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Precaution in global environmental politics

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Abstract: The article evaluates the application of the precautionary principle at the international level. It employs a comparative study of four cases in global environmental politics: ozone depletion, acid rain, deforestation and coral reef degradation. Contrary to widespread academic notions, the precautionary principle is not widely applied in international environmental policy. The empirical record shows that governments abstain from regulatory policy when they face uncertainty about key aspects of ecological problems. The key question that the literature has ignored is: what kind of uncertainty? Indeed, states do take action when the extent of ecological problems is unknown. However, uncertainty about the transboundary consequences of alleged problems prevents international policy. Existing scholarship has misappraised the status of PP in international law, by underspecifying when PP is applied and under what kind of scientific uncertainty.

Keywords: acid rain; coral reefs; deforestation; environmental policy; environmental science; international regimes; ozone depletion; precautionary principle.

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1 Introduction

An enduring subject of intellectual exploration in human history has been the relationship between ideas and human behaviour. In a variety of thematic contexts, thinkers for millennia on end have explored the connection between knowledge and action, between the ideational and the observable worlds. How does what we know affect what we do? To what extent is human behaviour purposeful and rational? Do policy makers make decisions on the basis of expert information? One of the areas in which these questions become particularly relevant and highly consequential is environmental management.

In this realm, decision makers and scientists confront the enormous complexities of ecological systems, high levels of uncertainty and overwhelming obstacles to scientific understanding.

How should societies respond to complex environmental risks when they do not have complete information about them? Traditional scientific standards require high levels of statistical correlation and the establishment of strict causal links between cause and effect. Against this backdrop, some observers point out that science has frequently failed to predict serious negative impacts of anthropogenically-generated substances and activities on human health and the environment. From this point of view, absence of evidence is no evidence of absence of harm. Many actors further stress that ecological impacts cannot always be quantified and that their timing and magnitude cannot be predicted with certainty. This is why advocates of the precautionary principle argue that irreducible uncertainty should be integrated in management decisions, and that incomplete information should not preclude environmental regulation (Tickner, 2003).

The contentious implication of this precautionary principle (PP) is that policy decisions should be made without the full support of expert information. This highly controversial point has generated heated debates among various social actors who have a stake in environmental policy making. Discussions on the pages of various journals, newspapers and edited books have been highly interdisciplinary, involving philosophers, biologists, economists, policymakers, corporate and environmental activists.[1]

Most of this literature is normative in its orientation: it discusses the merits of PP as a policy guide and whether authorities *should* use the principle. Previous work addresses the theoretical status of the principle, its ethical implications, the practical consequences of following it, whether it is unscientific and how it reflects on natural scientific enterprise. Proponents point out the merits of precaution in protecting human and environmental health, and argue that the PP should be embraced as a guide in policy making (Sandin et al., 2002; Tickner, 2003; Gollier and Treich, 2003). Opponents stress the importance of scientifically established facts, and insist on rejecting the PP and basing policy on traditional cost-benefit analysis and risk assessment using available information (Morris, 2000; Hammitt, 2000).

This article bypasses normative debates and turns to the empirical question of what governments actually do in the face of scientific uncertainty about ecological problems. The project evaluates whether governments apply the PP in international environmental policy making. Do countries engage in collective regulatory action when they have incomplete information about ecological problems? More importantly, in the face of *what type of uncertainty* do they take such policy action? These questions are pursued through a structured comparison of international responses to four environmental problems: ozone depletion, acid rain, deforestation and coral reefs degradation. In the first two cases, states reached a series of legally binding international policy agreements. By contrast, deliberations on deforestation and coral reef degradation have not led to international regulations.

The article summarises the findings of the comparative project. For each of the four cases, I evaluate the degree of scientific uncertainty about the ecological problem at hand.[2] The analysis takes stock of available scientific information in multilateral scientific assessments at the time when key decisions were made, and distinguishes between three aspects of a problem:

- its extent
- its causes
- its transboundary consequences.

Each case study investigates the state of scientific knowledge on these aspects and observes how it relates to the outcome of the international policymaking process. A refined notion of knowledge allows us to observe that policy makers apply the PP selectively. Governments do apply the PP under conditions of uncertainty about some aspects of the problem but demand complete information on other aspects. Different types of research-derived information play uneven roles in international policy making.

2 The precautionary principle: an introduction

The precautionary principle is commonly viewed as one of the principles of international environmental law (Trouwborst, 2002). However, the principle does not have a definition that is universally accepted. Conceptual inventories have uncovered as many as 19 different formulations (Sandin, 1999). Nevertheless, the common kernel of meaning involves linkage between scientific uncertainty and policy action: when the possibility of environmental threat arises, preventive action ought to be taken even when the relevant scientific information is incomplete or unreliable. The postulate has a reactive and a proactive version. Firstly, scientific uncertainty about a potential problem should not stop governments from taking regulatory policy action to protect the environment and human health. The Organisation for Economic Cooperation and Development, for instance, declared that 'the absence of complete information should not preclude precautionary action to mitigate the risk of significant harm to the environment.'[3] On the reverse side of the principle, governments should not allow new substances or activities such as genetically engineered foods if their potential impacts are not fully understood. The 1982 World Charter for Nature, for instance, stipulates that 'where potential adverse effects [of socioeconomic activities] are not fully understood, the activities should not proceed.' Thus, the PP implies that scientific uncertainty should be treated as either a green light for regulatory action or as a red light at the crossroads of policy choices.

