precautionary principle has neither a commonly agreed definition nor a set of criteria to guide its implementation. 'There is', as Freestone (1991: 30) cogently observes, 'a certain paradox in the widespread and rapid adoption of the precautionary principle': while it is applauded as a 'good thing', no one is quite sure about what it really means, or how it might be implemented. Critics deride it as being empty and devoid of practical meaning (Gray, 1990; Bodansky, 1991; Gray et al., 1991); advocates, on the other hand, foresee precaution developing into 'the fundamental principle of environmental protection policy at [all] scales' (Cameron and Abouchar, 1991: 27).

At the core of the precautionary principle is the intuitively simple idea that decision makers should act in advance of scientific certainty to protect the environment (and with it the well-being interests of future generations) from incurring harm. It demands that humans take care for themselves, their descendants and for the life-preserving processes that nurture their existence. In essence, it requires that risk avoidance becomes an established decision norm where there is reasonable uncertainty regarding possible environmental damage or social deprivation arising out of a proposed course of action. As was indicated in the 1990 Bergen Conference on Sustainable Development, 'it is better to be roughly right in due time, bearing in mind the consequences of being very wrong, than to be precisely right too late' (NAVF, 1990: 6). The environment should not be expected to signal pain on being hurt; it is up to humanity, as a matter of moral principle, to recognise that pain might be imposed and to adopt appropriate avoidance (precautionary) measures.

This in turn suggests that any action likely to result in serious environmental harm is morally wrong so should be excluded as a option against which other courses of action are to be compared. Thus a development project that might remove a particularly critical component of life support, say a protective coral reef, simply should not be put up as an option for alternatives to be costed against it. 'Critical' natural habitats such as ancient woodlands, unique wetlands or other features of the landscape that are judged to be historically, aesthetically or intrinsically valuable, should be left intact. There are strong links here with notions of 'inviolability' or 'sustainability constraints' (Jacobs, 1991) and, ultimately, social and environmental limits to conventional notions of economic growth (Owens, 1993). In effect, this means that humans must learn to widen the assimilative capacity of natural systems by deliberately 'holding back' from unnecessary and environmentally unsustainable resource use on the grounds that exploitation may prove to be counterproductive, excessively costly or unfair to future generations. It should be clear from the foregoing that the application of the precautionary principle can be both ethically and politically contentious.

CORE ELEMENTS OF THE PRECAUTIONARY PRINCIPLE

A number of core elements to the precautionary principle can be identified. There are seven main themes, though each of them has a different intellectual and policy underpinning.

(i) Pro-action: willingness to take action in advance of scientific proof, or in the face of fundamental ignorance of possible consequences, on the grounds that further delay or thoughtless action could ultimately prove far more costly than the 'sacrifice' of not carrying on right now. In practical terms, the application of some sort of cost-benefit analysis, or proportionality rule does apply. This has always been the German position (von Moltke 1988, 68; Boehmer-Christiansen, 1994, 40-46). This in turn triggers the minimisation of damage approach, based on reducing potential danger at the point of decision. This is the essence of the risk prevention approach in US pollution control policies, and in the European Union line on integrated pollution prevention and control (Jordan 1993).

(ii) Cost-effectiveness of action. The application of proportionality of response is designed to show that there should be a regular examination of identifiable social and environmental gains arising from a course of action that justifies the costs. This sets up an interesting ethical conundrum. If a possible outcome is potentially destabilising to the natural order or to social equity, can it truly be regarded as a realistic option to the point where lost 'benefits' ought to constitute a 'sacrifice'? This is the kind of dilemma referred to by Redclift (1993) when he discussed the distortions inherent in seeking to place a monetary yardstick on what essentially are ethical judgements. Thus the concept of proportionality remains embedded in precaution as does the next core element.

(iii) Safeguarding ecological space. A fundamental notion underlying all interpretations of the precautionary principle is how far natural systems and social organisations are resilient or vulnerable to further change or alteration. At stake here are judgements about adaptive capabilities and possible thresholds of irreversibility, or at least self-reinforcing deterioration or social injustice. Resilience is shorthand for self-renewal, vulnerability a metaphor for self destruction. Of course, there are myriads of shades in between, and every single environmental and social condition will be subject to interpretation on this scale. This is why the precautionary principle is both challenging and potentially self-defeating. The rules of resilience and vulnerability need to be carefully laid down. Hence, the concern within the scientific community about the possible misinterpretations of ignorance or indeterminacy in its assessment of assimilative capacities or critical loads (Horsman, 1992).

