



WHO

REGIONAL OFFICE FOR EUROPE



SCHERFIGSVEJ 8
DK-2100 COPENHAGEN Ø
DENMARK

TEL.: +45 39 17 17 17
TELEFAX: +45 39 17 18 18
TELEX: 12000

E-MAIL: POSTMASTER@WHO.DK
WEB SITE: [HTTP://WWW.EURO.WHO.INT](http://WWW.EURO.WHO.INT)

EUR/02/5036813
ORIGINAL: ENGLISH
UNEDITED
E77096

FLOODS: CLIMATE CHANGE AND ADAPTATION STRATEGIES FOR HUMAN HEALTH

Report on a WHO meeting

London, United Kingdom
30 June – 2 July 2002

2002

ABSTRACT

Within a European-Commission funded project (EVK2-2000-00070), WHO and the London School of Hygiene and Tropical Medicine organized a workshop to identify health risks associated with floods in the WHO European Region, explore projections of the implications of climate change for the risk of floods, and assess strategies to adapt to or prevent these implications in order to reduce the health risks. The participants recommended that:

- emphasis be shifted from disaster response to risk management, including the improvement of flood forecasting and warning systems, the addition of health protection as a goal and consideration of how climate change may increase or decrease flood hazards;
- environmental impact assessments include health risks from flooding as an issue;
- assessments be made of communities' capacity to respond to and manage flooding and its effects on health;
- governments support monitoring of and research on the health impact of all categories of flooding; and
- coordination be promoted among disciplines, policy-makers and international organizations.

Keywords

NATURAL DISASTERS
CLIMATE
ENVIRONMENTAL HEALTH
RISK MANAGEMENT
RISK ASSESSMENT
DISASTER PLANNING
FORECASTING
HEALTH STATUS INDICATORS
STRATEGIC PLANNING
PUBLIC HEALTH ADMINISTRATION

© World Health Organization – 2002

All rights in this document are reserved by the WHO Regional Office for Europe. The document may nevertheless be freely reviewed, abstracted, reproduced or translated into any other language (but not for sale or for use in conjunction with commercial purposes) provided that full acknowledgement is given to the source. For the use of the WHO emblem, permission must be sought from the WHO Regional Office. Any translation should include the words: *The translator of this document is responsible for the accuracy of the translation*. The Regional Office would appreciate receiving three copies of any translation. Any views expressed by named authors are solely the responsibility of those authors.



CONTENTS

Page

1.	Introduction.....	1
2.	Session I: Health risks associated with flooding.....	3
2.1	Overview of health risks associated with flooding.....	3
2.2	Mental health and flooding: issues and strategies.....	5
2.3	Human risk of coastal flooding as a result of climate change.....	7
2.4	Global Burden of Disease estimates for flooding.....	9
3.	Session II: Retrospective perspectives on European flooding.....	12
3.1	Problems and limitations of EMDAT data.....	12
3.2	Flooding in Europe: what is the situation?.....	13
3.3	The political fora in Europe.....	16
3.4	Flood risk management.....	17
3.5	Coastal vulnerability to climate change.....	20
4.	Session III: Climate change projections as related to flooding risk.....	20
4.1	Climate change and flooding risk.....	20
4.2	Weather, floods and health.....	21
5.	Session IV: Determinants of adaptive capacity to flooding risk.....	21
5.1	Determinants of adaptive capacity.....	21
5.2	Considerations in the development of indicators of risk, vulnerability and adaptive capacity.....	22
5.3	www.floods.com: Added value of information technologies against floods.....	22
5.4	Stakeholder-institutional analysis of adaptation to climatic hazards.....	23
6.	Session V: Discussion.....	23
6.1	Retrospective perspectives on health risks associated with flooding.....	23
6.2	Retrospective perspective on European flooding.....	24
6.3	Climate change perspectives.....	25
6.4	Adaptive capacity.....	25
7.	Conclusions.....	26
8.	Recommendations.....	27
Annex 1	Participants.....	29
Annex 2	Working papers.....	31
Annex 3	Guidelines on flood prevention.....	32
Annex 4	Draft guidelines on sustainable flood prevention.....	34
Annex 5	Good practices for flood prevention and protection.....	40
Annex 6	Good practices for flood prevention and protection: awareness raising, education and training.....	46

1. Introduction

European vulnerability to flooding was highlighted by the loss of life and economic damage from flooding events of the Rhine, Meuse, Po, Danube, Elbe and Oder rivers in the 1990s and early twenty-first century. With the exception of floods generated by dam failure or landslides, floods are climatological phenomena that are influenced by geology, geomorphology, land use and other conditions. Climate variability also plays a role; persistence of higher rainfall can lead to greater intensity of regional and local flooding.

The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) concluded that the general pattern of future changes in annual precipitation over Europe indicates widespread increases in northern Europe (between +1 and +2% per decade), smaller decreases across southern Europe (maximum -1% per decade), and small or ambiguous changes in central Europe (France, Germany, Hungary, Belarus). The climate scenarios suggest a marked contrast between winter and summer patterns of precipitation change. Most of Europe is projected to become wetter during the winter season (+1 and +4% per decade), with the exception of the Balkans and Turkey where winters are becoming drier. In summer, there is a strong gradient of change between northern Europe (increasing precipitation of as much as 2% per decade) and southern Europe (drying as much as -5% per decade). It is likely that intense precipitation events will increase in frequency, especially in the winter. These projected changes underscore the need to increase adaptive capacity to flooding-associated human health risks.

The damaging effects of floods are complex. Floods frequently cause major infrastructure damage, including disruption to roads, rail lines, airports, electricity supply systems, water supplies and sewage disposal systems. The economic effects of floods are often much greater than indicated by the physical effects of floodwater coming into contact with buildings and their contents. Indirect economic losses typically spread well beyond the flooded area and may last much longer than the flood itself. The local and regional economy may be badly affected by a major flood disaster and this may seriously affect the national economy.

Previous studies of the health effects of floods divided the health aspects into, direct effects caused by the floodwaters (such as drowning, injuries, and others) and indirect effects caused by other systems damaged by the flood (such as water-borne infections, acute or chronic effects of exposure to chemical pollutants released into flood waters, vector-borne diseases, food shortage and others (Table 1)). The number of deaths associated with flooding is closely related to the life-threatening characteristics of floods and to the behaviour of victims. Injuries are likely to occur in the aftermath of a flood disaster, as residents return to dwellings to clean up damage and debris. Ill health, particularly in the form of psychological problems, may persist for months to years following a flood. Subgroups vulnerable to adverse health effects of floods include children and the elderly.

Before, during and after a flood event activities may be undertaken by the population at risk, by policy makers and by emergency workers in order to reduce health risks. Traditionally, the fields of engineering and urban planning aim to reduce the harmful effects of flooding by limiting the impact of a flood on human health and economic infrastructure. This is accomplished by following construction codes and legislations aimed at relocating structures away from flood-prone areas, planning appropriate land use and managing costs of floodplains. Mitigation measures may reduce, but not eliminate major damage. Early warning of flooding risk and appropriate citizen response has been shown to be effective in reducing disaster-related deaths.

From a public health point of view, planning for floods during the inter-flood phase aims at enabling communities to effectively respond to the health consequences of floods and allows the local and central authorities to organize and effectively coordinate relief activities, including making the best use of local resources and properly managing national and international relief assistance. In addition, medium to long-term interventions may be needed to support populations affected by flooding.

Table 1. Effects of floods on human health

Direct effects

Causes	Health implications
Stream flow velocity; topographic land features; absence of warning; rapid speed of flood onset; deep floodwaters; landslides; risk behaviour; fast flowing waters carrying boulders and fallen trees	Drowning Injuries
Contact with water	Respiratory diseases; shock; hypothermia; cardiac arrest
Contact with polluted waters	Wound infections; dermatitis; conjunctivitis; gastrointestinal illnesses; ear, nose and throat infections; possible serious waterborne diseases
Increase of physical and emotional stress	Increase of susceptibility to psychosocial disturbances and cardiovascular incidents

Indirect effects

Causes	Health implications
Damage to water supply systems; sewage and sewage disposal damage; Insufficient supply of drinking water; Insufficient water supply for washing	Possible waterborne infections (enterogenic E. coli, Shigella, hepatitis A, leptospirosis, giardiasis, campylobacteriosis); dermatitis and conjunctivitis
Disruption of transport systems	Food shortage; disruption of emergency response
Underground pipe disruption; dislodgment of storage tanks; overflow of toxic-waste sites; release of chemicals; disrapture of gasoline storage tanks may lead to fires	Potential acute or chronic effects of chemical pollution
Standing waters; heavy rainfalls; expanded range of vector habitats	Vector borne diseases
Rodent migration	Possible diseases caused by rodents
Disruption of social networks; loss of property, jobs and family members and friends	Possible psychosocial disturbances
Clean-up activities following floods	Electrocutions; injuries; lacerations; skin punctures
Destruction of primary food products	Food shortage
Damage to health services; disruption of "normal" health service activities	Decrease of "normal" health care services, insufficient access to medical care

Within the European Commission funded project, Climate Change and Adaptation Strategies for Human Health (cCASHh) (EVK2-2000-00670), the WHO European Centre for Environment and Health and the London School of Hygiene and Tropical Medicine (LSHTM) organized a workshop entitled “Floods: Climate change and adaptation strategies for human health”. The objectives of the workshop were to:

- provide a retrospective perspective on health risks associated with European flooding;
- explore climate change projections related to flooding risks in Europe; and
- assess strategies to increase adaptive capacity and reduce health risks posed by flooding in the European Region.

WHO and LSHTM were fully aware of the many initiatives being carried out by several agencies and groups on flood risks. Maximum effort was made to include those involved in activities relevant to the issue.

Experts were asked to present a short and comprehensive background document at the meeting. These are available from bme@who.it on request.

The workshop was divided into five sessions: Session I reviewed the health risks associated with flooding; Session II provided retrospective perspectives on European flooding; Session III focused on climate change projections related to flooding risks; Session IV highlighted determinants of adaptive capacity to flooding risks; Session V was a discussion of conclusions and recommendations.

2. Session I: Health risks associated with flooding

2.1 Overview of health risks associated with flooding

Flooding is the most common natural disaster in Europe, and, in terms of economic damages, the most costly one. There has been an increase in the number of reported events since the mid-1970s. (Figure 2.1) The average number of annual deaths varies from year-to-year with no clear pattern (Figure 2.2.).

Figure 2.1.:Number of flood events in Europe

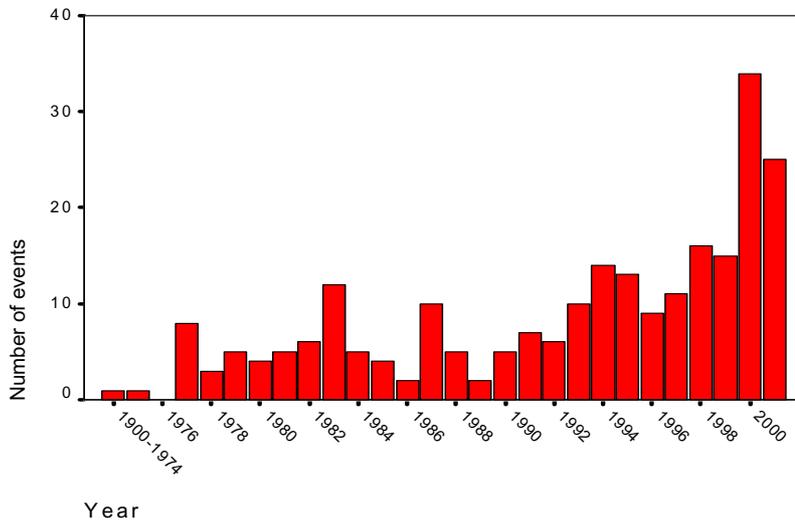
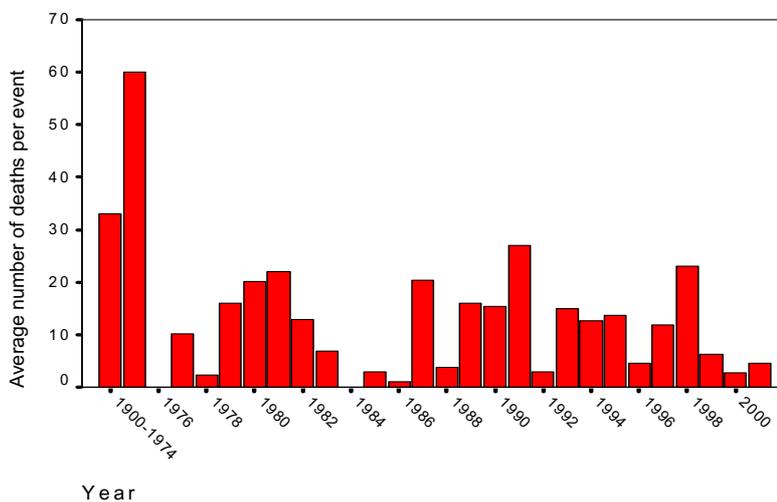


Figure 2.2. Average number of deaths per flood event in Europe



The physical health effects that occur during or after flooding include: mortality – mostly from flash floods; injuries – e.g. sprains/strains, lacerations, contusions, etc.; infectious diseases – evidence for this in Europe is relatively rare; poisoning – e.g. carbon monoxide; and other – e.g. hypothermia, respiratory diseases. One surprise of the literature review was the relative paucity of data on the health effects of flooding. A critical priority is the development of improved data collection systems to provide the necessary information to determine vulnerability to flooding. Instruments are needed for assessing health risks. The lack of health data makes vulnerability mapping very difficult.