Legal historians trace the origins of the PP back to German national environmental legislation and identify the 1976 air pollution act of the Federal Republic of Germany as the first policy instrument incorporating the PP. Germany also takes credit for introducing and promoting the concept at the international level, during negotiations regarding protection of the North Sea. Gradually, the principle permeated regional and global environmental politics, spreading through environmental law sector by sector (Trouwborst, 2002). Today, more than 50 multilateral agreements are said to contain references to precaution, in one version or another. These include the International Convention on Oil Pollution, the Bamako Convention on Hazardous Waste, the Framework Convention on Climate Change, the Convention on Biological Diversity, the Convention on Persistent Organic Pollutants and the Protocol on Biosafety. Observers note that by the mid-1990s, the PP was being incorporated into virtually every international policy document related to environmental management (Cameron, 2001).

3 Evaluating the application of PP

The notion that governments are increasingly embracing the PP in international environmental policy is indirectly supported by a number of studies that explore the interface between science and politics in the international arena (Andresen et al., 2000; Haas, 1992; Litfin, 1994; Social Learning Group, 2001). These investigations find that states create policy regimes in spite of significant gaps of information and scientific uncertainty. Again and again, scholars show that at the time when states made legally binding international policy commitments, there were significant scientific uncertainties and gaps of knowledge about the problem at hand (Haas, 1992; Litfin, 1994). For instance, scholars maintain that the international treaties on ozone depletion embrace the PP. 'In fact, the very adoption of the [Vienna Convention] and the subsequent 1987 Montreal Protocol represent major instances of precautionary environmental regulation *avant la letter*, since during the mid-1980s considerable uncertainty still clouded the comprehension of the influence of CFCs and other substances on stratospheric ozone' (Trouwborst, 2002, p.23).

Such conclusions are premature and perhaps flawed by a problematic analytical assumption. A cardinal problem in previous work that evaluates the application of PP is that scientific knowledge is treated as a single unitary entity. The literature does not pay sufficient attention to differences between *types* of information and how different types of uncertainty affect collective action. Most, although not all, treat scientific information as a single, dichotomous variable: 'knowledge about the problem'. No attempt is made to specify: information *about what* aspect of the problem?

This assumption of unitary science is not realistic. Ecological research in the natural sciences is an enormously complex, multi-component endeavour that involves many separate academic disciplines: chemistry, physics, biology, meteorology, geology, medicine, atmospheric chemistry, etc. Conceptually, therefore, it is not realistic to assume a singularity of 'science'. Moreover, the state of knowledge in different areas does not progress evenly or simultaneously. Variance over time in the state of knowledge on the extent of a development is not necessarily reciprocated by variance on the state of knowledge on its causes or consequences. There is no reason to assume, for instance, that advances in atmospheric chemistry on measurements of ozone concentrations would also entail progress in medical research on the health effects of ozone depletion. The two are separate realms of research that do not go hand in hand but make progress independently from each other.

Taking into account the distinction between types of information is essential for properly evaluating the application of PP in international policymaking. This new approach leads to different conclusions. In the case of ozone depletion, for instance, when the key Montreal Protocol was created, there was indeed no conclusive evidence of the *extent* of ozone depletion. There was also some uncertainty about the *causes* of the depletion. However, there was reliable information and complete scientific consensus about the negative *consequences* of ozone depletion (skin cancer, blindness, etc.). The mechanisms through which increased ultraviolet radiation damages human health, terrestrial plants and aquatic life were well understood and never disputed by either scientists or negotiators. This widely accepted knowledge existed from the very beginning of global discussions and provided an important zone of agreement that facilitated treaty negotiations. This becomes clear only if we make the distinction between types of information. Lumping together various kinds of information skews the analysis and leads to biased conclusions regarding the place of PP in international environmental management.

4 Four stories of global environmental politics

4.1 Ozone depletion

In 1974, two academic publications put forward a scientific theory that certain human-made industrial chemicals rise in the atmosphere and reduce concentrations of stratospheric ozone, thus thinning the protective shield that absorbs ultraviolet radiation from the sun. Since the effects of increased solar radiation were known to be detrimental, ozone depletion was believed to have negative consequences on human health and the immune systems of plants and marine species. The international political movement to address the problem evolved at the turn of the decade and met opposition coming from companies that either produced or used these substances.[4] At the formal request of Scandinavian countries, in 1982 UNEP convened the first meeting of a committee to negotiate an international treaty on ozone depletion. Western European countries were strongly opposed to control measures; while the USA, Scandinavian countries, Canada, Austria and Switzerland supported regulation.

