Flooding & Insurance

Report by: - Munich Re

Flood is defined as a temporary covering of land by water as a result of surface waters (still or flowing) escaping from their normal confines or as a result of heavy precipitation. A distinction is made between

- ♦ floods emanating from surface waters
- – river flood
- – coastal flood
- – storm surge
- – tsunami (seismic sea wave)
- – sea level rise
- – coastal subsidence, land subsidence, land settlement
- – rising lake-water level, backwater in rivers
- – seiche (resonance oscillations)
- – glacial lake outburst flood
- – dam and dyke failure

- ♦ local floods often not linked with large bodies of water or flowing water
- – flash flood
- – debris flow
- – backwater in storm-water drainage systems
- – rising groundwater, ground settlement

Causes: Are floods increasing in frequency?

The fact that flood catastrophes, have accumulated throughout the world in recent years raises the question as to whether a general increase in their frequency and intensity can be ascertained. This is not an easy question to answer because there are many interlinked factors responsible for the occurrence of floods. The frequency of flood catastrophes, for instance, is by no means only determined by natural conditions such as the amounts of precipitation or other water sources.

On the contrary, man has interfered in a direct way by settling the land and making it usable and in an indirect way by influencing the climate on a local and global scale.

- ♦ Settlement and industrialization of areas exposed to flooding
  Dykes and other protective structures often give a false sense of security and contribute to a more intensive settlement of exposed zones. Areas in which it would make sense to ban construction altogether are developed as commercial and industrial zones. In the event of flooding, therefore, the loss may be greater than if flood-control structures had not been built in the first place.
- ♦ Adverse developments in river engineering
  These include
- – inadequate design of dams, storage reservoirs, and flood-control reservoirs, coupled with a lack of areas that can be flooded without causing too much damage (e.g. natural flood plains)
- – river regulation, which increases the flood wave propogation and can lead to problems downstream
- – excessive dyke construction and hence channelling, which accelerates the flow
  faulty design of dykes, construction errors, incorrect construction materials
- – inadequate maintenance of protective structures (ageing, damage)
- – inadequate river bed maintenance (sedimentation or erosion at critical points)

– technical or human failure in the operation of safety installations such as dyke openings and spillways
– inadequate control of the amounts of water in storage reservoirs or behind barrages so that their buffer capacity is reduced

♦ Sealing, i.e. covering the ground surface with concrete and asphalt
Precipitation cannot seep into the ground any more but runs off on the surface, thus directly increasing the water level in rivers.

♦ Natural sealing
This phenomenon is encountered when there is ground frost or after long periods of rain. The pores and voids in the soil become so clogged up with ice or saturated with water that they cannot cope with any more water. The result is that precipitation runs off on the surface. After relatively long thaws or breaks in the rain, the soil water can seep away or evaporate or is absorbed by vegetation. When this has happened to a sufficient degree, the soil regains its important function as a buffer and storage medium.

♦ Changes in the vegetation
The influence of the natural vegetation on the flood hazard is often underestimated. Large-scale modifications to vegetation are always linked with changes in the regions water balance and they have far-reaching consequences. Deforestation and forest decline have extremely negative effects because the water-retaining capacity of large areas is impaired and at the same time the upper soil zone can be destroyed, which leads to severe erosion. Alterations in the natural landscape for agricultural purposes such as land consolidation, unsuitable methods of cultivation, and soil compaction by means of agricultural machines can accelerate the run-off of water from farmland.

Climate Change

At the end of the 1980s a number of reputed climatologists were drawn together by the United Nations to form the Intergovernmental Panel on Climate Change (IPCC). Their brief was to arrive at a well-supported consensus on the most important assertions about climate change in coming decades and to present this to the authorities as a basis for political decisions.
The IPCC has gained widespread recognition as a panel of scientific
experts that is to be taken seriously and what it says is largely accepted in the field worldwide.
In its first report published in 1990 and its second published in 1995, the IPCC predicts the following changes by the year 2100:

♦ The mean global temperature will increase by about 2-3^{0}C (with an uncertainty range of 1-4^{0}C) unless there is a drastic reduction in the emission of greenhouse gases (the so-called (business as usual) scenario).

