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EuroHEAT, a DG SANCO co-funded project, aims to improve public health responses to weather extremes and to heat-waves in particular. As coordinator of the project, the WHO Regional Office for Europe organized an expert meeting in Rome to inform participants of the current status in the area and the project, to discuss the various work packages and phases, to discuss which climate information is necessary for public health and to develop an outreach and communication plan for the project. The project's activities are organized into nine work packages, under the overall topics of assessing the evidence for the health impacts of extreme weather, developing climate forecasts, detecting early health impacts and developing actions to prevent health impacts.

The participants identified the need to use results and scientific information from the project work packages to:

- develop a minimum set of requirements for heat-health warning systems that Member States can use as guidance;
- compile guidance on the best practice for the treatment of heat stroke patients; and
- develop guidance for public advice and information materials.

Collaboration with country advisers is essential to achieve these results.

The next EuroHEAT meeting is planned for 18 and 19 May 2006 in Budapest and will be organized jointly by the WHO Regional Office for Europe and the National Institute of Environmental Health in Budapest, Hungary.

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**1<sup>st</sup> Meeting of the  
Project:  
Improving Public Health  
Responses to Extreme  
Weather/Heat-waves -  
EuroHEAT**

**Report on a WHO Meeting  
Rome, Italy  
20-22 June 2005**





# 1<sup>st</sup> Meeting of the Project: Improving Public Health Responses to Extreme Weather/Heat-waves - EuroHEAT



## ABSTRACT

EuroHEAT, a DG SANCO co-funded project, aims to improve public health responses to weather extremes, and to heat-waves in particular. As coordinator of the project, the WHO Regional Office for Europe organized an expert meeting in Rome to inform participants of the current status in the area and the project, to discuss the various work packages and phases, to discuss which climate information is necessary for public health and to develop an outreach and communication plan for the project. The project's activities are organized into nine work packages, under the overall topics of assessing the evidence for the health impacts of extreme weather, developing climate forecasts, detecting early health impacts and developing actions to prevent health impacts.

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### Keywords

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## **Key Objectives and Conclusions of the Meeting**

### **Objectives of the Meeting**

Europe has experienced an unprecedented rate of warming in recent decades. It is possible that the current increasing instability of the climate system will lead to increased weather variability and with it, to a change in the frequency and intensity of extreme temperatures. At the Fourth Ministerial Conference on Environment and Health, Budapest, 2004, Ministries agreed to take action to reduce disease burden, to coordinate and collaborate among public health authorities, meteorological services and agencies (national and international), emergency response agencies and civil societies in developing local, regional, national and European interventions. This collaboration will facilitate the sharing of information, data and lessons learnt, and the elaboration of tools for early warning systems as well as addressing rapid information exchange. To this end, DG SANCO has funded a project with the general aim of improving public health responses to weather extremes and in particular, heat-waves (EuroHEAT).

The WHO Regional Office for Europe, as coordinator of the project, has organized this meeting from 20 to 22 June 2005, to discuss the EuroHEAT project and its implementation with the focus to:

- inform participants on the status of research in the area and the project;
- discuss between the participants the various work packages and phases;
- discuss which climate information is necessary for public health;
- and develop an outreach and communication plan for the project.

This report is organized in two main parts. The first part briefly summarises the objectives and the outcome of the meeting; the second part reflects in more detail the presentations on the evidence and status of research as well as the discussion on the project methodology and management.

### **Outcome of the Meeting**

This expert meeting was organized by the WHO Regional Office for Europe to exchange information and develop methodologies to research and improve public health responses to heat-waves. The meeting was attended by 45 participants from 17 countries and included representatives of countries from the European Region, as well as of the European Commission, World Meteorological Organization, and scientists from around the world. The following were the discussion points of the meeting:

- Up-to-date evidence was presented and implications for public health were discussed at the meeting. The EuroHEAT project is taking up identified needs for research and measures in its 9 work packages.
- Investigations from several European cities show an increased risk of death due to high temperatures and also from the interaction of high temperatures and air pollution. With climate models suggesting that one in two summers would resemble the summer of 2003 in a future climate in Europe, a higher burden of disease and more deaths from high temperatures can be expected in European summers in future. All work packages of EuroHEAT, in a concerted effort, are aiming at improving public health responses to

extreme weather events. The relationship between high temperatures and burden of disease and mortality in various European geographic settings will be further investigated, also taking into account the interactive effects with air pollution.