After years of deliberations, in 1985 governments signed a general framework agreement, the Vienna Convention for the Protection of the Ozone Layer. Talks resumed in December of 1986, to negotiate a protocol to the convention. The proposed policy options were widely different, and as late as April 1987, countries of the European Community would not agree on more than a cap on production capacity. A compromise was reached and 24 countries signed the Montreal Protocol on Substances that Deplete the Ozone Layer in September of 1987. This treaty stipulated 50% reductions in the production of several ozone-depleting substances. The regulatory regime was further strengthened by amendments that provided for complete elimination of all major ozone depleting substances by 1996.

4.1.1 Ozone science

The state of scientific knowledge at the time of the negotiations was characterised by marked differences in certainty about the various aspects of the problem. There were significant problems with measuring the *extent* of ozone changes. Measurements indicated an increased quantity of ozone depleting substances and there was also general agreement that less ozone would mean more UV radiation; but whether there was actual ozone change remained a question with no certain answers until after the Montreal Protocol was signed. As late as the early 1990s, measurements of ozone depletion were considered unreliable (Parson, 1993, p.72). Just prior to the making of the Montreal Protocol, a comprehensive international study concluded: ‘We are still data limited . . . the measurements are not adequate for critically testing the photochemical models’ (WMO, 1986, p.13). The first conclusive evidence of an ozone hole over the Antarctic appeared *after* the protocol was signed in Montreal (Dimitrov, 2003).

Similarly, there was insufficient confidence about the *causes* of the problem and their relative contributions. There were several alternative explanations of ozone depletion that focused on natural phenomena such as the sea spray ejecting chlorine atoms from the oceans into the atmosphere; the role of ice particles on the surface of polar stratospheric clouds; and solar cycles causing vacillation of radiation and fluctuation of ozone levels (Stolarski, 1988). Scientists found it impossible to determine the precise contribution of anthropogenic sources relative to natural factors. As late as 1989, two years after the Protocol was signed, an international report explicitly stated that 'the current record is too short to differentiate the effects of natural and human-induced processes on ozone' and that no attempt to do so was made (WMO, 1990, p.ix).

By contrast, the potential *consequences* of the problem were known with certainty and were never disputed by either scientists or policy makers. The detrimental effects of higher UV light were known from the very beginning and did not change essentially over the years of research and discussion. They can be classified into three main categories: human health effects (skin cancer, eye disorders, and immune system suppression), effects on terrestrial plants and bacteria, and effects on marine life. These effects were well documented at an early stage, even before multilateral talks on ozone depletion began; and the reliability of knowledge of effects only grew further over the years (NRC, 1982).

The effects of excessive UV exposure on skin cancers result from a well-known mechanism through which UV-B solar radiation damages DNA. A number of nonmelanoma skin cancers had been 'unequivocally associated with sun exposure,' including premalignant actinic keratosis, basal cell carcinomas, and squamous cell carcinomas (Emmett, 1986). Ultraviolet radiation can also damage several parts of the eye: the retina, the crystalline lens, the cornea and the photoreceptors. The impact results in cataracts, visual ageing, impaired visual development in children and retinal degeneration. A review of the subject lists many studies from the late 1970s and early 1980s that demonstrate an association between cataracts and exposure to UV light (Waxler, 1986). In 1986, the Environmental Protection Agency of the US issued a report that was 1600 pages in five volumes, entitled *Assessing the Risks of Trace Gases That Can Modify the Stratosphere*. It estimated that increased UV would cause 40 million additional cancers over the next 88 years, 800,000 of them fatal, 12 million more eye cataracts, and a growing number of immune system disorders (Cagin and Dray, 1993, p.310).

Between 1975 and 1985, several hundred studies documented the effects of UV on plants (Teramura, 1986b, p.255). The resultant changes include reduction in leaf size, decrease in total dry weight, and in the efficiency of water use by the plant. In addition, in some plants photosynthesis was decreased (Teramura, 1986a, p.170). Eventually, these alterations led to stunting of plant growth and a decline in plant productivity. The implications for agriculture are significant because the plant species that were found to be most sensitive to UV were crop species: members of the bean, pea, cabbage, and squash families (Biggs and Kossuth, 1978). Scores of studies also converged on the conclusion that increased ultraviolet light inflicts damage to plankton and marine plants that are essential to aquatic food webs. As early as the 1930s, a number of experiments had shown detrimental impact of UV on aquatic organisms (NRC, 1984). The ramifications of this impact on phytoplankton are particularly sweeping because phytoplankton is at the bottom of the food chain.

Thus, governments agreed to engage in collective action in conditions of certainty regarding the consequences of ozone depletion. Throughout all the scientific trials and errors in ozone measurements, no one doubted the detrimental potential effects of ozone depletion. Because there was reliable knowledge about the consequences of the problem, this aspect of science was not debated. The chief negotiator of the US notes:

> "All of these possible effects were known to the negotiators of the Montreal Protocol, *and they were never seriously contested.* It was generally accepted that changes in the ozone layer pose serious risks to human health and the environment." (Benedick, 1998, p.22; emphasis added).

5 Acid rain

Similarly, governments address the problem of transboundary air pollution, commonly referred to as acid rain, through a series of binding policy agreements among European and North American countries. Common industrial emissions associated with energy production and transportation form acidic chemical compounds that come down with rain, snow and fog or are directly deposited on surfaces. This has a number of negative impacts on terrestrial and aquatic ecosystems, including soils, plants, freshwater species and human health. In the 1960s, scientific research in Scandinavian countries revealed that some of this acidification can be due to pollutants originating in distant countries, and that the transboundary transport of emissions occurs on a large scale. Sweden and Norway issued a call for international regulations of acidifying pollutants, and the movement slowly gained momentum, with more and more governments seeking a treaty.

