

Flood Insurance and Government: “Parasitic” and “Symbiotic” Relations

by Colin Green and Edmund Penning-Rowsell*

To be effective, flood insurance appears to require a partnership between the insurers and government: interdependence rather than independence. Relations between government and the insurance industry appear to lie on a continuum from the “parasitic” to the “symbiotic”. Changing circumstances appear to be pushing insurers and government apart, including the competition regulations that outlaw standard products. At the same time, insurers are making more demands on government for flood defence investment, so as to limit their liabilities. In parallel, government is becoming more and more concerned that insurance is not universal, and the socially excluded are those who suffer. As the insurance industry increases its demands for greater government intervention and policy change, it is in danger of becoming more like a parasitic extension of government, rather than retaining its autonomy and the ability to maximize its profitability within a more carefully crafted symbiotic relationship.

1. Introduction

To be effective, flood insurance appears to require a partnership between the insurers and government: interdependence rather than independence. This should be true in all countries where flood insurance exists (Berz, 2000), but this paper takes the example of Britain, where both parties have expressed concern at a significant deterioration in their relations in recent years (ABI, 2001).

It is often assumed that the interests of these two sets of parties are the same, and that the objective of flood management by government and its agencies is to reduce flood losses, and thereby assist the insurance industry in limiting its liabilities. But it is not. The objective of government should be to maximize the economic efficiency of the use of the catchment as a whole and, in particular, the use of flood plains and areas generating flood flows. Increases in this efficiency can be accompanied by increases in both flood losses and the costs of flood alleviation (Green, 1999). Indeed, flood plains were historically settled precisely because, as compared to higher ground, their advantages outweighed the sum of the losses from flooding and the resources required for flood protection (Penning-Rowsell *et al.*, 1986).

Equally, it is often assumed that the insurance industry exists to take risks on behalf of society, whereas in fact it exists to make profits for its shareholders and does so by only providing insurance cover for those risks where underwriting can be made to be profitable (i.e. where the risk/reward ratio is favourable to the insurers). In turn, if the costs to the insurance industry of managing a particular class of risk become too high, then it will be more profitable for it to withdraw cover from that risk or line of business, irrespective of what individuals or governments may desire to the contrary.

The nature of the partnership between government with its flood defence efforts and the

* Flood Hazard Research Centre, Middlesex University, Queensway, Enfield, London.

insurance industry seeking to manage its portfolios of risk is thus inherently complex. The partnership varies from country to country, and this variety is the subject of this paper.

2. Parasitic and symbiotic relations

The types of relationship and interdependence between government and the insurance industry appear to lie on a continuum from the “parasitic” to the “symbiotic” (Figure 1). The position of insurers and government on this continuum varies between different countries, not least because governments and national insurance industries have both different concerns and different complementary strengths (Green and Penning-Rowsell, 2002).

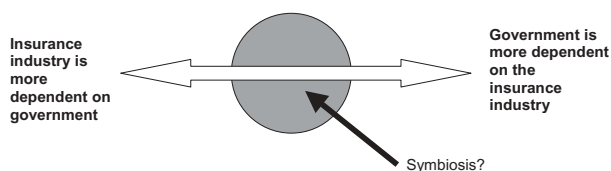


Figure 1: The “space” within which the relations between the insurance industry and government are developed: a parasitic or a symbiotic relationship

Thus in the U.S., the relationship between the insurance industry and the Federal Government is effectively “parasitic”. Put simply, the government bears the risks and the industry takes the profits. The U.S. government entered into this arrangement, in spite of its drawbacks, as a way of reducing its exposure to unmanageable claims for compensation for flood losses (Arnell, 2000). Essentially, therefore, the U.S. National Flood Insurance Program is an administrative device that allows the Federal Government to introduce controls over the standard and extent of building in flood risk areas, rather than simply being an arrangement for redistributing flood losses. The insurance industry, in this context, is more servant than master.

In other countries, such as Hungary, the state has traditionally provided flood protection to a high and consistent design standard, through a series of dikes along the Danube: the country has proportionately more floodplain than the Netherlands. The insurance industry will only provide cover against the residual risk of flooding in areas that are protected by these state-funded flood alleviation schemes (Halcrow *et al.*, 1999). Therefore the balance of the relationship is again more towards the “parasitic” than the “symbiotic”. Without the state there would be no flood insurance, although the situation is changing as the burden of replacing the dikes exceeds the country’s ability to pay, and policy is edging towards more non-structural measures.

Conversely, the insurance industry in the U.K. could argue that successive governments have been dependent on the insurance industry to the extent of being “parasitic”, in that universal flood insurance linked to household cover means the government has avoided the issue of itself paying compensation for flood victims (Green and Penning-Rowsell, 2002). That successive U.K. governments have been able to rely on (or to be dependent on) the insurance industry in this way reflects the unusual conditions in the U.K. Here there is a

highly developed and financially strong insurance industry, a relatively small area of the country at risk from flooding, and small rivers where the discharge and impact of major catastrophic floods are a relatively small multiple of normal annual events. The risks are therefore relatively low, and predictable.

The key theoretical question, therefore, is what balance of dependence and independence between insurers and government best serves the interests of the members of society that each serves. This balance implies a mutually beneficial or “symbiotic” relationship between the insurance industry (in its flood insurance role) and government, in all its various forms (including, in England, the Environment Agency). For this to be possible, it would seem that the two sides must have particular strengths that complement each other, and perhaps some common concerns. Each side will need to understand very clearly what are the interests of the other, and where compromise is possible between their competing interests in the pursuit of harmony and efficiency.

3. The changing economic and policy context of government-insurance relations

The role of insurance against flooding and industry-government relations needs to be considered in the wider context of the level of government flood defence investment and its trends, climate change, socio-economic change, and changes in our building stock at risk. In addition, catchment management, risk-based flood management, and the European Union’s water policies are important contextual developments.

From a national U.K. expenditure perspective, investment in flood defence is very small at about £5 per person per year. Annual average national flood losses are also low, at approximately £20 per person (OST, 2003). Even the projections of the increased sums required to cope with climate change have been very small: increases of about 50 per cent (DEFRA, 2003b). On the other hand climate change itself, which *appears* a major threat, needs to be considered in the context of the other parallel changes. At a conservative 2 per cent growth rate, our economy would be 2.7 times as large as it is now in 50 years’ time; at the 7 per cent annual average growth rates that characterize the advanced developing economies, their economies would be 7.6 times as large as they are now in 30 years’ time. Seen from this perspective, surprise-free climate change would have relatively small impacts on our economic situation: the degree of changes in precipitation and run-off that are predicted to result from climate change are well within the error margin of predictions about the structure and nature of those economies (Reynard, Prudhomme and Crooks, 2001).

