Floods in Europe

From Weather Conditions to Insurance

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Munich Reinsurance Company
Topics

Recent flood disasters

Flood types

Loss statistics and trends

Reasons for increasing losses

Flood risk reduction

Insurance aspects and flood risk modelling
Recent flood disasters

The costliest floods (> 500m US$) in Europe since 1993

<table>
<thead>
<tr>
<th>Year</th>
<th>Affected Countries</th>
<th>Total</th>
<th>Insured</th>
<th>% Insured</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>France, Switzerland, N. Italy (W. Alps)</td>
<td>1,500</td>
<td>500</td>
<td>33</td>
</tr>
<tr>
<td>1993</td>
<td>Germany, Belgium, Luxembourg (Rhine)</td>
<td>2,000</td>
<td>800</td>
<td>36</td>
</tr>
<tr>
<td>1994</td>
<td>Italy (S. Alps)</td>
<td>9,300</td>
<td>65</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>1995</td>
<td>Germany, The Netherlands (Rhine)</td>
<td>3,500</td>
<td>910</td>
<td>26</td>
</tr>
<tr>
<td>1996</td>
<td>S. Spain, Portugal</td>
<td>1,080</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1997</td>
<td>Czech R., Slovakia, Poland, Germany, Austria (Odra)</td>
<td>5,900</td>
<td>795</td>
<td>13</td>
</tr>
<tr>
<td>1998</td>
<td>Belgium, The Netherlands (Meuse)</td>
<td>530</td>
<td>2</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>1999</td>
<td>Austria, Czech R., Slovakia, Hungary, Yug., Rom., Poland</td>
<td>600</td>
<td>40</td>
<td>7</td>
</tr>
<tr>
<td>2000</td>
<td>Italy, Switzerland (S. Alps, Po)</td>
<td>8,500</td>
<td>470</td>
<td>6</td>
</tr>
<tr>
<td>2000</td>
<td>United Kingdom</td>
<td>1,500</td>
<td>1,100</td>
<td>73</td>
</tr>
<tr>
<td>2001</td>
<td>Poland, Slovakia</td>
<td>700</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>2002</td>
<td>Germany, Austria, Italy, Czech R., Hungary, Slovakia, Romania, Bulgaria, Ukraine, Russia (Danube, Elbe)</td>
<td>21,500</td>
<td>3,400</td>
<td>16</td>
</tr>
<tr>
<td>2002</td>
<td>France (Rhone)</td>
<td>1,200</td>
<td>700</td>
<td>58</td>
</tr>
<tr>
<td>2003</td>
<td>France (Rhone)</td>
<td>1,600</td>
<td>900</td>
<td>56</td>
</tr>
<tr>
<td>2005</td>
<td>Romania, Bulgaria (Danube)</td>
<td>2,440</td>
<td>15</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>2005</td>
<td>Switzerland, Austria, Germany, Slovenia (N. Alps)</td>
<td>3,300</td>
<td>1,760</td>
<td>53</td>
</tr>
<tr>
<td>2006</td>
<td>Central and Eastern Europe (Danube)</td>
<td>500</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>2007</td>
<td>United Kingdom (twice)</td>
<td>8,000</td>
<td>6,000</td>
<td>75</td>
</tr>
</tbody>
</table>
Countries affected in the 25 costliest floods since 1993

- Countries shaded in light blue were affected 1-2 times.
- Countries shaded in medium blue were affected 3-4 times.
- Countries shaded in dark blue were affected 5-6 times.
- Countries shaded in darkest blue were affected 7-9 times.

Legend:
- 0 times
- 1-2 times
- 3-4 times
- 5-6 times
- 7-9 times

Munich Re NatCatService 2008

Flood hazard intensity
- Very low
- Low
- Moderate
- High
- Very high
- Non ESPON space
Flood types

- Flood types

Flood types

- Flood types in Europe – From Weather Conditions to Insurance

- Flood types

- Flood types

- Flood types

- Flood types
## Flood types

### Storm surge

**Cause:**
high water level due to superposition of high tide and wind setup, additionally high waves

**Conditions:**
strong wind towards the coast for many hours

**Exposed areas:**
coastal areas

**Possibilities of forecast:**
good (several hours up to one day)

**Duration:**
usually < 1 day

**Damage factors:**
- salt water (corrosive)
- wave forces

**Losses:**
- very low frequency (high standard of coastal protection)
- extremely high loss potential
## Flood types

### River flood

**Cause:** long-duration rainfall with high depth over a large area (sometimes snowmelt)

**Conditions:** soil naturally sealed by previous rainfall or frost

**Exposed areas:** floodplains and valley grounds

**Possibilities of forecast:** depending on the characteristics (size, shape) of the catchment area (from several hours to days)