In 1979 European countries, Canada and the USA created the world's first multilateral treaty addressing atmospheric issues: the Convention on Long-Range Transboundary Air Pollution. Over the following years they built a strong international policy regime that consists of numerous agreements to control a variety of emissions: sulphur and nitrous oxides, volatile organic compounds, and persistent organic pollutants. The first regulatory step was the Protocol on the Reduction of Sulphur Emissions signed by 21 countries in July 1985 in Helsinki. It specified 30% cuts in emissions and transboundary fluxes of sulphur dioxide by 1993, with 1980 as the base year. With the 1988 Protocol on Nitrous Oxides signed in Sofia, Bulgaria, 25 countries pledged to freeze the levels of nitrous oxides emissions at the 1987 levels by 1994. In 1999, a Protocol on Volatile Organic Compounds was negotiated in Geneva that called for a 30% reduction of 1988 emission levels by 1999. In June of 1994, a second sulphur protocol was signed in Oslo by 28 countries. Today, the legal regime on transboundary air pollution continues to evolve. In June 1998, the parties created two protocols on heavy metals and on persistent organic pollutants, respectively, and those were followed by a 1999 Protocol to Abate Acidification, Eutrophication and Ground-Level Ozone that imposes stricter emissions ceilings on all major pollutants: sulphur, NOx, VOCs and ammonia (Levy, 1993).

5.1 Acid rain science

Characteristic of this case is the close integration between political negotiations and scientific data accumulation. An ambitious process for generating information was launched and between 1967 and 1986, there were no less than 6000 publications on acid rain (Schindler, 1988, note 4). Much of the research effort was triggered by the purposeful establishment of 'the most extensive monitoring programme to accompany an environmental treaty' (Levy, 1993, p.132). This process began in the late 1970s, was continuously strengthened and expanded, and became more and more integral to political processes throughout the 1990s. In 1978, the OECD programme evolved into the Cooperative Programme for the Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP). Its purpose is to supply governments with data on emissions, concentration and deposition of pollutants and the long-range transport of pollutants. The first sulphur protocol contains a clause stating that the agreement should be reviewed at regular intervals in light of updated scientific research.

In the 1970s, scientific knowledge on the acidification problem was not too well advanced but later it improved and was increasingly accepted in the early 1980s. EMEP began producing enormous amounts of data and through increasingly sophisticated methods made it possible to calculate depositions in each country and to trace them to sources in other countries. 'By this time . . . beyond doubt was the transboundary character of the problem, in which some countries gained whilst others lost' (Park, 1987, p.177).

The *extent* of acidification of precipitation, freshwater and soils could be measured accurately, and the geographical distribution of acid precipitation was well known even back in the 1970s (Drabløs and Tollan, 1980, p.11). Conclusions from many studies were firm and consistent: a rapid increase in acidification of waters had taken place since at least the 1940s. Evidence from four very different types of sources (geochemical theory, analysis of long-term trends, comparison of chemical records and paleoecological analyses) consistently demonstrated increased acidification of lakes and streams in North American and European areas that received acid precipitation (Schindler, 1988).

The state of knowledge on the *causes* of acidification was a mixed bag. On the one hand, the chemical reactions that convert oxides into acids were scientifically incontrovertible, and emissions could be measured or estimated accurately. On the other hand, acidification could be caused by several natural as well as anthropogenic causal factors, and their relative contributions were not known with certainty. One area of uncertainty involved the so-called dose/response relationship: the link between one unit of emissions and the amount of resulting change in acidity. Opponents of regulatory action such as the UK's Central Electricity Generating Board, argued that the conversion of oxides into acids depends so much on weather conditions that it is not certain whether emissions acidify the environment (McCormick, 1985, p.19). What increased acidification of lakes was also a matter of some controversy. Lakes could be acidic because of natural ecological conditions or because of anthropogenic interference. Increasingly, evidence led to strengthening the link between transboundary pollution and acidification, but information on the relative contribution of different causes remained incomplete.

There was widespread consensus about the principal cause – effects links and the potential *consequences* of acidification. Even in the 1970s it was well known that high concentrations of sulphuric and nitrous oxides and acids are toxic to plants – the only difficulty was in quantifying the exact threshold levels (Drabløs and Tollan, 1980, p.11). There was more uncertainty about terrestrial ecosystems (ibid.). By 1980, scientific knowledge about the effects of acid rain on aquatic ecosystems was solid and not disputed. Information about the response of fish to acidification was extensive, and evidence of damage to aquatic life was rich and consistent (Schindler, 1988).