♦ Sea levels will rise by about 60 cm
(20-100 cm) due both to the thermally induced expansion of ocean waters
(accounting for about half of the increase) and to the melting of continental ice.
In the initial phase at least, increasing snowfall in some parts of the Antarctic may slow down the rise slightly.

♦ Precipitation patterns will change with new local extremes and a spatial and temporal shift in precipitation zones.
An increase in precipitation is to be expected particularly in the tropics and in the upper latitudes but not in the drier subtropics. Although predictions of the regional effects are still not absolutely reliable, it is assumed that, given a doubling of the concentration of atmospheric carbon dioxide by the middle of the 21st century,

– winter temperatures in Europe will rise by 2-3^{0}C and winter precipitation will continue to increase,
– there will be an increase in monsoon activity in Asia coupled with a corresponding increase in rainfall, a particularly dramatic forecast in the light of the extremity and frequency of the floods that have affected Asia in recent years, and

– absolute precipitation amounts will increase generally but the number of precipitation days will decrease, meaning that the hazard of flash floods following torrential rain could increase considerably on both a local and a regional scale.

– Warming will be more intense in the higher latitudes than in the tropics, producing a less pronounced temperature gradient from the equator to the poles.

Nevertheless, the reduction in the dynamics of atmospheric processes that has often been postulated is not so likely to happen. This is mainly because with the increasing evaporation associated with the warming process, the oceans pump more and more energy into the atmosphere and thus put the (atmospheric heat-generating machine into top gear).

Even today there are numerous signs of climate change:

- ♦ The overall area of ocean regions with a surface temperature of at least 27^0C at some time during the year has increased by about one-sixth in two decades. This surface temperature of 27^0C is an essential factor in the generation of tropical cyclones. For this reason, the frequency and above all the intensity of tropical cyclones must be expected to increase in the future, as well as the areas and periods in which they can be generated.
- ♦ Glacier retreat has already reached dramatic proportions:

– The World Glacier Monitoring Service of the United Nations Environment Programme (UNEP) has examined about fifty glaciers in the Northern Hemisphere and has found a distinct trend towards glacier retreat in recent decades.

– Since attaining their greatest magnitude in the mid-l9th ce, the Alpine glaciers have forfeited about 30% of their area and no less than 50% of their volume. If warming continues as hitherto, they may have disappeared almost completely by the year 2050 and will no longer be able to function as the largest freshwater reservoir in central and southern Europe. this means that the discharge in rivers rising in alps will steadily increase in the winter and steadily decrease in the summer - with substantial effects on ecosystems, agriculture, water supplies, and shipping.

As yet, however, measurements of Arctic and Antarctic ice do not permit any definite conclusions. In some areas the ice is growing in volume and in others it is shrinking.

- ♦ In many regions the summers will probably be hotter and drier but precipitation will increase. This apparent contradiction can be explained by the fact that the number of rain days will fall but the intensity of precipitation will rise. As far as short-term heavy precipitation induced by convection is concerned, new extremes must be expected in many regions, leading to a corresponding increase in the frequency and severity of flash floods.
- ♦ Mild winters will become more frequent in temperate latitudes. Since the mid-1980s, central Europe has experienced a series of winters that have been much too mild. Such a series has probably not happened for at least seven centuries. It is without doubt one of the main reasons for the major windstorm and flood catastrophes of recent years, e.g. the 1990 winter gales in Europe and the floods that hit central Europe in 1993 and 1995. As a rule, mild winters are coupled with higher levels of precipitation because the warmer atmosphere can absorb more moisture and therefore generate more precipitation. What is more, this precipitation is in the form of rain rather than snow and as a result it flows into the rivers unchecked.

