Extreme Weather Events and Public Health Responses

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Contents

Foreword by Rudolf Zajac

Climate changes, a significant and truly global problem of mankind, represent a considerable risk factor for our environment and health. Extreme weather events are undisputed proof of climate changes. They are occuring with increasing frequency, affecting all continents of the world, with Europe being no exception. The intensity and frequency of *events* resulting from climate changes, such as floods, heatwaves and coldwaves, fires, winds and other natural disasters, have risen dramatically in recent years. The loss of homes, property, health, and human lives resulting from these disasters are a threat to people living both inland and on the coast. Therefore, it is necessary to intensify all efforts to identify effective measures to minimize the political, economic, social, environmental, and health consequences of these events.

Our present knowledge of extreme weather impact, gained by international cooperation of governmental and non-governmental institutions and organizations, has significantly contributed to the identification of factors influencing the change of climate and to the recognition of health impact assessment (WHO), but equally it shows that we are not yet adequately prepared to face threats and to overcome situations in which people are confronted with extreme weather events. Consequently, it is necessary to continue discussion on how to predict and prevent disasters, what to do once they have occured, and how to reduce the damages and the harm caused by them.

It is imperative to continue this discussion on the level of experts from various fields and professions, to inform the public, and to persuade government representatives and politicians to make reasonable decisions and to take effective measures to enable society to face the impact of climate changes on health.

Slovakia welcomed the opportunity to organize an international meeting in cooperation with the World Health Organization on the 9th and 10th of February 2004 in Bratislava and thus contribute to the discussion on the impact of extreme weather on human health. Experts from 25 countries outlined possible resources in the field of extreme climate changes. This publication is a compilation of concrete case studies and the presentations by individual countries delivered during the meeting.

I believe that this publication will be a significant asset for many countries and will serve as a knowledge base for the preparation of effective strategies, national action plans and measures, thus contributing to the minimization and the moderation of the negative consequences of global climatic changes.

March 2005 Minister of Health of Slovakia

Foreword by Karin Zaunberger

I am honoured to write a few introductory lines for the topic heat waves in the context of the book on "Extreme Weather Events & Public Health Responses". The heat wave of August 2003 in Europe was evidence that no-one is on the safe side when it comes to the impacts of climate change. Though some may argue about whether these extreme weather events are linked to global change or not, these events revealed in a rather drastic way our vulnerability and our lack of preparation.

The project cCASHh *"Climate change and adaptation strategies for human health in Europe"* (May 2001 – July 2004), co-ordinated by WHO and supported by the "Energy, Environment and Sustainable Development Programme", in the Fifth EU Framework programme for Research and Development aimed at

- identifying the vulnerability to adverse impacts of climate change on human health;
- reviewing current measures, technologies, policies and barriers to improving the adaptive capacity of populations to climate change;
- identifying for European populations the most appropriate measures, technologies and policies to successfully adapt to climate change; and
- providing estimates of the health benefits of specific strategies, or combinations of strategies, for adaptation in different climate and socio-economic scenarios.

Some of the research results are reflected in this book. Not only do these types of research activities need an interdisciplinary approach, but also prevention of and preparation for extreme weather events need cooperation at all levels and throughout disciplines. The cCASHh project was a good example and I hope that this important work will be continued.

Project Officer, European Commission, DG RTD

Preface by Wilhelm Kirch

When I was invited in November 2003 by Dr. Bettina Menne from the WHO Regional Office for Europe, European Centre for Environment and Health, Rome, to give a presentation on "Lessons to be learnt from the 2002 floods in Dresden, Germany" at a WHO conference held in February 2004 in Bratislava on "Extreme Weather Events and Public Health Responses", I was somewhat surprised since from the scientific point of view I had never had anything to do with extreme weather events. At that time I was President of the European Public Health Association (EUPHA) and in November 2002 had organized the EUPHA-conference in Dresden, which took place only three months after the severe floods of August 2002 in parts of Austria, Slovakia, the Czech Republic, Poland and in Southern Germany. The Dresden area was one of those centres of destruction caused by the floods and was really badly affected. Thus we were glad even to be able to organize the yearly congress of EUPHA after so much damage had occurred. I therefore answered Dr. Menne that my only connection to extreme weather events was that I come from Dresden, but this did not appear to disturb her, possibly in the sure knowledge of having invited enough real experts on the topic of the conference anyway.

Hence the theme of the Bratislava meeting sounded interesting to me. And because I just had edited a book about "Public Health in Europe" on the occasion of our EUPHA conference from 2002, during the preparations for my contribution on the Dresden floods the idea came up to edit another book entitled "Extreme Weather Events and Public Health Responses", to include most of the presentations of the Bratislava meeting. I suggested the idea to Dr. Menne and Dr. Bertollini from European Centre for Environment and Health of the WHO Regional Office for Europe, Rome who were the organizers of the Bratislava conference. They apparently were in favour for the book edition suggested by me and thus we started to collect manuscripts. I was surprised and appreciated very much that 25 authors out of 27 whom we asked to submit an article responded promptly and provided us with a manuscript of their contribution to the Bratislava conference. My biggest concern was to publish the book in due time, as nothing is more uninteresting than to have a publication from an event which took place a long time ago. Thus I am glad that we have managed to edit our book "Extreme Weather Events and Public Health Responses" so soon after the meeting. Furthermore, I appreciate that we have dealt in the book with several relevant aspects of the theme such as "Projected changes in extreme weather in Europe", "Heat and cold waves", "Flooding", "Public health and health care responses to extreme weather events" and to have made recommendations in this concern. The present book will be of interest not only to experts of various professions in this field, but also to people who have to deal in certain moments with extreme weather events.

Dresden, May 2005 | Past President EUPHA

Preface by Jacqueline McGlade[1] and Roberto Bertollini[2]

Recent episodes of extreme weather events in Europe, including the floods of 2002 and the heat waves in the summer of 2003, have been accompanied by a significant and somewhat unexpected toll of deaths and diseases. For example, the health crisis in France caused by the 2003 heat-wave was totally unforeseen and was only detected belatedly. Health authorities were overwhelmed by the influx of patients; crematoria and cemeteries were unable to deal with the excessive number of bodies; and retirement homes were under-equipped with air-conditioning or space cooling environments and human resources. The crisis was further aggravated by the fact that many elderly people were living alone without a support system and without proper advice to protect themselves from the heat.
Because of these calamities, the linkage between extreme weather events and population health has been increasingly recognised by the scientific and decision-making communities; research and actions have been initiated to set up an efficient system for preparedness and response throughout Europe.

This book collates a number of important case studies, research and experiences on the health impacts of these recent events. They show the efforts being made by the public health and environment communities to evaluate the effectiveness of the measures taken to respond to the crises, to assess the early warning systems in place, and to use the lessons learnt to better tailor future activities. The experiences summarized in this book also underline the need to address more systematically the health system response to weather related crises as well as the knowledge gaps regarding both the effectiveness of the early warning systems in place and the interactions between different phenomena, for instance heat and air pollution.

At the Fourth Ministerial Conference on Environment and Health, held in Budapest in June 2004, it was further recognized by the European Ministers that as a consequence of our changing climate the intensity and frequency of extreme weather events may vary and probably increase in the future. Even if the extent of the association between climate change and extreme weather events is still a subject of debate in the scientific community, there is no question that there are many modulating anthropogenic influences inducing extreme weather situations and sometimes enhancing the impacts of the weather events. Changes in land use and hydrology create multiplying effects when the natural or "ecological" protection has disappeared. Examples are reduced wetland buffering areas, straightening of rivers, forestry fragmentation and logging; and in the heat wave case, the induction caused by air pollution from transport and the urban heat island effect. The complexity of the processes involved further underlines the link between ecology and human health.

Extreme weather events will continue to pose additional challenges to current and future populations, in terms of risk management and the reliability of infrastructure, including health services, power supply and others. Every effort should therefore be made by the environment and public health communities to put in place evidence based interventions and where necessary precautionary measures to limit the impacts on the environment and actively to reduce the burden of mortality and disease on human populations and ecosystems.

There is no time for complacency. Actions must be taken urgently to protect the environment of Europe and assure the health of its citizens.

[1] Executive Director, European Environment Agency
[2] Director, Special Programme on Health and Environment,
WHO Regional Office for Europe

Editorial

'Si le respect de l´homme est fondé dans le cœur des hommes, les hommes finiront bien par fonder en retour le système social, politique ou économique qui consacrera ce respect'
"Lettre à un otage", Antoine de Saint-Exupéry

The global climate is changing. During the last 100 years warming has been observed in all continents with an average increase of 0.6 ± 0.2 °C (man ± SD) in the course of the 20th century. The greatest temperature changes occurred at middle and high latitudes in the northern hemispheres. The trend towards warmer average surface temperatures for the period since 1976 is roughly three times that of the past 100 years as a whole. In the last decades warming seems to be attributable to human activities (man-made environmental changes) like land-use changes, deforestation, urbanisation and the reduction of wetlands. Global climate change is likely to be accompanied by an increase in frequency and intensity of extreme weather events. Climate variability occurs at both the level of gradual change as well as the level of extreme events.