But if the changes in governance that are considered in the Foresight studies are added (OST, 2003), then the future could be radically different, and radically different social and economic structures are possible. To counter adverse possibilities it is important for the insurance industry to consider what kinds of social, economic and technological change will affect its interests. In the recent past, changes in technology, the structure of the economy and in building forms have tended to increase the losses from floods: both the overall structure of the economy and of the individual elements that make up the economy have become increasingly susceptible and hence liable to flood damage (Green and Penning-RowSELL, 2002; Parker and Penning-RowSELL, 2002; Penning-RowSELL *et al.*, 2002). This obviously creates the danger of insurance payments consistently exceeding premium income. For example, British industry is shifting from “dirty” to “clean” processing, from engineering to electronics and to “the knowledge economy”, biotechnology, and nanotechnology. In consequence, the time taken to dry and clean a plant before it can return to production after a flood is also increasing, and so too will business losses. The

contravening trend is for better contingency planning, and more opportunities for selling business continuity insurance.

Any reduction in flood susceptibility to reduce losses is most affected by building types and their fittings. But there are significant inflexibilities here: the rate at which the infrastructure in our economy can be adapted to different sources of change, such as increased flood risk, depends upon the rate at which the existing stock is replaced. For the U.K. stock of dwellings, this rate is currently around 0.1 per cent. Hence the rate at which the total stock can be adapted, for example to incorporate source control to mitigate run-off, is relatively slow. Consequently, the predicted growth in household formation, and hence the pace of house-building, presents the greatest opportunity for incorporating flood resistant changes into the stock of dwellings. At the same time, on current trends, those newer buildings would be more rather than less susceptible to flood damage than the existing stock, and might need higher insurance premiums to match this risk. If the “bundled” system of flood insurance, whereby flood, fire and theft insurance are sold together, becomes unbundled, such higher premiums may mean lower take-up.

The Aarhus Agreement on public involvement in decision-making (Department of the Environment, Transport and Regions, 2000) and the implementation of the Water Framework Directive (WFD) (European Union, 2000) are setting the framework for water management for the next 20 years. Each should create opportunities for the insurance industry to have a greater role in catchment management decisions and thus seek to limit its liabilities. This is because both stress the requirement for holistic catchment planning in which land and water management is undertaken in an integrated manner, and each advocates a decision process that involves the public and other stakeholders to the maximum possible degree. These two crucial developments are therefore mutually reinforcing.

The WFD requires that a competent authority be designated by the national government to prepare and implement a catchment management plan. Therefore, a critical issue is: what form should this competent authority take? The Environment Agency appears to lack the powers to implement an integrated catchment management plan that will satisfy the requirements of the directive. This will require the co-operation and co-ordination of a large number of different groups including the land-use planners, the sewerage and water companies and the insurance industry.

But there are threats here for flood insurers. The WFD also means, in principle, that there will no longer be flood alleviation projects *per se* but simply catchment management actions, only some of which will have improved flood management as a sole, principal, or secondary aim. Multi-functional solutions are likely to become more common. But it is unclear how far it is possible to have integrated catchment management with the kind of functional budget structure that characterizes flood defence in the U.K.; in the longer run, it seems likely that the current system of funding for flood alleviation works, as currently under review (DEFRA, 2003a), will be abolished and replaced by some system of catchment management funding. The replacement of the historic separation, even isolation, of flood defence as a single government-led function, will mean that the insurance industry will have a harder task in political lobbying for the kind of expenditure enhancement in flood defence that it has pursued rather successfully over the last five years (ABI, 2001, 2002).

4. What is a flood, and why is this important?

What constitutes a flood, flooding, and its causes (Table 1) is important for the insurance industry and for government, because that definition demarcates the responsibility

for the impacts of that flooding, and targets who might pay for its mitigation and have authority to act in this respect. In addition, the nature of the conditions attached to insurance and reinsurance also define what a flood is and therefore serve to control insurers' liabilities (in the same way that these conditions set a standard for a windstorm as an event with winds greater than, say, 60 kph). Such insurance and reinsurance conditions, again, vary from country to country (in Australia, for example, water run-off over the land is not covered (Smith, 2000)) but if varied significantly within one market can serve to distort competition and confuse consumers (Berz, 2000).

*Table 1:
Relative threat from different causes of flooding*

Cause of flooding	Annual probability of flooding	Per cent of national annual losses	Catastrophic loss potential
River	Medium	High?	Medium-high where the area is currently protected by embankments
Surface water run-off	High	Low?	Low
Sea	Medium	Low?	High where the area is currently protected by embankments
Dam failure	Low?	Negligible	High
Canal aqueduct	Low?	Low	Probably low
Water main	High?	??	Low
Sewer	High	High?? OFWAT figures imply an average 3,500 properties that flood on an annual basis	Low

Moreover, a flood is more easily recognized than defined (see Gately, 1973), since there are a number of mechanisms that can result in water causing damage and disruption (Table 2). However, any insurance policy that explicitly excludes either all or some forms of flooding must define what a flood is and, more importantly, detail the specific causes of floods that are excluded. Without clarity here, ultimately related to legal prescriptions, there will be endless disputes which will discredit both insurance itself and the U.K. government's reliance on it for damage compensation. In this respect, government would want all types of flooding to be covered, so that the public is reassured, whereas insurers may wish to exclude certain types of flood so as to limit liability.

Complications arise here because floods may develop from a multiplicity of causes, acting singly or in combination. Moreover, to compound the complications, flows of soil or

*Table 2:
A classification of the causes of flooding and their implications¹*

Cause of flooding	Responsibilities, etc.
River (main/non-main river)	Main rivers are the responsibility of the Environment Agency; non-main rivers are the responsibility of the local authority or riparian owner. There is no particular logic to the classification of rivers into “main” and “non-main”. Both intensified development and climate change can be expected to increase the frequency and severity of flooding from these watercourses.
Surface water run-off	Thunderstorms can overwhelm surface water drainage systems (“urban drainage”) which are generally only dimensioned to carry rainfall from the ten-year return period rainfall event (at most). If climate change promotes greater storminess, these flooding problems could worsen.
Sea (coastal/estuarine)	The responsibility of the coastal protection authority who may be a local authority, port authority, the Environment Agency or local landowner. Risk is increasing as a result of sea level rise induced by climate change and other factors (e.g. land subsidence).
Dam failure (artificial/natural)	Many dams in the U.K. date back to the Victorian era or even to the Industrial Revolution in the 18 th century, and those dams tend to be close to and upstream of urban areas. Because of their age, the form of construction of the dam and subsequent modifications are not always known.
Canals/aqueduct	The canal and aqueduct system is integrated into the land drainage system and in some cases, a canal is at a higher level than neighbouring urban areas. There have been a few instances of canals causing floods.
Water supply mains	Water mains differ in size; bursts by large mains have caused a number of floods, with several multi-million pound losses occurring in London in recent years. Water main bursts are a concern of London Transport who have recently spent £100 million on flood protection for the London underground system.
Sewer surcharges/collapses/pump failure	A high frequency event: OFWAT performance criteria for the water utilities relates to the number of properties who are likely to experience flooding twice in ten years. The number of such properties is known: OFWAT (1999b) gives a figure of 2.5 per 1,000 properties as the proportion of properties experiencing flooding each year, but not the numbers likely to be flooded less often.

mud are not readily differentiated or distinguishable from flows of water; any high velocity flow of water acquires a heavy load of sediment amongst other debris. So what, officially, is a flood? In some circumstances, and for some systems of insurance, this is a critical question, particularly those systems which insure explicitly and generally against “a flood”

¹ The number of properties at risk from the different kinds of flooding is generally unknown.

but not other forms or causes of water damage. Burst pipes or tanks under the control of the individual consumer are not usually classed as “a flood” but often are included in flood insurance cover.

