THE ENVIRONMENT, INFORMATION AND THE PRECAUTIONARY PRINCIPLE

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The Precautionary Approach to Environmental Change

The idea of a precautionary approach in Australian environmental management emerged in the nationwide Ecologically Sustainable Development (ESD) discussion process undertaken between 1990 and 1992. The first clear statement of the precautionary principle as a rule for environmental management was included in the Intergovernmental Agreement on the Environment (IGAE) signed by the Prime Minister, premiers, chief ministers and a local government representative in May 1992 (Harding and Fisher, 1994). The precautionary principle is one of four guiding principles stated in the IGAE.:

> 'Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
>
> In the application of the precautionary principle, public and private decisions should be guided by:
>
> (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and
>
> (ii) an assessment of the risk-weighted consequences of various options.'(IGAE, 1992, para 3.5.1)

According to Harding and Fisher, the IGAE was a response to the Commonwealth-State conflicts of the 1980's over control of environmental assets. Disputes such as that over the Gordon-below-Franklin dam led to pressures from both industry and environment groups for more uniform and certain environmental standards, which would create more stable conditions for business and government decision making and better protect the environment. Harding and Fisher recognise that, since the IGAE is not legally binding, its effectiveness in changing environmental management practice can be challenged; on the other hand, they point to recent examples where the precautionary principle has been included in state legislation and quoted in legal decisions.

To many, the above definition may seem just commonsense - a formalisation of the wisdom expressed in the aphorism 'an ounce of prevention is worth a pound of cure'. Advocates of the precautionary principle argue that, faced with the possibility of environmental changes which threaten humanity's life-support systems, a risk-averse society needs to institutionalise caution, by placing the burden of proof on those who wish to change the environmental status quo (O'Riordan and Cameron, 1994). Thus, in the absence of scientific certainty about the consequences of natural resource use, a logger or miner or resort developer should be required to provide appropriate proof that the proposed development will not result in some defined level of environmental damage. Otherwise, development should not proceed.

Critics, noting that absolute certainty is unattainable in modern science, point out that, taken literally, the precautionary principle would put a stop to developments which affect the natural environment (Brunton, 1994). On a strict interpretation of the principle, the aboriginal immigrants of 50-60,000 years ago should have left Australia to the giant kangaroos, marsupial lions and diprotodonts (Flannery,1994). So, practically, the principle requires qualifiers such as (i) and (ii) above. However the qualified principle raises major social choice and definitional problems which will challenge lawyers, political scientists and economists. Who is to decide what is 'serious environmental damage' and what is 'irreversible'? 'Risk' from whose point of view, who decides on 'options', and how are 'risk weighted consequences' assessed? The implied degrees of decision-maker discretion do not imply certain, stable environmental management rules.

Aside from the definitional problems, it is unclear why the IGAE specified 'serious <u>or</u> irreversible environmental damage'. Young (1993, 14) defines 'serious' as 'could have extremely adverse implications for future generations', and 'irreversible' as 'no known substitutes exist for the resource being used'. Precautionary principle advocates give no reasons why we should worry about 'serious' environmental damage which can be reversed, or irreversibilities which are not 'serious'.

In its non-absolute form, the essence of the precautionary approach is not rejection of scientific and economic analyses, but the reversal of the burden of proof. While the principle stems from the inadequacy of scientific knowledge, its qualified application will sensibly require the use of the best available science and economics, to establish the appropriate standards of proof which would-be developers must meet.

Some advocates of the precautionary principle disagree with the privileged position for science and scientists implied in the preceding paragraph. According to Hunt (1994, 121) the precautionary literature encompasses two distinct approaches to the problem of scientific uncertainty. One perspective, expressed above, is that implementation of the precautionary principle depends on the use of science and economics to establish and assess standards of proof. The alternative, more radical, perspective, expressed in Hunt (1994) and Harding and Fisher (1994), is based on the view that scientific (and economic) knowledge, and the concomitant uncertainty, are malleable social constructs. Those adopting this perspective believe that what is known and what is uncertain scientifically depends substantially on culture and who is making the claim, as well as on established scientific testing procedures. They therefore see the present social construction of science (and economics) concepts as impeding a full understanding of the consequences of environmental changes. For these people, precautionary policy involves as much cultural and political change as science; they advocate a decision process which puts decisions on 'how much' precaution into the hands of a wider set of stakeholders than at present (Harding and Fisher, 1994, 259).