Extreme weather events are those events which society is unable to cope with. They are by definition rare stochastic events. Europe has experienced on unprecedented rate of extreme weather events in the last 30 years. Heat waves occurred in France, Italy, Portugal, the Russian Federation, Hungary and Bulgaria between 2000 and 2003. The annual number of warm extremes increased twice as fast as expected based on the corresponding decrease in the rate of cold extremes. On the other hand cold waves brought serious health problems to Northern Europe, the Russian Federation and even Bosnia and Herzegovina. In 2002 Romania suffered deleterious windstorms and Public Health responses were necessary. Last but not least, in recent years severe flooding occurred in many European countries like U.K., Poland, Czech Republic, Austria, Italy and Germany causing enormous damages, e.g. in August 2002. On the basis of current predictions on climate, more extreme weather events have to be faced in the coming years and they are likely to be more severe. Thus appropriate actions have to be undertaken in order to protect the population and the countries affected.

In the present book, articles under the following headings are published: "Climate variability and extremes in Europe", "Temperature extremes and health impact", "Response to temperature extremes", "Flooding: the impact on human health", "National case-studies on health care system responses to extreme weather events" and "Recommendations". They shed light on the mode of development and the damages caused by extreme weather events and finally give some hints of what has to be done to cope with them.

Climate Variability and Extremes in Europe

Addressing „The climate dilemma", **A. Navarra,** Bologna, comments that the concept of climate has surged to a problem of planetary relevance with an impact on several sectors of human society. The fluid envelopes of the Earth, the atmosphere and the oceans are the main components of the climate system. It is the dominant pattern of motion of the fluids that determine the climate in any given place of our planet. The distribution of land masses and of mountain ranges is also a major factor in shaping the dominant climate features. Furthermore, sea ice, the biosphere, the soil as well as land ice sheets are contributing factors. The complexity of the climate system and limitations of experimental capabilities do not appear to allow a classical scientific approach to it. This leads to a complex situation where it is sometimes difficult to differentiate between facts and assumptions. But without any doubt there is increasing evidence that two additional factors have become relevant for changes in climate over the last century, namely the steadily rising carbon dioxide and greenhouse gas concentration in the atmosphere, and the higher surface temperatures on our planet. Navarra concludes that, in the case of weather extremes which may be caused by the factors mentioned above, two levels of monitoring are necessary: short term weather forecasts (up to 8 days) and the long term view which tries to assess the frequency and characteristics of weather extremes over a period of 20 – 30 years from now. **G.R. McGregor et al,** Birmingham, state in their article "Projected changes in extreme weather and climate events in Europe" that one possible outcome of the predicted global climate change is an increase in the frequency and, possibly, intensity of extreme weather and climate events. The purpose of this chapter is to review ways in which climate change may alter the occurrence of extreme events and to consider whether certain trends predicted are reflected in the observational record of extreme events for Europe. They point out that the terms extreme weather and climate events differ from each other and refer to different phenomena. An extreme weather event like a tornado or thunder storm lasts between 1 and 6 to 10 days, whereas an extreme climate event implies a number of extreme weather events over a given time period, like hot and dry summers or wet and stormy winters. They summarize that climate change projections indicate the likelihood of substantial warming by 2100 and expect non-linear increases in extreme weather events with a change in mean climate. Trends in time series of observed extreme weather and climate indices match those suggested by climate model based projections of future climate and support the hypothesis that more frequent extreme events across Europe are associated with the climate change. **Z.W. Kundzewicz,** Poznań and Potsdam, asks in the first of his two articles in this book "Is the frequency and intensity of flooding changing in Europe?" He reports that between the 1950s and the 1990s, yearly economic losses from weather extremes have increased tenfold (in inflation-adjusted US dollars). In the last decade several destructive floods have hit Europe, of which the flood of August 2002 in Central Europe was responsible for damage costs of about 15 billion Euro. Due to global warming, precipitation has increased (2 – 4 % in the last 50 years) directly impacting on flood risk. Some recent rainfall events have exceeded all-time records. On 12 – 13 August 2002 from 6.00 a.m. to 6.00 a.m., 312 mm rain was measured in Zinnwald, Saxony, Southern Germany. Z. W. Kundzewicz concludes that in many European places flood risk is likely to have grown and a further increase of this risk is projected. **J.-C. Cohen, J.-M. Veysseire and P. Bessemoulin,** Paris, present reflections on "Bio-climatological aspects of the summer 2003 over France". During June to August 2003 there was the hottest summer period of the last 50 years in France with an extreme heat wave in the first two August weeks of 2003. In Paris, with serial data files since 1873, morning temperatures on the 11th and 12th were highest ever registered at 25.5 °C (previous record: 24 °C in 1976). The heat wave was outstanding in duration and in geographical extension (over all parts of France, including mountains and coastal regions) followed by a six month period of drought. Its tragic health impacts induced 15,000 excess deaths, probably caused by high night temperatures and high levels of pollution. Metéo-France issued a press release on 1 August 2003 announcing a progressive climb in temperature for the following period and the whole country. In response to this heat wave an early Heat Health Warning System is being established in France. Starting with the definition of New Public Health (Public Health is the science and art of preventing disease, prolonging life, and promoting health through the organized efforts of society [Committee of Inquiry into the Future Development of the Public Health Function, 1988]) **Kristie L. Ebi,** Alexandria USA, presents an article on "Improving Public Health responses to extreme weather events". Measures to reduce disease and save lives are categorized into primary, secondary and tertiary prevention. Although adverse weather and climate events cannot be prevented, primary prevention, particularly development of early warning systems, can reduce the number of adverse health outcomes that occur during and following an event. These educational programs have often been implemented in a certain region when an event has caused injuries and deaths. Few programs have been established proactively. Instead, Public Health activities have focused on surveillance and response systems (secondary prevention) to identify disease outbreaks following an event. Surveillance and response systems are ineffective for identifying and preventing many of the adverse health outcomes associated with extreme climate and weather events. The increasing ability to predict extreme events and advances in climate forecasting provide Public Health authorities with the opportunity to have early warning systems available for reducing vulnerability to extreme weather events.