In general, “flooding” can be conceptualized as being inundated with someone else’s water, whether that water has been conveyed to the flooded property by means of a natural or artificial channels or pipes, or directly over land (Wisdom, 1975; Howarth, 2002). A property may however also be inundated as a result of the run-off from precipitation falling on that property. This may occur either because the drainage and storage on that property are inadequate to cope with the amount of run-off generated, or because of inadequacies or problems downstream of that property. For example, the sewer system may have inadequate capacity to cope, or it may fail as a result of a sewer blockage, or in low-lying areas the pumping capacity of water evacuation systems may be inadequate or fail. Since both the drains and storage for individual properties and also the sewer network are dimensioned to carry only the designed-for rainfall event, some precipitation events will cause localized flooding. Is this an act of God, who sends the rain, or of government and its regulators which help to decide the size of the sewers and the extent of sewerage investment?

Determining the cause of an inundation can be difficult but it may also determine whose responsibility, if any, it is to resolve the problem (Howarth, 2002). In the U.S., payments under the Federal Flood Insurance Programme are triggered if at least two properties are affected (Arnell, 1984, 2000). In France, however, payouts are not triggered until the Prefet declares a flood disaster (Rosenthal and Bezuyen, 2000): an explicit decision of government. Overland or channel flow of run-off is not, however, the only possible cause of flooding, and others such as groundwater flooding are harder to predict and hence to insure against.

A “hand-stitched” approach to insurance and premium-setting is what should occur, because flooding is highly localized and the probabilities are highest (or the impacts most severe) where the cause of flooding is most site-specific (e.g. urban drainage problems; dam bursts). For large industrial or commercial properties the premium may be tailored to the specific property, but for domestic insurance only relatively broad premium banding can be justified because the costs of premium-setting could otherwise become excessive. The development of GIS databases delimiting flood plain areas is reducing the cost of setting premium rates according to risk but the problem remains: where flood damage is likely to be greatest, there are the greatest difficulties in accurate premium-setting, and hence greatest exposure to the risk of the insurer encountering significant losses. There is also a real debate here about the access of the public to the data. Governments would want free access to all data (Berz, 2000), but insurance companies are bound to guard their data jealously, as it gives them competitive advantage, not least by pinpointing where cover is not to be offered as the risks are too high. Indeed, insurance cannot function as flood extent and probability data are improved, and made more and more public, leaving governments with a significant problem.

Given the high incidence of sewer-related flooding, properties below ground level (below grade) present a particularly high risk. The risk to life, here, also has insurance implications both in terms of life insurance and liability insurance (Environment Agency, 2003). After dams, the largest number of potential deaths is probably in relation to failure of flood or coastal embankments. Chatterton *et al.* (1993) estimated that the number of deaths following a breach in the coastal defences of the Wentlooge Levels in South Wales would be between 175 and 350, although the statistical basis for estimating the risk to life from

flooding is poor (Graham, 1999): again, the evidence basis for rate-setting is poorest where the consequences of error are greatest.

What is a flood determines who is responsible, and in the U.K. there is a plethora of fragmented flood defence responsibilities (National Audit Office, 2001). For the insurance industry, the government is an easy target (hence the demands for more flood defence investment), but in reality most flood damage is not caused by the floods for which the U.K. government is any longer effectively responsible: the water companies were privatized in 1989 and they now manage the system of urban storm sewers which appears in many localities to be inadequate for the flows that are occurring (OST, 2003). The simple ideal of a strong partnership between government and the insurers is made less practicable as the number of stakeholders increases.

5. Where are the flood losses?

In theory, insurance is about balancing claims and income. The former is a function of the probability of the risk and the magnitude of losses; in the absence of government intervention, the latter is a function of the number of policies, and the population's perceived need and willingness to pay for cover.

Compared to domestic fires, the degree of risk of a flood for any one householder at risk is high. The chance of a fire in a property that will be recorded in the Fire Service statistics is 1 in 340 per year; few areas at risk of flooding will be protected to better than a 100-year design standard. On the other hand, a relatively small proportion of the country is at risk of flooding so the total number of dwellings that are flooded in the average year should be comparatively small, and even the widespread autumn 2000 floods only affected approximately 10,000 properties (Penning-Rowsell *et al.*, 2002) and that figure, moreover, is considered by many to be an exaggeration (Environment Agency, 2003).

The insurance industry is seeking increased flood defence investment, to reduce losses and claims (ABI, 2001, 2002), but the effect of increasing the design standard of protection has a relatively small effect on the reduction in expected flood losses in an area and hence on insurance payouts. Table 3 gives some simulated flood damage and probability data. The impact on claims to the insurance industry of increasing design standards of protection

Table 3:
Simulated flood damage and probability data

Return period	Event loss (£)	Interval benefits (£)	Cumulative (£)	Above design (£)	Total (£)	Incremental benefits (£)
1	0					0
2	2,000	500	500	1,000	1,500	1,500
3	4,000	500	1,000	1,333	2,333	833
5	8,000	800	1,800	1,600	3,400	1,067
10	40,000	2,400	4,200	4,000	8,200	4,800
20	60,000	2,500	6,700	3,000	9,700	1,500
100	80,000	5,400	12,100	800	12,900	4,700
500	320,000	1,600	13,700	640	14,340	1,440
Total		13,700				

depends on the shape of the loss probability curve at its upper extreme (Penning-Roussel and Green, 2000), where it is at its most stable.

One consequence is that it is almost certain that the majority of losses to the insurance industry arise from flooding from inadequate sewers rather than from rivers or the sea. The revised standard of service with respect to flooding from sewers, protection only where it will not cost more than £52,000 per property (OFWAT, 1999a, 1999b), is that the design standard shall be for the ten-year event. In turn, the insurance industry would in general reduce its average annual claims total by seeking improved standards for sewer-related flooding rather than increased expenditure on, or in the design standard of protection for, flooding from rivers and the sea. The complexity here will be compounded by the fact that most river-based flooding is now sewage-contaminated as a result of combined sewer systems or the flooding of floodplain-located sewage treatment works, making the determination of responsibility even harder.

There are indications that one effect of climate change in the U.K. will be to increase the peak intensity of rainfall and for sewerage systems it is the intensity of rainfall that causes the problem. Hence climate change should be expected to increase the number and severity of sewer-related floods. Since the equivalent current value of the sewer system is £108 billion, some 70 per cent of the value of the total assets of the water industry, adapting to such a change in flood risk by increasing design standards will be both expensive and would take many years. The strategy of insurers to attempt to limit liability by seeking higher levels of flood defence investment looks destined to be a long and rocky road.

