THE INSURANCE INDUSTRY AND THE CONSERVATION OF BIOLOGICAL DIVERSITY

An Analysis of the Prospects for Market Creation

David Pearce

University College London

Prepared for the OECD Working Group on Economic Aspects of Biological Diversity (WGEAB)

DRAFT ONLY: DO NOT CITE

December 2000

Acknowledgements: I am very much indebted to the following for invaluable suggestions and documents: Rachel Crossley of Friends, Ivory and Sime, London; Mike Rubino; Anna Maria Vähäkuopus of Sampo Industrial, Helsinki ; Justin Mundy of Aon Environmental Solutions, London; and Oliver Zwirner of the RheinLand Insurance Group, Neuss, Germany. I also benefited from seeing an advance copy of Jean-Baptiste Lesourd and Steven Schilizzi's *Environment in Corporate Management*, (Edward Elgar, Cheltenham) which has a very useful chapter on insurance. None of those cited bears any responsibility for the contents of this document: the responsibility is entirely mine. DWP

Contents

1 Introduction

2 The nature of insurance
- 2.1 Insurance defined
- 2.2 The conditions for insurability
- 2.3 Reinsurance

3 Insurance as an instrument of environmental control
- 3.1 Insurance as private risk management
- 3.2 Insurance as an efficient means of control
- 3.3 Insurance can modify behaviour
- 3.4 Conclusions on the advantages of insurance

4 Obstacles to using insurance for biodiversity conservation
- 4.1 Are environmental risks insurable?
- 4.2 Climate change and biodiversity
- 4.3 Insurance against climate events

5 Illustrations of insurance and environmental conservation
- 5.1 Corporate environmental performance and liability insurance
  - 5.1.1 CERCLA
  - 5.1.2 European liability proposals
  - 5.1.3 European coinsurance initiatives
- 5.2 Ecoproducts: forestry
- 5.3 Ecoproducts: recycling
- 5.4 Ecoproducts: greener transport
- 5.5 Mutual insurance and risk reduction
- 5.6 Investing insurance funds
- 5.7 Insuring carbon trades
- 5.8 Genetically modified organisms and insurance
- 5.9 Common themes in the environmental insurance examples

6 Summary and conclusions

1 Introduction

It is now widely accepted that one of the fundamental driving forces of biodiversity loss is 'market failure'. Markets may exist but may fail to generate the optimal balance between biodiversity conservation and the forces that lead to the loss of biodiversity. Or markets may simply not exist at all, in which case there is a temptation to think that the unmarketed good is unmarketed because it is abundant and hence has a negligible price. As it becomes scarce, markets should emerge 'naturally'. But biodiversity is a complex good - some of its services and functions are already marketed, many are not, whilst many more are imperfectly understood and may be of such a nature that there are few incentives for anyone to claim ownership and market its services. In the latter respect, if some of the services of biodiversity take on the features of a 'global public good', it may not be possible for markets to exist because no-one could capture the revenues associated with these global functions[1]. Given the rate at which experts believe diversity is being reduced, there are also fears that markets may not be generated fast enough by 'natural' processes to prevent serious damage arising from diversity loss. While all the services of biodiversity may not be capturable through market formation, it may be that enough of them can be such that the remaining unmarketable functions are conserved incidentally. This is the rationale for market creation, the deliberate process of establishing a market to capture the benefits of biodiversity.

There are numerous forms of market creation. This report focuses on just one of them: the role that the insurance industry could play (and already is beginning to play) in creating markets for conservation. In order to understand what this role could be, it is necessary first to ask what insurance is (Section 2), and then to ask why insurance might benefit biodiversity (Section 3). It turns out that insurance has a number of benefits as a means of environmental improvement, but that there are major obstacles as well, obstacles that derive from the nature of insurance and the risks arising from biodiversity loss. Hence it is necessary to dwell briefly on what these problems are (Section 4). Finally, illustrations of the way in which insurance can benefit biodiversity in practice are given in Section 5. Summary conclusions are provided in Section 6.

[1] A public good is one that is jointly consumed ('non-rival') and non-excludable. Joint consumption means that if A consumes it, B, C, D etc. will also consume it. Non-excludability means that A cannot exclude B,C,D etc. from consuming. A has no incentive to own the good since he/she cannot prevent others benefiting from it for nothing. How far biodiversity is a local or global public good and how far it is a private good is debated in the literature (Pearce, 1998; Perrings, 1995).

2 The nature of insurance

2.1 Insurance defined

Insurance exists in order to reduce or eliminate the cost to an individual who faces an adverse event, say a storm or flood. Adverse events can be summed up in one word, risk. But risk is endemic to all economic activity and much risk is borne by those who take part in economic activity, especially entrepreneurs, but also shareholders and workers. Some risks can be transferred to others because they are *insurable risks*. The advantage of transferring risks to an insurer is that the insurer specialises in risks, both in terms of collecting the information about those risks and in risk management.

Insurance works by spreading the cost of compensating the individual who actually suffers from an adverse event (when it occurs) across a group of individuals. Each of these individuals is also at risk from the adverse event, but the chances of more than a few members of group actually suffering the loss are small. Each individual therefore pays a sum known as the *premium* to an agent, an *insurer*, in return for a guarantee that if the adverse event occurs the insurer will pay for the damage experienced. The insurer provides *insurance cover*. Insurance cover may be full or partial. In the former case, the premium ensures that the sufferer receives full compensation. In the latter case, he/she secures only part compensation, meeting the remainder of the loss himself. From the standpoint of the insured, the maximum premium paid will be equal to the maximum he is willing to pay rather than face a loss of a certain size with a given probability. Calling the loss L and the probability of it occurring p, pL is said to be the *actuarially fair premium*. If potential sufferers are *risk averse* it can be shown that the premium they will be willing to pay, call it P, will exceed the actuarially fair premium, i.e. $P > pL$, i.e. people pay more in premia than the expected value of the loss they might suffer (McKenna, 1986). This explains why losses of small financial value tend not to be insured. While individuals may co-operate to insure themselves, nearly all insurance takes place through specialised insurance companies. The advantage of this is that such companies specialise, thus keeping the transactions costs of insurance to a minimum. Compared to mutual insurance through a co-operative, the disadvantage of using a company is that the profits of the company are not returned to those at risk.

2.2 The conditions for insurability

Certain conditions must be met for adverse events to be insurable:

(a) Risk pooling: the loss must be capable of being *pooled*, i.e. the risk must be shared out across a significant number of people. The bigger the group of people over which the risk is pooled, the better. The insurance company collects premiums from the many who are insured, reducing the impact of any losses incurred by the few. Additionally, risk pooling reduces the variability or *variance* of the risk. Because of the law of large numbers, as the size of the insured group rises, so does the certainty with which the magnitude and the frequency of the loss can be estimated. It is very difficult to estimate the chance of any one individual person having an accident, say, but much easier to estimate the chance that an accident will occur within a larger group of people. Thus, there may be a 1 in 1000 chance that an accident will occur, but it is not possible to say that individual A has that risk. For risk pooling to work it is also essential that the risks faced by any one individual are *uncorrelated* with risks faced by other individuals, otherwise a significant part of the insured

group could be making simultaneous claims which could not be met by the revenues from premiums. This is a significant issue. If the good being protected (conserved) has public good properties, then its loss for person will be a loss for other people too. The basic requirement for insurance breaks down. This suggests that the public good aspects of biodiversity may not be readily insurable, an issue considered again later.