Temperature Extremes and Health Impact

The only article in this book about "Cold extremes and impacts on health" is presented by **J. Hassi** from Oulu. He states that the composition of the atmosphere is changing, thereby altering the radiation balance of the earth-atmosphere system, producing the global warming and extreme conditions which were already mentioned several times. The latter include not only anomalously high but also low temperatures with extreme cold spells. Despite the fact that excess mortality related to heat is increasing, deaths from cold exposure still represent the majority of mortality excess due to extreme temperatures. Although the death rate from excessive cold has been epidemiologically quantified, less attention has been given to the Public Health actions to prevent negative impacts of cold temperature. These preventive measures should not only be related to excess cold mortality but also include actions concerning cold injuries, diseases and physiological cold stress. Furthermore, exposure to cold increases the risk of respiratory diseases, coronary heart disease and other arteriosclerotic diseases. These in particular are responsible for the excess winter mortality which varies in different European countries between 5 and 30 %, while elderly people are especially susceptible to the impact of weather changes. Countries with a high prevalence of poverty and inequity are significantly associated with winter mortality. Public Health actions for preventing cold-related health impacts include adequate weather forecast, cold wave warning systems, warm housing, protection against outdoor body-cooling and intervention programs for developing behavioural changes in cold-exposed areas. Generally people from Northern countries are more experienced and successful in handling cold exposure. **G. Havenith,** Loughborough, provides background information on "Temperature regulation, heat balance and climatic stress". He points out that in the evolutionary sense, man is considered a tropical animal. Our anatomy as well as our physiology is geared towards life in moderate and warm environments. Human body thermoregulation is discussed under certain conditions like exercise, work load or heat with regard to air humidity, wind speed, morphology and fat, gender, an underlying arterial hypertension, drug and alcohol intake or age. In good health the body can deal well with heat and cold stress, but when thermoregulation becomes impaired, as it the case with ageing, the human is at risk. Age seems to be the best predictor of the increase of mortality at high temperatures. Longer periods of hot weather, especially when little relief is given at night, have hit mainly the older population. This is consistent with the observations of J.-C. Cohen, J.-M. Veysseire and P. Bessemoulin, but also with those of other authors of this book, who found an elevated death rate during heat waves especially in the elderly population. Concerning cold exposure, G. Havenith states that the analysis of mortality and morbidity data is more complex, hence cold related problems are not always attributed to the cold in statistics. Also **Stéphanie Vandentorren and P. Empereur-Bissonnet,** Saint-Maurice, report on the "Health impact of the 2003 heat wave in France" which has already been described by T. Michelon, P. Magne and F. Simon-Delavelle as well as J.-C. Cohen, J.-M. Veysseire and P. Bessemoulin in this book. After a warm month of June in 2003, with temperatures 4 – 5 °C above seasonal averages and two hot last weeks in July, a heat wave struck France as a whole in August 2003. In Paris, the temperature exceeded 35 °C for as long as 10 days, a situation never observed since 1873. This led to a total mortality increase of 55 % between 1 August and 20 August compared with the expected number of deaths estimated on the basis of the mortality in 2000, 2001 and 2002 for the same period. The mortality was particularly high for elderly people, to the extent of an increase of 70 % in people >75 years of age. In order to identify etiologic factors for the increased mortality, so-called case control surveys were carried out immediately after the heat wave. The results will contribute to establishing a Heat Watch Warning System in 2004 in order to prevent excess mortality during future heat waves. Further European projects dealing with this purpose are PHEWE (Assessment and Prevention of Acute Health Effects of Weather Conditions in Europe) and the PSAS9 program. Also Portugal was hit by heat waves in June, July, August and September 2003, which is outlined by **R. Calado et al,** Lisbon, in their article "Portugal, summer 2003 mortality: the heat waves influence". The authors point out that already in 1981 and 1991 longer lasting temperature rises above 32 °C were observed. As after these periods studies had indicated that there was a strong relationship between the heat waves and excess death rates, the National Observatory of Health established a Heat Waves Vigilance and Alert System, while data from the Meteorology Institute also had to be considered. Thus since 1999 each year from 15 May to 30 September institutions like the Civil Protection and the General Directorate of Health are provided with the so called "Icaro Index" on a daily basis. The index predicts the intensity of hot weather periods, which may possibly cause deaths, three days in advance. These alerts had to be given three times during the summer 2003 and regional and local health authorities were informed. A Public Health Call Centre provided information about heat prevention measures and it answered 1400 calls during this time period. Excess deaths were averaged to 1802 cases. Finally, in Portugal a Contingency Plan for heat waves is to be established. **Anna Paldy et al,** Budapest, point out that the 3rd Ministerial Conference on Environment and Health in London 1999 recommended that national assessments of the potential health effects of climate variability should be undertaken. Thus concerning weather changes, vulnerable populations and subgroups should be identified, furthermore, interventions that could be implemented to reduce the current and further burden of corresponding diseases should be proposed. In their article on "The effects of temperature and heat waves on daily mortality in Budapest, Hungary 1970 – 2000" Anna Paldy et al. report that during these years mean daily temperature and the number of hot days increased reaching peak values in the 1990s. Concerning mortality, the authors found a considerable reduction during these 31 years (about 10 %). But with an average rise in mean temperature of 5 % during each year, the risk of mortality increased significantly. During five heat waves since 1994 mortality in the adult group did not appear to be affected. Only one heat wave in August 2000 (3 days) was associated with an excess mortality of 72 %. Analogous to what is reported by Hassi in this book for excess cold mortality, also heat wave mortality is mainly attributable to cardiovascular, cerebrovascular and respiratory diseases. Weather variability, rather than heat intensity, is often the most important factor defining human sensitivity to heat. Relative humidity had a slight, but significant effect on mortality during the winter period. The influence of air pollutants on mortality was weaker than that of temperature in the Budapest-study. **Susanna Conti et al,** Rome, report on an "Epidemiologic study of mortality during summer 2003 in Italian regional capitals: results of a rapid survey" requested by the Italian Minister of Health. The period of 1 June to 31 August 2003 was analysed and a mortality increase of 3134 deaths was found due to the unusually hot summer (compared with 2002). 92 % of the people who died were 75 years and older. The mortality rise was most pronounced in Torino (44.9 %), Trento (35.2 %), Milan (30.6 %), Genova (22.2 %), Bari (33.8 %), Potenza (25.4 %) and L'Aquila (24.7 %). Concerning the Humidex, which is a discomfort index resulting from the combined consideration of excessive humidity and high temperatures, a significant correlation was found between this parameter and mortality in cities like Turin, Milan, Genova, Rome and Bari. Calculation of the so called "lag time" allowed presentation of data on the time between exposure to heat and the occurrence of deaths. The maximum correlation was observed a few days before the fatalities: 2 days for Rome, 3 days for Bari and Genova and 4 days for Milan and Turin. The relationship between mortality on the one hand, and discomfort climate conditions (Humidex) together with the short lag time on the other, gives a clear Public Health message: preventive, social and health care actions have to be administered to elderly and frail people in order to avoid excess deaths during heat waves (see L. Abenhaim in this book). Paola Michelozzi et al, Rome, state that the relationship between weather, temperature and health has been well documented throughout the literature, both for summer and winter periods. The correlation of mortality and temperature appears graphically as a "U" or "V" shape, meaning that mortality rates are lowest when temperature ranges between 15 and 25 °C, rising progressively when it increases or decreases. In their article **Michelozzi et al** deal with "Heat waves in Italy: cause specific mortality and the role of educational level and socio-economic conditions". The authors observed excess death rates in people with a low education level e.g. by 43 % in Rome or by 18 % in Turin. Diseases of the central nervous system (CNS), of the cardiovascular, respiratory, endocrine system and psychiatric disorders were most frequently responsible for the excess mortality during heat waves in Italy in the course of summer 2003. In Rome an increase of CNS, respiratory and cardiovascular diseases causing excess death of 85 %, 39 % and 24 %, respectively, was found. For Milan corresponding values for CNS, respiratory and endocrine diseases were 118 %, 82 % and 68 %, respectively. Paola Michelozzi et al. conclude that demographic and social factors, as well as the level of urbanization, air pollution, the efficiency of social services and health care units represent relevant local determinants of the impact of heat waves on human health. Therefore prevention measures are needed which are provided in Italy by the Heat Health Watch/Warning System (HHWWS).

Response to temperature extremes

In their article on "Lessons of the 2003 heat wave in France and action taken to limit the effects of future heat waves" **T. Michelon, P. Magne and F. Simon-Delavelle,** Paris, describe the severe heat wave of August 2003 in France. As already mentioned by J.-C. Cohen, J.-M. Veysseire and P. Bessemoulin as well as Stéphanie Vandentorren and P. Empereur-Bissonnet in this book, the catastrophic health consequences of this heat wave included an estimated 15.000 excess deaths. Thus health authorities spoke of a "health crisis" in this context, which was unforeseen and which had serious repercussions in the French public. As a deficit of health information, of defined responsibilities, a work overload of health authorities (during the summer holidays), under-equipped homes (e.g. missing air-conditioning) and the lack of support systems for elderly people living alone became evident, the French government had to intervene. Several steps were undertaken to limit damages of future heat waves on public health: retrospective studies were initiated in order to identify heat wave risk factors and defining Public Health action levels determined by meteorological parameters. Furthermore, health and environmental surveillance has to be established e.g. for registration of hospital admissions and meteorological data during heat waves. Finally, action plans were made to be implemented at national and local levels before June 2004. R. Calado et al reported on the heat wave of 2003 in Portugal and pointed to the relevance of the ICARO index as a useful instrument for identifying the impact of high temperatures. **P.J. Nogueira,** Lisbon, presents additional aspects of it in his article "Examples of heat health warning systems: Lisbon's ICARO's surveillance systems, summer of 2003". Without the ICARO system intervention during the heat wave in Portugal in 2003 might not have been successful as it is a full operational heat health warning system. A higher morbidity with an increased admission of patients to hospitals as well as to healthy emergency services and excess deaths were noticed, suggesting that heat may have an "endemic aspect" which has not been referred to elsewhere. In his contribution to this book entitled "Lessons from the heat-wave epidemic in France (summer 2003)" **L. Abenhaim,** Paris, draws some Public Health conclusions from heat related events in France, but he also attempts to broaden the scope for Europe as a whole. He asks questions like "should we concentrate on epidemics or endemics of heat-related events, can epidemics of these events be predicted, can epidemics of heat related events be detected, can heat epidemics be prevented, what can be done during epidemics and what is the difference between heat related epidemics and corresponding crises? He answers and concludes that the prediction, detection and prevention of heat related epidemics is restricted by a lack of scientific knowledge and experiences concerning this topic. Air conditioning is certainly the most efficient measure to mitigate heat related symptoms and it should be available during heat waves in a continuous fashion at least for the elderly and people with health problems. This certainly contributes to the management of heat-related epidemics, by which morbidity and mortality may be reduced. **T. Kosatsky, N. King and B. Henry,** Rome, Montreal, Toronto, point out in their article that Canadian cities have initiated active heat response strategies since 1998. In this concern, they report on Montreal's and Toronto's approach of issuing public advisories for hot weather response, especially for the elderly and the homeless, in cooperation with the Canadian Meteorological Service. Research and action programs were instituted to protect residents against the effects of heat on health. Furthermore, civil defense authorities established a heat wave emergency response plan. Research activities will include the definition of a heat emergency action level, the identification of the population segments adversely affected by heat, the development of a geographic information platform, the evaluation of air conditioner use, medication practices and patient hydration in chronic care centres. The results obtained should improve our knowledge about client-specific heat health management plans.