6. Design standards and disasters

The insurance industry is concerned about the standards of flood defences because, generally, that standard triggers their liabilities and payments. The Environment Agency has been holding on to the concept of fixed or consistent standards of flood protection for given types of urban areas. Conversely, DEFRA (the Department of Environment, Food and Rural Affairs) has adopted the view that it is necessary to consider how to manage all floods and not just those floods up to some design standard of protection. We would now go further and claim that the concept of a design standard of protection is a snare and a delusion and should be abandoned completely (Green, 2002).

That this is so is because, firstly, the estimates of flood return periods are subject to significant errors; the return period of the most extreme flood that can be reasonably accurately predicted from a given length of streamflow record is approximately twice the length of that record. Therefore there are few U.K. watercourses where satisfactory predictions can be made for floods with return periods greater than one in 50 years, and these depend upon conditions of stationarity, which is unlikely: runoff will have been changing over that period, with urbanization, and now with climate change. Arguments for higher design standards are diminished in that the reliability of predictions of, say, the 500-year return period flood will be very low.

With such poor predictions the Environment Agency's indicative flood maps, used by planners and insurers alike, should avoid using lines to delineate flood outlines and use shading areas instead. In turn, the insurance industry should not place too much reliance on these flood maps, not least where they still rely on the crude Centre for Ecology and Hydrology modelling of flood plain areas (Penning-Roussel and Wilson, 2003).

A shift to the approach of managing all floods rather than some also means that the information needs for flood risk management and for the insurance industry will

progressively diverge. For flood risk management, flood maps will emphasize critical thresholds at which points the behaviour or consequences of floods will change, for example with the breaching of artificial or natural embankments. They will progressively become less concerned with plotting the flood outlines of events with different return periods, as insurers need.

Secondly, it is inevitable that sooner or later there will be an extreme event somewhere in each catchment and it will be necessary to manage this flood rather than simply regret that it is above some rather arbitrary design standard. People flooded nearly always believe that the area in which they live was allowed to flood in order to protect other areas; in an extreme flood, this is exactly the kind of decision it will be necessary to make. Faced with a 500-year return period flood, it will be necessary to make deliberate decisions to allow some areas to flood and so create flood storage areas in order to protect other areas which are more important. In turn, it is necessary to consider how a flood defence system will perform in an extreme event; some flood defence projects such as channel deepening reduce the extent of flooding from all events and not just those up to the design standard of protection.

Thirdly, the concept of a design standard of protection is ambiguous except in the case of an embankment scheme. In that case, until the embankment fails, no property protected by the embankment is flooded, except possibly as the result of local drainage problems. In other instances, such as urban drainage schemes, the only meaning of a design standard of protection is that no single property is flooded in an event of this return period; most properties will have a higher standard of protection.

In this respect, decisions as to “standards” implies to the public that they will be uniformly applied, as in other areas of public policy. But it is already a DEFRA requirement that the managed realignment option be considered in riparian as well as coastal situations (DEFRA, 2003b). Managed realignment is more likely to be adopted in agricultural areas than in urban areas and this will mean that at least some isolated properties will be “left to flood”: those on the flood side of the line are consigned to their fate. Calls have been made for land abandoned in such ways to be purchased by the state; the Treasury can be expected to resist strongly such proposals as a dangerous precedent in which a government compensates people for it not doing something (e.g. not providing flood or coastal defence) for which there is no legal requirement that it should do anything (Howarth, 2002). The insurance industry in its turn will have to decide what to do about properties that were once protected but now are to be left unprotected.

Developments in Europe mean that it will be more and more difficult for British governments to continue with their traditional policy of not compensating the victims of natural disasters. Faced with a repeat of the 1953 North Sea flood, immediate comparisons would be drawn between the actions of the government of the U.K. and those of the Netherlands and Germany, particularly where E.U. money to be made available for compensation payments. In consequence, sooner or later, a U.K. government will have to define a policy for responding to disasters, including the definition of what is a “disaster”, rather than simply leaving this to insurers. In the worst case, this definition will be made in the immediate aftermath of a serious event, in the middle of a political storm. The insurance industry may wish to discuss now with the government what form that policy might take. Even if the government is not interested in adopting a new policy now, the industry might find it useful to have a proposed policy in a government filing cabinet ready for instant adoption when the disaster strikes.

All the above means that compensation for flood losses by government should not be ruled out, and it may come to pass if commercial flood insurance is withdrawn for one

reason or another. Such compensation would avoid the problem of the uninsured and the underinsured. On the other hand, it would involve the government in the problems of assessing claims and making payments, areas where it lacks both experience and capacity. An alternative is to agree a programme of coverage with the insurance industry where, perhaps, the government would act as reinsurer of last resort.

7. Distributional issues

As in any risk-related business, the distribution of gainers and losers from flood insurance is not symmetrical: some people gain, and some lose. Regarding the partnership between the insurers and government, the problem for the insurance industry, not least in trying to influence government, is that the government has views about what constitutes “fairness”.

In this sector this is expressed as a concern about social exclusion when the take-up of insurance increases with income: those who arguably most need insurance do not buy it (the rate of insurance for house contents in the lowest decile income group is only 50 per cent). In addition, low-income groups are at a higher risk from some other classes of losses than are the better-off, and the practice of “red-lining” (where insurance is refused) already occurs for some of those losses (e.g. burglary). Strategically, therefore, the insurance industry – in furthering its partnership with government – would be advised to develop ways of increasing the proportion of the population that is covered by flood insurance. This could include better insurance “package deals” for Housing Associations or local authorities, or better marketing. For government it could mean, if commercial insurance is not able to respond in some way or another, the automatic inclusion of an insurance cover element in housing benefits or tax credits targeted at the poor.

Flood damages are not distributed to match the factors causing run-off. If the distributional implications of the existing system of flood alleviation provision and funding are considered, then given that it is likely that the majority of people flooded are flooded by “other people’s run-off”, the current cross-subsidization element in insurance, whereby some people pay and receive no benefit whilst others benefit but pay less than an actuarial rate, may be appropriate as an application of the “polluter pays” principle. Essentially, the other policyholders are bearing the risk rather than the shareholders.

In theory, those who are flooded could recover their losses from upstream and uphill landowners if they could show that their actions had caused the flood. But this theoretical right is unenforceable in practice, not least because of the cost of taking such action. As catchments are more extensively modelled, it may become a route open to those who are flooded. In the meantime, however, there are obvious implications for those companies who provide legal liability cover to either individual land-owners or to public authorities, since such a case would certainly include the planning authority for a number of reasons including the principle that those who have made development decisions have some responsibility for the consequences.

However, because the other policyholders are sharing the risk by covering claims from those flooded, there is a distributional question as to how much risk they should share: whether or not the level of coverage for the individual policyholder should be capped to limit the risk to others. A question here concerns the distribution of sums insured. If the values at risk (the “total sums assured”) for properties on flood plains are higher on average than for the country as a whole, then the redistribution is from the less well-off towards the better-off: the premium payer in working class Salford may be subsidizing the affluent

floodplain dweller in Richmond. This is more difficult to defend than a redistribution in the opposite direction.

