Introduction

What is a flood? In some circumstances, and systems of insurance, this is a critical question, particularly those systems which insure against a 'flood' but not other forms or causes of water damage. Bursts in pipes or tanks under the control of the individual consumer are not usually classed as a 'flood'. In general, 'flooding' is categorised as being inundation with someone else's water, whether that water has been conveyed to the flooded property by means of a natural or artifical channels or pipes, or directly overland. A property may however also be inundated as a result of the runoff from the 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 runoff 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 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 rainfall event, some precipitation events will cause localised flooding.

Determining the cause of an inundation can be difficult but it may also determine whose responsibility, if any, it is to resolve the problem. Thus:

- if the flood is a result of extreme rainfall on the property that was flooded, then it is either the responsibility of the land owner or the sewerage utility;
- if the flood travelled over land to that property then it is the responsibility of the sewerage utility or the land owner where the water originated;
- if the flood originated in a non-main river, then it is the responsibility of the local authority or the riparian owner; or
- if the flood originated in a main river, then it is the responsibility of the Environment Agency who have permissive powers to deal with flood matters.

In the USA, payments under the Federal Flood Insurance Programme are triggered if at least two properties are affected. In France however payouts are not triggered until the Prefet declares a flood disaster. Overland or channel flow of runoff is not however the only possible causes of flooding (**Table 1**).

Table 1 Causes of flooding

note: the number of properties at risk from most kinds of flooding is unknown

Cause of flooding	
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.
surface water runoff	Thunderstorms can overwhelm surface water drainage systems which are generally only dimensioned to carry rainfall from the ten year return period rainfall event. The result is localised flooding; underground car parks (and any other facilities below grade) are a particular risk.

sea (coastal/estuarine)	The responsibility of the coastal protection authority who may be a local authority, port authority, the Environment Agency or local land owner. Risk is increasing as a result of sea level.
dam failure (articial/natural) overflow of lakes	Many of dams in the UK date back to the Industrial Revolution 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. Failure of a dam can be rapid and catastrophic; the resulting wall of water is very destructive, quite capable of completely destroying buildings for a significant distance downstream. Dam break modelling for one yielded an estimate of 1,000 deaths resulting from the breach of the dam in question. For some dams, such a dam break analysis has been undertaken to determine the resulting flood extent. Generally, such an analysis has not been undertaken. Natural lakes as well as reservoirs may also overflow; some of the sediment will also be transported and deposited by the released water. As sediment tends to trap and accumulate the heavy metals and other pollutants from earlier pollution, significant pollution may result from the flood deposited silt. A thunderstorm induced overflow from a lake at the Harwell research station deposited low level radioactivity over the local area.
canals/aqueduct	The canal system is integrated into the land drainage system and in some cases, a canal is at a higher level than neighbouring development. There have a few instances of canals bursting their banks and causing floods. Aqueducts may also breach.
water mains	Water mains differ in size; bursts by large mains have caused a number of floods, several multi-million pound losses occurring in London in recent years. The risk of flooding is partly a function of the diameter of the mains; the water utilities are increasingly building GISs containing details of the location of their underground networks. A concern of London Transport who have just 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* 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.

*OFWAT 1999 Draft Determinations: Future water and sewerage charges 2000-05, Birmingham: OFWAT

In addition, flooding can be a significant contributor to the total risk from other hazards. Thus, CIMAH sites are frequently located on flood plains and relative to other chains of events that can lead to a release of toxic, flammable or explosive substances, a flood is typically a high probability event. Thus, in the first quantitative risk assessment for Canvey Island, the dominant risk was of a flood causing the vapourisation and release of the liguified natural gas then stored in underground storage tanks (xxxx).

Impacts on the insurance industry

Table 2 seeks to compare the threat from the different potential causes of flooding in terms of their likely impact on the insurance industry. Whilst the catastrophic loss potential is important for reinsurance and similar purposes, the probability of the event would be important in any attempt to set actuarial premiums, and the proportion of total annual flood related losses is relevant for risk management. It is noticeable that many of the assessments can be based upon no more than expert judgment.

There are three further weakness from a national perspective. Firstly, 'flood risk mapping' conventionally only looks at a single flood event, usually the 100 year return period flood; the relative consequences of, say, the 500 year return period flood are not shown or considered. In some flood plains, the 500 year flood will only affect a slightly larger area and result in slightly deeper flooding. In other instances, the consequences can be dramatically different. The second limitation is that flood events on a single catchment are considered. However, a single precipitation event (or a snow melt) may affect a number of different catchments. Thus, the annual probability that, for instance, 10,000 properties on five different catchments will be flooded by the 100 year return period flood is not 100^5 but could be as low as 1 in 100. Thirdly, the flood extents and return periods are typically based upon short lengths of records during which time condition may be changing.