- Some individuals are at higher risk of dying during a heat-wave than others. Identified risk factors are age, gender, the health status (pre-existing medical conditions) as well as socio-economic and living conditions. The significance of specific determinants at individual level, however, needs to be further clarified for effective protection and targeting of advice to individuals at risk. Factors determining the risk of death will be further assessed in the project in order to allow specific targeting of at risk populations for protection measures and advice.
- Access to air conditioning or cool space on the other hand has been shown to have a protective effect and indoor heat protection measures need to be further developed. Guidance for context specific options for indoor heat protection will be compiled, particularly for the improved cooling of in-patients and institutional residents.
- Heat stroke is fatal in 10-50% of the cases and may lead to neurological morbidity in 20-30% of the patients. During the heat wave in 2003, heat stroke was not recognized and promptly treated, particularly with cooling. Guidelines for the diagnosis and management for heatstroke patients are needed. The project will formulate best practice guidelines for the treatment of heat stroke patients as well as guidelines for general practitioners with regard to medication that interferes with cardiovascular adaptation and thermoregulation during heat-waves for all European countries.
- Real time data on morbidity and deaths have been used for the detection of effects of hot weather events. First experiences show that availability and analysis of real time data need to be timely if appropriate health interventions are to be triggered and guided by this information. EuroHEAT will collect and evaluate experiences with the use of real time data for the early detection of health effects of hot weather events and provide suggestions for optimizing the current systems
- Early warning systems have been developed to increase preparedness of health systems as well as the population with the aim to reduce mortality. Some early warning systems existed in European cities prior to the 2003 heat-wave and several have been developed and established since.
- Medium term weather forecasts are important input for the development of an early warning decision making tool. For Europe, the forecast range of 12-18 days shows first encouraging results in improved accuracy. The German Weather Service will develop a web based decision support tool for climate information for the public health authorities.
- Overall, the effectiveness of early warning systems in reducing the mortality during heat-waves still needs to be evaluated. The effectiveness of existing heat health warning systems (HHWSs) and health care system responses will be assessed and minimum requirements for a national heat-wave response will be defined. New approaches to disaster preparedness and management are necessary to face these kinds of complex texture type disaster situations. Specific capacity building activities and guidelines for health advice are needed. A model advice package for the elderly, their care givers and physicians will be developed and pre-tested.

## Detailed Meeting Report

The second part of this meeting report is organized in five major sections. The first is dedicated to the introduction to the project, the second deals with information and knowledge generated after the meeting in Bratislava on extreme weather events, the third deals with the elaboration of the project specific methodologies and the fourth explores information, outreach and communication necessities. The fifth section was part of the restricted meeting to elaborate difficulties and constraints of the project and expected problems.

This report is also available on the website of the Global Change and Health Programme (<http://www.euro.who.int/globalchange>)

### Section I: Introduction to the Workshop and the EuroHEAT Project

*Michael Hübel, European Commission*

The planned project “Improving public health responses to extreme weather events/heat-waves” (EuroHEAT), funded by the European Community, started with this workshop. The project is addressing public health questions associated with our ability to co-ordinately respond to heat. It includes issues of health promotion, disease prevention as well as wider determinants of health. The project aims at changing best practice in member states of the European Community in order to prepare for and adapt to effects of climate change. The main interest does not focus so much on research but rather on the development of responses from the public health and user perspective, based on research results. These activities need to be seen in the context of the environmental health agenda and as a follow up of the action plan developed at the Ministerial Conference in Budapest in 2004. The effects of climate change are taken into consideration in this action plan. Specific activities and projects related to heat have been triggered by the summer 2003 events, particularly in France, and are backed by a political agenda to improve public health responses. As project results primarily practical outcomes are expected, such as recommendations for health systems on how to take into account weather and extreme events.