The logic is then that the sums insurable under the existing system should be capped, with the insured either bearing the losses above this amount or having the option of purchasing actuarially fair additional cover for the amount above this limit (at greater average cost than the current cover). This latter approach has the further advantage of providing the policyholder with an incentive to take action to reduce the flood losses that they experience so as to contain the losses within the cap figure.

Repetitive losses also bear examination: a significant proportion of the claims on the U.S. National Flood Insurance Program (“NFIP”) are from properties that have been flooded on a number of occasions (Czerwinski, 1999). It is obviously an option for the industry to refuse to continue to provide insurance cover to such a property (after all, insurance only works when flooding is a fortuity and not predictable); this would help the industry but would not address the underlying problem. Whilst the sewerage companies could buy out properties affected by such frequent floods, the Environment Agency appears to lack the powers to do so. That the sewerage companies have proposed schemes to reduce the risk of flooding from sewers with a cost per property in excess of £52,000 suggests that the cost per property of some schemes proposed by the sewerage companies exceeds the value of the property itself.

The insurance industry appears not to be concerned about distributional issues, yet this is one of the defining rationales of government. Indeed it is one of the reasons that insurer-government relations become parasitic, when government requires insurers to pursue its policies in such a way as to take them outside the realm of what market forces make commercially viable and it provides in return some special privilege. One such privilege is the mandatory “bundling” of household insurance which make flood insurance compulsory for all who insure, irrespective of risk. Yet there is a real chance that such bundling is deemed anti-competitive by E.U. competition regulators, thereby forcing government and insurers away from the partnership arrangement that seems necessary for flood insurance to be most effective.

8. The roles and strengths of the insurance industry and of government

In looking for a partnership approach, whether “parasitic” or “symbiotic”, we need to examine both parties and their comparative strengths (Tables 4 and 5).

Governments should take a wider perspective than the insurance industry can or should; it is when governments do not do this that they are seen to lack any clear vision. In the U.K., flooding is not a major problem even compared to other water-related issues such as river water quality. Annual investment in, and the operating costs for, wastewater collection and treatment dwarf the requirements for flood management. But at the same time a number of flood and coastal defence schemes have run into strong opposition on environmental grounds, and therefore the field is not unproblematic.

One clear difference in the perspectives from the two sides is that government and the Environment Agency look at the probability of a flood on a river. In comparison, the insurance industry is concerned with the risk of a catastrophic loss; this is likely to involve a number of rivers. The autumn 2000 floods illustrate that it is the probability of a given set of *meteorological* conditions which is important in determining the risk of a catastrophic event and those floods demonstrated the limitations of focusing solely on the risk of a flood on a particular river (Penning-Rowsell *et al.*, 2002). In this respect, the probability of a

*Table 4:
Government and insurance: the concerns of the two sides*

Government	Insurance industry
Holistic catchment management	Average annual losses
Evaluating public expenditure in terms of economic, environmental and social desirability	Catastrophic loss potential
Social inclusion and vulnerability: differences between individuals, households and groups	Lack of a level playing field for the companies making up the industry: differences between conditions governing different companies
Changes in risks	Changes in risk
Compensation as a precedent	

*Table 5:
Government and insurance: the strengths of the two sides*

Government	Insurance industry
Regulation	Assessing losses
Land use planning (e.g. for source control)	Paying compensation
Catchment management	
Depth of pocket: financial resources	
Risk assessment (?)	

simultaneous 200-year return period flood on the Severn, Trent and Thames is somewhere between 1 in 200 and 1 in 8,000,000; but hydrologists do not appear at present to have a better estimate.

Whilst this government is concerned with reducing social exclusion, and thereby alleviating those circumstances that inhibit individuals, households or groups from being able to access jobs, education and health care, the insurance industry has become concerned that the different companies are not competing on a level playing field. If some companies automatically include cover against floods and others do not, so as to reduce their charges, then the latter will be able to offer lower premiums than the former. The existing agreement automatically to include cover against floods in domestic insurance policies has probably lasted so long because of the lack of information, at a low cost, as to the relative risks of flooding in different areas.

But a generic problem that is emerging in insurance is that new techniques are emerging (e.g. gene testing, GIS) that allow the differentiation of risks between different populations at relatively low cost. This enables “cherry picking” of customers, with a competitive advantage going to those companies who can cherry pick best at the lowest cost. If those who are not cherry-picked then have to be supported by the rest of society, then

reductions in premiums to those who are cherry-picked may be offset by the additional costs of supporting the rest through national taxation.

There may therefore be no net societal gain from improving methods of assessing risks, but an extra burden for the state. A simple government response would then be to continue to require, through legislation, all domestic insurance policies to include cover against floods. This would enforce a level playing field for the insurance companies but, as indicated above, might be deemed anti-competitive. More generally, because of these differences in concerns, there is obvious scope for conflict: governments may not act in the interests of the industry and the insurance industry may not act in ways that are consistent with the government's objectives. Neither may have adequate incentives to identify ways in which these potential conflicts are reduced.

Governments and private industry have both different capacities and different legitimacies. Governments are accountable to the electorate and they are expected to act in terms of some vision of the good of the country whilst companies, accountable to their shareholders, are expected to seek to maximize profit in the short or long term. Governments are also expected to take account of multiple and conflicting concerns; industry is expected to take a much narrower perspective, although something wider than the maximization of profits in the short term. Governments can levy taxes but companies are subject to market forces. Governments can make and enforce laws, companies may attach conditions to their offers of insurance cover. Companies making conditions compulsory, such as levying what is in effect a tax by making flood cover mandatory, lack legitimacy. Equally, whereas companies in an industry are expected to compete, the different sectors of government are expected to co-operate. When a company gets into a position to levy a tax (e.g. compulsory flood insurance), then it has become a monopoly; when companies co-operate to reduce competition, such as by offering a standard bundled insurance product, it is equally undesirable.

Any public-private partnership needs to recognize these different legitimacies and capacities. At the same time, insurance is arguably a special kind of service industry. Buying insurance is seen as a conservative and responsible act, as with saving for old age, whilst society itself could be described as a mutual insurance system. This creates expectations in the public as to how insurance companies will behave, some of which are likely to conflict with the expectations of a profit-maximizing private company. Actions taken by the industry that appear to conflict with the public's and, in consequence, the government's expectations are likely to be damaging and risk the response of legislative action to enforce compliance with the public's wishes.

Governments have a capacity for regulation and land use planning; more importantly, they have a legitimacy for doing so in a way that the industry does not. If there should be no taxation without representation, so equally should there be no law-making without representation. In addition, because governments do regulate and plan, it will be cheaper for governments to extend regulations and planning than for the insurance industry to start such a function, and markedly cheaper than if each insurance company were to attempt to undertake such actions individually. Equally, risk assessment is a classic public good. It is generally considerably cheaper for the government to identify the relative risks of flooding and to make that information publicly available than for each company to seek to do so for themselves, although such extra costs to industry may be tolerable if premium income can compensate or 'cherry picking' leads to increased profitability.