(b) Clear and definable loss. Any loss must be reasonably definable, measurable and must occur within a clearly defined period of time. If risks are 'fuzzy', the insurance company cannot assess the likelihood that it will have to pay out and hence cannot know its own profit situation. The same goes for unquantified risks and risks that may stretch over some undefined period of time. Losses must also be verifiable - there must be an accepted standard of evidence such that the insured can prove loss and which the insurer can verify. This condition also affects the insurability of biodiversity loss. For example, it is difficult to prove what the consequences of biodiversity loss would be, an issue discussed in Section 4. In practice, the issue is not one of insurance or no insurance, but one of the scale of the premium when there is lack of clarity about the risk. Insurers tend to be both risk-averse and averse to 'ambiguity' of risk, i.e. its lack of definition (Kunreuther et al., 1995; Freeman and Kunreuther, 1997). Various mechanisms exist to share the risk between the insurer and the insured when risk is not precisely quantifiable.

(c) Loss frequency. While there are exceptions for famous 'one off' events, nearly all insurance works on the basis that there is prior information that acts as a source of data to calculate premiums. Theft is an everyday occurrence and hence it is relatively straightforward to determine the premium for theft insurance, and relatively easy to modify the premiums as experience changes. Weather is a further insurable event, but climate, for example, may not be. Climate change can be thought of as the long run trend of weather events (Tol, 1998). While this may make it seem that climate should be insurable because there is a lengthy history of 'weather', climate change may combine features of temperature change and levels of temperature for which there is no historical precedent, or, at least, no precedent for which information is available. This raises the issue of whether climate change is itself an insurable event, an issue discussed in Chapter 4.

(d) No moral hazard. The last two conditions for insurability are a little more complex. The first involves the absence of *moral hazard*. The insurer needs to be able to predict the behaviour of the insured and this underlines the relevance of past data on frequency and type of event. But if the insured change their behaviour once they are insured, and if this behaviour cannot be predicted, then premiums could be set too high or too low. If the behaviour of the insured changes so that they actually increase the frequency of adverse events, the premia will be too low and the insurer will lose money. If this phenomenon is significant then the insurer may withdraw from the market. Significant moral hazard would therefore reduce the chance that insurance will succeed. One way of overcoming moral hazard is to devise mechanisms for monitoring the behaviour of the insured. Moral hazard is a problem of *asymmetric information*, the insurer has one set of information but the insured has information to which the insurer is not party. Changing asymmetric to symmetric information, whereby the insurer knows what the insured is doing, is thus the means for overcoming moral hazard. Moral hazard thus provides the insurer with an incentive to secure the missing information. Once the information is secured, it can be used to adjust the premium upwards to allow for any anticipated increase in risky behaviour. Other ways of dealing with moral hazard are well known. The insurance contract may involve a *deductible*, a sum that the insured pays

towards the cost of the compensation if the adverse event occurs. In this way, compensation costs are shared, giving the insured an incentive not to relax the degree of care and caution about the adverse event. Deductibles tend to take the form of absolute sums, e.g. the first $500 of loss is payable by the insured. *Coinsurance* is similar in nature and involves the insured agreeing to pay a declared percentage of the costs of the loss. *Upper limits* act in the same way -i.e. the insurer agrees to pay sums up to an upper limit, anything beyond being payable by the insured.

(e) No adverse selection. *Adverse selection* is another phenomenon arising in contexts of asymmetric information. In the initial example of insurance premiums set out earlier, the implicit assumption was that each individual was equally likely to suffer the adverse event. But some people may be more likely than others to suffer the event and they may well be people (or firms) who will suffer large losses. This would not matter, in terms of setting the premiums, if the insurer knows who this group is, but it will matter if they do not have this information. Since insurers are risk averse, they will tend to set premiums very high in the absence of the information, making insurance unattractive to all the insured (since the insurer does not have the information to discriminate). The market may then fail. Again, the solution is to acquire the information and adjust the premiums according to risk groups. This is a common practice in insurance. An important procedure for acquiring the relevant information is to *audit* the insured, either directly or by requiring that the insured submit to some independent form of audit. This turns out to be important for environmental risks.

(f) Enforceability of contract. Finally, insurance will not work unless the insurer pays the premium and the insurer honours the obligation to pay out for damages in the event they occur and the losses are genuinely suffered. Some *legal force* relating to an insurance contract must therefore exist and there is also likely to be a legal basis for damage *liability* - the right of an injured party to claim damages from the individual or agent causing the damage. This may seem rather obvious, but it affects the applicability of insurance to some environmental risks.

In summary, not all adverse events are insurable, while many are insurable only through some form of damage cost-sharing arrangement. The basic conditions are that the risks must be pooled, that they must be reasonably well-defined and measurable, they must be calculable from historical or other information, they must be time-limited, there must be mechanisms for overcoming moral hazard and adverse selection and any contract must be enforceable.

2.3 Reinsurance

Reinsurance involves the risks borne by insurance companies being taken on by another company or companies. Essentially, reinsurers insure insurers. This is relevant when the risks that are insured by the insurer are correlated, for example some form of natural disaster. In those circumstances, insurers could be faced with very large multiple claims which would be difficult to meet. Reinsurance is therefor relevant when the risks take the form of earthquakes, major floods and so on, generally referred to as *catastrophes*. Reinsurance contracts vary in nature. *Quota share treaties* tend to share the costs of large claims made by policy holders, whilst *excess of loss treaties* mean that the reinsurance company takes on the burden of meeting any claim above some specified sum to be met by the insurer.

3 Insurance as an instrument of environmental control

There are considerable attractions in using insurance to manage environmental risks.

3.1 Insurance as private risk management

The first advantage is that the role of governments in managing risks is minimised if risks can be insured. The contract for insurance is between the insured and the insurer. The government's role may be non-existent if there is not thought to be any social dimension to risk taking. An example might be theft from an individual's home. While the theft may make neighbours uneasy, the overwhelming burden of the risk is borne by the individual. There are few 'externalities', i.e. spillover effects to third parties. By and large, then, individuals tend to be free to choose theft insurance or not. Where the externalities are significant, however, governments may simply legislate to make insurance compulsory. This vehicle insurance tends to be compulsory at least as far as third party liability is concerned - damages to others must be covered even if damages to the insured are not. The externalities from vehicle accidents can be considerable: damage to life and limb of other people, damage to property, demands on public infrastructure etc.

The rationale for minimising government involvement is simply that governments have no comparative advantage in risk management. Insurance companies are specialists in the subject and hence far better placed to estimate risks than government. Similarly, governments have no special knowledge about individuals' behaviour with respect to risk. By placing a cost on the individual through the payment of a premium, the problem of risk management s focused on the individual at risk. Hence insurance is efficient relative to other forms of public control.

3.2 Insurance as an efficient means of control

Freeman and Kunreuther (1997) contrast insurance with other means of recovering damages. The two selected are (a) government payouts when losses occur, as is still the case in many countries when there are floods or events such as BSE in cattle, and (b) tort liability. With respect to government compensation insurance is superior because it is self-financing, whereas government payouts can be substantial and unforeseen. Government payouts also have a clear social opportunity cost in the sense of forgone expenditures on other social goods such as health services and education. Payouts are also subject to pressure group activity and special pleading. Political considerations may therefore influence payouts rather than situations of genuine need. Governments may also find it difficult to allocate responsibility in such contexts, fearing that blaming those who suffer the adverse event will lose them political support.