Why are the consequences of use of the natural environment highly uncertain, and would implementation of precautionary policies improve matters for a risk-averse society? This paper first examines the nature of economic-environmental systems and of the resulting uncertainty. Second, the information requirements of precautionary policies are explored.

It turns out that there are there are precautionary arguments against adopting precautionary policies. Finally, the paper considers the perceptions and incentives of the citizens and planners who will decide on precautionary policies.

The Nature of Economic-Environmental Systems

Figure 1, a modified version of that in Common (1995, 32), shows the relationships between the economy and the environment. The large box containing all the others represents the environment. Human society is contained in and dependent on the environment. The economy is shown as a simplified circular flow of goods and resources. The environment provides four types of services to people, three of which are represented by the three overlapping boxes in the upper part of the figure. It is a source of natural resource inputs into production. It serves as a receptacle or sink for our production and consumption wastes. It also provides amenities which directly affect out well-being. The fourth service which the environment provides is human life support, the result of the combined functioning of the climate, chemical element cycling, water cycling and living organisms. Life support is represented by the environment box itself - without it, humanity and the economy depicted within it would not exist.

The four boxes overlap, to indicate that the different types of environmental services are not independent of one another. The interactions between the different services of the environment are sometimes so complex that we don't fully understand them. Consider interactions between the input, waste disposal, amenity and life support services provided by the water of the Murray system. The relationships between irrigation water use and downstream salinity, farm productivity, wildlife populations and the condition of riverine ecosystems are imperfectly understood, because we don't fully understand local soil conditions, or groundwater movements, or plant and animal responses to salinity or industrial chemicals.

The human society box in Figure 1 does not show the social institutions upon which economic exchanges and other social interactions depend. Social institutions are the rules and organisations which inform and motivate participants in all forms of social interaction. They include moral codes, conventions, property rights, rules of exchange, markets, laws and courts, administrative rules and penalties, elections and so on. Such social institutions are essential underpinning for the economic system simplistically depicted in Figure 1. They include property rights and other rules which guide people in their use of the natural environment.

Uncertainty about Economic-Environmental Systems

Uncertainty about the consequences of human actions affecting the natural environment can be appreciated by considering the physical and behavioural factors influencing the evolution of the combined economic-environmental system depicted in Figure 1. Uncertainty about changes in the system arises primarily as a result of:

(i) environmental complexity due to biological diversity and variations in the physical environment, leading to imperfect scientific understanding of the functioning of the natural world, and of ecosystems in particular;

(ii) economic complexity due to the numbers of human agents and goods, the diversity of technologies, preferences and institutions, and the ability of people to learn from experience and to change their preferences and institutions, and

(iii) consequences which extend far into the future. Thus current decision makers are ignorant of the identity and personal preferences of future people affected by current actions, and of the future technologies and resource costs which, together with future generations' preferences, will determine their happiness or unhappiness with the world we bequeath to them.

With so many possible interactions within and between the economy and the environment over space and time, it is simply impossible to know all the future consequences of current use of the environment.

What sort of uncertainty is involved? Common (1995, 173) distinguishes two types of uncertainty. What we will term **ordinary uncertainty** applies when the range of possible outcomes is known but not their probabilities. **Radical uncertainty** applies when the possible outcomes of actions cannot all be identified. Young (1993, 17) contains an example of radical uncertainty, the use of CFC's as refrigerants and propellants. CFC's were chosen because of their chemical inertness and stability, thought at the time to create minimal ecological risks. Ex post, scientists realised that these very properties allowed

CFC's to reach the stratospheric ozone layer. Another example would be the impact of proposed bans on tropical timber imports from South East Asia. There are likely to be unforseen environmental and economic outcomes in both exporting (e.g., Malaysia) and importing (e.g., Australia) countries, as timber producers and consumers adjust. There are also likely to be unforseen changes due to the commercial (eg. illegal trade via third countries) and political (retaliation by the timber exporters) responses to the ban.