Flooding: The Impact on Human Health

D. Meusel and W. Kirch, Dresden, present a report on the floods in the Dresden area and the "Lessons to be learned from the 2002 floods in Dresden, Germany". After unusually intense rain and thunderstorms in the second week of August 2002 catastrophic dimensions became evident in Bavaria, Austria, Slovakia, the Czech Republic and Poland. The meteorologically perfect cyclone "Ilse" with plenty of warm humidity in its lower spheres and a cold higher sphere, arrived in the mountains surrounding Dresden on the 10th of August 2002. More than 100 litres/m^2 rain during the night of 12th to 13th August caused small mountain rivers to collapse and water reservoirs to become overfilled. These masses of water and those coming from Bohemia and other parts of Saxony combined in the River Elbe causing flood damages never seen before in many cities (see figures in this article). Public Health issues of this disaster are discussed (hygiene, vaccination, problems with the decision making processes, multilevel management plans, transboundary adjustments, preventive measures). In addition to the Dresden flood experiences, **Z.W. and W.J. Kundzewicz,** Poznan and Potsdam, present a further contribution on "Mortality in flood disasters". They point out that the two most important socio-economic characteristics of disastrous floods are the number of deaths and the economic damage. Neither of these is easy to quantify in a reliable way. The term "flood related fatality" is self-explanatory and can be interpreted in a rather broad way. Certainly there is a substantial difference between the deaths of an old handicapped woman, who drowned alone in her bedroom, and that of a young, strong, and self-assured man who underestimated the danger and put himself in harm's way. In detail the authors inform about the death circumstances of 21 people all under the age of 44 who died during the July 1997 flood in Poland. As already mentioned, the damage costs of the floods of August 2002 in Central Europe are estimated at about 15 billion Euro. In the review on „The human health consequences of flooding in Europe" **S. Hajat et al,** London, Alexandria (USA), Rome, state that floods are the most common natural disaster in Europe. As already pointed out, various mechanisms may cause flooding. Flood characteristics influence the occurrence and consequences of the flood event. According to the 3rd Assessment Report of the Intergovernmental Panel on Climate Change, intense precipitation periods with floods will increase in frequency and intensity. Therefore the development and implementation of measures to prevent adverse health impacts from flooding are necessary. The health consequences of floods include drowning, injuries, anxiety and depression lasting for months after the event, whereas infectious diseases have been observed relatively seldom in Europe during and after flooding. Groups vulnerable to the health impacts of floods are the elderly, children, disabled, ethnic minorities and people with low incomes. Thus vulnerability indices have to be developed in order to establish public health interventions (risk-based emergency management programs). **E. Penning-Rowsell, Sue Tapsell and Theresa Wilson,** London, present "Key policy implications of the heath effects of floods". They point out that the impacts of floods are serious and far-reaching. Frequency and extent of flooding worldwide are expected to increase over the next 5 – 10 decades due to global warming. Despite this fact, the authors found very little information and guidance in a Europe-wide survey of emergency plans with coherent strategies for coping with health impacts of flooding or natural disasters. But there is no doubt that political measures for flood mitigation are about the priority of responses during and after flood events. In particular, a pre-planning for these activities with multi-dimensional emergency programs is needed. In this concern it has to be mentioned that early warnings of floods and the identification of those who are most vulnerable to floods and their health impacts have to be targeted. Most of the corresponding recommendations in terms of pre-event warning provision as well as post-event health care and their aftermath are straightforward. They include assistance for the elderly, for those with underlying diseases or prior-event health problems, for the poor or for dependent subjects e.g. children. In natural disasters the most striking problem is that the responsibilities for the different actions needed are split between too many organizations. **Merylyn McKenzie Hedger,** Bristol, finishes the flooding chapter with her article on "Learning from experience: evolving responses to flood events in the UK". She deals with tidal waters and spring tides (coastal floods) and also with the so-called flash floods which occurred in the UK and in Central Europe. Both Z. W. Kundzewicz and W. Kirch and D. Meusel only reported in their articles about riverine and flash floods. In the UK there were several floods from the catastrophic East coast flooding 1953 to the events in 1998 and 2000. The 1998 flood led to a management change in the responsible British Environment Agency and a new flood warning system which proved successful at the time of the 2000 floods, but has to be improved further. In 1953 a great storm surge accompanied by gale force winds swept over the North of the UK causing widespread flooding of coastal areas (more than 1000 miles). Over 300 people died, 32,000 had to be evacuated from their homes and 24,000 houses were flooded. The Easter flood 1998, however, was a flash flood caused by enormous amounts of rainfall in the preceding months affecting the Midlands and Wales leading to deaths, serious injuries and losses of homes and personal possessions. The autumn 2000 floods exceeded insured costs of >1 billion pounds. Merylyn McKenzie Hedger concludes that the policy for managing flood risk in UK is iterative and dynamic. Flood related topics such as the climate change demand further attention. As already mentioned in the case of the Dresden floods, guidance to planning authorities has to be improved. More tools and information must be delivered to local planning authorities to help them with delivery of flood risk assessment.

National case-studies on health care system responses to extreme weather events

In their article "Extreme weather events in Bulgaria from 2001 – 2003 and responses to address them" **Rajna Chakurova and L. Ivanov,** Sofia, describe the different various geographic formations of Bulgaria with consecutive climatic specifics. These led to various extreme weather events during 2001 – 2003. These included storms with hurricanes and tornados, extreme cold spells with ice-formation, warm and dry spells, torrential rains, floods, landslides or forest fires, although Bulgaria has the lowest water resources per capita of all European countries. The extreme weather events of 2001 – 2003 led to human losses and huge material damages, the most severe of which were incurred by floods. Management bodies, units of SA Civil Protection, ministries and different agencies have participated in addressing the aftermath of the disasters with their staff and equipment. In Bulgaria regulations exist for organizations for handling accidents, catastrophes and the aftermath of disasters. The authors conclude that measures for the prevention of extreme weather events should belong to the national priorities of Bulgaria. Anca Cristea, Bucarest, reports on a chain of calamities during the year 2002 in Romania. Starting with cold waves in Transylvania and the Republic of Moldova early in year, which led to a considerable decrease in the production of rape, barley, wine and fruits, a devastating drought was seen in April/May/June 2002 followed by heavy rains and floods in the centre and south of the country. The most dreadful phenomenon was a tornado in Făcăieni, South Romania, which caused severe damage. Due to unusually cold weather in the last third of the year, huge economic losses were registered once again. All of these extreme weather events had to be managed by so called Local Disaster Defence Committees which exist in every Romanian region. They care for hygienic problems, water supply, the health care of the population, its information about relevant necessary measures, but also for store houses of chemical substances. Anca Cristea assumes that the focal point in the approach of disasters is the human dimension: how prepared are the societies to cope with extreme events? She points out that any post-calamity evaluation is not able to register the real psychological impacts, the pain and the elapse of hope of every individual affected by the catastrophes. **A. Khadjibayev and Elena M. Borisova,** Tashkent, start their report on "A system of medical service to assist the population of Uzbekistan in the case of natural catastrophes" with the remark that the annual precipitation in the plain area of their country averages 120 – 200 mm, which makes Uzbekistan very vulnerable to heat waves and droughts. It has to be mentioned that in the context of the Dresden floods, 312 mm rain/m² fell within 24 hours. Thus the population of Uzbekistan is traditionally used to long, dry and hot summers and has accumulated effective measures against the heat. For cases of natural disasters Uzbekistan provides a Medical Emergency Service which functions on different levels from non-hospital medical assistance via qualified medical aid to specialized medical aid. In particular A. Khadjibayev and Elena M. Borisova point to the world's ecological tragedy, the Aral sea. Its inland waters used to provide prosperous life to the country's population. Nowadays the dried up bottom with around 700,000 tons of harmful salt damages the overall eco-system causing medical, social and economical problems ("Aral crisis"). Affected is an area of more than 100,000 km² including the Amudarya's delta. **V. Kislitsin, S. Novikov and Natalia Skvortsova,** Moscow describe a smell of burning and haze which was observed in the summer of 2002 for several days together with high concentrations of pollutants produced by forest and peatbog fires as well as industrial and vehicle emission in the Moscow region. This was preceded by a heat wave lasting several weeks leading to the pronounced smog mentioned. Smog is a well known health hazard consisting of chemical substances and suspended particulates (up to a diameter of 10 microns). Ozone, sulphur dioxide, nitrogen dioxide, carbon dioxide, benzene, formaldehyde, polychlorinated dioxins and benzofurans are among the chemical substances which were emitted. A health risk assessment methodology was used to evaluate the main adverse effects of the smog. Specifically, concentration-response functions were made for selected air pollutants. Thus a computer program was developed, the database of which contained information on the 25 most hazardous air pollutants in order to calculate different exposure outcomes. Consequently, warnings could be given to the people affected.