The impact of acidification on human health was potentially serious but evidence was somewhat mixed. Acid precipitation was known with certainty to increase the leaching of highly toxic metals such as lead, cadmium, mercury and aluminium into soil and water (Hutchinson and Havas, 1980, p.618). Aluminium was discovered to cause dementia, and a number of studies from diverse parts of the world linked it to a variety of neurological disease including Lou Gehrig's disease. On the other hand, some uncertainty about the extent of diseases actually caused by acidification was lingering until the mid-1980s. Apart from the indirect impacts of acid rain, the direct health effects of high concentrations of SO_x were considered as a 'conventional' local pollution problem rather than a part of the transboundary acid rain problem. These effects were very serious nevertheless and provided strong reasons for controlling acidification.

On balance, there was good principal understanding about the essential cause – effects relations and the potential impacts of acidification. Areas of uncertainty pertained to the quantitative measures of impact, as well as the relative contribution of acidification vis-à-vis other possible causal factors. Yet, no one in the scientific literature appears to have disputed the potential negative consequences of acid rain for soils, vegetation, aquatic life and human health.

Consensus was greatly strengthened during a 1982 Stockholm Conference on Acidification of the Environment, organised by Sweden and attended by most European countries. Its purpose was to hear a series of research presentations, consider the state of existing knowledge, and consolidate understanding of the problem. Over 100 experts from 20 nations produced a summary of the state of knowledge on the acidification problem. The conclusions pointed to scientific certainty about the causes and effects of the problem: that increased acidification was primarily due to industrial sulphur and nitrogen emissions, that it caused negative changes in ecosystems, and that reducing emissions would lead to roughly proportionate reductions in acidification (Wetstone, 1987, p.186). During a 1983 public hearing on acidification at the European Parliament Committee on the Environment, Public Health and Consumer Protection, 'all agreed that the adverse effects of acid rain were clear, and the debate centred not on whether or not to reduce emissions but on how it should be done and who should pay for it' (Park, 1987, p.174). States who chose to join the first sulphur protocol had accepted the scientific evidence. Those who chose to stay out (such as Poland and Spain) did not deny the science but explained their opposition with other considerations such as the large economic costs of regulation. Only the US and the UK claimed that more research needed to be done (McCormick, 1989, p.85) – a line that appears to be part of the standard operating procedures of US delegations at all international environmental fora in recent years.

6 Forest degradation

Despite popular support for halting deforestation and despite consensus among governments regarding the unsustainable rates of forest degradation, negotiations at a number of international fora have consistently failed to produce a binding policy agreement. The idea for a global forest convention emerged in the late 1980s and the 1990s saw an impressive array of global and regional state initiatives to introduce international policies for sustainable forest management. International talks on a forest treaty have taken place within three high-profile institutional settings: at the 1992 UN Conference on the Environment and Development (UNCED) in Rio de Janeiro; in four sessions of the Intergovernmental Panel on Forests (IPF) between 1995 and 1997; and during four rounds of the Intergovernmental Forum on Forests (IFF) between 1997 and 2000.

In preparing for UNCED, industrialised states tried to launch negotiations on a global forest convention but did not succeed due to concerted opposition by developing countries. In 1995, states embarked on a two-year process under the Intergovernmental Panel on Forests to discuss policy priorities and options regarding forest management. Major disagreements regarding international policy and an apparent lack of progress prompted governments to continue discussions after 1997 under a new institutional body, the Intergovernmental Forum on Forests (IFF). After eight rounds of negotiations, states did not reach agreement on the need for a global forest convention, and in 2000 decided to create a non-binding United Nations Forum on Forests that does not have a mandate for policy making (Dimitrov, 2003; Lipschutz, 2001).

6.1 Forest science

International scientific assessments provide reasonably good information about global forest cover and the rate of deforestation, as well as undisputed principal understanding of the causes of deforestation. However, there is a marked paucity of information about the non-wood benefits of forests and about the consequences of deforestation. The least reliable knowledge is on the shared, cross-border effects of deforestation. Multilateral reports explicitly acknowledge that global effects on climate change and biodiversity cannot be measured with any degree of precision.[5]

Assessments provide extensive and precise data about the *extent* of deforestation. A study by the Food and Agriculture Organisation (FAO) concluded that between 1980 and 1990 global forests and other wooded lands had decreased at an annual rate of 0.02% (FAO, 1995, pp.7–8). There is also general agreement that the main *causes* of forest degradation are human activities: commercial logging, agriculture, pasture, colonisation programmes, mining and hydroelectricity projects such as the construction of dams, and military activities. However, there is a marked paucity of data on non-wood benefits of forests and the corresponding *consequences* of deforestation. One review of existing research unequivocally concludes that information about the *non*-wood products and functions of forests is at a primitive level and that the problems with their estimate and quantification are overwhelming (Nilsson, 1996).

Comprehensive reports by the FAO explicitly recognise uncertainty regarding the impact of deforestation on biodiversity: ‘the magnitude of such losses or the extent of degradation of biodiversity is unknown’ (FAO, 1997, p.41). Eventually, assessments conclude that it is hard to draw conclusions from the available data. The FAO recognises that ‘the essential needs of researchers and policy makers cannot be met satisfactorily’ (FAO, 1995, p.41). Moreover, multilateral assessments explicitly state that ‘it is highly unlikely that it will be possible, in the near future, to make comprehensive inventories of non-wood goods and services on a global basis’ (FAO, 1995, p.30).