Governments in many countries, and specifically the U.K., have greater financial strength than either individual insurance companies or the industry as a whole. Where the

government is not formally the reinsurer of last resort, as in France (Gaschen *et al.*, 1998), it is so informally. If any insurance company were to fail as a result of a catastrophic flood, then it is difficult to imagine any government simply abandoning those who have outstanding claims. In this case, governments are left exposed to an unquantified liability, and it may be preferable to define this liability, as in France.

The industry is good at assessing losses and making payments, or at least it ought to be since this is the key interface with the consumers. Governments lack either skill; equally, it is an advantage for a government to have someone else to blame when problems occur and so there are benefits in having these functions performed by the insurance industry, independent of government.

9. Options for the insurance industry (and for government)

Flood risk in the U.K. may increase rapidly over the next several decades (OST, 2003), and the levels of profitability of the insurance industry have suffered significantly since the Twin Towers attack in New York on 11 September 2001. A number of options for the insurance industry have been identified in the preceding discussion, and there are others. All can be grouped into one of three strategies or classes: changes in the cover for individual properties; changes in the nature of insurance cover for the flood risk; and attempts to change one or another aspect of government policy. All three have dimensions of, and implications for, greater independence or dependence in government/insurer relations.

It must be recognized that changes in the cover for individual properties, and excluding some from cover, have the potential to bring about changes in government policy towards the role of flood insurance and, indeed, may be intended to do so. What it does mean is that the industry, in contemplating such changes, needs to consider what would be the likely retaliatory reaction of government. A range of changes in cover could be made (Table 6), and whilst this paper focuses on insurance coverage for domestic householders, the insurance industry would be advised to require both that commercial structures which have significant areas below ground are flood-proofed and that safe means of escape to above ground are also provided.

Table 6:

Examples of changes in the cover provided for individual properties (see also Green and Penning-RowSELL, 2002)

Contents coverage against flooding could be limited to an indemnity basis. This would provide the householder with an incentive to take action to reduce flood losses since they will value their possessions at more than their second-hand value. It also reduces the industry's exposure.

The maximum cover available under flood risk could be capped, perhaps with the option of further cover being available on an actuarial risk basis. As with the option of providing only indemnity coverage, it has the twin advantages of reducing the industry's exposure and providing incentives for the householder to minimize flood losses.

(continued overleaf)

Table 6:
Continued

Deductibles could be increased to a much higher level; this would reduce the industry's exposure but at the cost of shifting the risk and loss burden to the householder.

Some highly susceptible household contents, including electronic goods and antiques, could be excluded from coverage against flood losses.

Coverage might exclude building fabric losses from flooding for certain types of structure (e.g. those with chipboard floors, mobile homes, etc). Since new construction is generally more susceptible than old style mass masonry and heavy sectioned timber construction, this would rapidly affect new development.

Where properties are damaged in a flood, the insurance industry could require that the property should be flood-proofed as part of the repairs.

The industry could refuse to extend cover to building extensions unless those extensions were flood-proofed, and, possibly, flood-proofing were also undertaken for the rest of the property. This would have an incremental effect and would stabilize exposure, with exposure falling if the requirement of retro-fitting flood proofing to the property as a whole were to be included.

The industry could require flood-proofing as a condition of insurance for all new properties in designated areas. However, there are generally economies of scale from structural flood protection so that providing a flood defence dike, for example, is likely to be cheaper than flood proofing individual properties.

The industry could refuse to cover any new development in designated areas. This option has two variants. Firstly, it could refuse to cover any new development at all in those areas irrespective of whether or not the area has flood protection. Secondly, it could refuse cover to any development in those areas unless protection or flood-proofing were to be included as part of the development, or adequate provisions are made to provide protection as part of a wider scheme (e.g. subject to the developer depositing an agreed sum in an account established specifically to fund flood alleviation works for the area). The first variant above is best seen as a negotiating position because development plans are the outcome of a democratically accountable process, as is the granting of planning permissions. Planning itself is a process of balancing multiple conflicting objectives and constraints. Thus, the insurance industry cannot expect to replace this process with a single-constraint planning process driven by the concerns of a single stakeholder. On the other hand, the second variant is probably to push at an open door; the approach is immensely attractive all round, except to developers, and not least to the Treasury.

The industry could refuse to cover properties that have already been flooded once; this leads logically to a process of progressively withdrawing from coverage against flood losses. In effect, this is a slow change in the nature of insurance against flooding and politically it is likely to be preferable to discuss such an option openly with government.

(continued overleaf)

Table 6:
Continued

The industry could limit coverage to some kinds of floods whilst specifically excluding floods caused by other reasons. Theoretically, it would be possible to exclude flooding from sewers, the largest component of annual losses, in this way. In practice, it would be difficult and expensive since it would be necessary to determine for each claim the specific form of the flood causing that loss. In public relations terms, it is unlikely to be a success, inspiring instead complaints and derision from consumer advocates and journalists, together with protracted litigation.

The industry could seek to set actuarial (“technical”) premium rates for the flood risk, with insurance against flooding being an optional addition to standard policies. To do so would be relatively expensive and since the premiums would be significant, it may be seen as another way of seeking to withdraw from coverage of the flood risk. As such, some adverse government response would be almost inevitable and it is likely to be better to seek to negotiate that response.

The industry could refuse cover except where there exists a standard of flood protection to at least a specified standard. In effect, this would remove sewer flooding from cover and would require the development of sewer flood risk maps.

The industry could provide advice to the policyholder as to what to do in the event of a flood. The industry is in a better position to do this than other parties who fear the risk of liability if their advice is not correct in the particular circumstances.

The industry could provide recovery advice to the policyholder. The time of a claim is the period when the industry has best contact with the consumer and hence is the opportunity to impress them. The consumer at that time is also under intense stress and lacks knowledge as to the best course of action to adopt. Potentially, therefore, this is a good marketing strategy.

Changes also could be made in the nature of insurance cover against flooding (Table 7). In general, the insurance industry should seek to develop ways of extending flood insurance coverage to those who do not have insurance cover at present, particularly those covered by the government’s actions targeted at reducing social exclusion. In several ways, this model is the inverse of the variation of the French, where small flood events are covered by the industry and large events are covered through a government-backed pool. In the “Hungary” model, the government, through compensation, wholly covers damage from frequent events together with part of the losses from extreme events, whilst the industry covers the remaining losses from the more extreme events. The brief for the Hungary study was explicitly to save the government money.

A variant would be a shift to the U.S. system where the risks are entirely borne by the government, and the industry in effect takes a commission for writing the policies. There seems to be no particular reason why a U.K. government should agree to adopt this system, as opposed to the French system, given that U.K. governments do not suffer the constitutional limitations that resulted in the NFIP system being adopted in the U.S.

*Table 7:
Examples of changes in the nature of flood insurance cover (see also Green and Penning-
Rowsell, 2002)*

The industry could withdraw flood coverage altogether; this is best seen as a ploy to get the government's attention because it will inevitably result in some government response. That response will not necessarily be to the greatest advantage of the industry and instead the insurance industry should take specific and feasible proposals to the government. It should not be deployed in a threatening manner but delivered in terms of being in the best interests of the insurers' policyholders.