Tort liability is the system whereby individuals may seek legal redress for damage done by taking action against the individual or agent alleged to have caused the loss. Tort actions arise in situations when there is no contract between the sufferer and the causative agent. Whereas tort actions used to have to demonstrate cause and effect, measurable damage, negligence on the part of the causative agent, and a duty of care by the causative agent, it has evolved in many cases towards a system in which negligence does not have to be proved. Instead, the agent in question is assumed to have *strict liability* in respect of his or her activities. If damage is done, then the duty of care is breached and the causal agent is responsible, regardless of any proof of negligence. The result is an extension of liability regimes to products and services. The assumption is that liability of this kind encourages manufacturers and service agents to minimise the damage they do whilst at the same time spreading the costs of any damage across consumers

by internalising the minimised damage costs into product prices. In short, product liability acts like a form of insurance in the sense that damage risks are spread across large populations (Freeman and Kunreuther, 1997).

In the USA it is estimated that company environmental liabilities exceed $2 trillion, perhaps one-fifth of the entire value of property. The liabilities arise from government regulations about environmental standards that assign liability for environmental damage and clean-up costs. Probably the best known liability regime is that produced under the Comprehensive Environmental response, Compensation and Liability Act (CERCLA) of 1980. CERCLA established liability regimes for hazardous waste sites which had been abandoned and which were alleged to pose health risks. The liability of owners of such sites was established as being strict (no proof of negligence needed), joint and several (any one liable party may be eligible for all the liability of other parties) and retrospective (current owners are liable for the actions of past owners). CERCLA has been extensively studied. The essential conclusion of these studies is that it is an inefficient and extremely expensive form of regulation. Much of the cost of an action is dissipated in legal and other costs rather than going to the clean-up of sites. The result is a shortfall of funds for clean up.

In contrast, insurance appears to perform better than tort liability in generating the funds for clean up. Freeman and Kunreuther (1997) report studies which suggest that only 40% of claim expenditure was allocated to clean up in asbestos and CERCLA cases, compared to sums up to 66% of claim expenditure in the case of insurance.

Overall, then, legal procedures for recovering damages can be very expensive and very time consuming. Insurance tends to be faster and more efficient in terms of recovering the costs of the damage done or the clean up required.

3.3 Insurance can modify behaviour

A dominant aim of environmental regulation should be to alter the behaviour of those at risk. It is usual to classify risks as *exogenous* or *endogenous*. An exogenous risk is one over which the insured party has no control - a genuine 'Act of God'. Exogenous risks provide the classic context for insurance. But not that many risks are truly exogenous. Endogenous risks are risks over which there is control by the at-risk party. This is true of theft since the householder can take protective measures, thus reducing the risk of successful attempts at theft. It is true of fire, since precautions can be taken. But it is also true of many environmental risks. Siting a home or factory in a flood-plain area is an act involving acceptance of some risk, a risk that can be avoided by not siting in such vulnerable areas, or taking precautions through building design etc. The risk of ill health from air pollution can be reduced by wearing masks, and so on. The endogenity of risks is something that insurance companies know well. They frequently impose conditions on those who are insured (a) for any insurance at all to be granted, and (b) as a means of discriminating between risk groups. A basic requirement of economic efficiency is that those who are more at risk through voluntary behaviour (smoking, driving fast cars, etc.) should pay more than those who are less at risk because they take precautionary behaviour. Insurance has the capacity to discriminate between these classes of insured persons. To some extent, tort does this as well if negligence has to be proved. Those judged to be mainly responsible for the damage would then pay more in terms of damages. But insurance is a clearly more focused and delineated risk classification system than tort.

Yet all insurers *do* adopt performance-related premiums. The motivations for doing this vary:

- The first is competition: the insurance market tends to be highly competitive and differentiating premia by performance may be attractive to customers.
- The second is the growing sense of social responsibility among insurers. Few businesses now operate in isolation of social and environmental obligations, some of which will be self-imposed, some of which will be the result of legislative guidance or government-industry agreements.
- The third arises from movements towards socially responsible investment whereby fundholders may be reluctant to invest in companies that do not adopt or encourage socially responsible behaviour.
- A fourth factor relates to the insurer's own funds. If they are invested in, say, local government bonds, the insurer has an interest in the financial viability of the local government. If that viability is threatened, even marginally, by large expenditures to combat pollution, then the insurer has a stake in seeing pollution reduced. The same argument applies to risks that appear to be increasing through time but which lie in the traditional remit of insurance companies. The chance of a 'big hit', i.e. a major claim, could increase to the point where the insurer is at financial risk. Reinsurance can overcome some of this risk, but it is also sensible to reduce the policyholder risk by encouraging risk-reducing behaviour. Several commentators suggest that the United States CERCLA legislation has posed threats to the viability of the US insurance industry because of the potential scale of the liability payments for which their clients are insured.
- The fifth motivation may lie with encouragement by government. Insurance may be an alternative to 'command and control' regulations. Typically, such regulations are easier to define and promulgate than to enforce. Regulations are also subject to 'regulatory capture' whereby regulators relax enforcement due to lobbying and enticement by the companies. Insurance, on the other hand gives incentives to everyone to improve performance, and the improvements may well go beyond regulatory standards. Governments may therefore have an interest in encouraging better performance on the part of policy holders.

3.4 Conclusions on the advantages of insurance

Insurance has several major advantages over alternative means of compensation for damages. It is likely to be more cost-efficient, recovering more damages for actual compensation rather than transactions costs. It spreads the risk across large groups of people. It helps to encourage damage reducing behaviour by the insured, provided the insurer rewards precautionary or avertive behaviour with lower premia and punishes risk takers with higher premia. Insurers have an incentive to reduce policy holder risks. It also encourages the monitoring of behaviour by the insured in order to overcome the problems of moral hazard and adverse selection. This helps align premiums with risk classes, in line with the 'polluter pays principle'.

4 Obstacles to using insurance for biodiversity conservation

Section 3 suggested that insurance has a number of advantages over other means of recovering damages, whether to human health or to ecological systems. But insurance also has problems. These were alluded to when discussing the conditions for insurability (Section 2) and are expanded on here. This section also illustrates the problems using the example of *climate change* which has a strong link to biodiversity conservation.

4.1 Are environmental risks insurable?

Table 1 takes the conditions discussed in Section 2 and asks whether they are likely to be met in the case of environmental risks.

Table 1 Environmental risks and the conditions for insurability

Condition	Environmental risk
Risk pooling	Environmental risks can be borne by many thousands if not millions of people. Thus risks should in principle be capable of being pooled. But if the risks are public 'bads', then risks are correlated and risk pooling conditions will not be met. Reinsurance could help overcome this problem.
Clear and definable risk	Cause and effect are often known, but in other cases can be very problematic: e.g. tracing the effects of diffuse source pollution, determining whether this is cause and effect in the face of confounding factors. Cumulative pollution problems fail the time-dimension test.
Frequent risk	Condition often met, e.g. air pollution, but in other cases may not be fulfilled, e.g. major hazards from oil spills. There may be many oil spills but very few large ones. It may therefore be difficult to insure against 'environmental disaster'. *Risk and environmental audits* can provide essential information for low frequency, high potential damage risks.
Moral hazard	Generally, insurance companies can inspect the behaviour of the insured so moral hazard should not be a major problem. Insurers may provide incentives to the insured, e.g. by rewarding risk-reducing behaviour.
Adverse selection	As above, individual behaviour can be monitored so that premiums can be differentiated by class of risk. Ultimately, insurance may be refused for high risk clients.
Enforceable contracts	For local issues contracts should be readily

	enforceable but there are problems at the regional and global level.