We have added an Annex to the book with a working paper on 'Public health responses to extreme weather events' derived from the 4th Ministerial Conference on Environment and Health which took place in Budapest from 23 – 25 June 2004. Furthermore, a description on a currently ongoing study of health effects of extreme weather events is presented. **Inge Heim,** Zagreb, describes a five year study on this topic which ends in 2004. The investigation was performed in Zagreb. So far, more than 10,000 patients with coronary disease, arterial hypertension, cardiac arrhythmias and multiple risk factors for atherosclerosis were interviewed using a questionnaire. The answers and the symptoms of the patients were correlated with meteorological parameters like air temperature, humidity or winds which were registered in defined time intervals. Furthermore, the number of patients who were daily admitted to the Zagreb hospitals due to acute myocardial infarction, unstable angina pectoris, chronic heart failure or who had a sudden death was registered. Dr. Heim expects that the study results will shed some light on the influence of weather on the course of cardiac diseases and corresponding patients. Thus Public Health measures could be developed and used for certain meteorological conditions.

Finally, recommendations are given for the prevention of health impacts of extreme weather events from **Bettina Menne** from WHO Regional Office for Europe, Rome. A corresponding working document of the **Budapest Ministerial Conference** held in June 2004 on 'Public Health Responses to Extreme Weather Events' is presented at the end of the book.

Dresden, May 2005 W. Kirch, EUPHA

Extreme Weather Events and Health: An Ancient New Story

Bettina Menne [1]

"Two attitudes should characterize scientists: On the one hand he must honestly consider the question of the earthly future of mankind and, as a responsible person, help to prepare it, preserve it and eliminate the risk; we think that this solidarity with future generations is a form of charity. But the same time the scientist must be animated by the confidence that nature has in store secret possibilities which it is up to intelligence to discover and make use of, in order to reach the development which is in the Creator's plan".

Pope Paul VI, 19 April, 1972, address to the Pontifical Academy of Science.

Introduction

Weather is an ancient human health exposure, says Hippocrates, in "On Airs, Waters and Places", circa 400 B.C. (McMichael et al. 2003). History has shown that weather and climate variability are important determinants of health and well-being. Examples are many; like the "biblical flood" scenario purportedly 6000 B.C., the vast droughts in the MiddleAges, the severe drought in 1921 in vast areas in the former Soviet Union causing millions of deaths, the North Sea floods in 1953 causing thousands of deaths, the heatwave in 2003 causing an approximated 30,000 excess deaths. There is still considerable uncertainty about the rates of climate change that can be expected, it is now clear that these changes will be increasingly manifested in important and tangible ways, such as changes in extremes of temperature and precipitation, decreases in seasonal and perennial snow and ice extent, and sea level rise (Karl et al. 2003). Further, climate change may alter the frequency, timing, intensity, and duration of extreme weather events (Karl et al. 1995). This paper briefly summarises some of the knowledge currently available on extreme weather events and briefly introduces to the Bratislava meeting.

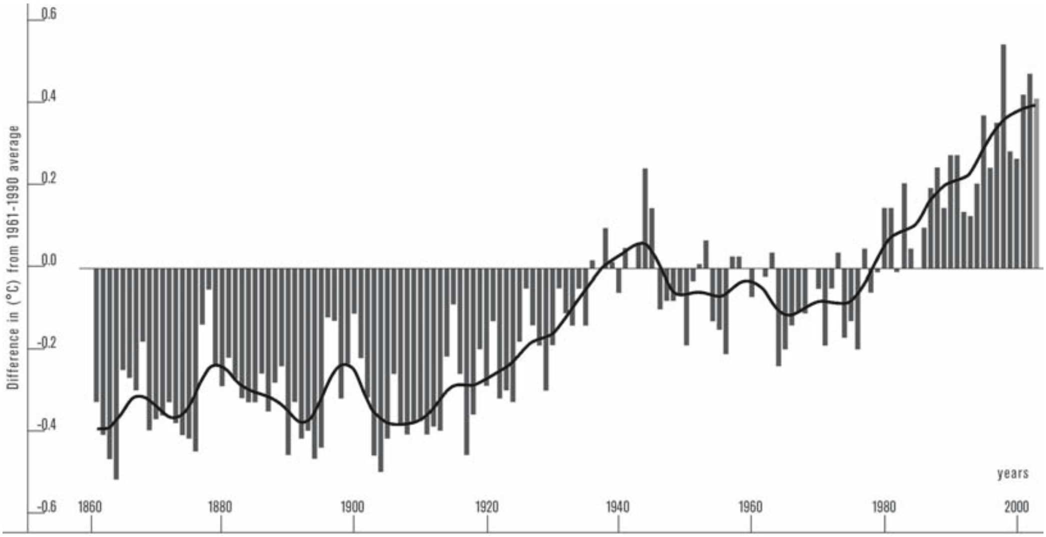
Extreme Weather in Europe

Human constant comparable observations of the "weather" at multiple sites are recent. Since 1861, the global surface air temperature has increased (IPCC 2001) and for most locations across Europe, increases in minimum temperature appear to be greater than in maximum temperature (Klein Tank et al. 2003) (➔ *Fig. 1).*

Several studies observed a warming tendency in winter extreme low-temperature events and summer extreme high-temperature events (Beniston 2003, Brabson et al. 2002). A lot of scientific debate is ongoing on weather the current warming trend will be also leading to increased frequency, intensity, duration and severity of extreme weather events. Several authors observed an increase (a) of the duration of heat waves

[1] with contributions from Tanja Wolf, World Health Organization

Fig. 1



Past and future changes in global mean temperature (Hadley Center for Climate Research)

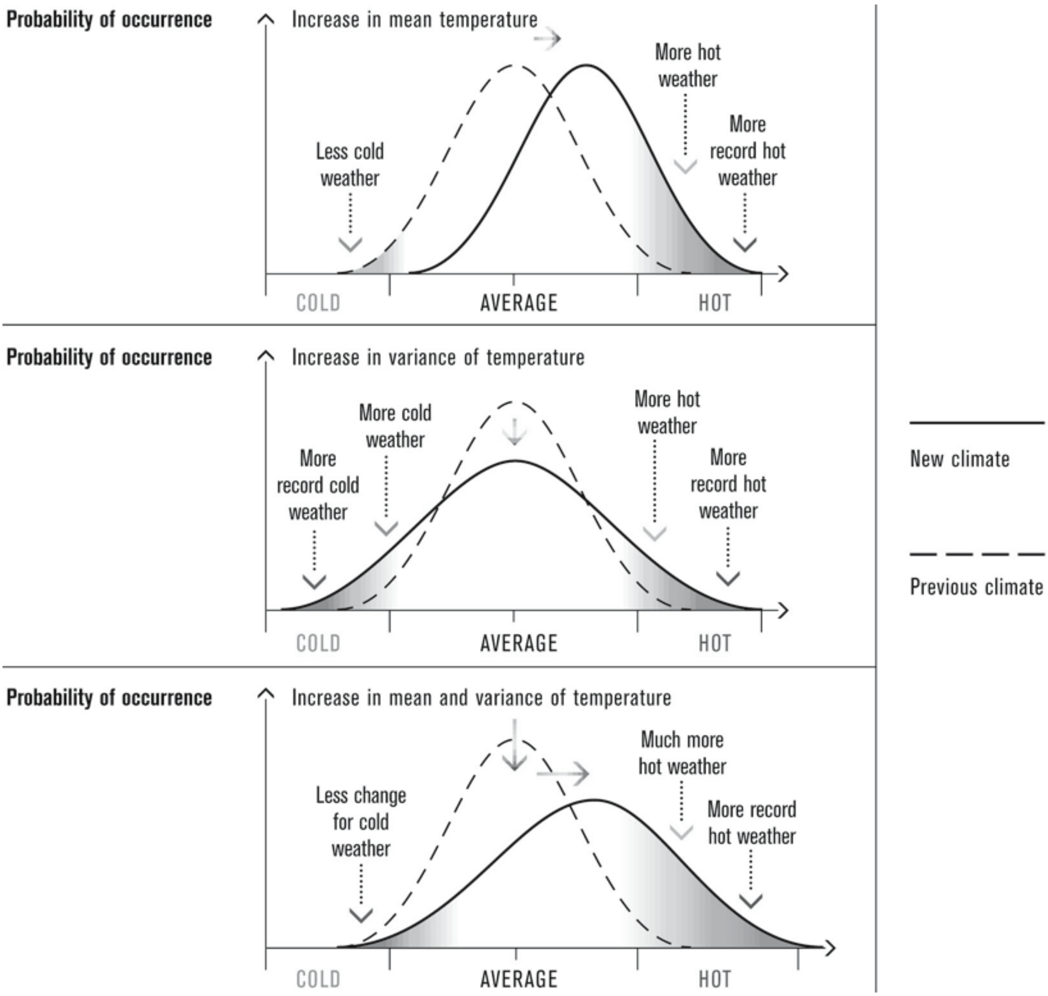
(Frich et al. 2002), (b) the summer 2003 was by far the hottest since 1500 (Luterbacher et al. 2004), (c) the 2003 heat wave bears a close resemblance to what many regional climate models are projecting for summers in the latter part of the 21st century (Beniston 2003), and (d) that the heat wave is statistically very unlikely given a shift in the mean temperature (Schar et al. 2004). An increase in variability is needed. This is also debated by the Intergovernmental Panel of Climate Change[2] (IPCC). *Figure 2* illustrates three possible scenarios of climate change with its impact on temperature: (1) an increase in mean temperature may result in less cold weather, in more hot weather and more record hot weather; (2) an increase in variance may result in more cold and hot weather as well as in more record cold and record hot weather; and (3) an increase of mean and variance might tend towards less change in cold weather, but may add to a significant increase in hot as well as record hot weather (IPCC 2001).