In European countries, it is perhaps the less tangible effects of floods that are the biggest public health problem. Many studies have observed increased rates of the most common mental disorders following floods, such as anxiety and depression. Suicides may occur. Certain subgroups of the population are likely to be most vulnerable to mental disorders, such as children and those on low incomes. The psychological effects may continue for months or even years after the flood events itself. This may suggest that anxiety remains high in populations in flood-prone areas due to the threat of future flooding. This also may reflect the stress of working with insurance companies, builders, etc., to repair flood damage.

But on the other hand it can be observed that 3 to 5 years after the event the same careless building policy and neglecting of prevention measures continues as before. Flood awareness is lost soon after the damages are repaired. It may depend on the size of the loss. In a large fluvial flood event many persons are affected, but most suffer only material losses, which are overcome in a certain period. Only few are really exposed to a danger of life or lose all their belongings. This may be one explanation the difference between the general loss of awareness and the particular persons that got the shock of their life.

2.2 Mental health and flooding: issues and strategies

Since the Easter floods in 1998, the United Kingdom has experienced the most extensive and widespread inland flooding in over 50 years. Following a wet spring and early summer, autumn 2000 was the wettest on record for over 270 years. Climate change could make extreme floods a more frequent occurrence, due to the projected wetter winters and more intense summer storms. An estimated 1.85 million homes, 185 000 commercial properties and approximately five million people are now considered to be at risk from flooding in England and Wales alone.

The increased likelihood of future flooding raises the issue of the risks to human health as a consequence of flooding and how these risks can be reduced or mitigated. Since the 1998 floods, there has been a growing awareness of the significance of the social effects that flooding may have on those affected. These “intangible” effects of flooding include the impacts on human health, which have effectively been ignored in investment appraisals, such as those providing flood defense schemes. Assessment of the “tangible” impacts of flooding, such as damage to property, has taken precedence over the intangible impacts, as these impacts are better understood and more easily measured and valued. One consequence of this is a danger of emphasizing what can be valued in monetary terms as opposed to what is often more important to people.

There has been little research in the United Kingdom on the health effects associated with being flooded. A study of the effects of the 1968 Bristol floods found mortality rates from all causes to have been greater in the year following the flooding among those people who had been affected by the flood. More recently, the Public Health Laboratory Service has undertaken a study in Lewes on the autumn 2000 floods, and the Flood Hazard Research Centre (FHRC) at Middlesex University has carried out small-scale research since the 1980s on the social aspects related to flooding, including the impact on human health. This research does indicate a time dimension to the health impacts of flooding. Health effects can be categorized as those resulting at the time of the flood event or immediately after, those which develop in the days or early weeks following the flood, and those longer-term effects which may appear and/or last for months or even years after the flood. There is growing evidence that these effects are predominantly psychological.

Recent years have seen a shift in emphasis associated with flooding from disaster response to preparedness and mitigation, and from the provision of services to more community-driven initiatives. There are a number of actions that can be taken by both agencies and the public to mitigate the adverse impacts of flooding. For example, the United Kingdom Environment Agency has been improving its flood forecasting and warning systems. New flood warning codes have been introduced which are less confusing than the previous codes, and regular flood warning messages are now broadcast on television and radio weather bulletins. Public awareness of flood risks has been highlighted through annual national awareness-raising campaigns and “Flood Awareness” weeks. A new dedicated telephone helpline has been launched whereby people can telephone the “Floodline” number and receive information on the latest flooding situations in their area, and also receive information on how to cope with flooding. Live flood warnings are also posted on the Environment Agency's internet site along with advice on what actions to take before, during and after flooding, and information on how to floodproof properties. These initiatives have generally been well-received and have been successful in raising awareness of flooding. They have also highlighted ways in which people can help themselves.

Self-help measures to reduce the damage to property and the stress caused by flooding are being increasingly encouraged, thereby alleviating some of the negative consequences on people's health. These measures include flood proofing of properties and development of community preparedness initiatives along the lines of those widely used in the USA for hurricanes and earthquakes. One example is of a “Family Flood Plan” that households who live in flood-risk areas can formulate and put into action in the event of a flood. Each member of the family or household is familiar with the Plan and knows what actions to take, such as how to contact other family members, where the family would be evacuated to, what precautions to take in the home (e.g. where to turn off power supplies) etc.

Where feasible and cost-effective, flood alleviation schemes also may be considered, along with development control, to restrict new building in the floodplain. In the United Kingdom, central government has recently issued more stringent guidelines to local authorities on development in floodplains in the form of the “Planning and Policy Guidance 25” document (PPG25). Disincentives to building in floodplains are also likely in the future with the refusal of insurance companies to insure new developments.

Awareness of issues relating to flooding and health needs to be raised among the various authorities involved in improving response to, and recovery from, flood events, e.g. local authorities, the Environment Agency, the Department for the Environment, Food and Rural Affairs (DEFRA), emergency services, and insurers. Systems of social support for flood victims during the recovery process may prove to be important in mitigating some of the mental and physical health effects resulting from flooding. These systems may include organization of teams of volunteers to help clean up properties after a flood (especially for the elderly or those living alone), the provision of child-care facilities for parents to allow them to concentrate on the recovery process, advice on insurance claims and building contractors and general counselling services help people to cope with their experiences. However, although factors such as flood warning, coping strategies and social support may mediate the stressful effects on people's health, these factors may be weakly developed or non-existent when flooding is unexpected, sudden and without warning.

More research is needed to understand the complex health consequences that may result following flooding. Disease surveillance and monitoring needs to be increased during floods and

information disseminated rapidly to dispel false rumours of public health epidemics. The longer-term psychological impacts on people's health and social wellbeing in particular require more investigation, along with social support during the recovery period. The social and community dimensions of flooding, which can have significant impacts on households and individuals, are also factors often neglected in post-flood studies. There is therefore a need to develop more predictive models of the social effects of flooding in order to alleviate these with future policies, plans and schemes. The Flood Hazard Research Centre's Social Flood Vulnerability Index (SFVI) is an example of such a model. The SFVI is a composite additive index based on three social characteristics and four financial-deprivation indicators. The Index aims at measuring the impact that floods could have upon the communities potentially affected by them and can be used in addition to knowledge of the potential flood damage impacts and losses that are more readily understood and modelled within benefit-cost analyses within investment appraisals.

In conclusion, the effects of flooding on mental health can be measured using standard survey instruments, can potentially be significant, and are likely to be long-term. Moreover, certain subgroups within communities may be more vulnerable to these effects than others, and may need special consideration. Finally, there is a need for much better information, particularly of a quantitative nature, on the potential health effects of flooding, in order to improve strategies to increase adaptive capacity.

2.3 Human risk of coastal flooding as a result of climate change

Globally, coastal floods present a major natural hazard from hurricanes (tropical cyclones), and in flood-prone Bangladesh an average of around 15 000 people die each year in flood disasters. A large coastal flood was the worst natural disaster in the United Kingdom and the Netherlands. Over the centuries disastrous floods with significant loss of life have occurred every one to two hundred years. Climate change and the rise in the sea level could result in the frequency of these severe events increasing by an order of magnitude by the year 2050. In other words, the conditions for major coastal flooding could reoccur once every 10–30 years.

The reference event for such disastrous coastal flooding was the Great Flood of 1953, the worst in recent times. The death toll from drowning was 307 100 died in E. Anglia and 58 on Canvey Island. In Holland, 1 795 died as the surge swept across the English Channel. The death toll would have been higher were it not for the efforts of 500 000 servicemen stationed in post war Britain at the time, along with their logistical back up and equipment.

Sea defences were improved after this event, but many of these are now losing their effectiveness. The Thames Barrier was opened in 1982 following the risk to Central London in 1953, just spared from the overflowing of the Thames. The Barrier was built to withstand a 1:1000 year high tide, with a design that allowed for predicted sea level rise until the year 2030. The criteria for sea defences along the coast are much lower. Holland, having been more severely inundated, set for many years more stringent criteria than the United Kingdom, including theoretical limits of 1:1,000 year events, but they have recently come into line with the criteria of the United Kingdom.

Relatively little is known about the traumatic impacts of coastal floods and the longer-term consequences in survivors. Nonspecific mortality appears to have been raised in the year after the 1953 floods on Canvey Island. Impacts vary according to the phase of the coastal flood.

- Impact phase, where deaths may occur by drowning and exposure.
- Immediate post impact phase, where deaths may occur due to the injured or sick being unable to obtain medical care or treatment. These deaths may be as many as 10% of the overall mortality. And
- Recovery phase, where there may be an increase in morbidity (hospital referrals and hospital admissions) and nonspecific mortality in the flooded group in the months after the flood. In addition, there may be subsequent mental health sequel, e.g., posttraumatic stress disorder, anxiety-depression, or nonspecific psychological syndromes.

In the Netherlands, in 1953, six medical problems were identified in the immediate post-flood period:

- identifying and recovering corpses;
- evacuating the sick and the old;
- providing physicians with routine supplies;
- setting up emergency hospitals to take care of the evacuated;
- restoring hygienic services (food, water, sanitation); and
- taking measures to fight epidemics.

In addition, there may be multiple health risks from events such as chemical releases caused by flooding. These need to be considered as part of the overall emergency assessment.

A recent United Kingdom Department of Health study on the health effects of climate change in the United Kingdom concluded that the impacts were relatively small using the United Kingdom Climate Impacts Programme scenarios to 2050, with the exception of temperate wind storms and coastal floods, both of which were likely to become more severe. The potential for greater losses of life from these causes was likely to increase. As an island in the northern Atlantic Ocean, the UK is vulnerable to sea level rise. Anticyclones are frequent. If they coincide with high tides, they can cause abnormally high water levels in the North Sea, including storm surges. The east coast of England is at special risk – the land is flat and low lying, with much land having been reclaimed, and the North Sea is relatively shallow. There is an average of 19 storm surges over 0.6 m above “normal” tide each winter. The greatest danger is when a large storm surge coincides with the time of high water during an abnormally high tide.

Although a highly developed flood forecasting system is in place, the areas at risk of coastal flooding have not been accurately defined. The current hazard maps are simply crude replicas of 5 m contour lines. The actual population at risk of lethal flooding is therefore unknown.

Adequate multi-sectoral contingency planning has not been undertaken. The Department of Health does not have disaster planning for a response to a major flood, for search and rescue of casualties, and their emergency treatment, or maintenance of hospital activity. Evacuation planning is rudimentary in most places. Another problem is education of the population to know what to do when the alarm to evacuate is given. For example, no advanced evacuation plans involving public transport (cars and buses) are in place.

Risk assessment and risk scenario development are now possible with more powerful computers. Future work should be multi-disciplinary and involve 3D simulation modelling together with

studies of impacts of floodwaters on buildings and their occupants, as well as determining the full effects of topography and buildings on flood-flow and on infrastructure. Mitigation measures must, in future, include land use planning to reduce development in flood-prone areas and community preparedness with evacuation planning. In summary, climate change and global health concerns have so far failed to become anything more than of marginal interest to health professionals and medical research funding agencies. The increased riverine flooding the United Kingdom, experienced in recent years, has excited politicians and insurance companies, but research into disaster mitigation has lagged behind. Innovative risk assessment platforms for extreme weather hazards are needed, including 3D computer simulation mapping and new approaches to estimating risk and uncertainty using Bayesian logic. Advances in risk mitigation methodology for climate change scenarios are also needed.

2.4 Global Burden of Disease estimates for flooding

The comparative risk assessment (CRA) methodology applied in the latest WHO global burden of disease assessment provides a framework for addressing the generation of comparable outputs of assessments for various health impacts in different regions of the world. The CRA method requires the definition of alternative exposure scenarios for individual risk factors at particular time points. The relative risk of occurrence of defined health outcomes is then estimated for each exposure scenario. These relative risks are applied to WHO estimates of the current and predicted future burden of each of these diseases, after accounting for temporal trends and changes driven by predicted future patterns of wealth and 'social capital'. These are then aggregated using a summary measure of population health such as the DALY – disability adjusted life year. These are used to estimate (a) the total burden of current ill health that is attributable to that risk factor, and (b) the amount that could be avoided by altering the risk factor to one of the alternative scenarios.

IPCC has summarized the evidence for increased frequency of different categories of extreme events in the past and the likelihood of changes in the future (Table 2).