Table 2 Relative threat from different causes of flooding

	probability	**% of annual losses**	**catastrophic loss potential**
river	medium	high?	medium-high where the area is currently protected by embankments
surface water runoff	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 flooded on annual basis	low

It is appropriate to differentiate between large properties, where the premium may be tailored for the specific property, and domestic insurance where only relative broad premium banding can be justified because otherwise the costs of premium setting would be excessive in relation to the expected premium income. However, the development of GIS data bases is cutting the cost of setting premium rates according

to risk. For large properties, both the probability of water damage and the consequences should be expected to increase over time for a number of reasons:

- the increasing importance of cleanliness in other industries in addition to the food industry;
- the increasing concentration and specialisation of industry;
- the increasing reliance upon electronics, particularly custom made circuits, in all stage of production and distribution;
- the shift to 'Just In Time' inventories and hence reliance on continuity of supply.

Properties below grade present a particularly high risk: underground car parks are perhaps the most common such facility as well as presenting a high value loss. For example, a small flood in Hong Kong flooded the underground car park of a hotel which happened to contain several Roll Royces as well as a number of luxury cars. Underground car parks typically flood in relatively minor floods.

The risk to life has insurance implications both in terms of life insurance and liability insurance. The failure of a dam probably would result in the largest single loss of life, and would result in a claim against the owner's liability insurers. In other countries (xxxx), it is normal to prepare offsite emergency plans for dams; it appears to be less common in the UK although there have been at least two dam alerts in the UK, although one was from a terrorist threat. In the past, there has strong official resistance to preparing and publishing offsite emergency plans for dams on the grounds that the public would either panic or object on the grounds that their publication would affect the value of their house. There is not any real evidence from other countries that panic would follow from publication of such emergency plans or that the required publication of offsite emergency plans for industrial plants designated under the CIMAH regulations (xxxx) results in either consequence.

After dams, the largest number of potential deaths is probably in relation to failure of flood or coastal embankments. Chatterton et al (xxxx) 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 (xxxx). It could be comparable in other areas lying behind high flood embankments; the risk of death is likely to be particular high in mobile home parks. The question of liability either for failure of embankments, which might be the result of inadequate maintenance, or of failure to warn those at risk and make adequate provisions for evacuation could be interesting. Should a flood result in a release of toxic, explosive or flammable materials from a CIMAH site, the question of liability would be more clear cut.

Flood hazard management is not about minimising flood losses but about maximising the efficiency of use of the catchment as a whole. It follows that increases in national annual flood losses provide little or any indication of the relative success of the flood management policy adopted. If there is no change in flood management policy from year to year, flood losses should be expected to rise in real terms simply as we become richer. Therefore, the interests of the industry and society do not necessarily coincide.

Flood losses from year to year will rise if:

- the flood risk increases;
- there are more properties at risk; and/or
- the loss per property increases (either or both fabric and contents).

The frequency and severity of flooding will change if either or both precipitation and/or runoff changes. One or both will change over time as a result:

- urban development, or intensified urban development, of the catchment; changes in agricultural drainage; or changes in forestation;
- climate change.

On average the rate of change in the stock of dwellings has been low over recent years. This slow rate of change has concealed greater regional differences. Current projections of the rate of future household formations implies both that the rate of change of stock as a whole will be greater and, equally, so will the regional differences. Wherever these developments take place, the result will be to increase flood risks either because they are located in flood risk areas or because runoff is increased. It seems likely that the emphasis on redevelopment of brown field sites, as opposed to green field sites, will mean that a significant part of this new development takes place in flood risk areas. Much early industrial development took place near rivers both to take advantage of transport by water and because the land was flat.

Loss per dwelling will increase if the value at risk increases or the susceptibility to flood losses increases. For existing dwellings, the value of the structure at risk is increasing over time as a result of the construction of extensions, including conservatories, and the enhancement of existing rooms (e.g. fitted kitchens). In some cases, the result is also to increase susceptibility to flood damage (e.g. the use of fibreboard and similar materials in kitchen units to replace existing heavy wood units). New buildings are generally expected to be more susceptible to flood damage than are old buildings constructed of masonry and with thick tongued and groove timber floors. Timber sections are typically now much thinner and therefore more susceptible to warping; and chipboard floors are generally more susceptible to flood damage than old style tongued and groove floor boards (they have been described as turning into 'weetabix'). In addition, modern practice is to sit lightweight plasterboard partitions on the suspended floor; in consequence, if the floor fails through flooding then so too do the partitions.