A decision tree can be used to depict the distinction between ordinary and radical uncertainty. A decision tree such as Figure 2 depicts the actions available to the decision maker, the uncontrollable events that can occur, and the relationship between actions and events. To be useful, it must correctly represent the important interactions between the decision maker and those parts of the economy and environment outside his or her control. In the simplistic greenhouse policy decision tree depicted in Figure 2, the decision maker has just two present options; to act now to reduce human emissions of greenhouse gases which may lead to major global warming within a few decades, or to postpone action now, which avoids present costs. Each option is followed one of two possible climatic events; either major warming will occur or it will not. In the future, there is no uncertainty; the decision maker will choose an action tailored to whichever of the specific climatic events, E_1-E_4, has occurred.

The decision tree in Figure 2 would be correctly structured if it included all the possible actions and all possible action-event scenarios. This is the situation for ordinary uncertainty. However, in the case of greenhouse gas emissions, this is not the case. While it is certain that atmospheric concentrations of greenhouse gases are increasing as a result of human activities, uncertainty about greenhouse science, future technologies and people's future responses to climate change means that the event branches, and the corresponding outcomes and values on the right hand side of Figure 2, are not all known. For example, the roles of clouds and oceans in modifying any global temperature changes are poorly understood, as are the abilities of species and ecosystems to adapt or evolve in a greenhouse gas enriched environment. Thus the greenhouse policy problem involves radical uncertainty - the decision maker cannot identify all the possible action-event scenarios, let alone their probabilities.

Given that uncertainty results from environmental and economic complexity and from long-lived consequences, one would predict that the more extensive and diverse the ecosystems and economic systems impacted by environmental changes, the more people involved, both as actors and as sufferers, and the longer the consequences extend in time, the higher the degree of radical uncertainty. These are in fact the characteristics of the most important global environmental problems, such as CFC and greenhouse gas emissions, and major forest clearing and marine pollution. At the other end of the scale, activities which are highly localised in space and time, and affect very few people, such as noise pollution between neighbours, are likely to be subject to relatively minor uncertainty.

The large scale-small scale dichotomy is potentially misleading; it overlooks the fact that the most important environmental problems, and hence the greatest uncertainty, commonly result from accumulation of the small-scale activities of large numbers of individuals, such as consumers, drivers, farmers and loggers. The fact that the individual actors are small makes the problem more, not less, serious. This is because smallness in relation to the overall magnitude of the problem encourages free-riding by both actors and sufferers. Consider the case of car exhaust emissions. Any effort which I make to control my car's emissions makes no discernible difference to city pollution or global CO_2 levels. Also, since my car's contribution to these problems is not identified, I will suffer no penalty for not acting and obtain no reward if I act to reduce my emissions. So the benefit I expect, either as a sufferer from pollution or as a controller of pollution, is zero. Since reducing my car's emissions is costly, I am better off doing nothing.

Uncertainty is most troubling when the possible outcomes of current actions may involve serious <u>and</u> irreversible damage to ourselves or to the community. Decisions to undergo risky major surgery have this character for individuals. Figure 1 suggests that major decisions on our use of the natural environment may have serious and irreversible consequences for whole communities, if an irreplaceable natural resource or ecological life support system is irreversibly altered. The construction and operation of the Chernobyl nuclear plant is one example. The decline of historic civilisations whose irrigated agriculture succumbed to increasing salinity appears to be another.

Given the interdependence between the s ıcial system and the environment depicted in Figure 1, we should guard against explanations for societal decline which are purely ecological, emphasising humanity's dependence on irreplaceable services of ecosystems. Continued compatibility of productive human societies and their supporting environment is also dependent on maintenance and enhancement of social institutions. It is much more difficult to envisage serious and irreversible environmental damage in a society where social institutions are inclusive and effective in signalling people's concerns to others and in motivating people to respond positively to those concerns. Such societies have institutions designed to identify major threats to the society, to inform members of those threats, and to motivate people to alter their behaviour in response to those threats. In other words, to sustain itself in the long-term, a society needs to maintain and enhance both its environmental capital and its social capital; the two are complementary.