The absence of reliable information about the transboundary consequences of deforestation has helped shape bargaining positions of states and has affected international debates at various stages. Many countries reject the idea of forests as a public good. At the 1992 Rio conference, developing countries maintained that because the problem is essentially local in nature, it is subject to national policy and legislation and not to be a matter of international obligations. The Brazilian Minister of the Environment, José Goldemberg, stated that Brazil saw no need for an international convention unless the uncertainty about greenhouse gas emissions was dispelled. Eight years later, Everton Vargas, principal negotiator for Brazil at IFF-4, concurred: ‘Forests are not global commons, they are national resources.’ The US delegate to the expert meeting in Ottawa, and later a negotiator at IFF-4, stated as a matter of fact, ‘Forests are inherently local, they are not global commons. The net effects [of deforestation] are too disaggregated.'[6] Notably, no delegation objected to such statements (Dimitrov, 2003).

7 Coral reefs

Concerns over the conditions of coral ecosystems have been expressed in several international fora, in the context of the Convention on Biological Diversity, the Framework Convention on Climate Change, the Convention on International Trade of Endangered Species, and the Global Conference on Sustainable Development of Small Island Developing States. Yet, there is no international policy regime to coordinate coral reef management. One policy development on the international level is the International Coral Reef Initiative (ICRI) that grew out of concerns expressed at a conference of small island states in Barbados in 1993. ICRI is a loose partnership of governments, international development banks, NGOs, scientists and the private sector. It is neither an international governance structure nor a policy-making body. It is an informal network of interested parties, an open forum for like-minded political actors to discuss coral reef issues, share information, promote research and identify policy priorities. The initiative does not have a permanent bureaucratic structure or organisation, and does not engage in action: it neither develops, nor funds, nor implements policy (Dimitrov, 2002).

7.1 Reef science

Despite the impressive array of research activities in which thousands of scientists are involved, existing knowledge on all three aspects of coral reef degradation is characterised with uncertainty. Although researchers and activists have a clear feeling that coral reefs are facing decline that is at least in part driven by human activities and that has undesirable consequences, the science of corals has not progressed enough to provide either details or reliable data about coral responses to stress, their prospects of adaptation, or the ecological and social impact of reef degradation. While some of these gaps are due to shortage of funding and could be filled with more monitoring, other gaps of information exist due to more fundamental limits to scientific understanding that most likely could not be resolved in the short term.

Various review documents indicated in the mid-1990s that comprehensive knowledge on the health and values of coral reefs is virtually absent (Bryant et al., 1998). Before 1998, the only information on the status of reefs was a widely cited estimate 'based on guesswork by a number of scientists and on anecdotal evidence' (Bryant et al., 1998, p.7) that 10% of reefs were dead, and that another 30% were likely to die within 10 to 20 years (Wilkinson, 1993). In response to the evident need for data, in 1996 the Intergovernmental Oceanographic Commission, the UN Environment Programme, the World Bank, and the World Conservation Union formed a partnership to establish a Global Coral Reef Monitoring Network (GCRMN). The goal of GCRMN is to collect, synthesise, and disseminate information on coral reef health, and to help communities and states build research capacity for coral assessment.

The first global assessment of actual reef conditions was GCRMN's first report, *Status of Coral Reefs of the World: 1998*. It was considered to be the first reliable estimate of global reef conditions. Interestingly, instead of ringing an alarm bell, it sounded fairly optimistic notes: in the executive summary, the authors announced that 'most of the world's reef corals are in good or excellent condition, because they are either remote from human populations, or are under good management . . . ' Furthermore, reefs that were already damaged were said to have high chances of recovery: 'Fortunately most reefs have high capacity for recovery, and if pressures are reduced or removed, many damaged reefs will rebound to a healthy status.' Only two years later, GCRMN's second report *Status 2000* took a more pessimistic tone. It concluded that 27% of the world's reefs were lost, that in 1998 alone 16% were destroyed, and that 'probably half of those will never adequately recover'. It also made predictions that 40% of reefs will be lost by 2010 and another 20% in 20 years afterwards.

Knowledge about the *causes* of the problem could be evaluated as moderately sufficient. Scientists involved in coral research share a general consensus on a cluster of factors that contribute to coral reef decline (Knowlton, 2001). Those can be grouped in three categories: natural, indirect human, and direct human causes. Coral reefs can be damaged by severe natural stresses such as hurricanes, typhoons, underwater earthquakes, seabed volcanoes, disease and pest outbreaks. All major assessments, however, focus on direct human factors. *Reefs at Risk* considers coastal development, overexploitation, inland pollution and erosion, and marine-based pollution. At the same time, the relative contributions of the particular causes remain undetermined. Furthermore, different scientific assessments throughout the 1990s give conflicting rankings of the causes of reef degradation, with a general shift away from local causes and toward regional and global factors.