The value of the contents of a dwelling is probably increasing although it is difficult to find statistics that could be used to calculate the real change over time other than changes in ownership rates for different items. At the same time, so is the susceptibility of those contents to flooding also increasing as electronics replace electro-mechanical equipment.

Therefore, total flood losses is neither a useful indicator of the relative success of a flood management policy nor a useful indicator to the insurance industry. Three more useful indicators for the insurance industry of flood losses are:

- changes in the proportion of total domestic losses contributed by flood losses (but a change may simply mean that other losses are rising faster or slower)
- changes in the total of flood losses compared to the total insured value (but insured value may not be simply related to the value at risk);
- the year on year rate of change in total domestic flood losses compared to changes in real Gross Domestic Product (but this assumes that increases in value at risk are simply related to changes in national income); and
- the year on year rate of change in total domestic flood losses compared to the estimated rate of change in the real value of dwellings and their contents.

Some flood management policy changes are likely to affect the insurance industry. In particular, the 'managed retreat' option is also being applied to rivers as well as coasts. In those areas where flood defences either need rehabilitation or replacement, the option of retreating those defences is an option which the Ministry requires the Agency to consider. The managed retreat option is probably only viable where the area protected at present is primarily agricultural and so the increase in the number of buildings at risk of flooding is likely to be small. The shift is likely to be towards localised protection of urban areas. However, where a single factory is located in a predominantly rural area, even where the provision of local protection for that factory is justified in economic terms, it likely that the use of public money to protect a single property will be questioned. There may, therefore, be some possibly large industrial or commercial properties which lose their flood protection unless they are prepared to fund the works themselves.

Options for the insurance industry

There are a range of options for the industry with regard to insuring domestic properties:

- go on as now

  changes in cover:

- withdraw flood coverage altogether
- exclude some risks (e.g. from river flooding)
- exclude some properties (e.g. those with chipboard floors, mobile homes)
- exclude some areas known to be at flood risk
- set actuarial premium rates
- refuse to cover properties that have already been flooded once
- refuse coverage in areas where flood defence standards are deemed to be too low
- increase deductibles, perhaps up to a quite high level (e.g. £10,000 each for structural and contents losses)
- limit cover (e.g. contents losses limited to indemnity cover)
- refuse to cover building extensions to property at risk
- limit total cover per property
- exclude some items (e.g. highly susceptible items such as electronic goods, antiques)

  The industry might seek to influence wider development policy in the following ways:

- 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)
- engage in development consents process
- lobby for greater public investment in flood and coastal defence
- require flood proofing in new properties in designated areas (but there are economies of scale from structural flood protection)
- refuse to cover any new development in designated areas
- require flood proofing of existing properties
- seek to shift to the US model where the government carries the risk

- seek to shift to the French model where the relationship between the government and industry is formalised.

risk management:

- provide advice to the policy holder as to what to do in the event of a flood
- provide help in the event of a flood (e.g. provide sand bags - the Local Authorities who used to do this can no longer afford to do so)
- provide recovery advice to the policy holder
- contribute to the costs of flood alleviation schemes which protect existing properties (or propose to underwrite PFI schemes for particular areas)
- provide a recovery service (e.g. via professional drying, cleaning etc)
- include coverage for non-monetary losses
- risk management of losses

Each strategy will provoke responses from different parts of central and local government, from individual consumers and consumer organisations. The likely reactions of those other parties need to be considered as these will influence the success of the strategy. Since flood cover is being subsidised by all policyholders, the interests of those policyholders ought to be considered. For example, in France, the catastrophy insurance addition has just been increased from 9% to 12%. From the perspective of the industry, it is also necessary to consider what part of the risk it is desired to manage, be this annual average flood losses or catastrophic flood losses. Again, a further issue is that of setting a precedent; if a rigorous intervention is made in respect of flooding then to be consistent it might be argued that the industry ought to intervene in other areas as well.

One key question is then whether it is new development about which the insurance industry is most concerned or changes in potential losses for existing development. The ABI statement of 1998 covers both aspects but the power of preparedness to refuse coverage to properties that have been permitted against the advice of the EA is probably in terms of internalising flood alleviation costs to the developer or builder. That it is, the ABI statement may be used to require the developer to contribute to the costs of providing flood alleviation works either for the development, or to those properties which would be placed at increased risk because of the new development, as a condition of development permission.