The simplest strategy would be to propose that the government require all those providing insurance to domestic properties automatically to include coverage against the flood risk. This is simply to formalize the existing agreement and to make it binding on all insurers. This ensures a level playing field between companies. It might be linked to a wider discussion as to which risks the industry would not differentiate on between consumers on the basis of identified risk.

Alternatively, the industry could propose a shift to the French system where all the purchasers of domestic insurance are surcharged, as in the current U.K. system, but with the difference that the income is held in a specific pool and this fund being backed up by the government. A variation of this model would define a threshold for total insured loss in any period. Below that loss figure, the losses would be covered by insurance companies under the existing system; above that figure, the losses would be covered from the disaster pool. This would avoid the problem of the French system which is that the Prefet has to declare a disaster before the disaster pool can be drawn upon. In this way, small floods, such as from sewers, would be covered by the companies but their liability would be capped.

A further alternative is a layered system of insurance. This was proposed for adoption in Hungary where currently the government has compensated flood victims and flood insurance is only available in areas protected from flooding (Halcrow et al., 1999). In that model, it was recommended that the bottom tier be funded by government; the middle tier would be similar to the existing system in the U.K.; and there would be a top tier of actuarially based ("technical") insurance. Thus, the bottom tier would be universal in coverage but the amount of coverage would be limited to the likely losses of low-income households. This would cover those who currently have no insurance cover. It provides an incentive for government to invest in the appropriate level of flood alleviation and applies the polluter-pays principle. Losses from frequent events, which tend also to be relatively shallow floods, would be wholly covered by this tier of cover. For more extreme events, only part of the losses to the individual household would be covered through this tier. The second tier would be available only to those who purchase insurance and would cover losses above those automatically covered under the first tier. Again, for the reasons discussed earlier, the maximum amount covered under this tier would also be capped. A third tier, for those wished to purchase it, would be an actuarially based ("technical") insurance policy.

A third strategy for the industry would be to attempt to change one or another aspect of government policy (Table 8). When seeking to influence government policy it is likely to be appropriate for the insurance industry to emphasize the coincidence of the national interest and the concerns of the industry: an emphasis on symbiosis. Equally, it needs to consider who may be its allies with regard to particular proposals and who will oppose them.

Table 8:

Examples of changes in government policy that could be pursued by the insurance industry to control its liabilities (see also Green and Penning-Rousell, 2002)

To seek to change building regulations (e.g. so that they require ground floor structures which are flood resistant: ground floor partitions that are independent of the floor structure, etc). This approach needs to be costed; the relative effects on costs are likely to be greater for low cost housing than for upper market housing.

The industry could seek the adoption of higher standards of flood protection. In practice improvements in the design standard of protection for flooding from sewers would be likely to have the greatest effect on annual losses. Seeking higher standards of protection for river and coastal situations may bring the industry into conflict with other stakeholders (e.g. the environmental NGOs) without buying a significant reduction in flood losses and hence claims.

The industry could promote source control more actively; in areas where water resources are tight rainwater harvesting offers dual economies adding to the supply of usable water whilst reducing the costs of carrying away run-off. Land take for rainwater harvesting is also small. Given that the expected expansion in households is anticipated to take place in those parts of the country where the water demand-supply balance is tightest (i.e. south-east England) this looks like a potential win-win option.

The industry can seek a role in the development of, firstly, the Catchment Flood Management Plans ("CFMPs") that are being introduced and subsequently in the development of catchment plans under the Water Framework Directive. In early drafts of the guidelines for the development of CFMPs neither the insurance industry nor the sewerage industry were identified as being amongst the stakeholders who should be consulted in the process of the development of the CFMPs.

In this regard, the environmental NGOs are potentially powerful allies or conversely very powerful adversaries. They are heavily engaged in seeking to influence the implementation of the Water Framework Directive. These NGOs (e.g. World Wildlife Fund, Royal Society for the Protection of Birds) have clear ideas as to how they wish to see catchment management develop, and the strategies they would wish to see adopted for flood risk management. Those strategies include the use of wetlands to store flood waters, the wider use of source control and, in some cases, the removal of existing development from the flood plain.

At the same time they are opposed to further modification of rivers for the purposes of enhanced flood management, which insurers appear to want, except where such modifications would result in environmental gains compared to the status quo. Some of their advocacy of these methods may be over-simplistic but their political power should not be underestimated. To retain independence of government, if this is the desired outcome, the insurance industry needs at least some of these allies as the field of water management becomes more multi-dimensional and politically complex.

10. Conclusions

Recently there have been a multiplicity of reviews of U.K. flood management including the President of the ICE's review (Institution of Civil Engineers, 2001), the Environment Agency's review of the lessons to be learnt from the floods of autumn 2000 (Environment Agency, 2001), the National Audit Office best practice review (National Audit Office, 2001), the study by the Parliamentary Office of Science and Technology (POST, 2001), and the review of flood defence funding undertaken by DEFRA (DEFRA, 2001, 2003a). Surprisingly, none has looked seriously at the question and role of flood insurance.

Our research has shown (Green and Penning-Rowsell, 2002) that globally, insurance against flooding is only viable and available when there is an effective partnership between the government and the insurance industry. The problem at present in the U.K. is that the industry no longer believes that the existing informal relationship can be sustained, and a revised, and probably more formal, relationship needs to be established.

The U.K. government will continue to depend on the insurance industry since otherwise it would be forced to introduce compensation for victims of disasters, including floods, and this is seen as an open-ended commitment and hence undesirable. However, it may be questioned whether U.K. governments can hold this traditional attitude when the public can now more readily compare practice in other European countries (where compensation by government is the norm). But U.K. governments can be expected to be reluctant to change and will wish to continue to use the insurance industry as far as possible; in particular, to appraise and make payments whether these payments are funded from premium income, from a disaster levy similar to the French system, or from central taxation.

Conversely, the insurance industry needs the government to provide information through funding research and thereby identify the extent of flood risks. It needs the government's power to plan and control land uses, and to reduce the risks from flooding through flood alleviation works, thereby limiting its liabilities. A weakness of the retail side of the industry is that it is not clear exactly which types of floods are resulting in what proportion of total losses, but there are strong reasons for believing that in the average year, the majority of losses are from flooding from sewers rather than from rivers or the sea. Hydrology has focused on the risk of a particular river or stretch of river flooding and not on the risk of the meteorological event that will result in a flood on that stretch of river and flooding on a number of other catchments simultaneously. Thus, the retail insurance and reinsurance sectors have somewhat different interests and hence different preferences as to the form of a new partnership with government.

In seeking this new partnership with government, the industry needs to recognize both the interests of the other stakeholders, and the changes in water management that are taking place. The form of the implementation of the Water Framework Directive is critical because it will set the shape of water management, including flood management, for the next 20 years. Any proposal by the insurance industry must recognize this context and also the

influence of other stakeholders, notably the environmental NGOs. In this respect, it is unlikely that the industry will be able to lobby successfully for the adoption of higher design standards of flood protection in so far as increasing standards will involve more extensive river modification. Only if and where these increased standards of protection can be delivered in a way that yields net environmental gains is it likely that increases in standards of programme will be acceptable to these NGOs. In this regard the environmental NGOs have more political influence than the insurance industry, not least in Brussels.