Clearly, insurance is suited to some forms of environmental risk but not others. The following sections illustrate the problems in respect of climate change and biodiversity conservation.

4.2 Climate change and biodiversity

Probably the single largest proximate cause of biodiversity loss is land use change. By and large, most land use change over the centuries has been to the disadvantage of forested land and to the advantage of agricultural and urbanised land. This is equivalent to shifting land uses from high to low biodiversity uses (Swanson, 1995). Another factor involved in biodiversity decline include 'biological invasions' (Perrings et al, 2000) whereby exotic or pest resistant species are introduced to endemic systems. But climate change is also now expected to hasten the loss of biodiversity, i.e. the diversity of species and habitats, since these systems will not be able to modify and 'move' fast enough in response to rates of temperature change and changes in other climate variables (McNeely et al, 1995).

Climate change remains an uncertain event in the sense that both the science and the nature of any impacts are not certain. Prima facie, this suggests that insurance could have a significant role to play in controlling the risks arising from climate change. The risks in question are multidimensional but would include the damage done by biodiversity loss. There have in fact been suggestions that the damage costs of climate change *as a whole* can be insured against (Chichilnisky and Heal, 1993; Chichilnisky, 1998). Tol (1998) shows that climate change cannot in fact be insured.

The first problem is that climate change affects many individuals at the same time, thus breaching the first rule of insurability, namely risk spreading. But not all individuals will be affected equally. Indeed, some may gain while many may lose. If there is uncertainty about who will gain and lose, and by how much the losers will lose, the risk pooling requirement could be met by pooling the risks across the different groups of people who will be affected. Effectively, the issue is akin to reinsurance, with individual insurers exposed to the risk of large collective payouts, but insuring this risk with a reinsurer. But if the number of groups is small, insurance will not be possible.

The second problem lies in the fact that those most at risk are probably already identifiable. It is fairly widely accepted that, in terms of percentages of GNP lost, the developing world is most at risk from climate change. But if those most at risk are already identifiable, those less at risk or at no risk at all (or even negative risk!) have no incentive to take out insurance. The several proposals that have been made for a 'climate insurance fund' to which individual countries contribute in proportion to their greenhouse gas emissions are in fact liability regimes, not insurance regimes.

Third, as Section 2 showed, risks must be measurable and attributable to climate change. But the science of climate change is uncertain and it may never be the case that an particular element of damage can be attributed to it. Even sea level rise is affected by many factors besides ocean temperature. Without clear guidance on cause and effect, and some form of measurement of the damage attributable to climate change, climate change is again uninsurable.

Fourth, it is sometimes argued that irreversible damages cannot be insured against. But many insurances only appear to 'restore' the pre-damage situation when in fact irreversible change has occurred, e.g. a disability due to an accident.

Fifth, biodiversity losses impose costs on local communities and on regions and global society in general. The former risks are potentially insurable, but the latter are not. If global life support functions are impaired because of climate change, then the risks in question are borne by the global population. There is no diversification of the risk - risks cannot be spread over space - and hence insurability cannot take place.

Sixth, Section 2 made it clear that risks should be time-constrained. But climate change is not constrained in this way. While it is usual to focus on damages done from '2xCO2', referring to a doubling of pre-industrial greenhouse gas concentrations, this is simply a benchmark. Unless deliberately slowed, global warming carries on. Moreover, the time lags in the climate system mean that emissions now are resulting in damages around 100 years hence. The insurer would therefore not be sure of when the claims would be made, what their scale is likely to be, nor how often claims would be repeated.

All in all, climate change is not an event like a hurricane or tornado, but rather a tendency or trend. Whereas the former are insurable, and indeed are insured, the latter is not. What is possible is to insure against the former events which may well be made worse by climate change. It is likely that only in this restricted sense is climate change insurable.

4.3 Insuring against climate events

Insurance against climate change itself may not be possible, but it is possible to insure against identifiable events that may or may not be associated with climate change. More strictly, these are *weather events* rather than climate change, the latter being a trend or general movement rather than an event. Re-insurance companies, particularly, are concerned with the insurance of storms and major weather events such as hurricanes and typhoons. In 1999, for example, insured losses from 755 natural hazards world-wide amounted to $22 billion (Munich Re, 2000). But economic losses exceeded $100 billion, so that insurance covered only around 20% of the economic damage done (ignoring loss of life and other damages: close to 100,000 people died in natural hazards in 1999). As far as can be ascertained none of the insurance cover related to ecological systems. Views on whether the systematic increase in the size of aggregated claims is due to climate change vary. Some argue that it is due to more people being at risk, more property in vulnerable areas, and higher values of assets at risk (Munich Re, 2000). Tucker (1997), on the other hand, argues that climate change is magnifying risks and that 'from the perspective of the insurers, the most effective way to reduce risk would be to take action to limit the probability of global warming or reduce its impact' (p.95).

The problems created by the increasing magnitude of damages can be illustrated with examples of major weather events. Hurricane Andrew caused $25 billion in damages, of which $17 billion was met by insurers. Nine smaller insurance companies were bankrupted by the pay-outs, and the Florida State government had to pass legislation forbidding non-renewal and cancellation of policies. Insurance premium rose by over 70 per cent. Cyclone Iniki in Hawaii led to the fifth largest insurance company going out of business and the largest company announced it would not renew residential insurances. The examples illustrate the limitations of insuring even major events which may or may not be linked to climate change.

Clark et al. (1996) report on a fairly widespread lack of awareness in the financial sector generally about the risks posed by climate change to the insurance and banking industries. This could be due to ignorance but may reflect the view that, as yet, climate change itself has not been responsible for the rise in damages. Moreover, the reinsurance companies carry regular features on climate change on their web-pages, and the United Nations Environment Programme 'Statement on Environmental Commitment by the Insurance Industry' , set out in 1995, has attracted a large number of signatories.

5 Illustrations of insurance and environmental conservation

Previous sections have shown that insurance has the potential to be a powerful instrument of environmental policy in certain circumstances. Its uses should not be exaggerated, but the main advantages of using insurance lie in the ability of the insurance industry to gauge risks far better than any other agent in a risk context, to pool risks and to discriminate between risk groups according to different risk factors, and to encourage better environmental performance on the part of policyholders.

5.1 Corporate environmental performance and liability insurance

Insurance contracts between insurers and companies increasingly account for environmental risks. Companies may face risks from liability legislation, e.g. for contaminated land, from civil actions for damages, the costs of meeting rapidly changing environmental legislation, etc. In so far as 'moral hazard' exists, insurers will seek to audit the company for its environmental risks, and will tend to expect an annual audit before the policy is renewed each year. But major risks may simply be declared uninsurable and this may well include risk exposure to climate change. The issue affects company accounting which may well not include details of environmental risk liability, insured or not. Shareholders are showing an increasing interest in a 'total liability' account that extends beyond standard financial liabilities. The links to biodiversity conservation are not specific, however. Companies can be fined by environmental regulators for environmental contamination, e.g. from oil spills, which may affect biodiversity, but the fines are often not a significant cost to offending companies. More onerous fines would attract more attention from insurance companies. In other cases, fines have been significant.