Loss potential and accumulation scenarios

As we have seen, it is no simple matter to determine flood probability, which is the basis for many structural, administrative, and insurance measures (e.g. protective structures, land use regulations, premium calculations). An even more difficult and crucial task, which confronts authorities and insurers alike, however, is estimating the size of catastrophe losses to be expected in individual extreme events.

Assessing the loss potential

As a rule the probable maximum loss (PML) cannot be calculated by simply adding up the potential flood areas and the concentration of values in them. There is too much variety and uncertainty in the factors involved, such as the soil conditions and the spatial - and especially in this context the vertical -distribution of values. Also, the amount of water that can lead to flooding varies extremely. The simple question of whether a dyke will hold or not can lead to the assessment of loss potential ranging between (none) and (total loss). When considering the loss potential, therefore, underwriters are often forced to rely on rough and very general assumptions.

a) Information required

In order to assess the loss potential in areas exposed to the risk of flood, information is needed from a number of different areas:

- ♦ Hydrological data on flood events, e.g. discharge amounts and water levels with the corresponding occurrence probabilities and their seasonal distribution, and information on the changes in these values produced by flood-control measures
  These data may not always be available in the form of local records, in which case they must be inferred from statistical analyses of representative measurements or derived by means of computer simulation. These are based on the gauge readings taken by the respective water authorities, sometimes supported by special gauging networks.
- ♦ Data on the use of areas exposed to the risk of flood and the soil conditions there

These data can be obtained from the databases of official registries of land use or derived from locally conducted surveys in which land use is identified.

- ♦ Loss data for each category of land use as a function of the level and duration of flooding, time of year and early-warning period, i.e. suitable (loss functions)

The availability of information on flood losses broken down by category of land use is still meagre. There are various ways of acquiring these data:

- ♦ A separate loss survey is performed in the project area (project-related loss data, obtained from loss adjusters). This is a labour-intensive solution but one which may be expected to produce good results. It can be used for statistical analyses by nature of event, situation, occupancy, type of loss, and cause of loss.
- – Use is made of standardized loss data on which generalized statements can be based. After major events, insurers calculate appropriate parameters such as average loss, loss ratio, and loss frequency. Further data can be derived from applications for state assistance after significant flood events.
- – Use is made of standardized loss functions (e.g. flood stage vs. loss) and special loss ratios for certain risk categories (e.g. industrial risks) that are available from global surveys.

b) A simplified method of estimating for insurers

In addition to these more complex methods, there is another way of estimating losses that is less exact but nevertheless produces quite plausible results.

Once the occurrence probability (return period) has been estimated for certain flood-prone areas and flood intensities, various scenarios can be developed (e.g. 100-year events). Using flood type, flood stage, and flood duration as a basis, it is possible to analyze past losses and determine a loss frequency as the proportion of buildings affected. The loss amounts in each case can also be used to derive benchmarks for the average loss affecting the respective categories of buildings and contents.

This means that a rough evaluation can now be made of an insurers intended or existing portfolio.

c) A method of assessment using Geographical Information Systems (GIS)

The future lies in computer-assisted analytical processes. Geographical Information Systems can already be used today to combine and analyse a wide range of spatial data. If the data relating to a stock of buildings or an insurance portfolio are stored on computer and are linked to spatial coordinates (geocoded), it is possible to ascertain the objects that will be affected by various flood stages.

It is, for example, conceivable to overlay aerial maps of historical flood events on up-to-date maps with the present buildings and infrastructure in order to visualize and analyse the present exposure. The data required for this kind of calculation (topographical maps, land-use maps, etc.) are currently being digitized by the authorities in many countries and will soon be available with a high degree of detail. In order to be able to take advantage of these data, however, insurers must already perform computer-assisted accumulation control of a high quality.

Underwriting aspects of flood coverage in property insurance

a) Differentiation by type of event, predictability, premium calculation basis

Flooding can be caused by various types of event, in the majority of cases by storm surges, flash floods, and river flooding.