Using global climate models, climate change scenarios have been developed forecasting what could happen under different atmospheric concentrations of CO_2. In general, temperatures will increase over land; the exact amount is not known. Following these models, there will be more frequent extreme high temperatures and less frequent extreme low temperatures, with an associated increase (decrease) in cooling (heating) degree days; an increase in daily minimum temperatures in many regions that will exceed the increases for daytime maximum temperatures; daily temperature variability will decrease in winter but increase in summer; there will be a general drying of mid-continental areas during summer; and there will be an increase in precipitation intensity in some regions. Confidence in such projections exists because trends in observed weather and climate extremes for Europe in many ways match the expected outcomes of climate change.

The Intergovernmental Panel on Climate Change (IPCC) defines an extreme weather event 'as an

[2] The IPCC was set up in 1988, by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). The role of the IPCC is to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation.

Fig. 2

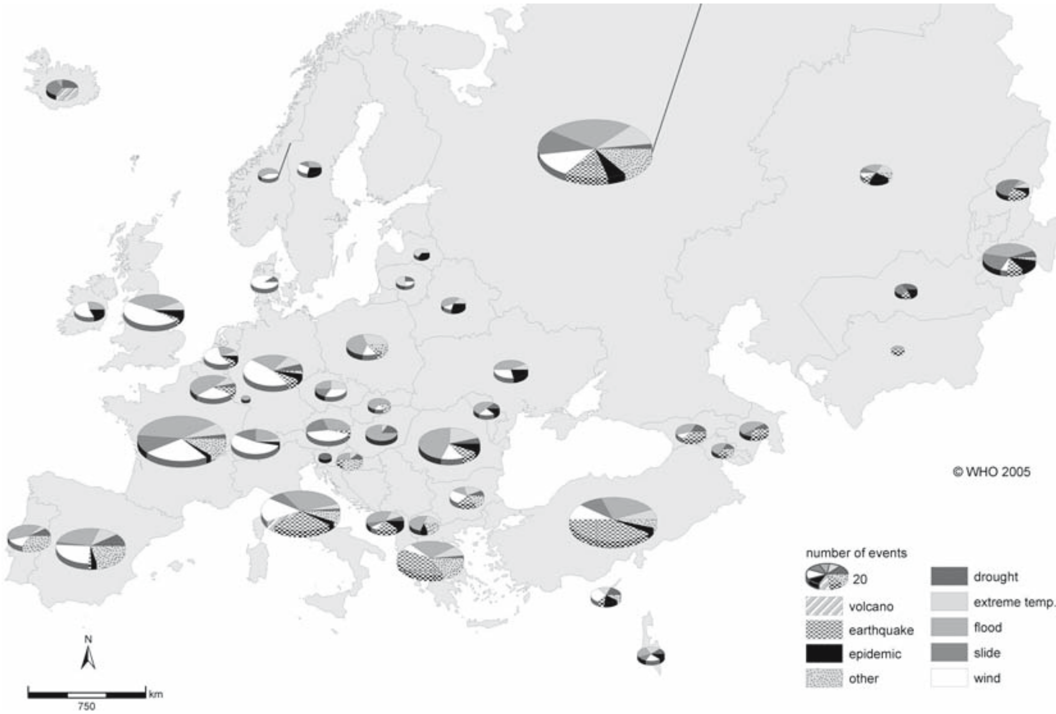


Climate change and changes in the distribution of daily temperatures (Source: Watson et al. (2001))

event that is rare within its statistical reference distribution at a particular place' and continues: 'Definitions of "rare" vary but an extreme weather event would normally be as rare or rarer than the 10th or 90th percentile' (IPCC 2001). An event may be further considered extreme merely if some of its characteristics, such as magnitude, duration, speed of onset or intensity, lie outside a particular society's experiential or coping range, whether or not the event is rare (Navarra, *Chapter 1;* McGregor, *Chapter 2*).

Figure 3, shows the distribution of natural disasters, by country and type of phenomena in Europe (1975–2001), as recorded by the EmDAT database. Although not reflected in the figure, in Europe reported extreme weather events are heatwaves, floods, windstorms, droughts and fires. The question for public health is, if extremes become more frequent and intense, will health systems and population be prepared?

Fig. 3



Distribution of natural disasters, by country and type of phenomena in Europe (1970 – 2004).
Important note: data for NIS available only since independency. Previous events have been added to the figures for the Russian Federation.
Source: EM-DAT: The OFDA/CRED International Disaster Database, www.em-dat.net – Université Catholique de Louvain, Brussels, Belgium

The health impacts of temperature extremes

Historically the relationship of temperature and mortality shows a V-like function with an optimum temperature (average temperature with lowest mortality rate), which varies with location and climate of a place (Braga et al. 2001, Huynen et al. 2001). For each degree rise above the 95th percentile of the two day mean, mortality increased by 1.9 % in London and 3.5 % in Sofia and without lag (Pattenden et al. 2003). In several studies in the United States a strong association of the temperature-mortality relation with latitude was found with warmer temperatures associated mortality in more-northern, usually cooler cities in the United States (Braga et al. 2001, Curriero et al. 2002, Keatinge et al. 2000) however this seems not to be confirmed for Europe (Michelozzi, personal communication). Several heat waves have affected the European Region during the last decades. Impacts have been elaborated in descriptive studies, mainly examining excess mortality. Excess mortality is calculated by subtracting the expected mortality from the observed mortality. The expected mortality is calculated using a variety of measures to construct averages of similar time periods of previous years. Results are difficult to compare because of the different denominators used. *Table 1* reports excess mortality rates from various sources, including country specific reports to the WHO.

Tab. 1
Heat wave events and attributed mortality in Europe (adapted from Kovats et al. 2003 and cCASHh 2005 [Climate change and adaptation strategies for human health, an EC funded research projekt]).

Place	Heat wave event	Excess mortality (all causes)	References
United Kingdom	1976 23.06. to 07.07.	9.7 % (2205) increase in England and Wales and 15.4 % (520) in Greater London	McMichael, 1998
Portugal	1981	1906 excess deaths (all cause, all ages) in Portugal, 406 in Lisbon	Garcia, 1981
Rome, Italy	1983	35 % increase in deaths in July 1983 in the over 65+ age group	Todisco, 1987
Athens, Greece	1987 21.07. to 31.07.	Estimated excess mortality > 2000	Katsouyanni, 1988
Greece (all urban areas except Athens)	1987 21.07. to 31.07.	32.5 % increase in mortality was observed in July	Katsouyanni, 1993
Portugal	1991 12.07. to 21.07.	1001 excess death (44.7 %)	Paixão and Nogeira, 2002
London, United Kingdom	1995 30.07. to 03.08.	768 (11.2 %) excess deaths occurred in in England and Wales, and 184 (23 %) in Greater London	Rooney, 1998
The Netherlands	1994 19.07. to 31.07.	1057 excess deaths (95 % CI 913, 1201) 24.4 % increase,	Huynen, 2001
Portugal	2003 30.07. to 15.08.	1854	Botelho et al, 2004
Spain (52 capitals of provinces)	2003 01.06. to31.07.	3166	Navarro et al, 2004
Italy (23 capital cities)	2003 01.06. to 15.08.	3134	Centro Nazionale de Epidemiologia, 2003
Italy (Milan)	2003 01.06. to 31.08.	559	Bisanti et al, 2004
Italy (Turin)	2003 01.06. to 31.08.	577	Bisanti et al, 2004
Italy (Rome)	2003 01.06. to 31.08.	944	Bisanti et al, 2004
France (13 cities)	2003 01.08. to 20.08.	14802	Institut de Veille Sanitaire, 2003
Germany (Baden-Wuerttemberg)	2003 01.08. to 22.08.	1415	Sozialministerium Baden-Wuerttemberg, 2003
England and Wales	2003 04.08. to 13.08.	2045	Office for National Statistics, 2003
Switzerland (Tessin)	2003 01.06. to 30.08.	No effect	Cerutti et al, 2004

Heat stress seems to most affect the aging population. A review of several epidemiological studies on heat and health underlines that persons at highest risk of death following heat-waves are over 60, or work in jobs requiring heavy labour, or live in inner cities and lower-income census tracts and thus are exposed either to low economic status or higher temperature or both (Basu et al. 2002, Keatinge et al. 2000). Prominent causes of death in studies of heat waves and elevated temperature were cardio-vascular diseases, respiratory diseases, cerebrovascular diseases and mental illness (Basu et al. 2002). People with pre-existing illness, especially heart and lung diseases, are at higher risk of dying in heat waves. In fact, cardiovascular and respiratory causes of deaths are most strongly linked with changes in temperature and this makes elderly people and people with impaired health but also those suffering from poor social conditions most susceptible to impact of weather changes (Ballester et al. 2003, O'Neill et al. 2003). Also mental illness shows a positive association with heat related death (Kaiser et al. 2001).