5.1.1 CERCLA

The major example of significant environmental liability legislation is the CERCLA Act in the USA which governs hazardous waste sites. CERCLA established a ‘Superfund’ to finance the clean-up of existing hazardous waste sites (the catalyst here being the famous ‘Love Canal’ case of 1978). Its second major provision was the establishment of liability of responsible parties for damages to natural resources due to oil spills or discharges of hazardous substances. In addition to the costs of clean-up, removal and remediation, responsible parties would also have to pay damages. Federal and state governments would be the trustees of natural resources and could therefore pursue claims for damages against responsible parties. CERCLA required that procedures for measuring damages be developed. In the event, these emerged along two lines in 1986/7 issued by the Department of the Interior (DOI): ‘Type A’ procedures whereby values might be taken ‘off the shelf’ and ‘Type B’ procedures which would require specific, targeted research for damages not suited to Type A procedures.

Type B procedures included the ‘lesser of’ rule, whereby whichever was the smaller of replacement costs or lost use values was to be adopted. Use values refer to the economic value that users of the damaged resource attach to that resource. A visitor would therefore be a user but someone who simply cared about the resource but did not make use of it would be a ‘non-user’. A second rule declared that market prices were to be used to assess damage if the resource was traded in the market place, or that prices derived from markets in similar assets could be used. Only if use values could not be determined was it to be permissible to use valuation techniques that elicited economic values in non-market situations. Even then, questionnaire

based techniques ('stated preference' techniques - see OECD, 2001) were to be regarded as a last resort, and non-use values were to be used only if use values could not be ascertained.

There were a number of legal challenges to the DOI rules. In a landmark case, *Ohio vs the Department of the Interior*, in 1989, the court ruled as follows:

(a) the 'lesser of' rule was illicit. Restoration costs were a proper valuation of natural resource damage unless totally out of proportion to lost use values;
(b) lost use values should include lost non-use values, using the term 'passive use' values to refer to non-use values;
(c) stated preference approaches to eliciting economic value were legitimate procedures for measuring lost wellbeing.

Basically then, the DOI rules were thrown out as far as assessing natural resource damages under CERCLA was concerned. Suits for natural resource damages began to appear in the mid 1980s, a few before the DOI rules were promulgated. The case that produced most controversy was that surrounding the oil tanker *Exxon Valdez*. The *Exxon Valdez* ran aground in Prince William Sound in Alaska in 1989, discharging 11 million tonnes of crude oil. Of the main consequences, two stand out. First, in 1990 Congress passed the Oil Pollution Act which superseded CERCLA as far as oil spills were concerned. The Act confirmed the principles enunciated in the *Ohio* case, namely that the lesser-of rule was not correct and that non-use values estimated via questionnaire-based approaches were admissible. Congress took the responsibility for devising the regulations for natural resource damage assessment for oil spills away from DOI and handed it to the National Oceanographic and Atmospheric Administration (NOAA). Regulations for the remaining CERCLA issues remained with DOI. Second, and pursuant to the Act, suits against Exxon were taken out by the Federal Government and the State of Alaska. A contingent valuation study came up with the answer that US households were willing to pay $31 per household as a once-and-for-all payment to prevent a similar accident. Aggregated across all English-speaking households in the USA (90.8 million) this comes to $2.8 billion.

There are several important features of the *Exxon Valdez* study and they have implications for the role of the insurance industry in insuring against liability for damage to biodiversity. The first, and dominant, issue is the use of economic valuation techniques to measure damage and the role played by non-use value. If non-use value is legitimate in damage assessment, then corporate liability for biodiversity-damaging events could be enormous. As the *Exxon Valdez* case shows, damage could be in the billions of dollars rather than the millions. As it happened, in 1991 state and federal governments announced they would settle out of court with Exxon to the amount of $1 billion, $0.9 billion of which was natural resource damages. After an initial rejection of the amount by a federal judge in Alaska, the same judge accepted a similar sum of $1.1 billion in late October 1991.

Second, and not surprisingly, Exxon itself did not accept the methodology for the damage assessment. It hired economists to criticise the contingent valuation methodology and sponsored a major meeting in 1992 at which academic criticism of the contingent valuation methodology was voiced. In the meantime the oil industry lobbied the White House against the use of contingent valuation in natural resources damage assessment. Damage assessment can therefore be controversial and the determination of the amount of liability can take a long time, consuming

substantial sums in transactions costs. Insurance deals would probably not insure against the costs of processing a claim, only against the actual damages awarded.

In 1996 NOAA issued final regulations for damage assessment under the OPA. Again, restoration costs were the primary component of damage. Losses during the period between the incident and the full restoration of pre-damage conditions were to be dealt with via additional compensatory restoration. This compensatory element can be 'scaled' using questionnaire approaches. In the meantime in 1994 DOI issued final regulations under CERCLA which identify restoration costs as the primary component of damage. However, in addition there would be damages during the period between the incident and the full restoration of pre-damage conditions. Any economic valuation technique may be used to value this *interim loss.* In contrast to the DOI rules, NOAA's 1996 regulations for damage assessment under the OPA effectively excluded economic valuation and required that the cost of restoration should be the measure of damage done.

The precise reasons for this shift of emphasis are not very easy to discern, but appear to relate to a resurrection of the public trust doctrine. Under this doctrine, natural resources are regarded as being held in trust by the state and federal governments of the USA for existing and future generations. The doctrine could therefore be taken to imply that damage to natural resources must be negated, i.e. the natural environment must be restored to its pre-damage situation. Moreover, the public trust doctrine requires that those who act as trustees can use any money recovered from actions against liable parties only for enhancing or creating natural resources (Jones, 1996). Monetary compensation, actual or hypothetical, would then have no role to play because, of itself, compensation does not restore the 'status quo'. As Jones (1996) states:

> '.. public trustees do not have the authority to make individuals whole by providing such recoveries [money recovered from liable parties] directly to individuals; rather, trustees are allowed to spend their recoveries only on enhancing or creating natural resources' (Jones, 1996,6).

This contrasts with the standard economic view where the status quo relates to the wellbeing of the individual. If, in a post-damage situation, an individual is compensated so as to be as well off ('made whole') – in his or her own judgement – as they were in the pre-damage situation, then compensation is efficient and just. So long as the individual regards the compensation as a substitute for the damage done to the environment, it is not necessary for the damage itself to be 'undone'. The public trust doctrine proceeds quite differently. It does not require that the status quo be measured in terms of the individual's wellbeing but in terms of the state of the natural environment. Hence any damages are measured by the costs of restoration and those costs can legitimately be recovered from the parties responsible for the damage.

The supremacy of the public trust doctrine can be traced to the decision of the Appeals Court in 1989 to overrule DOI's 'lesser of' rule which had stated that lost economic value could be used to value damages if it was less than the value of restoration costs. The Court ruling effectively established restoration costs as the prime criterion for damage assessment, and even its caveats to this regarding rejecting restoration costs if they were 'grossly disproportional' to the value of the resource were dropped by DOI in 1994. The loss of the grossly disproportional requirement was upheld on appeal in 1996. The public trust doctrine derives from English common law and was upheld in 1892 in the USA in *Illinois Central Railroad vs Illinois.* Combined with *parens patriae* – which refers to the role of the state as guardian of persons under legal disability –

public trust gives the state a right to protect the environment on behalf of its citizens. This right exists independently of ownership of the resource and derives from the state's duty to protect citizens. The combined doctrine was used to sue polluters in the late 1960s and the language of public trust began to enter environmental suits in the 1970s.