The precautionary principle is a proposed new addition to our stock of social institutions, specifically, to our rules governing human use of natural resources. Can a set of social institutions including the precautionary principle can do a better job of informing people about possible consequences of their use of the environment, and motivating them to respond appropriately, than our current set of social institutions? In the search for an answer, we need to compare the information requirements of ecautionary policies with our knowledge of economic-environmental systems.

The Information Requirements of Precautionary Policy

Consider the greenhouse policy choice depicted in Figure 2. It is feared that major global warming is occurring due to increasing atmospheric concentrations of greenhouse gases resulting from human activity. The serious, possibly life-threatening, consequences contemplated include expansion of the tropical cyclone belts to higher latitudes, extension of deserts due to changes in rainfall patterns, and substantial rises in global sea level. Given the uncertainty about greenhouse, there is an unavoidable choice between doing something now to avert possible damage, and postponing action until we see how the climate is changing. A precautionary approach would involve taking the first option; action to reduce human greenhouse gas emissions now, despite uncertainty about global warming due to those emissions, and about the costs of any global warming which does occur. The second option would involve reacting to climatic changes if and when they occur.

At first glance, if we believe that people are risk averse, the precautionary option seems sensible; better to act now to avert possible future disasters which may cause irreversible damage to society. However a precautionary policy makes little or no sense if the decision maker is faced with radical uncertainty. With radical uncertainty a future disaster may come as a complete surprise and, more importantly, there is no certainty that any precautionary policy adopted now will avert it. Choosing precaution over reaction implies that the decision maker knows something about events and outcomes, namely that a precautionary policy of reducing emissions now will eliminate or greatly reduce the possibility of severe future damages due to warming. If the decision maker does not know that a precautionary policy will be effective, then it is possible that the precautionary approach leads to the worst of both worlds - society incurs the up-front costs of precautionary actions, but still suffers the future costs of unanticipated (given precautionary measures) disasters (Chisholm and Clarke, 1992). Putting it another way, if the chances of very costly climatic changes, such as substantial rises in sea level, are little affected by costly reductions in current emissions, why incur such costs now? The adoption of precautionary policy is not consistent with radical uncertainty about its outcomes.

Figure 3 illustrates both the possibility of ineffective precautionary policy and the information required for precautionary policy to make sense. It incorporates the same climatic possibilities as Figure 2, plus the possibility that precautionary emissions reductions may be either effective or ineffective in reducing global warming. For simplicity, it is assumed that effective precautionary policy leads to a climatic outcome identical to that with no warming, and ineffective precautionary policy makes no difference to warming. Thus the climatic outcomes are the same for E_1, E_2 and E_4, and for E_3 and E_5.

The outcomes of possible action-event scenarios in Figure 3 are measured in terms of the (discounted) total costs of precautionary policy and of the climate change itself, less any savings due to future reactive policies. The precautionary option of reducing current greenhouse emissions involves a present cost C. If global warming does occur (events E_3 and E_5), the present values of the resulting losses and adjustment costs for unassisted households and businesses are x_3 and x_5[1]. The costs of future reactive policies when society acts to adapt to or counter climate change are c_3 and c_5. The savings due to future reactive policies are s_3 and s_5.

Assume that the decision maker knows the possible events, E_1-E_5, but not the associated costs and savings or their probabilities[2]. Assume also that the decision maker is highly risk averse, and wishes to choose whichever of precautionary and reactive policy minimises the maximum possible total cost. For the precautionary option of reducing current greenhouse emissions to minimise the maximum possible cost, the decision maker must believe that the worst of the possible total costs of precautionary policy, $C+x_3+c_3-s_3$, will be less than the worst of the possible total costs of reactive policy, $x_5+c_5-s_5$. Thus, to begin to justify precautionary policy, the decision maker needs information about first, the magnitude of C, and second, the difference in the future net costs of the worst possible outcomes of precautionary and reactive policy, E_3 and E_5.

Both the present cost of precautionary emissions controls, and the difference in the future costs of the two policies, are subject to major uncertainty. In the case of current actions to control emissions, the major uncertainty about cost is due to the major economic and social dislocation which could attend severe restrictions on the production of greenhouse gases, in particular CO_2. In the case of future costs, limited scientific understanding of global climate change, and ignorance of future technologies and human responses to

[1] Future costs are will vary between E_3 and E_5, because the prior adoption of precautionary policy will alter future activities, incomes and prices.