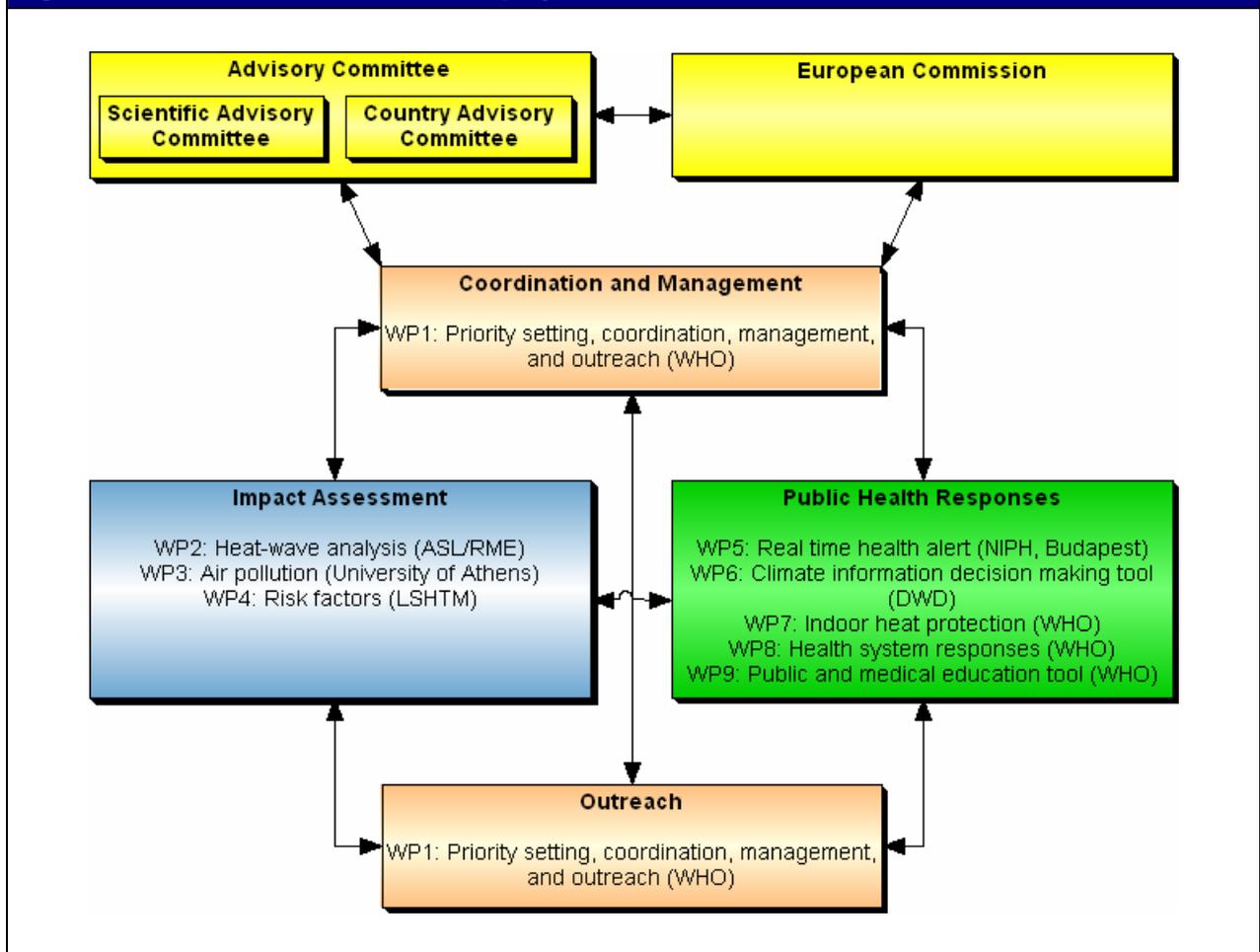
*Bettina Menne, WHO*

The EuroHEAT project is a two years project. The results should be presented at the next Intergovernmental Meeting in 2007 and the Ministerial Conference for 2009. The project's general aim is to improve public health responses to weather extremes and in particular to heat-waves. The specific objectives of the project are:

1. To share information and data between different networks: cities, national ministries and international organizations, as well as epidemiologists, meteorologists, emergency preparedness planners and decision-makers at European level;
2. To identify synergies between exposures to heat stress, risk factors for mortality and morbidity, co-exposure to air pollutants, for the development of European wide information on reducing health effects of heat stress;
3. To develop tools for early warning and detection of effects on health of extreme weather/heat-waves;
4. To develop models of good/best practice for national/local preparedness planning on extreme weather events, through the heat-wave example.
5. To develop guidance for intervention strategies at European level; and
6. To communicate the results in a coordinated fashion.

The project is organised on 9 work packages (Figure 1) and uses a number of methodologies: i) *epidemiology*: episode analysis, cohort studies, time series analysis; ii) *climatology*: short term forecasting and seasonal forecasting modelling and iii) *public health*: qualitative elaboration of case-studies, policy analysis techniques. The successful outcome will only be possible if lessons learnt are shared between countries and disciplines. This needs strong networking between a variety of stakeholders (from health care and public health to decision makers in public health). To support collaboration effective project management tools will be developed and used (meetings, interactive protected website, project information tools, and problem solving techniques).