The adverse health effects of heat are more evident and more often studied in urban areas. The Urban Heat Island, as the fact that within cities the ambient air temperature is higher than in the surroundings, poses to risk the urban inhabitants' health (Montavez et al. 2000). Many of today's large cities tend to amplify extremes of temperature. The heat island in summer is because of the expanse of brick and asphalt heat-retaining structures, the treeless expanses of inner cities and the physical obstruction of cooling breezes (McMichael 2001). The health of urban inhabitants may in addition be impaired due to urban air pollution from industry and traffic (Sartor et al. 1995, Smoyer et al. 2000).

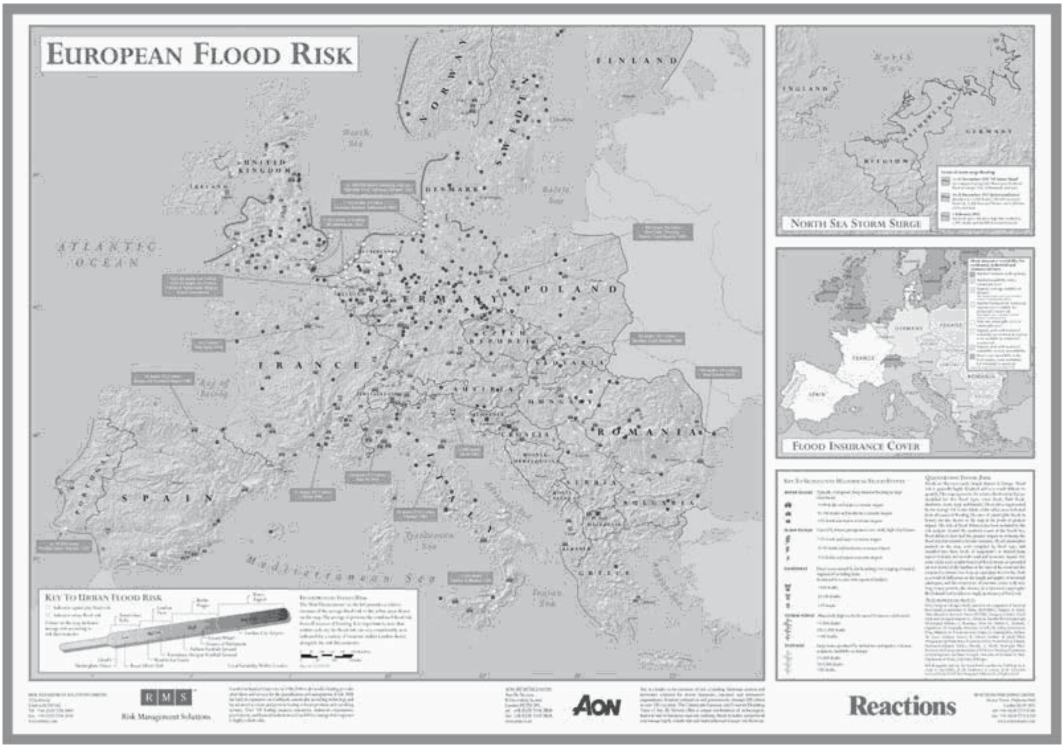
Beneath the demographical risk factors there are behavioural risk factors like living alone, being confined to bed, not being able to care for oneself, having no access to transportation or not leaving home daily and social isolation (Semenza et al. 1996). Similar finding have been drawn also from the 2003 heat wave in France (Empereur-Bissonnet, *Chapter 8*). A case-control study (INVS 2004) highlights the significant correlation with death during the heat wave of socio-professional categories (workers at risk), the degree of autonomy (people confined to bed at risk or not autonomous in getting washed and dressed), the health status (at risk patients with cardiovascular, psychiatric or neurological diseases) and the quality of thermo-isolation of the home. To wear fewer clothes and the use of a "refreshment measure" have shown some protective effect (INVS 2004). However, many more efforts are needed to understand how best to predict, detect and prevent the heat waves associated health impacts and how best to target intervention strategies.

Health impacts from cold spells can be classified as being derived from acute exposure (hours, days) as well as chronic exposure to cold (weeks, month, years). Exposure to cold temperatures can result in several negative health consequences, including death, disease, injury, other health complaints, degradation of performance, and degradation of motivation. Accidental cold exposure occurs mainly outdoors, in socially deprived people, workers, alcoholics, the homeless, the elderly in temperate cold climates. A simple lack of awareness combined with a lack of protective clothing, for instance, may carry a risk of death from hypothermia even during outdoor temperatures as mild as 0 °C. The onset of air-related frostbite appears at an environmental temperature of –11 °C. Wind, high altitude and wet clothing lead to onset of injury at higher environmental temperatures. The incidence of more serious frostbite requiring hospital treatment increases at temperatures of –15 °C and below. Mortality with respect to chronic exposure to cold is subject to seasonality. In many temperate countries 'all-cause mortality' as well as cardiovascular and respiratory mortality is higher during the winter months. Some epidemiologists use the term excess winter mortality to describe this seasonal phenomenon. Most European countries suffer from 5 – 30 % excess winter mortality. Ironically, increases in mortality because of cold temperatures occur more often in the warmer regions of Europe compared the colder regions. By means of protective clothing and a better infrastructure, North Europeans seem to be better adapted to extreme cold conditions (Hassi, *Chapter 6*). However there is significant scientific debate and uncertainty on whether the warming occurring has been or will be beneficial in reducing winter seasonal mortality.

Health impacts of floods

Europe experiences three types of floods: flash, riverine, and storm surges. ➜ *Figure 4* illustrates a European Map on sites of floods that occurred since the 19th century. Events as registered by the EmDAT database were used for the compilation of this map.

Fig. 4



Flood risk map for Europe. Source http://www.rms.com/Publications/UK_Flood.asp accessed on 30.01.2005

The adverse human health consequences of flooding can be complex, far-reaching, and difficult to attribute to the flood event itself (Hajat et al. 2003; ➜ *Chapter 16*). Floods can cause major infrastructure damage, including disruption to roads, rail lines, airports, electricity supply systems, water supplies, and sewage disposal systems. The economic consequences are often greater than indicated by the physical effects of floodwater coming into contact with buildings and their contents. Economic damage may reach beyond the flooded area and last longer beyond the event (Kundzewicz, ➜ *Chapter 16;* Ebi, ➜ *Chapter 5*).

Adverse health impacts of flooding can arise from a combination of some or all of the following factors: characteristics of the flood event itself (depth, velocity, duration, timing, etc.); amount and type of property damage and loss; whether flood warnings were received and acted upon; the victims' previous flood experience and awareness of risk; whether or not flood victims need to relocate to temporary housing; the clean-up and recovery process, and associated household disruption; degree of difficulty in dealing with builders, insurance companies, etc.; pre-existing health conditions and susceptibility to the physical and mental health consequences of a flooding event; degree of concern over a flood recurrence; degree of financial concern; degree of loss of security in the home; and degree of disruption of community life.

The physical health effects can be further categorized into direct effects caused by the floodwaters (such as drowning and injuries) and indirect effects caused by other systems damaged by the flood (such as water- and vector-borne diseases, acute or chronic effects of exposure to chemical pollutants released into floodwaters, food shortages, and others) (➤ *Tab. 2)* (Menne et al. 2000). There is a common perception that the problems associated with a flooding event end once the floodwaters have receded. However, for many victims, this is when most of their problems begin.

From several international assessments and literature reviews carried out it is apparent there is very little systematic research on the health effects of floods on a sufficient long time scale. For example no longitudinal studies on the health effects of natural disasters could be found for the United Kingdom except that reported by Tapsell (2000), and more recently by Hepple (2001) or as a follow up of the Central European floods in 2002. Anecdotal evidence from the 2002 floods showed that thousands of patients in flood prone health care facilities needed to be dislocated and expensive health care equipment was located in basements without flood building protection measures (➤ *Kirch in this book)*. Further health systems can be further badly affected by flood events, in particular through disruptions to electricity, water supply, and transportation systems. However, in Europe there is no systematic assessment of the impacts on health care systems. The European medical communities need to be prepared to address these concerns and both the short and the long term health needs of people who have been affected by flooding. There is also the issue that healthcare facilities will be stretched at times of disasters, and this will adversely impact on normal service delivery, not just on the healthcare provision for the disaster victims themselves.