[2] The following discussion understates the radical uncertainty attending greenhouse policy. Contrary to the decision tree depicted in Figure 3, decision makers cannot identify all of the environmental-social consequences which may follow the choice of precautionary and reactive policies. Event branches, as well as the corresponding outcomes on the right hand side of the tree, are not clearly specified.

climate change, cause major uncertainties about the x's, c's and s's. Thus, as pointed out above, with radical uncertainty about greenhouse a highly risk-averse society could make matters worse by adopting precautionary policy.

The preceding point is important. It is commonly believed that precautionary policy, involving the minimisation of currently-observable environmental damage, is sensible if people are risk averse. This is almost certainly the case when we are dealing with relatively well-understood environmental systems such as a municipal sewage disposal or local air pollution. Such situations involve mostly ordinary uncertainty; the decision trees can be fairly precisely structured, and the chances of very costly surprise outcomes of precautionary policy are negligible. On the other hand, with the radical uncertainty characteristic of extensive and complex economic-environmental systems precautionary policy can be ineffective and could lead to unpleasant surprises, and therefore could be more damaging than reactive policy[3].

The Importance of Planners' Preferences, Judgements and Incentives

With radical uncertainty about greenhouse, there is no right choice between precautionary and reactive policies. Decisions, precautionary or reactive, will often turn out to be incorrect with the wisdom of hindsight. The correct ex ante policy choice depends heavily on the responsible decision maker's preferences and subjective evaluation of possible alternatives. For example, policy choices may differ according to the degree of risk aversion. As explained above, if there is a perceived slight chance that precautionary policy may be ineffective and therefore the most costly option, a highly risk-averse decision maker is likely to choose reactive policy. A less risk-averse decision maker, one who is willing to accept a perceived low chance of the high costs of ineffective

[3] Wildavsky gives additional reasons for caution about precautionary policies (Wildavsky, 1988). First, due to the productivity of the foregone investment opportunities, adoption of anticipatory policies reduces the resources available to counter future unforseen dangers. Second, precautionary policies designed to avoid change limit people's opportunities to learn from the experience of change, and thus design more effective responses to unforseen changes. In terms of Figure 3, present expenditures (C) are less effective than future expenditures (c_i's) in reducing future damage costs (x_i-s_i's).

precautionary policy, $C+x_3+c_3-s_3$, in return for a perceived higher chance of effective policy which avoids the high costs of global warming, $x_5+c_5-s_5$, will prefer precautionary policy. Policy choices will also differ if different decision makers perceive different probabilities and consequences of global warming. A decision maker who is pessimistic about climate change and its consequences (who judges E_5 as likely and the total cost of warming, $x_4+c_5-s_5$, as very high) and optimistic about the effectiveness of precautionary emissions reductions (E_2 is judged much more likely than E_3), is likely to choose precautionary policy. Conversely, a decision maker who is optimistic about climate change and pessimistic about the effectiveness of emissions reductions will prefer reactive policy.

The greater the degree of radical uncertainty, the less the scientific and economic basis for the precautionary-reactive policy choice, and the greater the reliance on the preferences and subjective judgement of the person responsible for the choice. This is not a concern when the chooser also bears all or most of the important consequences of the choice; an individual contemplating risky heart surgery has strong incentives to consider all the possible outcomes of both the precautionary and reactive options. However, the subjectivity of decisions made under radical uncertainty increases the degree of discretion enjoyed by political and bureaucratic environmental planners, who do not personally bear all the consequences of their decisions. Because current citizen-voters will have extraordinary difficulty in establishing the possible long-term consequences of precautionary-reactive policy choices, politicians and bureaucrats will have more than their usual ability to pursue personal goals inconsistent with majority desires.