The most astounding characteristic of shared knowledge on coral reefs is the virtually complete absence of information on the *consequences* of coral reef degradation. Reports from comprehensive multilateral assessments are mute on the socio-economic and ecological impact of the problem. Not only is such information missing from available reports but no ostensible effort is exerted to study this aspect of the problem. The composition of the GCRMN is indicative in this respect: it involves many biological and physical scientists but not social scientists to provide economic analysis of various scenarios for coral reef use. As its coordinator readily acknowledges, GCRMN focuses exclusively on the extent and causes of coral decline but does not even seek to provide information about the consequences of these problems for human communities (Wilkinson, personal communication).[7]

This is not to say that coral reef degradation is not considered a problem. Articles in popular magazines and political statements regularly make references to the important roles of coral reefs, implying grave consequences of coral decline. However, multilateral assessments are entirely void of any specific estimates of the ecological and socio-economic values of reefs and of the corresponding impact of their decline. Only one report attempts to address the effects of coral reef degradation, only to explicitly acknowledge the paucity of such data. With regard to biodiversity, for instance, *Reefs at Risk* only submits that information is missing: 'experts have barely begun to catalogue the total number of species found within [reef] habitats' and even the roughest of estimates vary (Bryant et al., 1998, p.8).

Thus, existing information on coral reefs does not portray their degradation as a global issue that involves interdependence, and does not offer clear reasons for collective action through a system of state-to-state obligations. Even activists committed to coral reef preservation do not deem an international treaty necessary. Indeed, no state has called for treaty negotiations. And no social group other than scientists and environmental activists has advocated regulatory policy (Dimitrov, 2002).

8 Summary of findings

The conclusions of this project are based on comparative analysis of the four cases. The empirical findings are summarised in the table below.

Table 1 Summary of empirical findings

	Knowledge of:		
Cases	*Transboundary consequences*	*Extent of problem*	*Causes of problem*
Ozone Regime	High	Low	Medium
Acid rain Regime	High-medium	High	Medium
Forests Non-regime	Low	High	High
Coral reefs Non-regime	Low	Medium	Medium

Common to both cases of successful regime formation (ozone and acid rain) was the high degree of scientific consensus about the transboundary consequences of the problem. This involved reliable information about the negative effects of the ecological problems, as well as certainty that these effects could take place in countries other than the countries of origin. Regarding acid rain, there was scientific consensus on the negative impact of acidification on aquatic ecosystems, water supplies and human health. Similarly, the consequences of ozone depletion were a matter of scientific consensus. The mechanisms through which increased UV radiation damages human health, terrestrial plants and aquatic life were well understood and never disputed by either scientists or negotiators. In contrast, both cases of collective inaction (on forests and coral reefs) are characterised by uncertainty about the transboundary consequences of the problems. Multilateral assessments produced solid information about the extent and causes of forest degradation and coral reef decline, but there was a severe paucity of data on their cross-border effects. Most of the known impacts are confined to the local and national levels.

The key conclusion is that *governments do not apply the PP in the face of uncertainty about the transboundary consequences of a problem*. Information about transboundary consequences of a problem appears to be an important requirement for environmental policy making. There is a clear correspondence between the state of knowledge on the transboundary dimensions of a phenomenon and the overall dynamics of regime-making processes. The certain and widely accepted knowledge about shared impacts of ozone depletion and acid rain served as a focal point in international policy discussions of these ecological problems. It provided a constant background to negotiations and created zones of agreement. Conversely, when good information about negative cross-border effects is missing (as in the case of forest and coral reef degradation), this gap severely hampers the process and may preclude the formation of international agreements (Dimitrov, 2002, 2003). Because such transboundary impacts of the two problems are not known with certainty, the benefits that a country would reap from protection of forests and coral reefs in other countries remain unclear. This type of uncertainty reduces incentives to create international treaties and diminishes countries' willingness to compromise with each other during political discussions.

Evidence does support the notion that *governments do apply the PP under uncertainty about the extent of an ecological problem* – when this problem is expected to have serious consequences. The pattern clearly indicates that complete information about the precise extent is not a necessary condition for policy regime formation. Decision makers tolerate a high degree of uncertainty regarding the exact magnitude of a problem and can take costly policy action even in the absence of such knowledge. To use the language of causality, this particular type of information is not sufficient and not even necessary for regime formation. On the one hand, states created a strong policy regime to address ozone depletion despite the lack of conclusive evidence of the extent of ozone depletion. On the other hand, states have failed to form regimes on forest and coral reef management despite the availability of solid data about the high rates of deforestation and the extent of coral reef decline.

The cases also offer limited support for the application of the PP under uncertainty about the causes of a problem, although the pattern here is not so clear. On the one hand, complete information about the causes of a problem does not appear to be an essential requirement for international cooperation. *States take action without having precise estimates about the relative contributions of different causal factors*. Ozone depletion and acidification, for instance, are caused by various natural processes as well as human-made substances. At the time when states committed themselves to collective action, scientists could not determine what was the relative contribution of these substances, compared to natural causes. At the same time, however, *good principal knowledge about particular human-related causes is needed before policy action can be undertaken*. The importance of this type of information pertains primarily to the design of policy because knowing a cause of a problem alone allows actors to identify possible policies that could ameliorate it. Otherwise how would actors know which particular human activities to regulate or what emissions to control? This is why this type of knowledge could affect the substantive policy content of a regime.