**Duration:** days to weeks

**Damage factors:**
- long-lasting impact of water
- contamination of the water (e.g. oil)

**Losses:**
- low frequency
- high loss potential
## Flood types

### Flash flood

**Cause:** intense (often local) precipitation (thunderstorm)

**Conditions:** none

**Exposed areas:** practically everywhere

**Possibilities of forecast:** only via rainfall forecast (uncertain to hardly feasible)

**Duration:** hours (minutes)

**Damage factors:**
- mechanical effects of fast flowing water
- sometimes much sediment

**Losses:**
- high frequency (not at the same location)
- mostly relatively small losses from single events
Loss statistics and trends

Munich Re NatCatSERVICE

The world‘s greatest data base for losses from natural catastrophes

- systematic collection of NatCat data since 1980
- retrospective findings for events before 1980
- information for all GREAT natural catastrophes since 1950
- all important natural catastrophes in history since 79 AD (destruction of Pompeii)

>25,000 data sets
Classification of natural catastrophes in four event groups

A Geophysical events
- Earthquake
- Subsidence
- Volcano

B Windstorms
- Blizzard / Snowstorm
- Hailstorm
- Sandstorm
- Tempest / Severe Storm
- Tornado
- Tropical Cyclone
- Windstorm
- Winterstorm

C Floods
- Flash Flood
- Flood
- Storm Surge
- Tsunami

D Others
- Avalanche
- Drought / Heat Wave
- Landslide / Rockfall
- Wildfire
- Winter Damage / Cold Wave

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Flood losses in Europe

Insured losses [US$ bn]

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As at: February 2008
Reasons for increasing losses

- Population trends
- Change in environmental conditions (deforestation, conversion of natural areas to cropland, etc.)
- Land-use changes (loss of retention, “anthropogenic sealing“)
- Settling on flood-plains (inexpensive, attractive, easy to develop)
- Access to water (processing, cooling, shipping)
- High accumulation of values
- More values in the lower parts of buildings
- Higher vulnerability of values
- Less risk awareness and risk perception („the feeling of safety behind the dyke“)
- Climate change (more extremes, more loss events)
Effect of flood control measures

without flood control

$T = 4 \text{ h}$
Effect of flood control measures

without flood control

$T = 8 \, h$

- surface flooding
- property damage often reduced, sometimes even avoided
Effect of flood control measures

with flood control

$T = 4 \text{ h}$

→ no surface flooding

→ people feel safe, do not undertake precautionary measures
Effect of flood control measures

with flood control

T = 8 h

⇒ when the dyke fails, no measures are possible anymore

⇒ high flow velocities causes greater destruction
Effect of flood control measures

loss

Return period

years

50

100

200

Without flood protection

With flood protection

design: 100 year flood
Number of loss events 1980 – 2006 (worldwide)

- **floods**
- **earthquakes**
- **windstorms**

(2006 values)

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Climate Change

The hottest years since 1856 (152 years)

All 7 years since 2001 rank among the 8 hottest years ever.

1. 1998
2. 2005
3. 2002
4. 2003
5. 2004
6. 2006
7. 2001
8. 2007
9. 1997
10. 1995

* Global mean temperature near the ground (source: WMO)
### Effects of Global Warming on Extreme Weather Events

<table>
<thead>
<tr>
<th>Phenomenon (increase in)</th>
<th>observed trend</th>
<th>human contribution</th>
<th>future trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warmer and fewer cold days and nights over most land areas</td>
<td><strong>Very likely</strong></td>
<td>Likely</td>
<td><strong>Virtually certain</strong></td>
</tr>
<tr>
<td>Warmer and more frequent hot days and nights over most land areas</td>
<td><strong>Very likely</strong></td>
<td>Likely (nights)</td>
<td><strong>Virtually certain</strong></td>
</tr>
<tr>
<td><strong>heat waves</strong></td>
<td><strong>Likely</strong></td>
<td>More likely than not</td>
<td><strong>very likely</strong></td>
</tr>
<tr>
<td><strong>heavy precipitation</strong></td>
<td><strong>Likely</strong></td>
<td>More likely than not</td>
<td><strong>very likely</strong></td>
</tr>
<tr>
<td>Area affected by droughts increases</td>
<td><strong>Likely in many regions since 1970s</strong></td>
<td>More likely than not</td>
<td>Likely</td>
</tr>
<tr>
<td>Intense tropical cyclone activity increases</td>
<td><strong>Likely in some regions since 1970</strong></td>
<td>More likely than not</td>
<td>Likely</td>
</tr>
<tr>
<td>Increased incidence of extreme high sea level (excludes tsunamis)</td>
<td><strong>Likely</strong></td>
<td>More likely than not</td>
<td>Likely</td>
</tr>
</tbody>
</table>