Tab. 2

The health effects of floods in Europe, with examples of flood events [adapted from Hajat, Ebi, Kovats, et al. 2003; Ebi et al., forthcoming; and Few et al. 2004]

Health outcome	Comment	Example
Deaths	Most flood related deaths can be attributed to: high floodwater velocities; rapid speed of flood onset; deep floodwaters, where floodwater is in excess of 1 metre depth; long duration floods; debris load of floodwaters; characteristics of accompanying weather and clean up activities in the aftermath of floods	February 1953, the great storm surge, caused 307 deaths in the United Kingdom and 1795 deaths in the Netherlands (Greave 1956) (Summers 1978). After the February 1953 floods in Canvey Island Essex, UK, Lorraine (1954), compared routine deaths data for the period with the previous year, and suggested there was an increase in mortality. In the UK, Bennet (1970) conducted a retrospective study of the 1968 Bristol floods, and found a 50 % increase in the number of deaths among those whose homes had been flooded, and the most pronounced rise was in the 45 – 64 age group. In October 1988, a flash flood occurred in the Nimes region of France, 9 deaths occurred (Duclos, Vidonne, Beuf et al. 1991). In 1996, 86 people died in the town of Biescas in Spain as a consequence of the water and mud that suddenly covered a campsite located near a canalized river. In 1997, river floods in central Europe caused more that a 100 fatalities (Kriz, Benes, Castkova et al. 1998).

Tab. 2 (Continued)

Health outcome	Comment	Example
Deaths (Continued)		In the 1998 flood in Sarno, Italy, 147 people were killed by a river of mud that rapidly destroyed an urban area (Thonissen 1998). Between 1980 and 1999, an annual rate of 1.3 deaths and 5.7 injuries occurred per 10,000,000 population due to inland floods and landslides in Western Europe. (McMichael, Campbell-Lendrum, Kovats et al. 2002).
Injuries	Surveillance of morbidity following floods is limited. Little reliable information on injuries found in relation to European floods.	Duclos et al. (1991) report that in their community survey (108/181 households completed a questionnaire) of the 1988 floods in Nîmes, France, 6 % of households surveyed reported mild injuries (contusions, cuts, and sprains) related to the flood.
Infectious disease	Small risk of communicable disease following flooding, although severe occurrences are rare due to the public health infrastructure in place prior to and following a flood event such as water treatment and effective sewage pumping.	Leptospirosis outbreak occurred after the flooding in the Czech Republic in 1997. (Kriz et al. 1998). No increase in infectious disease was observed following the flash flood in Nimes in 1988, or 1995 river floods in eastern Norway, or in floods in UK in 2002. (Duclos et al 1991, (Aavitsland, Iversen, Krogh et al. 1996). Finland reported 13 waterborne disease outbreaks with an estimated 7300 cases during 1998 – 1999, associated with untreated groundwater from mostly flooded areas (Miettinen, Zacheus, von Bonsdorff et al. 2001).
Respiratory disease	Very little information available, mainly anecdotal	Following the floods in the north-eastern Republic of Sakha (Yakutia) in July 1998, a high incidence of respiratory diseases was observed by the International Federation of Red Cross (IFRC) (IFRC, personal communication).
Mental health (anxiety depression)	Few well conducted studies – but clearly an area for further investigation.	Higher levels of depression among flooded households compared to controls following floods in South east of UK. (Tapsell, Tunstall 2001) (Green, Emery, Penning-Rowsell et al. 1985). In a retrospective case-control study of the 1968 floods in Bristol, UK, Bennet (1970) found a significant increase (18 % versus 6 %; × 2 7.57; $p < 0.01$) in the number of new psychiatric symptoms (considered to comprise anxiety, depression, irritability, and sleeplessness) reported by flooded female respondents compared with the non-flooded group. In the Netherlands, Becht et al. (1998) interviewed children (n=64) and their parents (n=30) 6 months post-flood, and found 15 – 20 % of children having moderate to severe stress symptoms. After the 1997 floods in Opole, Poland (Bokszczanin 2000, 2002) studied children aged 11 – 14 years, and 11 – 20 year olds. Results confirm long-term negative effects on wellbeing of children, with resultant PTSD, depression and dissatisfaction with ongoing life.

Conclusions

Extreme weather events impact negatively on public health at many dimensions. Increased rates of mortality and morbidity are among the most important (Meusel et al. 2004). The meeting in Bratislava had the objective of exchanging information and discussing and developing recommendations on public health responses. These recommendations are discussed in ➲ *Chapter 26.* There is growing recognition that climate variability and change are causing serious risks to human health. How much climate variability may increase over the next decades is highly uncertain. Changes in extreme events may be experienced as changes in the rate or frequency of events and/or as changes in their intensity or magnitude. Spatial and temporal clustering of events may become more common. For example, heat-waves may increase in both frequency and duration in coming decades. Projections for cold spells are more uncertain. What is certain is that increasing climate variability will challenge public health systems. These possible changes require policy makers at all levels to take a proactive, anticipatory approach to designing strategies, policies and measures to reduce current and future burdens of climate-sensitive diseases. There is a need to increase collaboration and coordination between the health and meteorological communities, including the use of meteorological indicators by the health community.

Heat-waves are associated with an increase in all causes of death. Many knowledge gaps exist: in characterizing the relationship between heat exposure and a range of health outcomes, in understanding interactions between harmful air pollutants and extreme weather and climate events as well as on analysis of the health-threatening characteristics of heat wave episodes as opposed to the more general assessment of the overall relationship between temperature and health. Research is also needed on what information is necessary and how that information should be communicated, to motivate appropriate changes in behaviour during heat-waves. People perceive risks differently and have different responses to perceived risks. More information is needed on how to effect appropriate behavioural changes in vulnerable populations. Finally, criteria need to be developed for how to identify regions with more vulnerable populations. The assessment of the environmental and health consequences of heat-waves highlighted a number of knowledge gaps and problems in public health responses. Until 2003, heat-waves have not been considered a serious risk to human health with “epidemic” potential in the European Region. In order to reduce the health impacts of future heat-waves, fundamental questions need to be addressed, such as can a heat-wave be predicted, can it be detected, can it be prevented and what can be done.

The risk of floods will probably increase during the coming decades. Two trends point to this. Firstly, the magnitude and frequency of floods are likely to increase in the future as a result of climate change, i.e. higher intensity of rainfall as well as rising sea levels. Secondly, the impact of flood events may increase, because more people live in areas at risk of flooding and also more economic assets (business and industry) are located in such areas. Moreover, human activities such as the clearing of forests, the straightening of rivers, the suppression of natural flood plains and poor land planning, have contributed significantly to increasing the risk of floods. In 2002, the flooding in central Europe was of unprecedented proportions, with dozens of people losing their lives, extensive damage to the socioeconomic infrastructure, and destruction of the natural and cultural heritage. Germany, the Czech Republic, and Austria were the three countries most severely affected. Estimates of the economic and insured losses were € 11.0 billion in Germany, € 3.9 billion in the Czech Republic, and € 3.4 billion in Austria (Munich Re Group, 2001). With regards to floods there is no European comprehensive data base and there is no common understanding on what best health targeted measures are needed. The health sector should be more pro-active in planning for and providing pre and post-flood event assistance. With better information, the emphasis in disaster management could shift from post-disaster improvisation to pre-disaster planning. A comprehensive, risk-based emergency management programme of preparedness, response and recovery has the potential to reduce the adverse health effects of floods.

This meeting contributed to the preparatory process for the Fourth Ministerial Conference on Environment and Health (Budapest, June 2004), by submitting a working document (*Annex 1)* to the 4th Ministerial Conference in Budapest. This was endorsed in paragraph 7b of the declaration of the 4th Ministerial Conference. *( )* Chapter 26 of this book describes the ongoing preventive activities and the potentials for additional cooperation to further prevent health effects.

"We (Ministries of Health and Environment) recognize that climate is already changing and that the intensity and frequency of extreme weather events, such as floods, heat-waves and cold spells, may change in the future. Recent extreme weather events caused serious health and social problems in Europe, particularly in urban areas. These events will continue to pose additional challenges to health risk management and to the reliability of the power supply and other infrastructure. This demands a proactive and multidisciplinary approach by governments, agencies and international organizations and improved interaction on all levels from local to international. Based on the working paper Public health responses to extreme weather and climate events (*Annex 1)*, we decide to take action to reduce the current burden of disease due to extreme weather and climate events. We invite WHO, through its European Centre for Environment and Health, in collaboration with the World Meteorological Organization, the European Environment Agency (EEA) and other relevant organizations, to support these commitments and to coordinate international activities to this end. We agree to report on progress achieved at the intergovernmental meeting to be held by the end of 2007".

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Climate Variability and Extremes in Europe