9 Concluding remarks

Governments do follow the PP and take costly policy action despite uncertainty and/or incomplete information. It is crucial to emphasise, however, that such uncertainty pertains only to particular aspects of the ecological problems: the precise extent of the problem and the relative contributions of its causes. Other types of uncertainty, however, have the opposite effect and hamper policy making. In particular, gaps of information about the ecological and socioeconomic consequences of a problem are clearly detrimental to efforts at international regime formation.

The findings suggest that international policy-making processes display a significant degree of large-scale rationality, at least over the long term. They portray international cooperation as a purposeful problem-solving activity. Even critics of rational choice theory agree that actors seek to benefit from their own actions. Therefore, according to even the most basic notion of rationality, the expectation of utility is necessary for action.

The utility of regulatory policy is in preventing or ameliorating the problem's negative consequences. In order to assess the stakes regarding an ecological development, actors seek to know what consequences this development may have. Reliable information about the impact of a problem plays an integral role in this process, by allowing actors to make utility calculations. Indeed, the very act of defining something as a 'problem' presupposes, and is based upon, negative impact. A particular event, trend or development is perceived as a 'problem' only by virtue of its undesirable consequences.

Information about transboundary consequences is important also because it supplies elements of interdependence. International policy regimes are collective responses to transnational problems that cannot be managed effectively in a unilateral manner. What makes a problem transnational is defined by its cross-border consequences. Hence, the formation of common interests that stem from perceived interdependence is dependent upon reliable information about the transboundary impact of an alleged problem.

Some readers are less interested in theories of international politics and more concerned with environmental degradation and the need for prompt and well designed environmental policy at national and international levels. Apart from its theoretical import, the study offers insights that may be useful to policy makers and natural scientists who are interested in ways to strengthen the science – politics interface and optimise the use of scientific research in policy making. The advice for policy makers that draws on the lessons from this study is to appraise carefully the state of expert knowledge about the consequences of a problem before they embark on international political initiatives. The forest case in particular provides a stark example of the futility of political efforts when the information base for decision making is weak.

The study also offers recommendations on where to focus scientific research on ecological problems in ways that strengthen efforts to introduce responsible environmental policy. Worldwide, scores of biologists, chemists, atmospheric scientists, and other natural scientists try to help policy making and are often frustrated when policy makers do not heed their input. Enormous amounts of money go on a regular basis into scientific research on national and multilateral levels. As far as 'mandated research' is concerned – whose explicit purpose is to provide input for policy makers and help them make decisions – the design and goals of scientific assessments become important. In particular, scientific assessments should focus on research on the consequences of ecological problems. As the coral case illustrates vividly, even ambitious scientific assessments are not likely to facilitate environmental policy if their design omits research on the consequences of the problem. When there is no conclusive information about the transboundary impact of a 'problem', then perhaps no effort should be wasted in discussing international treaties.

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Notes

[1] See for instance special issues of *Foundations of Science* 2 (1997), *Human and Ecological Risk Assessment*, Vol. 6, No. 3 (2000) and *Journal of Risk Research*, Vol. 5, No. 4 (2002).

[2] Regarding sources of scientific information, the attention here is primarily on multilateral scientific assessments coordinated by international institutions. Those include: the joint studies on ozone depletion by the World Meteorological Organisation and the National Aeronautics and Space Administration of the USA; research on acid rain conducted in the international research network that provides input to the LRTAP Convention; the regular assessments of *Global Forest Resources* commissioned by the United Nations Food and Agriculture Organisation; and the reports of the Global Coral Reef Monitoring Network that comprises a large number of researchers around the world.

[3] OECD Council Recommendation C(90)164 on Integrated Pollution Prevention and Control, cited by Trouwborst 2002, pp.227–228.

[4] The process of negotiations is extensively documented in Litfin 1994 and Benedick 1998.

[5] An extensive and detailed analysis of available scientific information regarding deforestation is made in Dimitrov 2003 and 2004.

[6] Jan MacAlpine, Senior Forest Officer, US State Department, Office of Ecology and Terrestrial Conservation. Interviewed December 11, 1999.

[7] Clive Wilkinson, Coordinator of the Global Coral Reef Monitoring Network. Interviewed November 2, 2000.

POLI375A Global Environmental Politics - GLOB ENV POLI Sections. Ecological consequences of the global political economy. Ã—.Â â€œResearch Trends in Global Environmental Politics,â€ in Peter Dauvergne, Handbook of Global Environmental Politics, second edition (Cheltenham, UK: Edward Elgar Publishing, 2012), pp. 3â€“28. The university of british columbia. EXECUTIVE SUMMARY of Peter Dauvergneâ€™s Curriculum Vitae. PART I: Transitioning from Precaution to Profit in Global Environmental Governance. 2 From Public to Private Global Environmental Governance: A Brief History. 2 From Public to Private Global Environmental Governance: A Brief History. (pp. 39-64).Â Contributions in the sociology and politics of science and technology have long questioned the pure objectivity of science, showing that political culture partially determines how science and technology are received and even produced. Differences between U.S. and European receptivity to science and technology, Sheila Jasanoff argues, â€œcannot be explained in terms of discrepant ideologies, national interests, policy priorities, or states of technological development.â€