(iv) Legitimising the status of intrinsic value. The pages of this journal are filled with earnest analysis of the meaning and importance of intrinsic value of natural systems. The stronger formulations of the precautionary principle are consistent with a bioethic; that vulnerable, or critical natural systems, namely those close to thresholds, or whose existence is vital for natural regeneration, should be protected as a matter of moral right. This in turn places a strain both on the application of cost-benefit analysis generally, including the proportionality rule, and the normal practice of considering all options as comparators for decision making.

(v) Shifting the onus of proof. In the case cited above, the precautionary principle suggests that the burden of proof could shift onto the proto-developer to show 'no reasonable environmental harm' to such sites or processes, before development of any kind could proceed. This is the reversal of the normal position where it is up to the opponents of development to show likely and unreasonable harm (Cameron and Wade-Gery, 1992). Such a reversal of the liability rule would be truly radical and difficult to implement since it would involve some definition of 'harmfulness' (or if the burden is to be reversed completely, some measure of 'harmlessness'). In effect such an arrangement would mean imposing a 'duty of environmental care' on all developers, as proposed by Costanza and Cowell (1992). This might carry a requirement to provide an 'up-front' compensation fund to pay out 'no fault' liability claims, subject to independent verification and arbitration.

(vi) Meso-scale planning. The meso-scale is the period, roughly for 25 to 100 years from now, over which any major decision will have an influence, yet where the normal tools for foresight and decision analysis are simply not workable. Cost-benefit analyses rarely take into account the likely costs and benefits of various courses of action during this period. Similarly, legal rules for compensation or obligation to take care are still ill-developed. Needless to say, democracy itself is poorly suited to this time-scale with its heavy political biases in favour of immediate gratification and gain today rather than tomorrow. Here is an arena where the precautionary principle challenges institutional performance and the sense of citizenship which primarily concentrates on the well-being of society today rather than the state of the world in the future.

(vii) Paying for ecological debt. Precaution is essentially forward looking, but there is a case for considering a burden-sharing responsibility for those not being cautious or caring in the past. This is a difficult matter. Responsibility for actions taken in ignorance, or in a climate of opinion that did not regard environmental vulnerability as a serious basis for evaluating options, should not reasonably be placed on those for whom there was no clearly defined duty of taking moral legal care. Nevertheless, shouldering the burden is an

important component of precaution. For instance, the notion of common but differentiated responsibility enshrined in the UN Framework Convention on Climate Change, and the concept of conducting precaution 'according to capabilities' in Principle 15 of the Rio Declaration, reflect an embryonic version of these ideas. Despite all this, 'precaution in reverse', while attractive from a moralistic viewpoint, could well founder in the courts. Its future, therefore, lies in the political realm.

Two points should be apparent from the foregoing. First, each of the seven elements requires some form of mechanism or institutional tool, for it to be made operational. These could be legal (e.g. the introduction of strict liability regimes), economic (i.e. weighted cost-benefit analysis), or technological (e.g. clean production). The myriad difficulties involved in actually *implementing* precaution are discussed below.

Second, precaution works through a continuum within each distinct element – from very 'weak' formulations that are relatively protective of the status quo through to very 'strong' formulations that predicate the need for much greater social and institutional change. There are, of course, a host of variations in between these poles. The *weaker* formulations, for example, tend to be restricted to the most toxic and human life threatening substances or activities. They advocate a role for biased cost-benefit analysis, incorporate some concern for technical feasibility and economic efficiency arguments and tend to emphasise the importance of basing judgements on 'sound science'. These are very much the concerns of the 'lighter' greens. The following, a statement from the UK government, prescribes a particularly limited role for precaution:

> Where there are *significant* risks of damage to the environment, [we] will be prepared to take precautionary action to limit the use of potentially dangerous materials or the spread of potentially dangerous pollutants, even where scientific knowledge is not conclusive, *if the balance of likely costs and benefits justifies it*. The precautionary principle applies particularly where there are *good grounds* for judging either that action taken promptly at *comparatively low cost* may avoid more costly damage later, or that irreversible effects may follow if action is delayed (HM Govt, 1990: 11, emphasis added).

The *stronger* formulations, on the other hand, have more in common with the 'deep green' worldview and ecologism although few political analysts have actually made that link. Dobson (1990, 205), for example, makes an implicit reference to precaution when he discussing the axioms of 'deep' greenism ('ecologism'):

> ... ecologism asks that the onus of justification be shifted from those who counsel as little interference as possible with the non-human world, to those who believe that interference is essentially non-problematic.

In the policy domain, examples of strong formulations are more difficult to find. The Third Ministerial Declaration on the North Sea signed by various North Sea states in 1990, for example, states that governments should:

> ...apply the precautionary principle, that is to take action to avoid potentially damaging impacts of [toxic] substances... *even where there is no scientific evidence to prove a causal link between emissions and effects* (emphasis added).