The insurance industry might have more success in calling for a reappraisal of the standards of protection against flooding from sewers, particularly in light of the likely impacts of climate change. This is the form of flooding that probably causes the majority of the losses to the insurance industry in the average year, and the sewerage industry's profits depend upon the amount of investment it can justify.

But there are general dangers here for insurers and their relations with government. As the insurance industry increases its demands for greater government intervention and policy change, it is in danger of becoming more like a parasitic extension of government, rather than retaining its autonomy and the ability to maximize its profitability within a more carefully crafted symbiotic relationship. There are important choices to be made here, and the future of flood insurance is at stake for all concerned.

REFERENCES

- ARNELL, N.W., 1984, "Flood hazard management in the United States and the National Flood Insurance Program", *Geoforum*, 16, pp. 525-542.
- ARNELL, N.W., 2000, "Flood insurance", in Parker, D.J., *Floods*. London: Routledge, pp. 412-424.
- ASSOCIATION OF BRITISH INSURERS (ABI), 2001, *Flooding: a partnership approach to protecting people*. London: ABI.
- ASSOCIATION OF BRITISH INSURERS (ABI), 2002, *Renewing the partnership: how the insurance industry will work with others to improve protection against floods*. London: ABI.
- BERZ, G., 2000, "Flood disasters: lessons from the past – worries for the future", *Proc. Inst. Civ. Engrs Water & Mar. Engineering*, 142, pp. 3-8.
- CHATTERTON, J.B., GREEN, C.H. and PENNING-ROWSELL, E.C., 1993, *Wentlooge Levels Benefit-Cost Analysis*, report to National Rivers Authority Welsh Region. London: Middlesex University: Flood Hazard Research Centre.
- CZERWINSKI, S.J., 1999, *Flood Insurance: Information on Financial Aspects of the National Flood Insurance Program*, Testimony before the Subcommittee on Housing and Community Opportunity, House of Representatives, Washington DC: United States General Accounting Office.
- DEPARTMENT OF ENVIRONMENT, FOOD AND RURAL AFFAIRS (DEFRA), 2001, *The flood and coastal defence funding review: consultation document*. London: DEFRA.
- DEPARTMENT OF ENVIRONMENT, FOOD AND RURAL AFFAIRS (DEFRA), 2003a, *The funding of flood and coastal defence*. London: DEFRA.
- DEPARTMENT OF ENVIRONMENT, FOOD AND RURAL AFFAIRS (DEFRA), 2003b, *Flood management: policy and implications*. London: DEFRA.
- DEPARTMENT OF THE ENVIRONMENT, TRANSPORT AND REGIONS, 2000, *Public Participation in Making Local Environmental Decisions: The Aarhus Convention Newcastle Workshop*. London: DETR.
- ENVIRONMENT AGENCY, 2001, *Lessons learned: Autumn 2000 floods*. Bristol: Environment Agency.
- ENVIRONMENT AGENCY, 2003, *Flood risks to people, Phase 1 report*. Bristol: Environment Agency.
- EUROPEAN UNION, 2000, *Water Framework Directive* (<http://www.europa.eu.int/eurllex>).
- GASCHEN S., HAUSMANN P., MENZINGER I. and SCHAAD W., 1998, *Floods - an insurable risk*. Zurich: Swiss Re (<http://www.swissre.com>).
- GATELY, J., 1973, *The idea of a flood*. London: Middlesex University Flood Hazard Research Centre.
- GRAHAM, W.J., 1999, *A Procedure for Estimating Loss of Life Caused by Dam Failure*, DSO-99-06, Denver CO: Bureau of Reclamation, Dam Safety Office.
- GREEN, C.H., 1999, "The economics of floodplain use", *Himganga*, 1 (3), pp. 4-5.

- GREEN, C.H., 2002, Paper presented to DEFRA conference, September. London: Middlesex University: Flood Hazard Research Centre.
- GREEN, C.H. and PENNING-ROWSELL, E.C., 2002, *Flood risk and insurance: strategic options for the insurance industry and for government*. London: Middlesex University: Flood Hazard Research Centre.
- HALCROW/VITUKI/FHRC/EXTERNAL/FOMI/MTA/Koros Valley District Water Authority, 1999, *Hungary flood control development and rehabilitation project*. Final report, Budapest: Vituki Consult.
- HOWARTH, W., 2002, *Flood defence law*. Crayford, UK: Shaw and Sons.
- INSTITUTION OF CIVIL ENGINEERS, 2001, *Learning to live with rivers*. London: ICE.
- NATIONAL AUDIT OFFICE, 2001, *Inland flood defence*. London: NAO.
- OFFICE OF SCIENCE AND TECHNOLOGY (OST), 1999, *Environmental Futures*. London: Department of Trade and Industry.
- OFFICE OF SCIENCE AND TECHNOLOGY (OST), 2003, *Flood and coastal defence project: Synthesis report*. London: Department of Trade and Industry.
- OFWAT, 1999a, *Final determination: future water and sewerage charges 2000-05*, Birmingham: OFWAT.
- OFWAT, 1999b, *Draft determinations: future water and sewerage charges 2000-05*, Birmingham: OFWAT.
- PARKER, D.J. and PENNING-ROWSELL, E.C., 2002, Paper delivered to Senate House Conference, London.
- PENNING-ROWSELL, E.C. and GREEN, C.H., 2000, "Enhanced appraisal of flood alleviation benefits", in Parker, D.J. (ed.), *Floods*. London: Routledge, pp. 214-237.
- PENNING-ROWSELL, E.C. and WILSON, T., 2003, *Project Unicorn: final report*. London: Middlesex University Flood Hazard Research Centre.
- PENNING-ROWSELL, E.C., CHATTERTON, J.B., WILSON, T. and POTTER, E., 2002, *Autumn 2000 floods in England and Wales: Assessment of national economic and financial losses*. London: Middlesex University Flood Hazard Research Centre.
- PENNING-ROWSELL, E.C., PARKER, D.J. and HARDING, D.M., 1986, *Floods and drainage*. London: Allen and Unwin.
- POST, 2001, *Managing Flooding*. London: Parliamentary Office of Science and Technology.
- REYNARD, N.S., PRUDHOMME, C. and CROOKS, S.M., 2001, "The flood characteristics of large UK rivers: potential effects of changing climate and land use", *Climate Change*, 48, pp. 343-359.
- ROSENTHAL, U. and BEZUYEN, M.J., 2000, "Flood emergency management in developed countries: the experience of 1993, 1995 and 1997 in Europe", in Parker, D.J. (ed.), *Floods*. London: Routledge, pp. 340-350.
- SMITH, D.I., 2000, "Floodplain management: problems, issues and opportunities", in Parker, D.J., *Floods*. London: Routledge, pp. 254-267.
- WISDOM, A.S., 1975, *The law of rivers and watercourses* (4th edn). Croydon, U.K.: D.R. Publications.