These conclusions have been strengthened by recent demonstrations of increases in the frequency of large floods over the twentieth century and projections of several-fold increases in the frequency of what are currently considered extreme wet seasons, for various regions over the world, using a range of climate models.

Based on this, estimates of impacts of increasing frequency of coastal flooding caused by sea level rise and inland flooding and landslides caused by increased frequency of extreme precipitation events, described by IPCC as very likely (90-99% probability) to increase in many areas under climate change.

An estimate was made of the potential impacts of increasing frequency of coastal flooding caused by the rise in sea level, and of inland flooding and landslides caused by increased frequency of extreme precipitation events. Longer-term health impacts were excluded due to mechanisms such as population displacement, economic damage to public health infrastructures, increased risk of infectious disease epidemics and mental illness. Although these impacts are likely to be greater than the acute impacts, it is currently impractical to attempt quantitative estimation of these more complex mechanisms.

Table 2. Estimates of confidence in observed and projected changes in extreme weather and climate events: Adapted from (IPCC, 2001)

Changes in phenomenon	Confidence in observed changes (latter half of 1900s)	Confidence in projected changes (during the twenty-first century)
Higher maximum temperatures and more hot days over nearly all land areas	Likely ^c	Very likely ^c
Higher minimum temperatures, fewer cold days and frost days over nearly all land areas	Very likely ^c	Very likely ^c
Reduced diurnal temperature range over most land areas	Very likely ^c	Very likely ^c
Increase of heat index^a over land areas	Likely ^c , over many areas	Very likely ^c , over most areas
More intense precipitation events^a	Likely ^c , over many Northern Hemisphere mid- to high latitude land areas	Very likely ^c , over many areas
Increased summer continental drying and associated risk of drought	Likely ^c , in a few areas	Likely ^c , over most mid-latitude continental interiors. (Lack of consistent projections in other areas)
Increase in tropical cyclone peak wind intensities^b	Not observed in the few analyses available	Likely ^c , over some areas
Increase in tropical cyclone mean and peak precipitation intensities^b	Insufficient data for assessment	Likely ^c , over some areas

(a) For other areas, there is either insufficient data or conflicting analyses.

(b) Past and future changes in tropical cyclone location and frequency are uncertain.

(c) Judgement estimates for confidence: *virtually certain* (greater than 99% chance that the result is true); *very likely* (90–99% chance); *likely* (66–90% chance); *medium likelihood* (33–66% chance); *unlikely* (10–33% chance); *very unlikely* (1–10% chance); *exceptionally unlikely* (less than 1% chance).

(d) Based on warm season temperature and humidity

Coastal floods: changes in the frequency of coastal floods were defined using published models that estimate change in sea level for each climate scenario. These changes were applied to topographical and population distribution maps to estimate the change in incidence of exposure to flooding, by region. The predictions did not account for changes in frequency of storm surges. The global model used has been shown to be relatively accurate in validations against more detailed assessments at a national level.

Inland floods and landslides: Despite the clear causal link, intense precipitation and inland flooding/landslides is poorly researched and has not previously been modelled as a health exposure: i.e. there are no published analyses of global relationships between intensity of precipitation, the likelihood of a declared disaster, or the magnitude of health impacts. It is clear that at the local level the frequency of health impacts will be determined by the temporal distribution of rainfall (i.e. not only by the average amount of rain over an extended period, but by the peak amount falling in a week, day or hour) and modulated by topography and social aspects of vulnerability. However, in the absence of detailed data on these variables and their

effects, the prior assumption was made that flood frequency was proportional to the frequency with which monthly rainfall exceeded the 1 in 10 year limit (i.e. upper 99.2% confidence interval) of the baseline climate. It was also assumed that determinants of vulnerability were distributed evenly throughout the population of a region – so that the change in relative risk of health impacts was proportional to the per capita change in risk of experiencing such an extreme event. For each 1 by 1 degree population grid cell, the 99.2% upper confidence interval was estimated for the ‘baseline climate’ using means and standard deviations derived from the 1961–1990 averages for each month of the year. Using equivalent data for future scenarios and time points, the change in frequency with which such a “1 in 10 year event” occurs was estimated.

Health impacts caused by natural disasters do not relate to a specific disease code for global burden. Relative risks were, therefore, applied to estimates of health impacts such as deaths and injuries attributable to these climate events under baseline climate (i.e. rather than change in total incidence of these outcomes).

The models presented for coastal flooding assumed that protection evolved over time in proportion to projected increases in GNP, but without any additional response to climate change. The only published sensitivity analyses related to an unmitigated emissions scenario applied to the HADCM2 model with four slightly varying sets of initial conditions and a comparison with the same emissions scenario runs on the HADCM3 model. These resulted in almost no difference in model outputs over the time-scale considered. Remaining uncertainties in the model related to the degree and manner to which individuals responded to the increased risk. Although these have not been quantitatively explored, it would seem reasonable to assume that individual-level responses would act to some degree to reduce the projected impacts in addition to the effect of improving socioeconomic conditions/GNP. The estimates generated by the model were quoted as an upper estimate, the mid-estimate assumes that 50% of the projected impacts could be avoided by such individual level adaptation and the lower estimate assumes that 90% of the impacts could be avoided.

The model for inland flooding was subject to the same uncertainty over adaptive responses. As for coastal flooding, the mid-estimate was based on a 50% adaptation to the model projections of changing exposure. As described above, however, the uncertainty was greater for a hazard driven by the magnitude and temporal variation of precipitation (which varies considerably between climate models), rather than the more predictable process of temperature-driven sea level rise. This consideration was particularly important as only one climate model was used. Although the relative risks estimated were broadly comparable to estimates of changes in frequency of extreme wet seasons generated using multi-climate model analyses (5 fold for northern Europe for the period 2060–2080), more formal analyses are necessary to give more accurate estimates. It was assumed that there would be a 50% greater exposure and no adaptation for the high estimate and no increase in risk under any scenario for the lower estimate. As for the other impacts, this uncertainty range should be interpreted with caution.

Following some of the preliminary results, in Europe the annual incidence of deaths per 1,000,000 is estimated to range from 11 in 2000 to 15 in 2030. The Annual incidence of deaths per 1,000,000 populations caused by inland floods and landslides is estimated to vary from 12 in EU countries to 92 in NIS countries.

The potential health impacts of a change in the frequency and intensity of extreme weather events are surprisingly poorly researched. Substantial improvements in assessment could be made through better estimates of the current health impacts of natural disasters, which suffer

from poor baseline data and probably severe under-reporting, particularly in developing countries. These are the most likely explanation for the apparent anomalies in the reported data, such as discrepancies in the ratios of deaths vs. injuries in different regions. Analyses could also be greatly improved by georeferencing and more detailed descriptions of disasters to allow differentiation of inland and coastal events, detailed analysis of the relationships between intensity of precipitation and health impacts and projections of future precipitation at higher temporal and spatial resolution, using output from a range of climate models. In order to generate better uncertainty estimates, formal sensitivity analyses of the contributions of each model parameter to the final uncertainty estimates are required.

Finally, it should be stressed that the estimates presented represent only the immediate acute impacts of natural disasters, which are likely to be only a small fraction of the total disease burden. There is a clear need to consider other impacts of natural disasters, such as the probability of outbreaks of water, vector and rodent-borne diseases, the effects of sequential disasters on both public health defences and stability of natural ecosystems limiting disease outbreaks and longer term-impacts such as posttraumatic stress following floods and of population displacement through coastal flooding. More importantly, it is necessary to expand the range of natural disasters analysed. There is an obvious causal chain between apparently increasing variability in precipitation frequency of droughts and their associated health impacts, particularly food shortages and (if not appropriately managed) famine. While these impacts may be expected to increase under climate change, no models have yet been developed to link climate scenarios, frequency of drought, and associated health impacts, so that quantitative estimation of climate change effects is not currently possible.

3. Session II: Retrospective perspectives on European flooding

3.1 Problems and limitations of EMDAT data

In Europe there is only one database that collects disaster information. The EMDAT database on international disasters is one of the initiatives of the Centre for Research on the Epidemiology of Disasters (CRED). Data are available at www.cred.be/emdat. Each disaster is recorded by type, date, country of disaster and numbers of people dying, injured and affected. The data is obtained from insurance companies (Munich Re, Suisse Re and Lloyds of England), Federation of Red Cross, UN-OCHA, WHO, Reuters and governments. Data is collected for events in which there are ten or more deaths, or when international assistance is requested. Since 1975 there was a substantial improvement in reporting and data collection, and since the 1990s more than 90% coverage was achieved. Although the data shows an increase in hydro-meteorological disasters between 1960 and 2000, flood data in developed countries is poor. The data is not considered to be standardized, accurate or complete.

The IPCC definition of extreme events is the least likely weather events in the statistical sense. Concentrating on extreme events is too narrow when trying to prevent morbidity and mortality. Events within two standard deviations from the mean also cause significant adverse health impacts. As global analyses of vulnerability to disasters show, non-extreme events can have severe effects on human health. Floods in particular pose a problem both as a phenomenon that is on the increase due to climate related factors aggravated by urbanization and other social factors and, more crucially, an increase in numbers of persons affected.

The EMDAT database will be improved over the next year. It will begin to identify events against a unique number used as a tracking device to capture information. In particular, plans are underway to improve the European region data. While most European events are included in EMDAT, there is room for improvement in the quality and completeness of records. In the first instance an assessment of existing data and its sources is required followed by the development of an inter-European compatible reporting format that is simple and limited to essential information. The 15-year EMDAT experience has showed that, if essential information is compiled on standardized and transparent criteria, it serves as a fertile basis for specialists for different disciplines to undertake more detailed research using the sources.

3.2 Flooding in Europe: what is the situation?

During the 1990's severe floods affected Europe. In several international meetings it was recognized that the main driving forces for these floods were recognized in being the temporal and spatial changes of precipitation and the human induced changes in vegetation coverage, soil, ground surface retention and drainage networks. In particular, in the Mediterranean, intense precipitation falling on small catchment areas has caused rapid onset floods. These short extremes normally take place at the end of summer and at the beginning of autumn. The range of adverse effects of floods depends on a number of pressing human activities. Changes in catchment areas, mainly caused by deforestation and consequent increased surface water run off, land sealing, urbanization, increased road and rail infrastructure and some hydraulic engineering measures.

Table 3. The 10 most disastrous floods in Europe within the last decade

Country	Year	Month	Day	Killed
Tajikistan	1992	5	25	1346
Italy	1998	5	6	147
Russia	1993	6	17	125
Romania	1991	7	28	108
Uzbekistan	1998	7	8	95
Spain	1996			86
Turkey	1995	11	4	78
Turkey	1995	7	10	70
Italy	1994	11	5	64
Turkey	1998	8	10	60

3.2.1 Alluvial flooding in the United Kingdom: experiences in Sussex, England, in October 2000

In October 2000 very heavy rainfall combined with very high spring tides was responsible for severe flooding in the south east of England. Based on historical data, this was a 1 in 300 year event. The worst affected town was Lewes, the county town of Sussex, which sits on the tidal River Ouse. The flooding was alluvial in nature and there were very few physical injuries.

The District conducted a flood damage survey of 258 flooded households. In addition, the Public Health Laboratory Service in partnership with the Lewes Borough Council, the local Health Authority and the London School of Hygiene and Tropical Medicine organized a study to assess the health effects of this event. A case-control study was conducted using a telephone-administered questionnaire of 103 flooded and 104 non-flooded households (227 and 240 residences, respectively) to assess adverse health and psychological impacts. Interviews were conducted nine months after the event. The results of these studies indicate that there were very little physical health effects from this event but that mental health effects such as anxiety/depression were very significant and were persistent. Results have been submitted for publication. Funding is being sought to conduct longer-term follow-up of the mental health of the flooded population.

3.2.2 Experience in the Netherlands

There is a law in the Netherlands that a river shall not flood more than once in 1000–1250 years. Trends in water management include:

- the recognition that water has many functions;
- the beginning of integration of water and land use management;
- the change in democratization over the past 50 years; and
- the greening of public opinion, which has led to the current policies of “no more dikes” and “room for rivers.”

There are seven components to adaptive capacity: technological options, resources, institutional structure, human and social capital, risk spreading and information management. The crucial issue in the Netherlands will be the institutional structure. Adaptation is about natural resource management. The current adaptation strategies in the Netherlands include:

- accept more floods – out of the question;
- let Germany solve the problem (increase retention capacity in Germany);
- higher dikes – this is counter to current policy, would be expensive, and would need to replace existing dikes (many of which are over 1000 years old);
- increase discharge capacity (lower river bed) – the problem then is drought during the summer, unless extensive wetlands could be built. This is not really possible due to the high population density and because the Rhine has to be navigable for 362 days of every year;
- dig a fourth branch of the Rhine – the problem is where to put it and the costs involved in doing so; and
- dig a bypass – cheapest and least disruptive option.