On this conception, science plays little or no role in policy making; administrators undertake to go beyond science to address known, but still uncertain, threats to the environment. This interpretation is both promoted by and finds support within environmental pressure groups which challenge the legitimacy of science, such as Greenpeace (Horsman, 1992). The Germans tend also to adopt a fairly strong definition of precaution. Boehmer-Christiansen (1994) for example, quotes the following from a 1984 German Federal Government report on air quality:

> The principle of precaution commands that the damages done to the natural world.... should be avoided in advance and in accordance with opportunity and possibility. [Precaution] further means the early detection of dangers to health and environment by comprehensive, synchronised..... research..... [I]t also *means acting when conclusively ascertained understandings by science is not yet available...* (emphasis added).

Norton's admonition, namely that meta-concepts must be brought to the heel of pragmatic guidelines, codes of practice and organising principles for regulation and valuation, is most apt. The difficulty facing the adherents of precaution is that there is no agreement over how serious the predicament is. At the root of this dilemma lie contrasting positions on the robustness of natural systems to withstand shock, the seemingly bountiful adaptiveness of human societies to cope with change of whatever kind, and the apparently inherent unwillingness to attach much importance to what may or may not happen beyond one's lifetime.

CONTEXTUALISING PRECAUTION

We are now in a position to place precaution within institutional frameworks that most particularly influence its role. These are: (i) the changing interpretation of science in the face of uncertainty, ignorance and indeterminacy; (ii) the widening political basis of sustainability; and (iii) the use and significance of cost-benefit analysis.

(i) Extending science. The centre of the problem here is how society deals with the burden of proof when the benefits of a proposed course of preventative action cannot be determined with accuracy. (As a secondary consideration, if phase changes are in the offing, then the shape of the benefit function might rise steeply

in some distant time from now). In a nutshell, science may not be able to offer sufficient reliability upon which to form a basis for action or to establish a burden of proof as to who should be responsible if an anticipatory decision is either not taken, or taken in error.

Both Wynne (1992) and McDonnell (1993) seek to show that judgements over uncertainty are shaped by a mixture of technical knowledge, experience, peer group influences, the political mandate of the organisation in which judgement is taking place, the personalities of key decision makers, and the general political climate in which scientists create expectations of their role and authority. The problem for science in the precautionary mode is that its normal reliance on experimentation, theory falsification, verification, consistency and predictability is thoroughly challenged. Uncertainty takes three forms, each of which creates a different set of difficulties.

- **Uncertainty as data unavailability**. The main issue here is that monitoring is rarely so diverse or so long term that the spatial and historical record can be known with certainty. This is the case for human-ecological systems such as land degradation, as much as it is for natural phenomena such as species population trends, rainfall data or biomass production. To get round this, the scientist models via simplification of complexity. The only true solution to data deficiency is to increase the intensity of monitoring and to upgrade the practice of taxonomy.
- **Uncertainty as ignorance**. Increasingly scientists are recognising that many of their hypotheses are based on evidence that cannot be generalised. For example McGarvin (1994) claims that in marine ecology, the widespread use of indicator species, and so-called keystone species, as predictors of diversity and resilience of ecosystems cannot be sustained. Detailed fieldwork reveals that indicator species that supposedly suggest a particular mix of species or robustness of species composition in the face of environmental change cannot be guaranteed from one ecosystem to another, even under broadly the same environmental conditions. This suggests that the burden of proof of vulnerability or resilience in natural processes has to fall on groups outside the science community, such as lawyers, politicians, active citizens and special interest groups.
- **Uncertainty as indeterminacy**. Here even the parameters of the system are not known, nor are their interrelationships, for the complexity is so great that modelling becomes a lottery. An example would include the relationship between land cover change, regional rainfall and the spatial incidence of desertification (see Hulme and Kelly, 1993). At stake here are two complex systems – namely climate and human response. The physical connection between rainfall patterns and changes in land use would be problematic enough. To incorporate a probabilistic dimension as to how local societies

> may respond to drought induced by vegetation change that is partly of their doing, adds enormously to the uncertainty. We are talking here of chaotic systems where initiating events trigger relationships that cannot be predicted beforehand. The same could be said for identifying the ramifications for regional climates of large scale removal of tropical forests, or the significance for littoral marine biomass should most of the remaining coral be eliminated.