Wildavsky (1988, 223-27) argues that planning in Western democracies is biased towards precautionary policies. The possible disasters that we recognise loom much larger in our imaginations than disasters which we cannot imagine or the everyday harms to which we have grown accustomed. It is well-established that lay persons overestimate the probabilities of events which are widely publicised and thus easily imagined, such as nuclear accidents and ~~dramatic climate changes due to greenhouse warming~~ [Shark attacks]; conversely the probabilities of unspectacular and rarely-reported events such as strokes and domestic accidents are underestimated (Slovic et.al., 1990). This leads to demands for precautionary policies to avert the recognisable disasters, with inadequate recognition that those policies may reduce society's ability to respond to the unforseen and to reduce the incidence of the mundane. In the case of greenhouse, many people may perceive the possibility of serious and irreversible damage due to climate changes and rises in sea level, and demand emissions reductions as a result. They are less likely to recognise that the resulting reduction in community income and wealth can reduce expenditures on other ways of saving people's lives and property, and on the research and development which equips society to handle the unforseen. For example, the search for a cure for the unforseen disaster of AIDS is underpinned by research in molecular biology which occurred before AIDS revealed itself.

When a politician or public servant is making a decision on environmental policy, most citizens' information gathering and signalling will be influenced by free-rider logic; since we do not expect our vote to make any difference to the planner's decision, there is little incentive to collect information beyond that ready to hand, and considerable likelihood that votes will express perceptions rather than judgements based on facts. Since the public is more aware of the possible costs of not acting on greenhouse than the costs of acting and getting it wrong, environmental planners' self-interest encourages them to act now. It takes a strong politician or bureaucrat, dependent on the public's votes and its tax dollars, to resist demands to 'do something' in the way of precautionary action in response to well-publicised environmental dangers.

Harding and Fisher (1994), advocates of the precautionary principle, are also concerned about the self-interest of environmental planners. Harding and Fisher fear that, left to the usual policy participants, adoption of a precautionary approach to environmental policy will make little difference to environmental management in practice; for many current decision makers the precautionary approach 'requires no changes to environmental practice and decision-making since we are already operating precautiously'(259).

There is evidence that the implementation of precautionary policy is not immune to planners' self-interest. In Germany, where the precautionary principle originated, it commonly involves the development and promotion of cleaner technologies, via the adoption of 'best available technology not entailing excessive costs'. Boehmer-Christiansen (1994, 50-52) attributes Germany's technology-led precautionary policy to the dominance of the German advisory and legal processes by the engineering profession, rather than natural scientists.

The Roles of Experts and Citizens

Recall that some advocates of the precautionary principle see environmental problems as, in part, socially constructed (Hunt, 1994; Harding and Fisher, 1994). For these critics of the present approach to environmental problems, part of the solution lies in opening the decision making process up to hitherto underrepresented stakeholders. This raises the difficult question of the respective roles of scientific experts and citizens in the process of determining environmental policies and standards of proof. Remember that people generally pay more attention to the spectacular than to the mundane. Further, the costs of stress based on people's fears of unknown and unfavourable outcomes, stress which occurs whether or not such outcomes eventuate, may be substantial[4]. Faced with such fears and stresses related to our use of the natural environment, what weight does a planner attach to expert opinion, and what to citizens' perceptions?

Politically-sensitive environmental planning will require two-way communication of the judgements of experts (meteorologists, biologists, economists, etc.) and of the concerns and values of affected citizens. This emphatically does not mean downgrading rigorous science, but rather more systematic assessments of the limitations of science in the face of radical uncertainty. The new field of 'risk communication' emphasises the need to communicate what is 'culturally rational', in terms of fitting in with acceptable standards of morality, decency and due process, as well as what is 'technically rational', as perceived by technical experts (Plough and Krimsky, 1988). Improved societal communication about technical and cultural concepts of 'risk' is a prerequisite for any serious attempt to implement precautionary policies.

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[4] For a discussion of concern about the outcomes of technologies which pose hazards for people, see Fischoff et.al., (1990).

Given radical uncertainty about economic-environmental systems, democratic choices between precautionary and reactive environmental policies must take account of both expert knowledge and citizen perceptions. In an age of environmental disaster scenarios, perhaps we need an independent and transparent body analogous to the IC to facilitate honest communication between the parties. And we should remember that the future of society is as dependent on maintaining our social capital as our environmental capital.