Digging a bypass is only acceptable if reasons and options are adequately communicated to the public and if compensation is provided. New infrastructure would imply local disruption, loss of social life and landscape changes.

In Holland, the technology, money and awareness for adaptation are present. The main obstacles are the policymaking process, public acceptability, the complexity of modern society, and congestion of the flood plain.

3.2.3 Hungarian flood control and flood mitigation strategy

Rivers arrive in the territory of Hungary from mountainous catchment areas belonging to neighbouring countries and they flow predominantly through the Great Hungarian Plain. This means that excess water coming from the high headwater catchment areas can accumulate in the Hungarian plain. For example, 11.4% of the Danube river basin is in Hungary (93 thousand km² of the 817 000 km² catchment area). Included in the flood plain are 40% of arable lands, 32% of railways, 15% of the main roads, and 2.3 million people.

Owing to the topographic conditions, 23% of the country is lower than river flood levels. This presents a flood protection problem that is unique in Europe. This topographic condition is extremely unfavourable, particularly as it affects flood protection, and is aggravated by Hungary's climate. Influences on the local weather include the Atlantic-ocean and continental and Mediterranean effects. Maritime air currents might result in extended rainfalls of great intensity that can cause violent floods on the rivers of the Danube water system; these can occur in any part of the Danube River Basin at any time of the year.

A significant amount of winter precipitation falls in the form of snow. The spring and early summer snow melt, especially in the case of rapid warming accompanied by rain, can cause violent flood waves; these are a characteristic and frequent phenomena of the Danube and Tisza rivers. Based on mathematical/statistical assessments of floods, it was estimated that medium floods occur every two-three years, significant floods occur every five-six years and great floods occur every 10-12 years. On upper river sections, more significant flood waves might extend to 5-10 days while on the middle and lower sections, more significant flood waves might extend to 50-120 days.

The system of flood protection works includes:

- 4 181 km of first-class flood protection works built along the rivers, of which 3.980 km are earth dikes, 23 km are flood protection walls and 178 km are high banks;
- a flood channel built to transfer the floodwaters from two minor rivers (Lajta and Répce) to other river valleys. The former is 13 km long, with a water transport capacity of 50 m³/s, the latter is 10 km long with a capacity of 120 m³/s; and
- area emergency reservoirs for the retention of floodwaters from rivers with violent water regimes and relatively low water discharges (total of 10 with a capacity of 350 million m³).

Recent flood events – mainly in the Tisza basin – highlighted for the population the need for security, including the protection of residences. These events also demonstrated the limits and uncertainty of protection. Planning work was initiated to direct rational development of reservoirs for the retention of floodwaters. One objective is to decrease the level of the transit

floods by 1.0 m. That means water levels on the Tisza would need to be lower than critical flood levels. Potential intervention might include:

- storage in mountainous areas in the catchment area of the Tisza beyond national borders;
- increase in high water transport; and
- emergency storage of flood in flat areas.

For the Tisza basin, a plan has just been launched that includes the following interventions: sufficient storage capacity to efficiently decrease flood levels through emergency storage of floodwaters in flat areas; amelioration of high water transport; and increasing the height of dikes. An important aspect is that these plans will be realized simultaneously and in a harmonized way.

3.3 The political fora in Europe

In 1993 and 1995, flooding on the Rhine led to the countries involved (Switzerland, Germany, France, Netherlands, Luxembourg) developing a coordinated action plan, which became the first International Initiative on Flood Protection in Europe. Initiatives soon followed for other rivers, e.g. Elbe, Oder (Poland and Germany). One result of these and other efforts was the development of Guidelines on Sustainable Flood Prevention (UNECE/ISDR/WMO/WHO), which was adopted in March 2000 (Annex 3). These contain non-binding rules that are strategic rather than technical. Some general considerations highlighted in this report include:

- society has become more vulnerable to natural hazards;
- there is a need to change the current paradigm, with a shift from defensive actions to management of risk;
- flood protection is never absolute;
- a holistic approach is necessary – local flood protection measures can have negative effects both downstream and upstream; and
- as a consequence, the whole river basin should be taken into account.

There are seven basic principles and approaches to flood prevention:

1. floods are part of nature;
2. human interference into the processes of nature has increased the threat of flooding;
3. the entire catchment area needs to be considered;
4. structural measures are important, but the focus should lie on human health and safety;
5. everyone should take precautionary measures;
6. human uses of flood plains should be adapted to existing hazards;
7. appropriate preventive measures are required.

The UNECE/ISDR/WHO/WMO “guidelines on sustainable flood prevention” focus on recommendations for:

- water retention areas;
- land use, zoning and risk assessment;

- structural measures and their impact; and
- early warning and forecast systems.

Public awareness, education and training is another important element of preventive strategies.

These guidelines are currently being tested on eight pilot rivers, including the Latoritca/Uzh (Slovakia/Ukraine), Maros (Hungary/Romania), Morava (Czech Republic/Slovakia) and others.

A review meeting on the level of implementation of the flood guidelines will be held in 2005, under the UN ECE transboundary water Convention

Special consideration should be given to the fostering the recognition that security from disasters is a human right. The Universal Declaration of Human Rights do not mention expressly this right, but indirectly in Art 25.1 under which:

Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control.

International Organizations such as EU have a Statute commitment in ensuring a high level of health protection and may provide significant guidelines and general advice about setting intervention priorities (e.g. through a monitoring system), but cannot interfere with the delivery of health services.

3.4 Flood risk management

The definition of the level of desired and or tolerated protection against flood is a difficult task without a unique answer. The level of tolerated risk to society from flooding varies across the European Union countries and Switzerland. For example in the United Kingdom, indicative standards of protection are set according to damage potential (or vulnerability) of the land at risk (typically a risk of one flood occurring in 100 years for urban areas) where the defence standard can be justified through cost benefit analysis. In the Netherlands, however there is statutory standard of defence to be provided (typically one flood in 1000-1250 years) with a statutory periodic review process. In Germany the canalization of main rivers was designated to protect major urban areas against floods for return periods¹ ranging between 50 and 100 years. At present it is planned to give protection for return periods of 200 years for the river Rhine. The dykes in Hungary have been designed for return periods of a hundred years. In Finland agricultural areas are protected for return periods of 20 years and residential areas against 50 year return period floods. Obviously there should be no tolerated damage to human health,

¹ The analysis of the probability of the occurrence of floods is traditionally based on the concept of return periods and the frequency law of maximum river discharges. The return period associated with a defined flow is equal to the numbers of years between floods that exceed that flow. It is important to highlight that the stochastic nature of floods, this number of years is only an average value. The maximum discharge frequency law is formed by discharges corresponding to different return periods. Maximum discharge frequency laws corresponding to large basins and moderate hydrological regimes have usually a small growth rate. On the contrary, in many Mediterranean basins, frequency laws are commonly composite, with a small growth rate for return periods and a strong one for medium and high periods. That meant that in practiced medium size floods do not exist. The ratio between the ordinary and the extraordinary discharge of rivers varies enormously depending on the meteorological regimes and on the basin characteristics.

however, flood risk policies relate to a certain level of tolerated damage and to a certain level of desired protection.

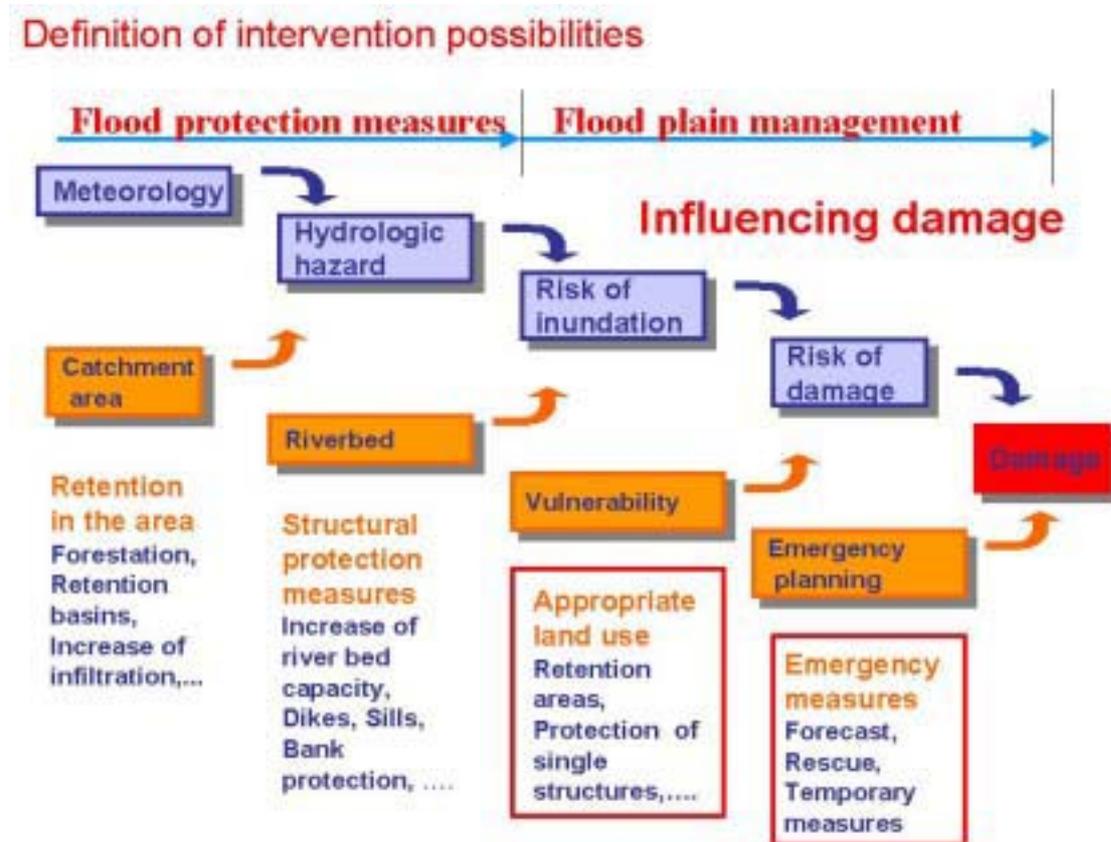
Flood damage is a consequence of exposing values in flood prone areas. Therefore any risk management starts with identifying the hazards. According to topography and river regime can have different forms. The type of impact (static or dynamic flooding, erosion or debris flow) its intensity (flooding or erosion depth, dynamic pressure) and the probability must be known. The intensity of the impact determines the type of the measures; the probability of the event and the possible damage its economic feasibility. The possible damage is depended of the type of land use, the values exposed and their vulnerability.

Since there are many actors in creating and mitigating the hazard must be communicated to all in an easy understandable form. Hazard maps shall show where which danger exists. The Swiss system has been developed not only to show that a hazard exists, but giving at the same time an indication of the necessary actions. Four zones are distinguished.

- **Red zone** = high risk area; houses may collapse by the impact or deeply flooded so people inside houses are not safe; In this area no new construction is allowed.
- **Blue zone** = medium risk area; People outside the house are in danger, but safe inside a solid house. The construction of new houses may be allowed, but only with the necessary prevention measures.
- **Yellow zone** = low risk area; shallow flooding might occur. This may cause high damages but persons are not in danger. To avoid damages the information must be given to the landowners.
- **Yellow/white** = residual risk area; Very rare but intensive events may effect the area. No sensible objects should be implemented in this area.

Fieldwork and model simulations outline hazard zones. The hazard alone does not say anything on the damage, since values are unevenly distributed. For example along the Rhine River 99% of total damages comes from 15 % of the endangered area. Until a strong rainfall events causes damage several conditions must be fulfilled and the following diagram shows the possible interactions to mitigate the damage. The graphic also illustrates the impossibility to relate rainfall directly to damage since any measure at any level might diminish (or hopefully not increase) damage.

Figure 3.1: Definition of intervention possibilities



To prevent inundation by retention basins and river training methods is the classical approach. However it is now recognized that this is not sufficient. Only a coordination of all measures at all levels can lead to sustainable risk management which protects people and limits impacts in the natural environment. The strategy of today is:

- to avoid construction wherever it is possible in flood endangered areas;
- to limit the potential damage by appropriate building codes;
- to encourage people to minimize damage by own preventive measures (little values in sub terrain parts of the building, water-proofing, preparing temporary closer of doors and windows, emergency escapes etc.);
- to plan and prepare emergency measures.

Recent examples of Germany and in the Netherlands have shown that damages can be cut by one half by simple measures of the house owner even if the same flooding occurs.