(ii) Widening the political basis of sustainability. All this suggests that science would do well to be extended into the 'civic' realm (Lee, 1993). Forecasting then becomes a matter of public negotiation, of quasi-formal arrangements between honest 'best guess' predictions and social weightings of agreed criteria, according to the preferences of representative interest groups intent on reaching consensus. This kind of arrangement is very much in its embryonic form. For example in Canada, Australia, New Zealand and more recently the UK, 'round tables' have been created to look at sustainable transition pathways, and to reassess the economics of resource extraction and preservation. So far, few of these groups have remotely reached consensus. The muddle is often greater than before it began. Ironically this irritates politicians and their powerful clients who seek more clearly defined public guidance, but cannot find it in the time frames through which they feel they have to operate. This suggests that more attention will have to be paid to the fairness of the procedures that determine uncertainties, to guarantees of safeguards against folly and ignorance, and to mechanisms for ensuring that those who initiate decisions with potentially damaging outcomes (because thresholds are possibly near) should be responsible for any consequences. The implication is that the onus of proof is shifting towards the risk creator (Hey, 1992; Costanza and Cowell, 1993).

Actual proof of this shift of emphasis remains elusive. The well known techniques of risk analysis and environmental impact assessment are supposed to convey this role. In practice this is not the case, because few policy-analytical arrangements have incorporated the conditions of 'adaptive environmental assessment' associated by Holling and colleagues (1978), or of participatory (or 'civic') science promoted by Lee (1993). Both those contributions bemoan the lack of an adequate institutional arrangement to disentangle the unknown, and instead advocate cautious experimentation, seeking to engender interest group support and participation from the 'bottom up'. Both also caution against the use of evaluative procedures that do not explicitly take into account the transitivity and surprise element of ecological and social change in the face of abrupt adjustments.

Despite the admonitions of both Norton and Redclift that economists do not value irreplaceable life support functions in an appropriate manner, environmental and ecological economists are beginning to re-define sustainability in terms

of the resilience, criticality and vulnerability of natural systems. Turner (1993), for example, identifies four interpretations of sustainability:

- **Very weak sustainability**: assumes no change in aggregate capital stock, but infinite scope for substitution between natural resources and environmental protective systems, and artificial substitutes, human ingenuity and adaptability.
- **Weak sustainability**: accepts that some life support systems, habitats, and human artefacts are important for survival and human well-being and should be preserved. This block of assets is referred to as 'critical' natural capital. In the weak mode, this capital would largely be confined to key life support processes or elements, such as stratospheric ozone and a large proportion of tropical forests. This class of natural resources and processes therefore deserve protection, signalled by a mix of prices and regulatory safeguards. Here, the notion of precaution as providing 'ecological space' has more meaning, while the benefits of protection are boosted by high social valuation.
- **Strong sustainability**: adds more weight to critical natural resource protection and enhancement, greater use of assimilative capacity and environmental carrying capacity modelling for policy, pricing and planning, and widespread adoption of the 'critical load' approach to determining tolerable levels of pollution. Here, the notion of criticality would be extended to heritage, via biodiversity indicators (where these can be determined) and to socially valued landscapes and historical features (as revealed by political pressure). This valuation procedure is never satisfactorily justified, nor is the scientific basis of ecological significance.
- **Very strong sustainability**: takes more of a deep ecology or Gaian viewpoint, familiar to readers of this journal, through which the intrinsic value of natural objects is given prominence, as is the humility of humanity in managing earthly resources.

(iii) Reassessing the significance of cost-benefit analysis. The principle of cost-benefit analysis is to determine whether a proposed investment will provide value for money, and at what point in terms of scale of costs the additional gains that accrue equal the additional expenditure. As is well known, the basis for such calculations assumes not only that some actual or computational value can be placed on the cost-benefit stream, but that the future flow of gains and losses should be equated at the point of analysis through discounting to present values. Extended cost-benefit analysis therefore not only employs imaginative techniques of non-market valuation; it will also be aware of the appropriate discount rate. (Pearce, 1993, provides a useful and readable summary of these points).

In the precautionary mode, however, the benefit stream is problematic. In many cases it cannot be computed even within bounds of probability estimates, for the very act of determining probability is unreliable. This is the case, for example, with estimating the damage associated with climate warming or biodiversity losses. Both the likelihood of the global change, and the possible 'costs' are simply not known for sure. Because too, the likely consequences are in the meso-scale, discounting is relatively ineffective as a tool. Thus the actual benefits from avoidance action now depend very much on the shape of the damage curve 50 to 100 years from now.