Property insurance for **storm surge** is generally impossible in the private sector. There are numerous reasons for this, of which the following are examples:

- Owing to the lack of long statistical series and the generally low incidence rate, there is no sufficient basis for calculating the insurance premiums.
- The exposure largely depends on the flood-control measures in place and thus in the end on the states willingness to invest in measures. The failure of poorly designed or overaged dykes can lead to a catastrophic loss but insurers have no influence on the degree of protection that dykes afford.
- Since only coastal regions are exposed, there is no chance of building up a community of insureds with a good balance of risks over a broad area. The premiums would have to be extremely high on account of the danger of antiselection because cover would only be taken out by people living on the coast.
- The regional accumulation risk is particularly extreme for the insurance industry because it can concur with the hurricane accumulation risk. Orientation towards common limits of indemnity could reduce or even exhaust the capacity for hurricanes, which are encountered much more frequently. Therefore, in some countries like the Netherlands and Germany, where the risk of storm surge goes hand in hand with particularly high concentrations of values in coastal regions, loss or damage caused by storm surge is almost always explicitly excluded under property insurance.

Flash floods caused by local storms can occur almost anywhere. This means that consumer demand for insurance protection could already be quite large or could be developed on a broad front. Adequate premiums can be calculated with a relatively high degree of reliability and the necessary geographical spread of risks is given. Flood damage caused by flash floods is therefore insurable as a rule.

River flooding is quite a different matter since the exposure of each object depends entirely on where it is situated. Only a relatively small proportion of the covers for buildings and contents in any given insurance market is exposed. The areas affected are always the same.

Flooding on a specific river at almost regular intervals cannot be regarded as an unforeseeable event. On account of this predictability of losses occurring in adversely selected insurance locations, the problem of providing cover for river flooding cannot be solved on a broad scale using traditional insurance techniques, at least not by private insurance companies selling individual policies on a voluntary basis. If an insurance company wished to do this, the insurance premiums calculated on the basis of past loss experience and future loss expectations would have to be so high that policyholders would normally find them prohibitive.

Rating

The price for flood insurance depends -more than for any other types of cover -on the risk circumstances in each individual case.

A clear definition of the scope of cover is essential. For the premium to be adequate it must be calculated on the basis of the full insurance value.

The insurance industry is largely unanimous in its view that flood insurance should only be offered on the understanding that an adequate deductible is retained by the policyholder - in the order of at least 5% of the sum insured. In many instances involving the risk of total loss, which is the case particularly with the cover of the contents of buildings, limits of indemnity beginning at 10% of the sum insured are essential.

Given the necessary preconditions, i.e.

- insurance of freak flooding only,
- no anti-selection,
- full-value basis,
- deductible, limit of indemnity,

it would be reasonable to provide flood cover at a flat premium rate for a large segment of the mass business portfolio, i.e. for those objects that are not regularly exposed to river flooding.
Objects that are to be classed as particularly exposed to flooding, however, must be rated individually if they can be considered insurable at all. In order to register the particular risk circumstances, specially designed questions must be incorporated in the application for insurance cover. These include questions on

- previous losses,
- the vertical and horizontal distance from bodies of water,
- the building class of the structure.

Further information is required if the contents are to be covered:

- height (storey) above or below ground level,
- susceptibility of the insured goods to water (see also the questionnaire in the Appendix).

The method of calculating the loss potential can also be used to calculate an adequate risk premium, even if this can do no more than serve as a rough indication. The most important factors in this estimate are the insurance density and the geographical distribution of liabilities and risks.
The basic parameters for a technically correct premium calculation, i.e. return periods and expected losses, usually bear quite a large degree of statistical uncertainty and an adequate fluctuation loading is needed to compensate for this. If necessary, this fluctuation loading will also serve to finance losses that may arise in areas where loss events are so seldom that there can be no balance over time. Added to this come the customary loadings for administration and acquisition costs and for the attainment of an underwriting profit.