River floods in Europe are characterized by large monetary damages but fortunately by low numbers of casualties. This is due to the fact that rivers rise gradually, thus giving time for rescue operations. Large numbers of casualties have only been observed at coastal events such as the flood of 1953 in the Netherlands or 1964 in Hamburg. Large areas have been deeply flooded, the breaching of the dikes was recognized very late, thus too little time for rescue of a great number of persons remained. In addition the event happened in wintertime and during the night, which aggravated the situation. Another dangerous process is flash floods and in alpine regions debris flows. These occur suddenly, with large dynamic impact. They can destroy

houses, where people felt safe. The most frequent cause is wrong behaviour owing to underestimation of the acting forces. All casualties show the same causes:

- to short rescue time either because of a sudden event or owing to a large distance to a safe place;
- seeking shelter at a place which during the event turns out not to be safe;
- wrong behaviour as using cars, remaining in the cellar during the event, underestimating the strength of the current, when being outside the building.

As mentioned there are little reports on injuries and diseases after flood disasters in Europe. Floods in Europe last for days and perhaps weeks, which is within the capacity of the emergency units to provide all necessary means to the affected population.

3.5 Coastal vulnerability to climate change

Changes in various climatic factors are likely to produce many biogeophysical effects. Previous assessments of coastal vulnerability are of limited sophistication. Usually the only climatic variable considered is sea level rise, and the limited numbers of impact indicators often constrain meaningful assessment. Three generic strategies exist for adaptation in coastal assessment: protect, accommodate and retreat. These have limited usefulness to coastal planning and management.

The annual average number of people at risk of coastal flooding is large and will increase substantially due to population growth. Greenhouse gas reduction will have limited effect up to at least 2050 because of the slow climate response to the gases already in the atmosphere. There is a EU-funded three-year project entitled DINAS-COAST that will improve estimates of vulnerability by country, region and for the world as a whole. This project will use higher resolution datasets and include a range of climate and environmental scenarios. However, many methodological issues remain unresolved.

4. Session III: Climate change projections as related to flooding risk

4.1 Climate change and flooding risk

The frequency of heavy rainfall events has been increasing since the 1950s. England and Wales has seen a significant increase in winter rainfall from intense events since 1961.

The Hadley Centre has developed a regional climate model for Europe with 50km resolution. This model is better than HadCm3 in predicting extreme rainfall in Europe.

Pluvial flooding can be caused where intense rainfall (1–6 hr) is unable to be drained away quickly enough. The main cost impact is in urban locations, and is responsible for 40% of UK flood damage.

Climate change is likely to be a major factor in riverine, pluvial and coastal flooding. Europe is likely to experience more winter rainfall and more heavy rainfall events, both of which could increase the potential for more pluvial and river flooding. Sea level rises will result in higher and

more frequent storm surges, although a large degree of uncertainty remains over probability predictions.

4.2 Weather, floods and health

At global level the main causes/sources of floods are:

- storm surges;
- el niño/la niña events;
- other extremes of climate variability;
- land terrain;
- poor drainage systems; and
- regulation of dams.

The impacts of floods can include effects on:

- population, including loss of life, displacement and diseases (malaria, diarrhea, other waterborne diseases, etc.);
- infrastructure destruction, including land transport systems (roads and bridges), buildings and power supply, and farms; and
- disruption of crop production. Starvation can be a consequence.

For the most part, little systematic work has been done in making effective linkages between climate databases and the increasing number of national, regional and global databases on disaster statistics. Meteorological information, especially seasonal prediction, when packaged well and provided to users in good time (including the health sector) can aid planning activities.

5. Session IV: Determinants of adaptive capacity to flooding risk

5.1 Determinants of adaptive capacity

Adaptation matters need to be taken into account. Adaptation can be viewed as taking advantage of opportunities. The determinants of adaptive capacity include a variety of systems, sectors and location specific characteristics that are path dependent. They can work to reduce exposure or sensitivity. For most systems, climate change and variability over short time periods fall within a “coping range” – a range of circumstances within which, by virtue of the underlying resilience of the system, significant consequences are not observed. There are, however, limits to resilience for even the most robust of systems. It is important to understand the boundaries of systems’ coping ranges – thresholds beyond which the consequences of experienced conditions become significant. Coping ranges are not necessarily fixed over time. The recent European (August 2002) floods are a good example.

Adaptive capacity depends critically upon both defining a coping range and upon understanding how adopting new or modified adaptations might expand the efficacy of any coping strategy. A consistent method is needed for comparing adaptation options.

Early preparation for adaptation can be important. Identification of points of divergence can pay off significantly. Prepare for the worst and adapt for the better.

5.2 Considerations in the development of indicators of risk, vulnerability and adaptive capacity

Vulnerability is the potential of a system to suffer harm as a result of exposure to an external stress. Vulnerability focuses on the potential occurrence of a particular outcome following exposure to a particular stress. The IPCC Third Assessment Report definition of vulnerability conflates current and potential vulnerability. Current vulnerability is a result of past adaptation to climatic variability and is a function of the resilience or robustness of a system. Potential vulnerability is vulnerability at a specified point in the future that would result from the realization of adaptive capacity, starting from the baseline of current vulnerability. Potential vulnerability is a function of current vulnerability and current adaptive capacity. Political will and policy are required at the governmental level for an adaptive capacity to be realized. Policy determines whether adaptation is pursued effectively and whether capacity building takes place. Policy drives planned adaptation and determines whether people have resources and opportunities to pursue autonomous adaptation.

Adaptation is incremental. One question is how much must the coping range of systems be expanded to deal with new or historically recurring hazards.

Risk is equal to hazard times vulnerability. Vulnerability is socially constructed. The distribution of vulnerability should be examined when analyzing a homogeneous region defined by exposure to common hazards. Risk should be examined when comparing regions facing different hazards.

There is a need to develop national level indicators of vulnerability and capacity to adapt to climate change and variability. In particular, socioeconomic factors should be addressed. A balance is required between effective policy and strong regulatory framework to facilitate adaptation and prevent maladaptation and to provide space for people to pursue their own adaptation strategies.

5.3 www.floods.com: Added value of information technologies against floods

The “Information Society” has become a leitmotiv in the application of Information Technologies (IT) to an increasing number of everyday life functions, including earth/atmosphere observation. This includes the monitoring, analysis, mitigation and management of natural hazards and disasters, as well as on the management of health-related issues, which are often at another scale.

Major improvements have been achieved in the introduction of information technologies in flood mitigation and control. Yet, and paradoxical as it may seem, developing technological solutions for flood-related information management might represent a risk in itself, and increase users’ vulnerability to floods by introducing a growing sophistication of information management in risk-related social practices. In addition, flood-related IT solutions should not be designed independently from other water-related functions (e.g. resource management, early warning for droughts).

Elements that should be considered in flood-related information include the status of information, users and uses. IT solutions for flood mitigation and management were reviewed, together with selected examples. The societal context (cultural, economical, political) in which information technologies are designed, implemented and evaluated is important. One question is the social ownership of flood-related information technologies. User-based approaches are one possible methodology for successful flood-related IT initiatives.

5.4 Stakeholder-institutional analysis of adaptation to climatic hazards

Policy issues summarized included:

- The status of the present capacity to cope with flood risk. Coping capacity has increased in the past five years through improved monitoring and warning systems;
- The extent to which climate change is included in managing climatic hazards. Concern has entered the policy process as one factor in risk management;
- The degree to which stakeholders and institutions are prepared to cope with future risks. The prospects are variable, but promising. Monitoring changing risks; and
- The main processes for coping with changing risks of climatic hazards. There is less of a consensus, with competing definitions of success.

Hypotheses generated regarding coping processes include: variability and signal events are not drivers of policy change; conflicts over use of flood plains is likely; conflict resolution is essential; decision-making processes should include relevant stakeholders; greater transparency of the process is desirable; the more easily institutions learned, the more easily they could adapt to unexpected hazards and interactions between processes can accelerate policy or inhibit new initiatives.

6. Session V: Discussion

6.1 Retrospective perspectives on health risks associated with flooding

The presentations all echoed the fact that relatively little good quality data is available on the health risks associated with flooding. For many types of impacts, e.g. leptospirosis, meningitis, hazards from foul flooding, the effects are relatively rare and so the risk needs to be kept in context. However, even small numbers of impacts such as deaths and injuries would contribute useful information to formulating prevention programmes. The full effects of floods may be underreported because not everyone will seek medical help. In this context more epidemiology data could be obtained by conducting interviews or from local newspaper reports. It was commented on that the North Sea is a very special case as the potential physical effects for countries affected (e.g. United Kingdom, Holland) are likely to be more important than the mental health aspects. Aside from the range of outcomes presented, other health impacts may be important.

- **Drinking water:** Sources of drinking water may become polluted. As a consequence, these sources may need to be cut off for a certain time period following a flood event. The catchments are usually known and could easily be mapped.
- **Sewage system:** In Cologne, the Rhine infiltrated the sewage system. As a result, valves were fitted.

- **Animal diseases:** These can be passed to humans via contact with water (not necessarily drinking water).

The problems of predicting an event are particularly difficult for pluvial floods; this is mainly due to the difficulties in predicting where heavy rainfall is likely to occur. Furthermore, more difficulties lie in educating the public to react in the appropriate way in anticipation of or during a flood. Public service announcements have been shown to be highly ineffective in helping people under event stress. Reduction of risky behaviour is a clear need; overall 40% of health impacts of floods have been estimated to be directly related to wrong behaviour. Evidence from the 1999 storms in France suggested that, from 17 deaths, 8 were due to risky behaviour, including 2 deaths in people repairing roofs and 2 deaths in people out jogging at the time of the storm. Many people in London asked about how they would react in the event of a flood responded by saying they would descend underground into the public transportation system. In California, earthquake preparation programmes have been quite successful, and could be a model for schemes for flood events.

There is a need to distinguish between frequent and extreme events. Structural defences should be geared towards minimizing the effects of frequent events. A primary requirement is the need for long-term infrastructure development; this is a key issue independent of the potential effects resulting from climate change. In Europe, tight regulations already exist around nuclear and chemical plants, but consideration of the potential health effects are not part of these laws. In France, it is sometimes difficult for directives to be enforced at the local level. For urban storm water events, management may not be ready. Vulnerability maps are needed, including consideration of cascading effects. Safety is one of the rationales for warnings, however, warnings do not include consideration of mental health and other health outcomes. Risk should focus on the health impacts and not just on economic damages, as is currently the case.

6.2 Retrospective perspective on European flooding

There are many examples of successful precautionary measures. To illustrate, major floods occurred on the Rhine in both 1993 and 1995. In 1993, there were enormous damages in the city of Cologne. Leaflets were circulated and door-to-door visits were conducted in order to inform the public on how to avoid damages in future flood events. In the 1995 flood, the effects in the city were halved. Similar work has been going on in the United Kingdom. In Switzerland, it has been observed that education has been insufficient. One reason was the lack of motivation for people to react if the damages incurred were reimbursed.

Insurance companies may be just as uninformed as the government when making insurance calculations. For example, in the event of a disaster, companies such as Munich Re and Swiss Reinsurance do not conduct a formal risk assessment but instead hike their premiums to what the market can bear. Another example is the complete ignorance of the potential impacts of El Nino events when pricing premiums. Experience suggests that private companies are collecting useful information, but it is not easily accessible.

Further issues that were raised include the following.

- **The effectiveness of education/behavioural changes:** Case studies would be useful for assessing whether or not these have been implemented successfully;

- **Structural measures:** The presentations suggested that structural measures such as dykes are becoming increasingly used despite the feeling that other types of strategies have been favoured in recent times; and
- **Early warning systems:** Floods are of such different types and severity that it is difficult to discuss a standard type of early warning system. One major component of an early warning system is the behavioural response, and, as such, a warning of less than a day would seem inadequate. More time can be given, however, this depends on the catchment in question. Many countries give flood warnings based on their weather forecasts. Therefore, one new initiative could be the sharing of more meteorological information via regional climate centres. There would be mileage in listing mitigation options and their associated health impacts, for example, in the case of warning systems, the warning may actually increase stress levels and complicate lives more so than the actual disaster. In Holland, early warning systems are considered a very important part of any flood strategies. The feeling there is that it is better to be evacuated and under stress rather than drown. Anecdotally, people that have been evacuated tend to respond that they would do so again. However, asking that question immediately after an event may not generate reliable responses. A proactive evaluation of warning systems, e.g. surveys, valuation schemes, etc., would increase the believability by the public of the effectiveness of the system. A warning system without response is of no use, so people need to be aware of how to respond. In the United States, training for response to natural hazards is provided in schools. It is highly likely that local authorities, regardless of whether a warning is issued, would receive complaints.

6.3 Climate change perspectives

Flooding events are likely to be more severe as well as frequent. Winter flooding events are more likely, although changes in summer flooding events are more uncertain. It has to be remembered that the climate change component is an incremental effect; not all floods and health impacts of floods can be attributed to climate. Recent United Kingdom floods have highlighted the issue of increased vulnerability; it is unclear however how much of this can be attributed to climate change. The United Kingdom has always had a major coastal hazard but this has been totally ignored thus far.

6.4 Adaptive capacity

Adaptation matters and needs to be taken into account. A key question is: Who adapts to what? Climate change needs to be put into perspective with other risks, and so may lead to the need for more of the same and/or new activities and measures. As noted in several presentations, resilience is not necessarily a good thing. The goal is to prepare for the worst and adapt for the better.