Analysts will tend to visualise the significance of such a curve on the basis of how resilient or vulnerable they perceive to be the capacity of the earth's life support systems to adjust. Also critical is the degree to which human society can adjust. Resilience or vulnerability therefore applies to the adaptive capabilities of both natural and human systems. The more the bias is towards vulnerability the more the precautionary principle will be invoked. This will cause the cost benefit analysis to be skewed in favour of costs now over delay, on the grounds that the benefits of early, prudent action will justify this investment. Naturally those whose bias is towards resilience will adopt the opposite view. There early prudent action would be regarded as an unnecessary cost. So for the 'vulnerability perceivers', cost-benefit analysis is loaded in favour of high costs to reputedly but unproven high benefits, while for the 'resilience perceivers' the benefits of early avoidance would have to be more clearly justified. Any cost-benefit decision rule therefore is likely to be intensely political, not purely financial.

IMPLEMENTING THE PRECAUTIONARY PRINCIPLE

The three above perspectives of 'civic science', contradictory certainties over the sustainability definition, and differential treatment of cost-benefit analysis interconnect. Figure 1 seeks to show how this can be portrayed. It is based on a diagram produced by Norton (1992: 102), subsequently reinterpreted by Turner et al. (1994: 59), and further substantially amended here.

The two vertical axes reflect the scale of damage costs and the scope for reversibility. On the right hand of the diagram, where a pro-resilient line is dominant, any loss of natural capital is always seen as reversible, though as the loss becomes greater the cost of replacement increases. On the left hand side, this loss is steadily regarded as genuinely irreversible. The difference between the two vertical axes is the perception of resilience: towards the right, resiliences are deemed very considerable, while towards the left, vulnerability is the dominant condition.

So on the upper right, reversibility is still possible but at a very high (and ultimately too great a cost). The clean up of abandoned radioactive waste dumps in Eastern Europe would be an example. On the upper left, we have the

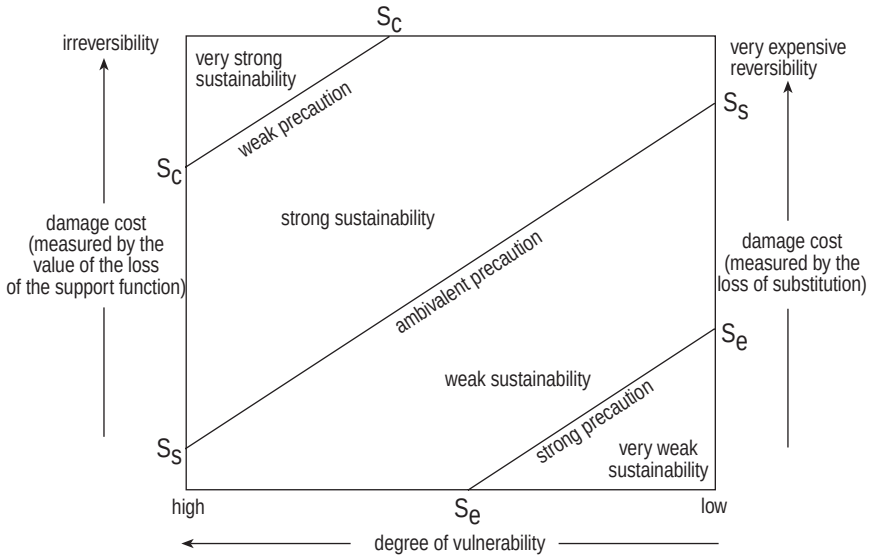

FIGURE 1
Precaution in the context of sustainability, resilience and vulnerability.

interpretation of true catastrophe. This would be the case with the complete loss of the stratospheric ozone layer, or the wholesale removal of tropical forests. The varying judgement over true irreversibility helps us to see why the notion of protecting critical natural capital becomes such a vital component of moderate precaution and strong sustainability.

The horizontal axis captures the very debate raised by Norton, namely the perception of resilience or vulnerability in life support systems. In this diagram, the concern for vulnerability, or pessimism in adaptive capabilities of natural and social systems increases from right to left. The length of the axis is essentially the gap between optimists (or 'cornucopians') who believe in the inherent resilience of natural processes and the immense adaptive capabilities of human societies, and the pessimists (or 'ecocentrists') who see in ecological alteration the very basis of non-survivability for human species (and possibly many other species as well). It is probably fair to say, judging from an interesting global opinion survey conducted by Gallup for the 1992 Rio conference (Dunlap et al., 1993) that public opinion the world over is moving from right to left in the

diagram. This comprehensive survey shows how even the very poor and the underprivileged regard the protection of life support systems as paramount.