The relevance of the US debate between public trust and economic valuation is that the former uses costs of restoration as the measure of damage whilst the latter requires the use of valuation techniques. In the latter case it is difficult to argue that only use values matter: non-use values can be as legitimate as lost use values. This opens the way to substantial liability claims and raises the issue of whether the insurance industry would enter a market for this kind of liability. In contrast, restoration costs are probably (though not necessarily) less than damage costs, at least in the case of ecosystems that have some features of uniqueness. Insurers may be more likely to enter this market.

The insurance industry's experience with Superfund is informative. Transactions costs remain substantial with around 30-40% of costs being taken up in legal fees. The industry was clearly alarmed by, and not prepared for, the size of some of the early settlements and many insurers withdrew from the market. A somewhat less punitive approach has resulted in clean-up costs being reduced on a per site basis to around $13 million. The insurance industry has made its own adjustments, offering environmental impairment liability (EIL) insurance based on careful audits of companies at risk. In an effort to cover potential liability a whole set of new insurance instruments have emerged, primarily concerned with limiting payouts, especially in cases where restoration costs turn out to have been underestimated (Price, 2000). It is important, therefore, that liability legislation should not be overly 'aggressive' against polluters. Whilst this may appear to weaken the environmental effectiveness if liability legislation, insurers are not bound to supply insurance and will not do so if damages are likely to be substantial. If insurers do not pay, then the offending party has to pay and this may be impossible - indeed, it is the reason insurance exists. Thus, large damages may simply result in no-one paying, with the result that the environment suffers more than if damage assessments are reduced in size.

5.1.2 European liability proposals

The European Union is actively considering the introduction of environmental liability legislation. A White Paper of 2000 proposes a liability regime that would not be retroactive (i.e. would not apply to past damage), would not apply to diffuse sources of pollution, but would apply to any activity or product already the subject of EU environmental law, including 'dangerous substances', waste, genetically modified organisms, and accident hazards (European Commission, 2000). Relevant damage would be to individuals and also to biodiversity. The limitation restricting liability to areas where EU legislation applies means that only biodiversity on land protected under EU Directives on birds and habitats (Natura 2000 sites) would be covered. Liability would be strict, i.e. does not involve proof of negligence or fault, but for biodiversity damaged by 'non-dangerous' activity the liability would be fault-based. Liability would be for 'significant' damage only.

The proposed Directive has profound implications for the insurance industry. The White Paper does not in fact propose compulsory insurance but stresses its importance. Insurance is required to avoid the likelihood that companies might transfer activities likely to cause environmental risk to associated entities that are underfunded and which could not therefore meet the costs of any settlement. The inclusion of biodiversity damage poses special problems. Estimating the money

value of biodiversity damage is clearly complex (OECD, 2001). Economic valuation techniques have been used to value the damage from oil spills, notably in the case of the *Exxon Valdez* where contingent valuation techniques were used. In the USA (see above) the focus of attention has shifted somewhat towards the 'public trust' doctrine which requires that the damaged ecosystem be restored to its pre-damage state. The resulting cost of restoration then becomes the effective settlement of the liability claim. For insurers, damage restoration costs are likely to be more 'concrete' than damage costs estimated by economic valuation techniques. Both, however, carry a considerable element of uncertainty and this may well limit the extent to which insurers will enter the market for cover for bioidversity damage. The White Paper suggests that restoration costs are the starting point for damage assessment, but also refers to an 'asset valuation' as well. There are suggestions that bioidversity damage may be 'capped' in some way to ensure that the insurance industry enters the market for insurance.

Biodiversity liability also has to be fault-based under the White Paper proposals, which in turn implies that someone engaged in 'best practice' management could avoid liability. Fault-based liability is more attractive to insurers provided they can monitor best practice and ensure that operators (e.g. land owners or managers) enforce it. The difficulty will be that managing a site for best practice in respect of biodiversity is not a well defined activity. Thus, there may be considerable latitude in the interpretation of the meaning of best practice. Self-evidently, there are many issues to be resolved before a Liability Directive can be implemented, and insurance is central to some of these issues.

5.1.3 European coinsurance initiatives

Europe has several schemes where insurance is 'shared' between several different insurers, or 'pool'. The pool may in turn seek reinsurance for potentially large claims. Assurpol has operated in France since 1989 and insures against environmental liabilities and other risks. It uses excess thresholds and a 'cap of 200 million French francs to redistribute some of the risk to the policyholder. Assurpol conducts regular environmental audits to assess risk and has a refusal rate of around 30%. There has, however, been limited demand for insurance pool cover, perhaps reflecting the less litigatory nature of Europe compared to the USA (Lesourd and Schilizzi, 2001). The Dutch coinsurance pool (MAS) similarly provides cover, mainly for smaller enterprises. The major Swiss reinsurance company, Swiss Re, has stakes in many of these coinsurance ventures. Swiss Re has been instrumental in introducing environmental management systems into its own operations, and in developing environmental insurance guidelines for insurers.

5.2 Ecoproducts: sustainable forestry

Adverse selection is a potential problem faced by companies concerned to produce 'ecoproducts', i.e. products that are differentiated from other products through some environmental attribute which is likely to be of benefit to biodiversity. An example might be sustainably managed timber. Adverse selection arises if the consumer cannot distinguish the ecoproduct from non-sustainably managed timber. Sustainably managed timber tends to attract a premium on cost because of the restrictions on operating conditions (Pearce et al, 2000). But if consumers are not able to differentiate between the two products, they will have no incentive to pay the higher price and the ecoproduct will rapidly disappear from the market. The solution is to differentiate the products through a certification procedure. Certification has advantages to the insurance industry as well. It involves careful collection of data on the manner in which timber

concessions are carried out and managed, and this information can be of great value to companies insuring forestry activity. In much the same way, forestry companies engaged in carbon sequestration activities (joint implementation and carbon offsets) also generate significant amounts of information on forestry practice. Better information allows the better definition of risks. Sustainably managed timber should also reduce some of the risks involved in forestry, thus reducing the exposure of the forest company and the insurer.

No evidence has so far been found to indicate that insurance companies are engaged in this process, but it is known that several have considered supporting certification on these grounds.

5.3 Ecoproducts: recycling

Recycling waste products is known to have environmental benefits to biodiversity because of savings in energy and hence in pollution. The exact relationship is impossible to quantify. One Swedish mutual insurance company, Länsforsäkringar Miljö, has developed insurance to cover the requirement placed on product producers to ensure recycling of the product at the ends of its useful life. The exact timing of the recycling and its cost is not certain, making insurance attractive. The insurance company provides insurance to cover the cost which is determined in turn by a recycler when the product ends its life. The insurer therefore bears the risk of an uncertain product lifetime and uncertain cost of recycling. Insurance guarantees that the cost of recycling will be met. Consumers pay for the cost through the higher price of the product required to cover the insurance premiums paid by the manufacturer. The premium is determined by the complexity of recycling the product (mainly old computers) and the estimated useful life of the product. The insurance also provides an incentive for manufacturers to build 'recyclability' into their products, i.e. turning them into 'ecoproducts', since premiums are lower the easier it is to recycle the product (Tengå, 1999).