- Very likely: > 90%
- Likely: >66%
- More likely than not: > 50%

IPCC 2007
Change in weather patterns

Observation in Southern Bavaria
(Hohenpeissenberg station):

1. Trough Central Europe pattern
   (TrM/Vb situation)

   Significant increase
   in days with
   rainfall depth > 30 mm
   in summer (Jun-Aug)
   during weather pattern
   Trough Central Europe
   (Vb pattern)
   (1891 - 2001).

Source: Fricke/Kaminski (Sept 2002), GAW 12
Change in weather patterns

Number of days with westerly patterns Dec - Feb

2. West zonal pattern (Wz) Persistence (duration) of westerly patterns

- N + E + SE + NE

West zonal (11-year moving average)

Fraedrich et al. 2001

P. Bissolli (1999), Klimastatusbericht 1999
Climate Change

What must we expect?

- increase in sea level
- higher weather variability
- more frequent events
- stronger events
- more loss events
- higher losses
Elbe, Dresden

Flood 2002: comparable to 1862 and 1890
Danube, Vienna

5 out of the 6 largest floods in past two decades!

Merz, 2007, TU Vienna
Danube, Vienna

Climate changes cannot be blamed for everything!

Merz, 2007, TU Vienna
Flood risk reduction

Risk = f (Hazard, Values at risk, Vulnerability)

How can we reduce the risk?
by reducing one or more of these influencing factors
Flood risk reduction

**Hazard:**
- natural event (storm, rainfall, flood, ...)
  - cannot be influenced
    - (at least almost not; exception: via anthropogenic climate change; but this is only possible in the long run)

**Values at risk** and **Vulnerability** → are man-made
Strategies against the flood risk

1. Preparing for floods
   Avoiding high flood peaks

2. Preparing for flooding
   Preventing high-value areas from flooding

3. Preparing for losses
   Limiting and reducing damage

4. Preparing for risk
   Preparing (financially) against ruin
Risk reduction requires a risk partnership between Public authorities (state, community, NGOs) and People concerned (private persons, companies) and Finance industry (insurance and capital market).
Main tasks of the partners

Public authorities/organisations

→ basic prevention measures :
- avoiding frequent losses
- mitigation during rare events

- land-use regulations
- technical flood control
- observation networks
- forecasting and warning
- flood retention
- providing information
EU Flood Directive

on the assessment and management of flood risks

FLOOD HAZARD MAPS AND FLOOD RISK MAPS

1. Member States shall … prepare flood hazard maps and flood risk maps…

3. Flood hazard maps shall cover … floods with a low … medium … high probability …

4. For each scenario … shall be shown … the flood extent … water depths or water level … flow velocity …

5. Flood risk maps shall show … the indicative number of inhabitants potentially affected … the type of economic activity of the area potentially affected;

FLOOD RISK MANAGEMENT PLANS

1. On the basis of the maps … Member States shall establish flood risk management plans ….

2. Member States shall establish … objectives for the management of flood risks … focusing on the reduction of potential adverse consequences of flooding …

5. Member States shall ensure that flood risk management plans are completed and published by 22 December 2015.
Main tasks of the partners

People concerned/affected

→ actions during rare events: loss prevention/reduction/limitation

- proper construction
- spot protection
- appropriate behaviour (alarm plan, checklist)
- seeking/receiving information
- maintaining risk awareness
Main tasks of the partners

Insurance industry

→ securing existence, prevention of ruinous consequences for personal/business property

- assuming part of the risk
- proper risk assessment
- adequate contracts
- providing information
- accumulation control

→ Make sure that the commitments towards the insureds can be fulfilled.
Insurance aspects and flood risk modelling

General problems

- large loss potential
- linear rather than area impacts
- high variation of exposure within short distance
- high influence of local factors
- flood control structures (e.g. dykes) make floods rare, but have almost no effect during extreme events
- loss of awareness and feeling of security
- anti- or adverse selection
Flood insurance

Principle of the insurance

\[
\text{sum of premiums from all clients} \quad = \quad \text{sum of payments to the affected clients} \\
( + \text{yields}) \\
( + \text{administrative costs + profits})
\]

Adverse selection

A Only those, who subjectively feel threatened by a flood, have interest in insurance cover; a large portion of them is in fact exposed to a high risk and experiences losses more or less regularly.