The diagram reveals three zones of 'ecological intolerance', namely areas where precaution should be applied at any point upwards and to the left. Se-Se represents the views of the advocates of very strong sustainability, who would apply a strong bias of precaution in a zone where, given the themes on the axes would be regarded as very weak sustainability. This may appear contradictory, but the confusion should be removed if the all the 'S' lines are seen as points where the precautionary principle would be invoked, and the sustainability modes are simply set by the dimensions of the box itself. So a 'shallow green' mainstream environmentalist (O'Riordan 1991b) would plump for line Ss-Ss, while a 'cornucopian' in Cotgrove's (1976) memorable phrase would be more comfortable along line Sc-Sc. Bearing in mind that these lines represent the point at which precaution would be invoked, the Sc-Sc line reflects a weak variant, i.e. it would be applied late when any further effort at substitution is regarded as cost ineffective. The Ss-Ss line reflects an ambivalent application of precaution, being applied variously according to interpretation, of the light green theme outlined at the outset to this paper. The area to the right of each of these curves is the perceived depth of 'ecological imprint' that is permitted: the area to the left is the 'ecological buffer' that should be protected by anticipatory action, burden sharing and global citizenship.

The diagram reveals a huge difference in perspective of criticality, assimilability and ecological carrying capacity between the very weak and weak models of sustainability and the application of precaution. Here the views of scientific authority, discussed earlier, have enormous importance. The reason lies in the degree of 'sacrifice' implied by any cost-benefit analysis in the central zone. An example would be the tussle over the precise nature of any carbon tax as a viable measure for offsetting climate warming. Fankhauser (1994) provides a fine review of the economics of this issue. He suggests that the nature of the benefit function arising from reducing greenhouse gases and land use change very much determines the magnitude of the carbon tax. The longer the onset of serious climate warming repercussions, the more costly appear any counter measures now. But the steeper the perceived damage function, if delay is permitted, the more impressive will be the outcome of procrastination. So the actual size and timing of any carbon tax is very dependent on the zone in Figure 1 where the policy analysis lies. Sc types would delay and counsel a small tax, while Se types would advocate high taxation and early action. How the revenue would be used is also a matter of judgement influenced by the location in Figure 1. The advocates of strong sustainability (shown by the line Se-Se) would like to see the money converted into offsetting greenhouse gas emissions. The cornucopians (shown as Sc-Sc), however, would prefer a tax geared to economic stimulation, albeit in a more sustainable manner. In both of these cases, those taking a middle course between the two (the Ss-Ss group) would be more divided.

Equally significant however is the manner in which cost-benefit analyses are to be construed in the light of the precautionary principle. Figure 2 provides a useful guide.

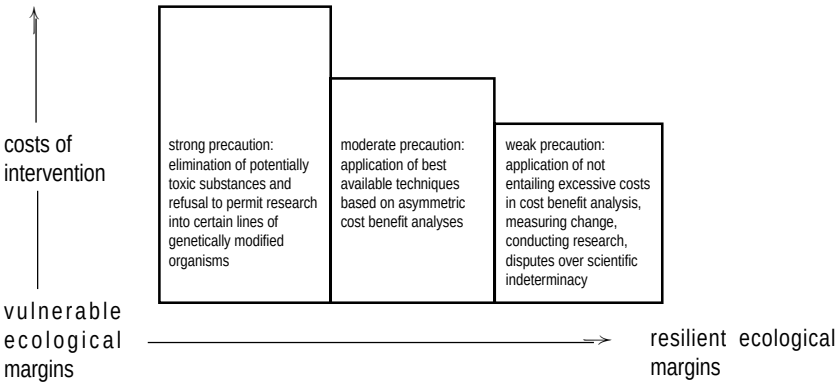

FIGURE 2
Precaution and the principle of proportionality

Proportionality applies to the application of costs and benefits, where part of the benefit is the avoidance of unnecessary risk by playing safe. Proportionality is defined by atitudes to resilience, vulnerability and periodic irreversile thresholds, measured in turn by attitudes to science, expertise, international obligations, and rights of nature.

Again the dimension of interest is the perception of natural resilience. This is a slightly more comprehensive version of the inconvenience to catastrophe theme suggested by Norton (1992: 10). On the horizontal axis is some notion of degree of vulnerability or resilience running from left to right in terms of greater resilience. The vertical axis represents the cost of action.

To the left, we have the strong precaution mode which is evident in the growing resistance to potentially damaging toxic substances, such as organochlorines and volatile organic compounds (VOCs) which persist in the nooks and crannies of all ecosystems, slowly building up chemical 'time bombs'. Bodansky (1994) shows how US statute law is becoming strongly precautionary over the elimination of such substances. The European Union is also in the process of banning a range of chemicals in these categories, and has produced a 'red list' of 23 substances where emissions are to be controlled not just by the very best end of pipe technology, but by fundamental process changes and very strict duties of care and waste handling. Hill (1994: 180-1) and Tait and Levidow (1992) reveal how the release of genetically modified organisms in the UK is being controlled by open peer review that is extremely precautious, with an in-built bias against release or commercial production, except under the most stringent safeguards.