Determinants of adaptive capacity are both location specific and path dependent, and consistent methods to compare options are required. Health impact assessments of flooding events need to be conducted, and, in this context, instruments to assess health risks should be developed. Education is one critical component of adaptation, as is the need for more integrated management of various functions of water. Stakeholder involvement is important, and so too are information technologies. However, technology cannot resolve every issue – expect to be surprised.

7. Conclusions

- (a) Floods are a common natural disaster in Europe. Not all floods are the same. The causes vary and might require different control strategies. A number of factors influence the damage of floods, thus it is not only directly related to rainfall. Pluvial flooding may be unpredictable and potentially significant.
- (b) Winter flooding events are more likely with climate change, and may be more severe. Summer flooding events are more uncertain but might be present in Southern Europe. There is uncertainty in the extent of increase.
- (c) The Health risks associated with flooding are surprisingly poorly characterized and need to consider the whole event and entire recovery process. More and better quantitative data are needed, including the better registration of injuries and deaths. Long-term effects such as mental health outcomes are likely to be significant for riverine flooding.
- (d) Support services are needed to deal with insurance companies and builders, and the population and health personnel need to be informed about the process.
- (e) A better understanding is needed of vulnerability risk factors, including delayed effect. This includes the characterization of areas that are potential sources of adverse health impacts (drinking water catchment areas, sewage plants, chemical plants, etc.). Scenario-based analyses tools will be very useful and a cascade approach advisable.
- (f) Focus on only extreme events may miss significant health impacts. Frequent versus extreme events may need different intervention strategies. The level of desired protection, e.g. through return periods need to be re-understood and be adjusted to frequent events, under the consideration of climate change.
- (g) More and different instruments are needed for assessing health risks: for flood, dislocation and recovery process. Maps are one possible tool. Health risks should be included in the risk characterizations.
- (h) Retrospective perspective on European flooding:
 - floods are part of nature;
 - flood protection is never absolute;
 - local measures are important;
 - human activities have increased the threat of flooding;
 - holistic approaches are needed – policies should consider entire catchment areas;
 - structural measures are important, but there is a need to focus on human health and safety;
 - education is important but not sufficient;
 - everyone should take precautionary measures;
 - insurance policies may influence behaviour; and
 - information collected and scenarios generated are not in the public domain.

- (i) Adaptive capacity: Adaptation matters and needs to be taken into account. Climate change may lead to the need for more of the same and/or to new activities and measures. It is important to determine who is adapting to which type of flooding event (coastal, riverine, pluvial; static vs. dynamic). Determinants of adaptation are both location specific and path dependent. Consistent methods need to be used or developed to compare options. Prepare for the worst and adapt for the better use the precautionary principle. Water basin management and national management need to be integrated, as well as the various functions of water. When defining the interventions the Stakeholder involvement is important. Information technologies can be useful: Resilience might be not useful. Education at all levels is one critical component. It is critical to have preparation of the population and the different actors included in early warning systems development and implementation. Broad casting of regular flood warning messages and annual flood awareness campaigns might be useful. Assistance to self help measures to reduce the damage to property and stress, flood proofing of properties, assistance for property insurance and community preparedness plans, might improve populations adaptive capacity. There is a need to increase the social acceptability of uncertainty. Expect to be surprised: Technology cannot resolve every issue, as has been shown by frequent dyke breaks.

8. Recommendations

For WHO and its Member States:

There is a need for more and better quantitative data on health impacts associated with all categories of flooding. These data is needed for a better understanding of vulnerability. This includes centralized and systematic national reporting of deaths and injuries from floods using a standardized methodology. This includes also the follow-up of long-term sequel of flooding including studies on post-traumatic stress disorders. The WHO should develop jointly with the Ministries of Health instruments to assess health risks, by identifying data needed to prepare for and evaluate future events and, together with the University of Louvaine, test these instruments in some of the European potentially affected countries. There is a need for government-supported research into health impacts of flooding

There is a need to assess health impacts of adaptation options (structural and non-structural measures). This should be built into environmental and strategic impact assessments. Case studies should be identified where health impact assessments could be included in flood mitigation strategies. It would be important to identify lessons learned after other disasters, particularly for mental health outcomes.

For other sectors:

Shift emphasis from disaster response to risk management. This includes improving flood forecasting and warning systems, including health “actors” into the communication flow.

Include climate change and health in risk management. Determine who is adapting to what for planning and response purposes. Education and communication are important. Risk reduction will require tackling difficult issues, such as building on flood plains, insurance schemes, etc. Include within development planning programmes.

For communities at risk:

Assessments are needed of community response capacity to flooding, including building community preparedness. Disincentives to building in floodplain areas are also likely in the future with the potential refusal of insurance companies to insure new developments.

Coordination is needed across disciplines, along with integrated training. Coordination is needed across policymakers and across organizations. The Parties to the Framework Convention on climate change might need to propose a policy that a priority for adaptation is to mitigate the effects of climatic disasters and frequent events.

For the purpose of the research on “climate change and adaptation strategies for human health”: there is a need to further investigate the adaptive capacities in European countries. To make this effective a number of case studies should be further developed. Potential countries include Germany, France, the Czech Republic and Italy. These case studies should look at the institutional framework and network of responsibilities and functions, the involvement of the health sector in responses, and the communities’ ability to react.

It must be recognized that security from disasters is a human right.

Annex 1

PARTICIPANTS

Mr Bastien Affeltranger
Adviser, UNESCO Division of Water Sciences, Paris, France

Dr Peter Baxter
University of Cambridge, Department of Community Medicine, United Kingdom

Dr Nick Brooks
School of Environmental Sciences, University of East Anglia, Centre for Social and Economic Research in the Global Environment (CSERGE), United Kingdom

Dr Diarmid Campbell-Lendrum
London School of Hygiene and Tropical Medicine, United Kingdom

Dr Thomas Downing
Stockholm Environment Institute, United Kingdom

Mr Benedek Goncz
National Water Authority, Department of Water Damages Prevention, Hungary

Dr Debarati Guha-Sapir
School of Public Health, Centre for Research on the Epidemiology of Disasters, Belgium

Dr Shakoor Hajat
Department of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, United Kingdom

Dr Geoff Jenkins
Met Office Hadley Centre, United Kingdom

Mr Richard J.T. Klein
Postdam Institute for Climate Impact Research (PIK), Germany

Ms Sari Kovats
Centre on Global Change and Health, London School of Hygiene and Tropical Medicine, United Kingdom

Mr Otto Malek
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany

Professor Edmund Penning-Rowsell
Middlesex University, Floods Hazard Research Centre, United Kingdom

Dr Armin Petrascheck
Head Risk Management Section, Federal Office for Water and Geology, Switzerland

Dr John Simpson
CDSC South East, United Kingdom

Ms Sue Tapsell
Middlesex University, Floods Hazard Research Centre, United Kingdom

Dr Richard Tol
Centre for Marine and Climate Research, Hamburg University, Germany

Dr Gary Yohe
Wesleyan University, Economics Department, United States of America

Dr Alexander Malyavin
UNICEF Regional Office for CEE, CIS and the Baltics, Switzerland

Dr Buruhani Nyenzi
Chief, World Climate Applications and CLIPS Division, World Climate Programme
World Meteorological Organization (WMO), Switzerland

World Health Organization

Mr Matteo Albrizio, Global Change and Health, WHO European Centre for Environment and Health, Italy

Dr Kristie Ebi
Global Change and Health, WHO European Centre for Environment and Health, Italy

Dr Bettina Menne,
Technical Officer, Global Change and Health, WHO European Centre for Environment and Health, Italy

Annex 2

WORKING PAPERS

5036813/01	Provisional list of working papers
5036813/02	Scope and purpose
5036813/03	Provisional agenda
5036813/04	Provisional programme
5036813/05	Provisional list of participants
5036813/06	Overall cCASHh project by <i>Bettina Menne</i>
5036813/07	Mental health and flooding: issues and strategies by <i>Sue Tapsell</i>
5036813/08	GBD estimates for flooding by <i>Diarmid Campbell-Lendrum</i>
5036813/09	Hungarian flood control and flood mitigation strategy by <i>Benedek Göncz</i>
5036813/10	Flood risk management by <i>Armin Petrascheck</i>
5036813/11	<u>www.floods.com</u> : Added value of information technologies against floods by <i>Bastien Affeltranger</i>

Annex 3



GUIDELINES ON FLOOD PREVENTION

**Economic and Social
Council**

Distr.
GENERAL

MP.WAT/2000/7
14 January 2000
ORIGINAL: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

**MEETING OF THE PARTIES TO THE CONVENTION
ON THE PROTECTION AND USE OF TRANSBOUNDARY
WATERCOURSES AND INTERNATIONAL LAKES**

Second meeting,
The Hague, Netherlands, 23-25 March 2000
Item 6 (b) of the provisional agenda

SUSTAINABLE FLOOD PREVENTION

Submitted by the Chairman of the task force on flood prevention
and protection, led by Germany, and prepared with
the assistance of the secretariat

1. At its first meeting, the Working Group on Water Management welcomed the offer of the delegation of Germany to lead a task force on flood prevention and protection, and agreed on its twofold mandate: to prepare draft recommendations on flood prevention for consideration and adoption at the second meeting of the Parties to the Convention (23-25 March 2000), and to prepare a Seminar to assist in the drawing-up of these recommendations (MP.WAT/WG.1/1998/2). The Working Group set an overall timetable for the task force's activities, and invited

delegations as well as representatives of secretariats of international organizations and joint bodies to assist in the preparation of these recommendations.

GE.00

2. The following countries nominated experts to this task force: Austria, Belgium, Finland, Germany, Hungary, Netherlands, Poland, Russian Federation, Spain and Switzerland. Representatives of the secretariats of the United Nations Economic Commission for Europe (UN/ECE), the International Decade for Natural Disaster Reduction (IDNDR), the World Meteorological Organization (WMO) and the World Health Organization's Regional Office for Europe (WHO/EURO) participated in the task force. Representatives of the International Commission for the Protection of the River Rhine and the International Commission for the Protection of the River Elbe also participated.

3. At its three meetings in October 1998, January 1999, April 1999, the task force prepared preliminary elements for guidelines on flood prevention and protection (MP.WAT/SEM.2/1999/4), which were submitted for consideration at the UN/ECE-IDNDR-WMO-WHO/EURO Seminar on flood prevention (Berlin, 7-8 October 1999). The task force considered the outcome of the Seminar at its fourth meeting on 9 October 1999, and made arrangements to finalize the guidelines for submission to the Parties to the Convention at their second meeting. The duly revised draft guidelines are annexed.

Draft decisions

4. The Meeting of the Parties may wish to:

- (a) Adopt the guidelines on sustainable flood prevention (annex);
- (b) Invite the Parties and non-Parties to the Convention to apply these guidelines in the framework of their cooperation on transboundary water management and, as far as appropriate, in the national context;
- (c) Request the Parties to the Convention to inform it at its third meeting on the application of these guidelines within the framework of bilateral and multilateral cooperation on the basis of a reporting scheme to be drawn up by the Working Group on Water Management;
- (e) Commend the task force for the excellent work;
- (f) Request the secretariat to publish these guidelines in the UN/ECE Water Series;
- (g) Express its gratitude to the Government of Germany for having supported the joint UN/ECE-IDNDR-WMO-WHO/EURO activity.

Annex 4

DRAFT GUIDELINES ON SUSTAINABLE FLOOD PREVENTION

Introduction

1. These guidelines aim to recommend measures and best practices to prevent, control and reduce the adverse impact of flood events on human health and safety, on valuable goods and property, and on the aquatic and terrestrial environment.
2. They are intended to assist the Parties to the Convention, other UN/ECE countries and joint bodies in developing and implementing sustainable measures and good management practices for flood prevention and protection that take account of economic, environmental and social considerations. As this depends on the specific conditions and circumstances in the respective catchment areas, the proposed guidelines are non-binding.
3. The character of the guidelines is strategic rather than technical. They attempt to provide the essential elements to be considered when drawing up concerted action plans.

I. GENERAL CONSIDERATIONS

Flood events are part of nature

4. Natural hazards and flood events are part of nature. They have always existed and will continue to exist. With the exception of some floods generated by dam failure or landslides, floods are climatological phenomena influenced by the geology, geomorphology, relief, soil, and vegetation conditions. Meteorological and hydrological processes can be fast or slow and can produce flash floods or more predictable slow-developing floods, also called riverine floods.

Society has become more vulnerable to natural hazards

5. Human activities and human interventions into the processes of nature have considerably changed the situation in whole river basins. Although floods are natural phenomena, they may be intensified by human alteration of the environment such as alterations in the drainage patterns from urbanization, agricultural practices and deforestation. In some cases, it seems that the impact of floods in terms of human health and economic losses has risen, and the planning of protection against floods can no longer be limited to protecting some isolated assets from certain types of danger.