B The others feel safe and do not want to get insured.

If the portfolio mainly consists of members of group A, the spatial and temporal risk compensation is not guaranteed anymore.
Flood insurance

Approaches to a solution

- information about the individual exposure
- definition of zones according to exposure level (country-wide for all areas)
- exclusion of particularly exposed areas
Flood insurance

Hazard zonation: Flood hazard classes in the German system ZÜRS

Background: Satellite picture  
Topographical map
Flood insurance

Hazard zonation: Flood hazard classes in the German system ZÜRS

GK 4, high hazard:
Flooding at least once in 10 years*

GK 3, medium hazard:
Flooding at least once in 10 to 50 years*

GK 2, low hazard
Flooding at least once in 50 to 200 years*

(≈ area protected by dykes)

GK 1, very low hazard:
Flooding less than once in 200 years*

Brook: 200 m wide corridor along brooks indicating flash flood hazard
Flood insurance

Hazard zonation: Flood hazard classes in the Austrian system HORA
# Flood insurance

**Hazard zonation: Flood hazard classes in the Austrian system HORA**

**High hazard:**
- Zone 1: Flooded at least once in 30 years

**Medium hazard:**
- Zone 2: Flooded at least once in 30 to 100 years

**Low hazard:**
- Zone 3: Flooded at least once in 100 to 200 years

**Very low hazard:**
- Remaining area: Flooded less than once in 200 years
Flood insurance

Hazard zonation: Flood hazard classes in the Italian system SIGRA

Water depth for return period 200 years (medium)

- $0 \leq h < 50$ (cm)
- $50 \leq h < 100$ (cm)
- $100 \leq h < 150$ (cm)
- $150 \leq h < 200$ (cm)
- $200 \leq h < 250$ (cm)
- $250 \leq h < 300$ (cm)
- $300 \leq h < 350$ (cm)
- $350 \leq h < 400$ (cm)
- $h \geq 400$ (cm)
Flood insurance: Accumulation control

WANTED:

The **Probable** Maximum Losses (PML) that a portfolio, i.e. a company may face

* “Probable” depends on the company’s risk policy, but also on legal requirements (e.g. Solvency II)
Flood insurance

Accumulation control - Calculation of the PML curve

To obtain (estimate) the loss of a single event, we have to combine:

Values at risk  Vulnerability  Hazard

liability distribution  vulnerability  event scenario

- loss ratio (in % of s.i.)
- water depth
Flood insurance

Identification of areas hit by flood waters → Superposition of flooded areas with built-up areas
Flood insurance

Loss analysis per postcode-sector

SI = sum insured

$A_s$ = total settled area

$A_f$ = flooded part of settled area

$R_D$ = damage ratio

Loss: \[ L = SI \times \frac{A_f}{A_s} \times R_D \]

Result: probable losses per postcode sector

Sum of the losses from all postcode sectors = accumulated event loss
Flood insurance

from historic events, we have some loss experience

but as we have only a VERY limited number of historic events, we need to generate more events stochastically
Flood insurance

- loss “experience” from a stochastic event set

![Graph showing loss experience from stochastic event set.](image)
Flood insurance

How high is 200-year loss?
What is the return period of a given historic event?
Final remarks

Flood losses are increasing. Loss potentials have reached new dimensions.

The main driving factors are:
- settling in flood-prone areas,
- higher and more vulnerable values,
- climatic and environmental changes,
- low risk awareness, short memory.

Risk reduction is necessary (and possible).

The key is proper land-use policy.

Adaptation to the increasing weather hazards is vital.
Efficient risk reduction requires a partnership between the authorities, the people concerned and the insurance industry.

Insurance is a central hub of risk reduction.

Premiums reflecting the individual risk adequately must be determined on the basis of zoning models.

The insurance industry and societies as a whole must prepare for extreme losses.
We must learn to live with floods.

At the same time, we must establish a culture of coping with the resulting risk.

Thank you