In the middle zone of Figure 2, ambivalent precaution would demand the application of the best available technology with only limited safeguards against excessive cost, or uncertain benefits. This is the region in which German support for the precautionary principle has stimulated a lucrative clean technology industry. As Boehmer-Christiansen (1994: 30) notes in a comprehensive review of the German experience:

> ... the precautionary principle therefore helped to lay the conceptual and legal basis for a proactive environmental policy, which, once spread into Europe, was also directed at ensuring 'burden sharing' in order that German industry would not lose its competitive edge, but rather gain new markets for its environment-friendly technology and products.

Pearce (1994:149), in line with his reasoning on critical natural capital, accepts that where irreversible margins, or phase-change thresholds are in the offing, given the best scientific knowledge and public support, reliance solely on economic instruments would be inappropriate. This is the zone where risk management depends less on a purely economic calculus than on a social setting of trust and accountability (see Pidgeon et al., 1992). For example, both health and safety and environmental protection legislation in the UK contain caveats for regulators to have regard to the marginal social benefits accruing from a given investment in safety or vulnerability margins. This is the basis of the twin legal phrases 'as low as reasonably practicable' (ALARP) in health and safety and 'best available techniques not entailing excessive cost' (BATNEEC) in integrated pollution control (Jordan, 1993).

Both these discretionary phrases are meant to provide room for manoeuvre for regulators faced with steadily improving but costly technology , and dubious gains in terms of immediate or longer term social benefits. The rules of thumb, however, are to err on the side of caution, and the challenge is to provide reasoned scientific evidence to justify a higher than expected cost. This is by no means straightforward, as the legal profession tends to look for the 'certainties' of science as a guide, and may become exasperated when the evidence is uncertain via either ignorance or interdeterminacy. As McDonnell (1993: 7) notes:

> ... arrangements for applying the precautionary principle should include some process of testing scientific reliability. The development of appropriate procedures for this is a large challenge for the future.

Now we come to the most contentious arena of all, namely where precaution is ambivalently applied, because the perception holds that nature can 'take it' or that human adaptation is both purposeful and successful, but where there is growing doubt about the justification of such a proposition. As we have already noted, efforts by economists to calculate the intrinsic social value of critical natural capital (see for example Brown and Moran, 1993) and the externality

adders of electricity production (see Lockwood, 1993; Pearce et al., 1992) run into two sets of difficulty: on the one hand, there are critics like Redclift (1993) and Sachs (1993: 2) who deride the ideology of converting life support systems into commodities, irrespective of the shaky science. On the other hand, there are the established politicians who look with considerable suspicion on estimates of benefits of avoidance of, say, biodiversity loss or future climate warming, which almost by definition produce cost-benefit analysis loaded against long term benefit gains, yet alarmingly loaded towards the present on the cost front. This is an unstable relationship for an embryonic cost-benefit analysis in precautionary clothes, especially during times of economic recession.

THE PRECAUTIONARY PRINCIPLE AND POLITICAL LEGITIMACY

So far the precautionary principle is primarily perceived as a reasonable presumption against uncertainty. It is not a political philosophy in its environmental sense. The point about the precautionary principle is that it swims against the economic, scientific and democratic tides. It requires 'sacrifice' of anyone who cannot see the justification of taking careful avoidance. As we have repeatedly stressed, the strength of the precautionary principle lies in beliefs about social or environmental resilience, and in the capacity of social groups or political systems to respond to crises. Therefore those who support the notion of resilience and accommodation/adaptation would require precautionary 'sacrifice' as a higher level of cost than those who are more ecocentric on such matters.

So the political legitimacy of the precautionary principle depends on a number of factors, many of which will only be relevant for some rather than all issues:

- the general standing of scientific expertise, and especially its image of authority, independence of political or commercial bias, and its international recognition;
- the public experience of scientific fallibility, in such areas as toxic substance exposure thresholds, epidemiological surveys, and the openness of the scientific community to accept doubt;
- the degree to which scientific evidence is examined by individuals, or groups who represent legitimate consumer, environmental, or ethical positions, and whose views are known to be relevant to any final outcome; and
- the extent to which 'civic science' or the science of open public debate about determining uncertain futures, is from an airing close to the centre of established scientific opinion.