5.4 Ecoproducts: greener transport

A significant number of insurers differentiate premiums according to the 'lifestyle' of the policyholder, with lower premiums being offered for those who behave 'ecologically'. This can be illustrated with the example of the RheinLand Insurance Group, a German insurer that has developed several ecoproduct insurances. People using public transport are offered a 10% discount on their insurance for vehicles, encouraging public transport and hence reducing pollution. Public transport companies benefit from increased usage - indeed they are the means by which the insurance is advertised, the policyholder benefits from reduced premiums, the insurance company benefits from attracting 'green' policyholders to their 'Drive and Save' initiative. Proof of use of public transport is provided by season tickets. In 1999 this initiative extended to around 5 per cent of all RheinLand's private car policyholders.

The same company introduced discounts on normal premiums for car drivers if they took training in driver safety and energy reduction. The take-up was, however, poor and the scheme was discontinued. More directly beneficial to biodiversity is the same company's 'CO2OL' initiative which involves policyholders paying normal premiums for car insurance and also purchasing a one-off contract to offset carbon dioxide emissions. The money raised by the additional premium is used to grow trees in a certified forest project in Panama. Each 500 Euros pays for 40 trees on 830 m^2 of land, and 12 years of subsequent maintenance. The additional premium is in fact a donation and is voluntary. Donations are tax-deductible under German law.

In 1999 the scheme evolved so that the donation became an investment through sharing in the returns to sustainable forestry and the value of any carbon credits (Zwirner, 1999).

Finally, RheinLand collaborates with environmental NGOs to gather information on the requirements of ecologically-minded policyholders. Public transport or bicycles have their own risks (missed trains, accidents) and these are separately insured through dedicated travel insurance.

The essential features of the RheinLand initiative are that (a) premiums discriminate between policyholders in such a way that environmental improvement is encouraged, and (b) specialist information is gathered on the insurance needs of individuals who wish to be environmentally friendly in their behaviour. RheinLand is clear that the initiatives are good business for them, but with the added advantage of being environmentally beneficial.

5.5 Mutual insurance and risk reduction

Mutual insurance companies are conventional insurance companies but with the ownership of and operation of the company vested in the policyholders to whom the company is dedicated. Their significance in terms of environmental risk is that they began life as a mechanism for insuring factory risks in the 19th century, a process which involved regular inspections and variation in premiums according to measures taken to reduce risk. FM Global, one of the largest remaining mutual risk companies, confers a 'Highly Protected Risk' label to companies who meet exacting standards of risk reduction. The oil companies own a mutual company, Oil Insurance Ltd, which was set up after the Torrey Canyon oil spill (Lesourd and Schilizzi, 2001).
.

One advantage of mutuals is that their incentive to encourage risk reduction is perhaps greater than that in conventional insurance, those having to pay insurance being the same as those who receive the premiums.

5.6 Investing insurance funds

By the very nature of insurance, a vast array of risks are insured every day and in every country. It is no surprise then that the revenues generated by the industry amount to some $2.2 trillion every year. Of this, $200 billion is set aside for reinsurance, leaving some $2 trillion to meet claims, pay shareholders and invest. The power of the insurance industry as a major investor cannot therefore be underestimated. There are two forces that drive the industry to consider carefully in their own portfolio of investments the environmental risks to industry at large. First, there is a growing awareness of the moral case for socially responsible investment (SRI), a concern shared by many other sectors of industry. Secondly, if environmental risks are not curtailed, then the rate of return performance of the insurers' own investments will be at risk. There is evidence, for example, that environmentally sound industries perform better on the stock exchange than companies with lower environmental profiles. Swiss Re has gone further in developing a venture capital fund for young companies with products centred on renewable energy technology.

Thus, regardless of insurance risks, the insurance industry has a vested interest in improving environmental quality wherever it can, using its leverage both as insurer and as investor.

The transition to an environmentally more responsible insurance industry is a slow one. A UK Friends of the Earth survey of fourteen major insurers found that they represented an investment value of UK£550 billion, that many of the investments were in fossil fuel industries and that most had not signed up to the UNEP Insurance Industry Initiative on commitment to sustainable development. Some 50% offered an ethical investment or fund (Friends of the Earth, 2000).

5.7 Insuring carbon trades

Under the Kyoto Protocol it is intended that countries with greenhouse emission gas reduction targets can meet part of those targets by reducing emissions outside their national boundaries. The resulting 'credits' for emission reductions can then be counted against the national target or traded on an open market. While the formal trading measures have not yet been agreed, some forms of carbon trading have been taking place for over a decade (Pearce, 1996). One issue that emerges with carbon trades is buyer and seller liability. A credit is a paper claim to a real emission reduction. Someone reducing emissions secures a credit which he/she sells on to a buyer. The buyer is at risk in the event that the seller's credit turns out not to be a real claim, i.e. the emissions reduction has not occurred. Under the Kyoto Protocol, the first 'reckoning' date is in the period 2008-2012. Hence the extent to which credits are claims to real emission reductions may not be known until then. Currently, the Kyoto Protocol has no enforcement mechanism, but clearly agreements cannot be workable without some form of penalty for non-compliance. On the assumption that such a penalty is developed, the buyer or seller will be liable for the penalty of non-compliance.

Who should have liability for 'false' credits is debated. Sellers may have liability, effectively insuring the buyer against non-compliance. Alternatively, buyers may have liability in which case he/she will need some insurance because there will be limited information as to the extent of compliance with 'real' emission reductions. Thus, while there are many options for monitoring and enforcing compliance, insurance is one possibility and some insurers, e.g. Norwegian company Storebrand, are already working on emissions trading insurance. The UNEP Insurance Industry Initiative for the Environment rejected buyer liability insurance at its 1998 meeting as being too impractical and too risky from the insurer's standpoint. The UNEP Group similarly concluded that commercial insurance for carbon trades generally appeared 'inappropriate at present' (UNEP III, 1999). There appear therefore to be divergent views on the role that insurance can play in covering compliance risks.

The carbon trades involve actual physical investments in emission reduction and carbon sequestration. Emission reduction in advanced economies may be low risk, but it will have a higher risk in the developing world and in the economies in transition. Under the Kyoto Protocol, trading with both geographical areas is enabled under the Clean Development Mechanism and Joint Implementation. The attraction of these trades is that investment in carbon reduction is far cheaper than in the industrial economies: cheaper, but riskier. Again, insurance could have a strong role to play in insuring against project failure (Mundy, 2000). Insurance companies are familiar with assessing the many kind of risk involved in investment projects: political risks, financial risks including exchange rate movements, credit failure etc.

5.8 Genetically modified organisms and insurance

Genetic engineering has moved from the realms of science to practical business. There are over 2000 registered biotechnology companies in the USA and Europe with a turnover of some Euros

19 billion. The risks associated with genetically modified organisms (GMOs) are unknown and relate to hypothesised risks to human health and to biological diversity. In Germany the 1990 Genetic Engineering Act sets a maximum liability of some 80 million Euros for operators of genetic engineering facilities and for the accidental release of GMOs. German insurers have developed guidelines for cover, including the exclusion of changes to genotypes. To date, there have been no claims but the potential for future claims is large given the rapid spread of the biotechnology industry (Zuefle, 2000).

5.9 Common themes in the environmental insurance examples

None of the examples of the ways in which the insurance industry is responding to environmental risk concerns biodiversity directly. Nonetheless, all of them have beneficial repercussions for biodiversity conservation.