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FIGURE 1: ECONOMY ENVIRONMENT LINKAGES

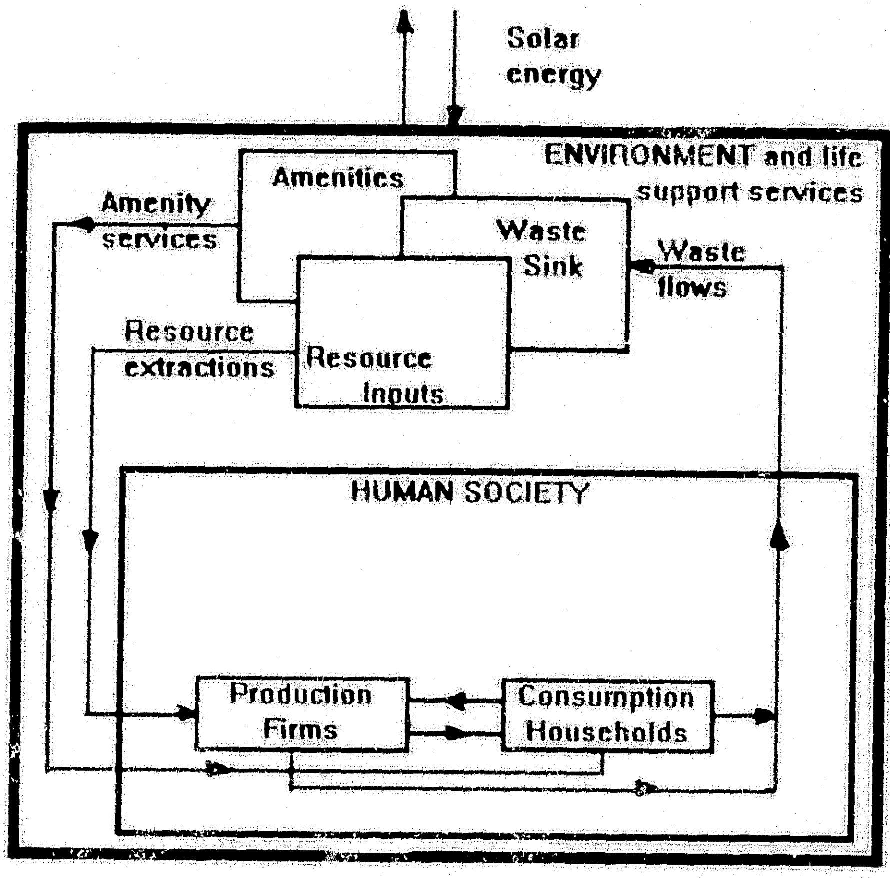

FIGURE 2: GREENHOUSE POLICY DECISION TREE

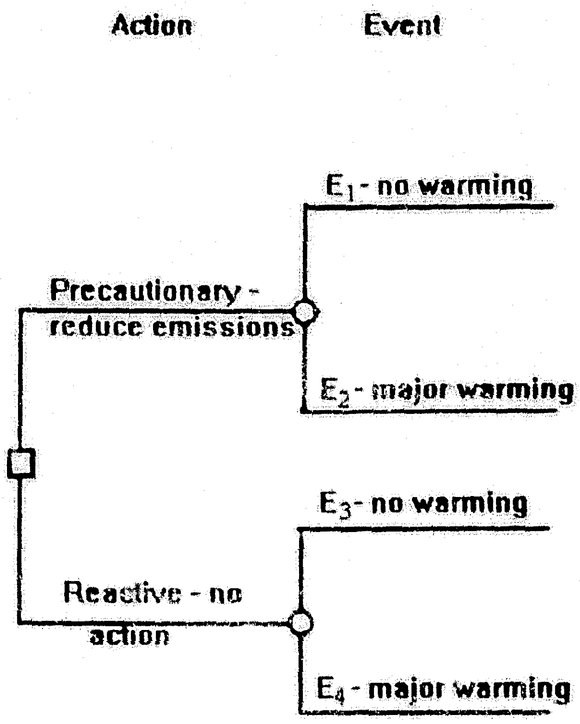

FIGURE 3: GREENHOUSE DECISION TREE WHEN POLICY MAY BE INEFFECTIVE