These are not positions that stabilise around a particular issue. They are part of an evolving science-policy culture that becomes more accommodating and more trusting. Thus the precautionary principle will succeed so long as it 'seeps through the pores' of a transformational science-policy culture, rather than tackle it head on (O'Riordan and Cameron, 1994). This suggests that precaution will be promoted in three ways, in terms of political legitimacy:

(i) Through international agreements where collective action is vital to protect a critical environmental resource, and where non-compliance undermines the very essence of the agreement. This is why precaution is such a vital theme in international environmental law (Cameron 1994).

(ii) Through the opening up of commercial industrial decisions to open forums of sensitive but informed interests, in order to establish common business positions on such contentious issues as toxic exposures and the threatened loss of critical environmental functions. Only when business acts in unison can any common position with a global commercial equivalence be put in place. We are some distance away from this position, but it is an important principle.

(iii) Through mechanisms for compensation over the loss of property rights in areas where there is genuine uncertainty over thresholds of tolerance, so where some buffer for ignorance is put in place. This obviously means that holders of property rights in such circumstances are 'sacrificing' for a commoner good. For this to be politically tolerable, some form of compensation must be paid. This could come in the form of transferable development rights, or in the form of specially targeted aid payments (as in debt for nature swaps) or in help to assist the 'sacrificers' more towards an economically and environmentally more sustainable future. Such an arrangement begs many questions of how much these rights are nationally, or even individually owned, and how much they are global property. These arrangements also bypass the contentious topic of how far any indigenous sustainable development strategy should be financed by the recipient nation, and not be a matter for international subsidy. These are all issues over which the Global Environment Facility is currently grappling (Jordan, 1994). All that can be said here is that various forms of compensation have to be debated and made available if this, arguably the most crucial aspect of the precautionary principle, is to be put into effect.

We do not see any rapid movement in developing the political legitimacy of the precautionary principle. We see a steady shift towards greater acceptance on a number of fronts, along the lines we have identified. As with all matters environmental in this modern age, the once-clear distinction between environment, economy and society is becoming increasingly blurred.

PROSPECTS FOR THE PRECAUTIONARY PRINCIPLE

The search, therefore, is on for a more meaningful relationship between precaution, sustainable development and global citizenship. All these ideas are so befuddled with contrary ideologies and inconsistent interpretations that they have become metaphors for a global power play between the forces of what might be termed 'humanity' – namely caring for the well-being of others and the survival of the Earth via some sort of primordial Gaian urge, and the drive for material acquisition, economic security and efficiency in the conduct of human affairs. The dialectic, identified by Habermas (1976) amongst others, is therefore between humanism and capitalism, between fairness and efficiency, emotional value and utilitarianism. This is an age old division, and indeed may be part of the human condition. The historian Arnold Toynbee (1976: 20), for example, contemplated the enduring enigma about humanity, namely that humans have rational minds and emotional souls; they are consumers and also citizens; they can destroy but also protect and restore. Similar sentiments have been expressed by Sagoff (1988) and Lowe et al. (1993). Precaution is wrapped up in this clash of value spheres. Habermas (1976) believed that the normative culture of 'the market' could supersede the culture of 'democracy' and 'justice'. Critics of modern environmental economics, such as Sachs (1993) and Ekins (1992) bemoan the fact that the world is being carved up into market opportunities or price signals to reinforce the application of individualism and efficiency as the guide to social action.

Precaution seeks to stand four square in this debate. It is the voice of conscience and care set against the strident demands for progress and prosperity. Arguably, there is a mediating middle ground between humanism and capitalism. This could emerge through the development of a 'civic science', as identified by Kai Lee (1993) or the discourse of 'ecological modernisation' as argued by Albert Weale (1992; 1993). Both authors call for a more mediative science-policy relationship, the nurturing of communicative and arbitrative mechanisms at early stages in dispute resolution, and the preparedness to give both the Earth and marginalised groups in society some space to breathe in the application of environmental policies.

These two, broadly similar, approaches seek negotiable interchanges between citizen and expert to create consensus around the various modes of uncertainty. Whether this is done by imaging, simulating or gaming 'futures' is a matter of experiment and cultural acceptance. But the opportunity exists for science to reach out into more democratic structures so that the possible consequences of various courses of action can be given greater understanding and due political weight. Precaution would then seep through the pores of this challenging debate, gently asserting itself into the culture of nations as the practice of managing futures becomes an indispensable aspect of civic educa-

tion. As Kai Lee (1993: 201) put it: 'the message of sustainability is that we must acknowledge the pace and scale of nature's teaching'. Civic science aims to reposition society's relationship to nature by giving its role and its potential vulnerability fuller appreciation. This is the basis on which precaution can become more reliably implanted in the sustainable transition.

NOTE

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