- Insurance necessarily requires that the nature of the risk, its extent and the probability of its occurrence are understood. This has led insurers to invest heavily in information systems that greatly improve corporations' and individuals' understanding of risk.
- While insurers make their profits from the existence of risk, it is in their interests to ensure that policyholders reduce risks. Insurers have therefore devised many different incentive systems for risk reduction - ranging from making insurance contingent on an environment audit or an environmental management system being in place, to changing premiums for environmentally beneficial behaviour, to various forms of shared insurance that do not transfer 100% of the risk to the insurer.
- Insurer are demonstrating that encouraging risk reduction and environmentally sound behaviour is both good for their businesses and good from a social standpoint. This socially responsible approach extends to insurance and to the investment of their own assets in socially responsible investment (SRI). The sheer scale of these investments and the risks to which they are exposed underlines the rationality of being engaged in risk reduction.

6 Summary and conclusions

Insurance can be a powerful instrument for environmental protection. The source of its effectiveness lies in the ability to spread uncorrelated risks through insurance and, where risks are correlated across defined groups, through reinsurance. However, of itself, insurance does not reduce risks and, if moral hazard exists, may even increase them. Risk reduction can occur, however, in contexts where risks are at least partly endogenous - i.e. under the control of the policyholder - and where the insurer can develop mechanisms for monitoring policyholder behaviour and performance. These contexts appear to be many and varied and have resulted in the rapid development of insurance where the premiums are varied according to the behaviour of the insured and according to risk categories.

In the environmental context, insurance has developed most rabidly for the cover of liability for environmental damage. Liability regulations have developed fastest in the USA and the European Commission has proposed analogous liability legislation for the European Union. Damages under liability legislation can be very large, so much so that insurers and insured have a mutual goal of minimising exposure to liability. Where a contaminated site is 'inherited' there may be little that can be done to minimise liability beyond lobbying for the standards applied to site restoration not to be so strict. Where liability is fault-based, there is a substantial incentive to adopt best environmental practice to reduce insurance premiums and reduce exposure. Insurance also avoids many of the costs involved in tort cases and direct regulation. The insurance industry is a specialised and possesses information that governments do not possess and which they would have to acquire if they did regulate. Insurance is therefore an attractive regulatory instrument.

But the powers of insurance should not be exaggerated. It seems unlikely that it can insure biodiversity against many of the risks it faces. It cannot, for example, insure against climate change, and this has to be contrasted with its more obvious role of insuring against weather events such as hurricanes. Moreover, if biodiversity is a global public good, the loss of biodiversity results in losses that affect everyone on Earth. Such losses are effectively an uninsurable event. Additionally, the conditions for insurance require that the losses be measurable. In the case of global biodiversity loss this requirement is not met. But biodiversity loss may be insurable in a liability regime if either economic damage approaches are used or costs of restoration of ecosystems are used. The risk with damage assessment is that it may result in very high damages, as illustrated in the *Exxon Valdez* case. Care then has to be taken that insurers do not leave the market for liability insurance, making environmental protection worse under a liability regime than under some other form of regulation. Designing insurance deals to have 'cost caps' or some form of coinsurance and deductibles can overcome some of these concerns.

While the insurance industry has taken serious note of climate change there is less evidence that it has concerned itself with bioidversity conservation directly. Nonetheless, there are some promising initiatives involving ecoproducts and sound ecosystem management. It is also clear that the insurance industry is concerned that corporations generally minimise environmental risk through environmental management initiatives.

References

Chichilnisky, G and Heal, G, 1993. Global environmental risks, *Journal of Economic Perspectives*, **7(4)**, 64-86

Chichilnisky, G. 1998. The economics of global environmental risks, in Tietenberg, T and Folmer, H. 1998. *The International Yearbook of Environmental and Resource Economics 1998/1999: a Survey of Current Issues*, Cheltenham: Edward Elgar, 235-278

Clark, K., Knecht, F., McCaulay, D., Palutikof, J and Yambi, W. 1996. Financial services, in Intergovernmental Panel on Climate Change, 1996, *Climate Change 1995: Contribution of Working Group II to the Second Assessment Report of the intergovernmental Panel on Climate Change*, Cambridge: Cambridge University Press, 539-560

European Commission, 2000. *White Paper on Environmental Liability*, http://europa.eu.int/comm/environment/libility.

Freeman, P and Kunreuther, H. 1997. *Managing Environmental Risk Through Insurance*, Washington DC: American Enterprise Institute.

Friends of the Earth (UK), 2000. *Capital Punishment*, London: Friends of the Earth.

Jones, C. 1996, *The new restoration-based measures of compensation in natural resource damage assessment regulations: methodological challenges*, Paper to Allied Social sciences Association meeting, Jan5-7.

Lesourd, J-B and Schilizzi, S. 2001. *Environment in Corporate Management: New Directions and Economic Insights*, Cheltenham: Edward Elgar.

Kunreuther, H., Meszaros, J and Spranka, M. 1995. Ambiguity and underwriter decision processes, *Journal of Economic Behavior and Organization*, **26**, 337-352

McKenna, C.J. 1986. *The Economics of Uncertainty*, Brighton: Wheatsheaf.

McNeely, J., Gadgil, M., Leveque, C., Padoch, C and Redord, K. 1995. Human influences on biodiversity, in Heywood, V and Watson, R, 1995, *Global Biodiversity Assessment*, Cambridge, Cambridge University Press, 711-822

Mundy, J.2000. Risk management and sustainability, in Proceedings of Royal Institute of Economic Affairs Conference, *Biodiversity and Business: Putting Principles into Action*, London: RIIA.

Munich Re, 2000. Press releases and reports on www.munichre.com.

OECD, 2001. *The Value of Biological Diversity*, Paris: OECD.

Pearce, D.W. 1996. Global environmental value and the tropical forests: demonstration and capture, in Adamowicz, V., Boxall, P., Luckert, M., Phillips, W and White, W (eds), *Forestry, Economics and the Environment*, Reading: CAB International, 11-48.

Pearce, D.W. 1997. The political economy of the global environment, *Scottish Journal Of Political Economy*, **44**, 4, , 462-483

Pearce, D.W., Putz, F and Vanclay, J. 2000. *A sustainable forest future?* CSERGE, University College London, *mimeo*.

Perrings, C. 1995. Biodiversity conservation as insurance, in Swanson, T (ed), 1995. *The Economics and Ecology of Biodiversity Decline*, Cambridge: Cambridge University Press, 69-78

Perrings, C. 2000. *The Economics of Biological Invasions*, Cheltenham: Edward Elgar

Price, S. 2000. *Insurance responses to the Superfund legislation*, paper to 4th International Conference of the UNEP Insurance Industry Initiative, Oslo, 10-11 June 1999

Tol, R. 1998. Climate change and insurance: a critical appraisal, *Energy Policy*, **26**, 3, 257-262

Tengå, T. 1999. *Recycling insurance*, paper to 4th International Conference of the UNEP Insurance Industry Initiative, Oslo, 10-11 June 1999.

Tucker, M. 1997. Climate change and the insurance industry: the cost of increased risk and the impetus for action, *Ecological Economics*, **22**, 85-96

UNEP III (UNEP Insurance Industry Initiative), 1999. *The Kyoto Protocol and Beyond: Potential Implications for the Insurance Industry*, Geneva, UNEP.

Zuefle, R. 2000. Genetic engineering liability risk, *The Bottom Line, Newsletter of UNEP's Programme Finance Initiatives*, Issue 10, Spring.

Zwirner, O. 1999. *Examples of insurance products*, paper to 4th International Conference of the UNEP Insurance Industry Initiative, Oslo, 10-11 June 1999 and COP-5, Bonn, October 1999.