Change of paradigm

6. Considering the evolution and trends, the approach to natural hazards requires a change of paradigm. One must shift from defensive action against hazards to management of the risk.
7. Flood protection is never absolute; only a certain level of protection against flooding can be guaranteed. The question regularly arises as to what safety is available at what price, and how much of the remaining risk has to be accepted by society. Risk management will be the appropriate method to deal with this challenge.

Holistic approach

8. Experience has also shown that local flood protection measures can have negative effects both downstream and upstream. Therefore, a holistic approach is necessary to take into account the whole river basin. Such a holistic approach is based on multilateral cooperation, including interdisciplinary planning for the whole catchment areas. On transboundary rivers, international cooperation is needed.

Prerequisites for proper action

9. Knowledge is needed on potential threats. Flood prevention should not be limited to flood events which occur often. It should also include rare events, as human safety is mostly endangered by them.

10. There is a need for reliable information, for example, to take the necessary precautions.

11. Moreover, there is a need for interdisciplinary cooperation regarding all phases of risk management: risk assessment, mitigation planning and implementation of measures.

12. The answer to the question “which level of flood protection can we accept” presumes that one has examined what could happen, i.e. that the risks were properly assessed.

II. BASIC PRINCIPLES AND APPROACHES

13. There are at least seven basic principles and approaches regarding sustainable flood prevention. To implement them, cooperation at all government levels, and coordination of sectoral policies regarding environmental protection, physical planning, agriculture, transport and urban development is needed. As regards transboundary waters, cooperation is needed among the riparian countries to harmonize national policies and strategies, and to draw up concerted action plans:

- (a) Flood events are part of nature. They have always existed and will continue to exist;
- (b) Human interference into the processes of nature has increased the threat of flooding. As far as possible, such interference should be reversed, compensated and, in the future, prevented;
- (c) Flood prevention should cover the entire catchment area of watercourses; this also applies to transboundary waters and their catchment areas. Flood prevention has also to be based on the precautionary principle;
- (d) Structural measures will remain important elements of flood prevention and protection. However, these measures should primarily focus on the protection of human health and safety, and valuable goods and property. Requirements of nature conservation and landscape management should be taken into account;
- (e) Everyone who may suffer from the consequences of flood events should also take his/her own precautions. To this end, an appropriate information and forecasting systems should be established by the competent authority;
- (f) Human uses of flood plains should be adapted to the existing hazards. Appropriate instruments and measures should be developed to reduce the risk of flooding;

- (g) In flood-prone areas, preventive measures should be taken to reduce possible adverse effects of floods on aquatic and terrestrial ecosystems, such as water and soil pollution.

III. POLICIES AND STRATEGIES

14. All appropriate action should be taken to create legal, administrative and economic frameworks that are stable and enabling and within which the public, private and voluntary sectors can each make their contribution to flood prevention, dam safety and the reduction of adverse impacts of dangerous flood events on human health and safety and valuable goods and property, and on the aquatic and terrestrial environment.

15. To protect human health, primary and secondary preventive measures are necessary. Primary preventive measures include: building codes; legislation to relocate structures away from flood-prone areas; planning appropriate land use; adequately designed floodplains and flood-control structures; and early-warning systems. Secondary preventive measures are those actions taken in response to early evidence of health impacts. They include all types of flood response, but also guidelines on how populations are to act during floods, as well as disease monitoring and correct risk communication.

16. Priority should be given to integrated water management measures for the whole catchment area rather than to the management of floods as such.

17. The impact of all major human activities concerning flood prevention and protection in the catchment area on society as a whole should be properly considered. All major undertakings with the potential of adversely affecting human health or significantly affecting water quality or quantity, biological communities, landscape, climatic factors, architectural and archeological heritage, or the relationship between them should be subject to environmental impact assessment (EIA) and authorization procedures. EIA should also be applied on an international scale, in particular with regard to activities with a potential transboundary effect on health and aquatic ecosystems.

18. Physical planning as well as urban and rural development and construction should take into account the requirements of flood prevention and reduction, including the provision of retention areas.

19. In setting up these frameworks local problems, needs and knowledge, and local decision-making mechanisms should be duly taken into consideration. 1/

20. An information policy that covers risk communication and facilitates public participation in decision-making should be developed.

IV. JOINT AND COORDINATED ACTION

A. Joint bodies

21. Governments should set up joint bodies, such as international river commissions, where they do not yet exist. They should request these joint bodies to incorporate flood prevention and protection into their activities and entrust them with the development of good management practice for flood prevention and protection.

BOX 1

Cooperation is necessary within each riparian country as well as between riparian countries and is most effective if it involves the public

As a rule, measures to prevent and control floods should be drawn up in such a way that they take into account the whole catchment area, irrespective of administrative or State borders, and be agreed upon and jointly coordinated.

This cooperation is imperative at least among ministries and other authorities and institutions responsible for water management, human health, civil defence, regional planning, agriculture and forestry, traffic planning and nature conservation and should be established and ensured.

22. These joint bodies, when developing this good management practice, should:

(a) Draw up a long-term flood prevention and protection strategy that covers the entire transboundary river basin and its entire water system rather than the transboundary watercourse as such;

(b) Include in the strategy at least such major objectives as reduction of the risk to health and damage to property; reduction of the scales of floods; building of flood awareness; and the setting-up or improvement of flood notification and forecasting systems;

(c) Draw up an inventory of all structural and non-structural measures to prevent, control and reduce floods; analyse the existing scope of flooding and human activities based on a risk analysis that goes beyond national borders in the catchment area; and identify the inadequacies of the existing scope of the technical and non-technical flood control and preventive measures;

(d) To achieve the long-term goals of flood-related risk management, draw up an action plan that contains all the measures (as well as their costs and effects) that came up as a result of the review and have been ranked according to their relative importance and timetables.

23. Through their respective joint bodies, countries riparian to the same transboundary waters should cooperate in establishing the water balance for the entire catchment area or parts thereof in order to characterize the natural water regime of these units as to precipitation, evapotranspiration, as well as surface and underground run-off. This cooperation should also cover assessments of man-made effects that originate from water use and influence water quantity.

B. Provision of information

24. To control and reduce the risks originating from floods, dam failures and ice hazards, arrangements should be made to:

(a) Inform without delay each downstream country likely to be affected by floods, critical water levels or ice drifts;

(b) Provide forecasts of water levels, run-off and ice hazards;

(c) Inform the public about the authorized institution that is expected to issue reliable information on floods.

25. Flood warnings, information and forecasts should be forwarded and circulated in real time between the riparian countries following an agreed procedure. Relevant information should also be made available to the public through the media, the Internet or other appropriate means. This should include information what the public should do.

26. Free and unrestricted provision and transfer of meteorological data and products, as defined by WMO in its resolutions 40 and 25 of the twelfth and thirteenth World Meteorological Congress, respectively, should be secured by close cooperation between hydrological and meteorological services.

C. Critical situations and mutual assistance

27. Comprehensive national and local contingency plans to respond to flood events should be properly prepared in due time. The authorities should have the capacity to respond to such events, in accordance with the relevant contingency plan.

28. Where appropriate, joint exercises to respond to floods and dam failures should be arranged.

29. Riparian countries, when drawing up and agreeing upon procedures for mutual assistance in critical situations, should spell out formalities to facilitate the travel of flood response personnel from abroad (whether by plane, boat or on land) during flood events.

V. PUBLIC AWARENESS, EDUCATION AND TRAINING

30. To reduce the potential for damage, both the public concerned and the authorities should closely interact. Correct flood warnings and forecasts are important elements for adequate behaviour of the public during flood events. To ensure the commitment of both the authorities and the public, the authorities should develop an information policy that covers risk communication and facilitates public participation in decision-making.

31. The public should be informed by the competent authority and/or other appropriate entity that floods are a natural component of the hydrological regime of watercourses. Thus, the public should become aware that there is a need to restrict uses, such as for industrial, agricultural, tourist or private purposes, in areas at risk of flooding to reduce the potential for damage. Information about restrictions on construction in flood areas should be easily accessible.

32. Information about risk assessments should be easily understood, for example, clear flood maps and, where appropriate, information based on geographic information systems (GIS) should be distributed. The public should be encouraged to take their own flood prevention measures and be informed about how to act during flood events. This requires, *inter alia*, that forecasts and related information are easily accessible and that real-time media coverage is ensured. Media plans should be prepared together with the riparian countries and a citizens' information desk could be useful in some countries.

33. All envisaged measures concerning flood prevention and protection should be compiled in a comprehensive action plan. Such action plans can cover several years, sometimes up to 15 years. Most measures represent a considerable environmental impact. A sustainable commitment of the public concerned is a cornerstone of successful implementation of these plans. Public participation in decision-making concerning flood prevention and

protection is therefore needed, both to improve the quality and the implementation of the decisions, and to give the public the opportunity to express its concerns and to enable authorities to take due account of such concerns.

BOX 2

If the flood situation is to change, everyone's objectives and actions must change: in the catchment area, alongside water bodies - everywhere

As the "public" means any one or more natural or legal persons and, in accordance with national legislation or practice, their associations, organizations or groups, a holistic approach to flood prevention and protection includes measures related to public information and awareness raising which are addressed to policy makers, governmental authorities, municipal and local authorities, the business sector, agriculture and forestry, research and development, the media and the citizens.

Access to information and public participation in decision-making concerning flood prevention and protection is needed, *inter alia*, to improve the quality and the implementation of the decisions, to contribute to public awareness, to give the public the opportunity to express its concerns and to enable public authorities to take due account of such concerns. Such access and participation should be supplemented by appropriate access to judicial and administrative review of relevant decisions.

34. The authorities should ensure that the information concerning flood prevention and protection plans is transparent and easily accessible to the public. The information should be disseminated early and actively, not just on request. It should be accompanied by the envisaged procedures for public participation.

35. All measures linked to public information and awareness raising are most effective when they involve participation at all levels, from the local community through the national government to the regional and international level.

36. The Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, done at Aarhus, Denmark, on 25 June 1998, gives an extensive framework in which the above recommendations on public participation fit.

Note

1/ Following the definitions of the Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes (MP.WAT/2000/1) "local" refers to all relevant levels of territorial unit below the level of the State. Although the recommendations in these guidelines are based on experience from a great number of rivers, it goes without saying that special conditions in the catchment area are to be taken into account, such as densely populated areas on protected flood plains.

Annex 5

GOOD PRACTICES FOR FLOOD PREVENTION AND PROTECTION

I. RETENTION OF WATER ON THE SOIL

1. Retaining water on the soil should have priority over swift water run-off.
2. Natural wetlands, forested marshlands and retention areas in the river basin should be conserved, and where possible restored or expanded.
3. Former flood plains and lakes, when possible, should be reclaimed, for example by relocating dykes to reincorporate these areas as natural retention areas into the discharge dynamic.

BOX 3

Rivers are important parts of the landscape: anthropogenic interference into the balance of nature in the entire river basin has influenced the risk of flooding

Several measures have decreased the travel time of the flood waves, and increased their levels and volumes. These include river regulations, the construction of dykes and walls, and clearance of riparian forests. River regulations, for example, to narrow or straighten the course of the river have shortened rivers and made them drop more sharply, and previous flood plains are no longer part of the “natural” flow regime due to the construction of dykes and walls.

The reduction of the forest population, for example, above all in areas of flood formation, and soil compaction on agricultural areas have reduced the capacity of the soil to take up and store water. This has led to increased soil erosion. It has also increased the amount of surface run-off of rainwater and meltwater and accelerated their speed. Moreover, increased sealing of the land surface and accelerated drainage of rainwater have further increased this run-off.

4. Soil sealing as part of urbanization (e.g. built-up land in residential areas and on industrial and business estates, and the construction of traffic routes and areas) should be limited. Unsealing measures encourage rainwater infiltration.
5. The water absorption capacity of the soil should be conserved and excessive soil compaction and erosion should be avoided through proper and site-specific agricultural land use. This leads at the same time to a reduction in nutrient and pesticide input into rivers.
6. The forest population in the river basin should be maintained and expanded by semi-natural reforestation, particularly in mountain and hilly ranges, as forests are the greatest natural water storage basins and contribute considerably to reducing soil erosion.

7. The required run-off capacity should be taken into consideration when restoring developed river courses to their “natural” state. If, however, the development of a watercourse, including the construction of dykes, is unavoidable to protect people and valuable properties, compensation measures should be made available.
8. Manageable flood polders, which should preferably be used as extensive grassland or to restore alluvial forests, should be developed at selected locations of former flood plains to lower flood peaks.
9. The effectiveness of measures on flood wave run-off, particularly dyke relocation and the development of flood polders, should be measured by surveys in the longitudinal section of the main watercourse.
10. In some river basins, there are technical structures to manage water flow in retention areas. The operation of such structures should follow a holistic approach to take due account of the whole catchment area. The management of these retention areas should not exclusively serve the purpose of local flood reduction but also flood reduction in the whole affected area. Organizational schemes in accordance with this goal are to be developed.

II. LAND USE, ZONING AND RISK ASSESSMENT

11. Uses should be adapted to the hazards in the immediate and in the potential (dyke-protected) flood plains. Furthermore, preventive measures against possible adverse ecological consequences, such as water and soil pollution, should be taken.
12. Non-structural prevention and protection should include zoning, based on hydrological and risk assessment studies. Identification and mapping of hazards and high-risk areas should be integrated into land-use planning policies.
13. Specific activities and uses in designated areas should be subject to administrative permits or authorizations. Restrictions and prohibitions should be based on risk assessments.
14. Where this is not yet the case, and where necessary, immediate flood plains should be identified and designated by law. In steep river valleys in hilly and mountainous areas, flash floods can cause mudflows and landslides with devastating effects. These effects can be further aggravated by human settlements and installations on the river banks. Structural protection measures, such as channelling, in these areas should be carefully selected and adopted on a case-by-case basis.

BOX 4

Risk managers and human health considerations

To avoid serious health effects, risk managers and assessors should:

- * Map the potential risks (e.g. the estimated frequency; location of chemical and nuclear plants and other hazardous sources; location of dwellings; location of public buildings and transport systems at risk);
- * Analyse and predict the vulnerability of communities (taking into account population density, vulnerable structures, economic aspects, etc.);
- * Drawing up inventories of existing resources (including infrastructure; personnel; communication; transport; health services, medical stocks, etc. to facilitate the rapid mobilization of all available resources if need be);
- * Establish a regional or national coordination mechanism, including the health sector, to deal with floods.

15. When identifying and designating areas that are prone to flooding, it should be borne in mind that they may require multi-purpose and/or cross-sectoral action such as flood protection, nature conservation and protection, protection of specific habitats and protection of sources of drinking-water supply. It is, therefore, necessary to consider everything that is in need of protection.

BOX 5

Public health impacts of flood disasters

The human health effects of floods may be divided into direct effects or indirect contributory effects as a result of being flooded. Direct effects on health are those caused by the floodwaters. Indirect effects are those caused by other systems that have been damaged by floods. Some of the health effects may be acute or short-lived; others may be chronic or long-lasting (see tables 1 and 2).

A further effect of floods on health is the likely disruption of 'normal' health and social services. Health and social service personnel are likely to be heavily involved in responding to the immediate and lasting impacts of disaster, thus removing them from their normal caring activities. Secondly, normal patterns of communication, either routine visits of health and social service personnel to districts, or visits of patients to hospitals or other care centres, are likely to be disrupted because of damage to transport systems. Thirdly, hospitals and other health and social service facilities may themselves be adversely affected by flooding or storm damage or their medical and other supplies may be interrupted, thereby temporarily reducing their capabilities. These problems might last for months, even years.

Source: MP.WAT/SEM.2/22

16. Existing constructions located in flood plains should be made flood-compatible. Further constructions in immediate flood plains and on areas at risk of floods, landslides or dam failures is not recommended. In potential flood plains, the planning and approval stages of further construction work should take account of the fact that only small quantities of hazardous substances may be deposited or stored, and that this has to be done in a proper way.

III. STRUCTURAL MEASURES AND THEIR IMPACT

17. Dams, flood ways, dykes and other flood-control works, hydraulic structures and other water-construction works should be built, maintained and rehabilitated to ensure that they are safe and provide a sufficient level of flood protection, in keeping with applicable construction standards or the best available technology and taking into consideration, in particular, the impact of climate change on river run-off.

18. However, flood protection is never absolute; only a certain level of protection against flooding can be guaranteed. The concept of residual risk should therefore be explained to the public.

19. The impact of measures on other parts of the river has to be taken into consideration. The risk of flooding, landslides and dam failures must on no account be increased if developing a watercourse.

20. When operating dams and flood retention basins during flood events, the flood situation in other parts of the river system, including other riparian countries, should also be taken into consideration, not only the local or national conditions.

21. In deciding on rehabilitation measures for flood-related structures, the relocation of dykes should be considered.

BOX 6

Structural measures

Flood protection by means of dykes and walls, retention basins and impounding dams, reservoirs and dams has a long tradition and remains a basis for an effective policy on flood prevention and protection. However, before using such technical means, the proper sequence of preventive and protective measures must be proved.

One should also realize that the building-up of flood plains, although protected by dykes and walls, increases the potential for damage in case of flooding. This also applies to construction downstream of reservoirs. Permitting these activities is now deemed to be a mistake as it has had fatal consequences for human health and property during floods.

IV. EARLY-WARNING AND FORECAST SYSTEMS

22. An effective early-warning and forecasting system for extending the reaction time should be supported by meteorological information and the earliest possible warning of extreme weather conditions. Within this system, the meteorological parameters - especially precipitation and temperatures and their forecasts - serve as input for hydrological forecasting models.

23. Flood forecasting models should be worked out, verified and adopted and, if appropriate, harmonized by riparian countries, introduced and regularly improved for the catchment area of the main watercourse and its most important tributaries.

BOX 7

Early-warning and forecast systems

Early flood warnings, flood information and forecasts are extremely important to be able to recognize dangerous situations in time, as the period between the beginning of a flood event and its reaching critical levels can be used to prevent or reduce damage.

24. In some cases, for example for technical, scientific or even administrative reasons, it may not be appropriate to develop a forecasting model that covers the whole catchment area. Models or sub-models then need to be developed for various parts of the catchment. In these cases, it is of the utmost importance to ensure a proper link between the models covering the various sub-basins.
25. Forecasts of ice jams and ice break-up should be examined jointly, and ice jams should be prevented jointly.
26. Because of the short reaction time in the event of flash floods in mountainous areas, the warning of flash floods should be based on real-time information from an automatic precipitation gauges network combined with quantitative radar precipitation data and supported by quantitative rainfall forecasts.
27. A compatible meteorological and hydrological information system and database, if possible with a fully automated data communication system, should be created for the entire river basin.
28. If possible, an automatic information system, providing and exchanging data about the operation of relevant water storage reservoirs and other hydraulic structures, should be set up and operated.
29. An effective and reliable system of flood forecasting and warning dissemination should be set up to inform the respective flood authorities and citizens in threatened areas.

Table 1. The impact of floods on human health - direct effects

CAUSES	HEALTH IMPLICATIONS
1. Stream flow velocity, topographic land features, absence of warning, rapid flood onset, deep floodwaters, landslides, risky behaviour, fast-flowing waters carrying boulders and fallen trees	Drowning, injuries
2. Contact with water	Respiratory diseases, shock, hypothermia, cardiac arrest
3. Contact with polluted waters	Wound infections; dermatitis; conjunctivitis; gastrointestinal illnesses; ear, nose and throat infections; possible serious water-borne diseases
4. Increase of physical and emotional stress	Increase of susceptibility to psychosocial disturbances and cardiovascular disease
5. Disruption of transport systems	Food shortage, disruption of emergency response
6. Rodent infestation	Possible diseases caused by rodents

Table 2. The impact of floods on human health - indirect effects

CAUSES	HEALTH IMPLICATIONS
1. Damage to water-supply systems, sewers and sewage disposal systems; insufficient supply of drinking water; insufficient water supply for washing	Possible serious water-borne infections (enterogenic E. coli, Shigella, hepatitis A, leptospirosis, giardiasis, campylobacteriosis), dermatitis and conjunctivitis
2. Underground pipe disruption, dislodgement of storage tanks, overflow of toxic-waste sites, release of chemicals, destruction of petrol storage tanks (may lead to fires)	Potential acute or chronic effects of chemical pollution
3. Standing waters, heavy rainfalls, expanded range of vector habitats	Vector-borne diseases
4. Clean-up activities following floods	Electrocutions, injuries, laceration, skin punctures
5. Destruction of primary food products	Food shortage
6. Damage to health services, disruption of "normal" health services	Decrease of "normal" health care services, insufficient access to medical care

Annex 6

**GOOD PRACTICES FOR FLOOD PREVENTION AND PROTECTION: AWARENESS
RAISING, EDUCATION AND TRAINING**

Recommendations to policy makers

1. Policy makers:
 - (a) Should become aware of the need to maintain the natural balance as a basis for flood protection without expecting all flood problems to be solved in this way;
 - (b) Should, moreover, recognize the need to limit land uses in areas under threat of flooding;
 - (c) Should become aware of the need to strengthen the law to ensure that limitations on use are actually enforced;
 - (d) Should avoid giving the impression that flood problems can be solved by action elsewhere alone;
 - (e) Should avoid making any promises to flood victims if the required financing is not available.

Recommendations to governmental authorities

2. Staff of governmental authorities should be informed and properly trained to:
 - (a) Consistently apply the existing laws by enforcing limitations on land use and other uses in areas threatened by flooding, landslides or dam failures;
 - (b) Assist in drawing up action plans for natural water retention, technical flood protection and more far-reaching precautionary action in rivers under threat of flooding;
 - (c) Where necessary, designate flood plains and try to keep these areas empty;
 - (d) Assist in upgrading flood notification and advance-warning systems in line with technological advances;
 - (e) Review the framework for elemental damage control insurance in dialogue with the insurance industry;
 - (f) Take measures to promote the natural development of watercourses; in watercourses passing through urban areas maintain the watercourses and their banks to ensure proper conditions for swift water run-off when floods strike.

Recommendations to municipal and local authorities

3. Staff of municipal and local authorities should be informed and properly trained so as to enable them to:
 - (a) Review land use and construction plans in the light of flood risks as well as risks of landslides and dam failures;

- (b) Initiate and carry out measures to allow rainwater leakage in construction areas and create financial incentives for this;
- (c) Provide information on risks of flooding, landslides and dam failures, in particular in the protected areas;
- (d) Draw up and regularly update flood warning and action plans for risks posed by flooding and ice.

Recommendations on education

4. Measures are needed to enable:

- (a) Architects and engineers to recognize flood risks as a natural threat and formulate recommendations for environmentally sound construction;
- (b) Engineers to avoid increased drainage and to allow rainwater to leach where it falls;
- (c) Skilled workers to take account of flood risk in the installation of equipment.

Recommendations on agriculture and forestry

5. Measures are needed to enable farmers and forestry workers to:

- (a) Promote water retention by means of site-adapted agriculture and forestry;
- (b) Use flood plains as grassland, where appropriate;
- (c) Promote healthy, multifarious forests and avoid large clear-cuttings to prevent erosion and flood-wave movement.

BOX 8

Lack of awareness of the danger posed by floodwaters

Characteristics of stream-flow velocity, waters carrying debris such as boulders and fallen trees can put residents and passers-by at risk of death or injury. Landslides may occur after floods and exacerbate hazardous conditions. Behavioural patterns and lack of awareness of the danger posed by fast-moving floodwaters can also lead to death. Obviously, flood-specific mortality varies by country. More than 90% of the studies carried out in the United States have shown drowning as the first cause of mortality associated with flood events. In general, mortality due to drowning is frequently observed in flash floods, when heavy water run-off inundates communities suddenly.

Motorists in particular are at high risk of death when driving into swiftly moving water or when traffic is diverted by floodwater. The majority of deaths from drowning in floods occur among occupants of motor vehicles. Deaths may be in part attributed to the misconception that motor vehicles provide adequate protection from rising waters. In fact, vehicles driven into water become more buoyant because the momentum of water is transferred to the vehicle. Other contributory factors are related to the increased level of physical and emotional stress, which promote the likelihood of myocardial infarction and even cardiac arrest among people with a pre-existing heart condition.

Source: MP.WAT/SEM.2/22.

Recommendations on science, research and technology

6. Specific research and developments programmes should be initiated or intensified, where necessary, to:
 - (a) Improve quantitative forecasts of precipitation and thaws, taking into consideration, in particular, the impact of climate change on river run-off. The precipitation and thawing forecasts should be improved to extend the warning and forecasting periods. The aim is to achieve quantified, timely and spatially based precipitation and snow-melt forecasts with a high resolution both in space and in time and with a high accuracy;
 - (b) Provide information on the importance of new forms of agricultural and forest management for flood run-off;
 - (c) Develop operational flood forecasting models, taking particular account of the effort required to achieve specific improvements;
 - (d) Improve instruments to manage flood retention systems and demonstrate their limits;
 - (e) Provide information on the growing damage potential that exists behind water protection facilities;
 - (f) Improve methods, devices and materials for protection, develop construction technologies.

Recommendations to the media

7. The media should:
 - (a) Help to provide flood information;
 - (b) Avoid sensationalist reporting.

Recommendations to citizens and the public at large

8. Citizens and the public at large should be made aware of their duties and existing measures and practices so that they:

- (a) Accept their responsibilities for damage reduction when floods strike;
- (b) Gear building work towards the threat of floods and observe limitations on land use and other uses;
- (c) Cover the residual risk by insurance – including in the areas protected by walls and dykes.

Recommendations to business

9. Measures are needed to enable insurance companies to offer blanket insurance for elemental damage including the risk of flooding.