**Figure 1: Framework of the EuroHEAT project.**



**Discussion:**

The project does not assess all impacts of heat-waves (e.g. health insurance and public transport issues, accidents, psychological impacts etc.). However, through the enlargement of the network additional actions might be possible and are to be explored throughout the project.

## Section II: Knowledge Exchange

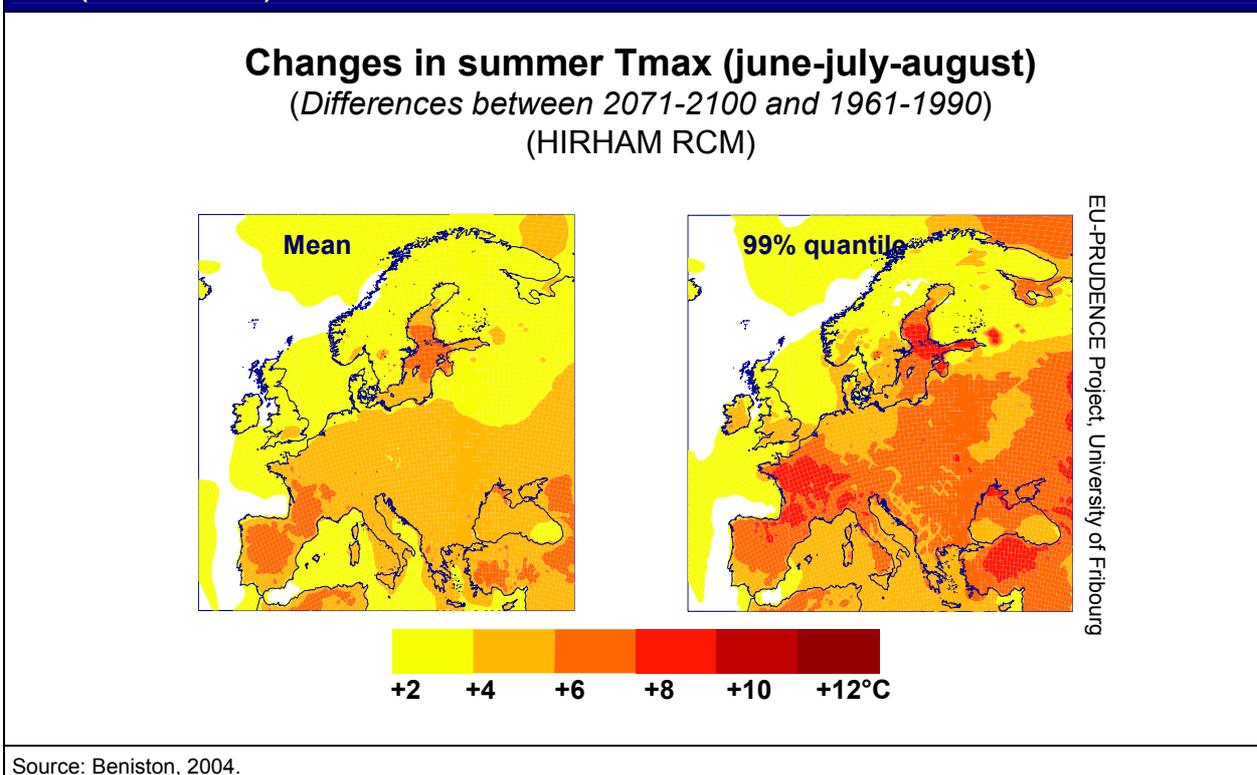
### *The Heat-wave of 2003, a feature of the future to come?*

*Martin Beniston*

The EC funded PRUDENCE project (Prediction of Regional scenarios and Uncertainties for Defining European Climate change risks and Effects, <http://www.prudence.dmi.dk/>) assessed changes in European temperature and precipitation using Global Climate Models (GCM) and Regional Climate Models (RCM) with the IPCC SRES A2 Emission Scenario. It provides a series of high-resolution climate change scenarios for 2071 – 2100 for Europe (Prudence, 2005). The predicted temperature curve of the summers 2071 – 2100 shows a similar shape to the extreme event of 2003.

The statistical view of weather extremes reveals that with a shift in the mean temperatures to the right we will get more warm events. With changes in the symmetry and shape of the temperature curves, more extremely warm events can be expected and there are indications for this to actually happen. There is a linear correlation between average summer maximum temperature ( $T_{max}$ ) and extreme values of  $T_{max}$ . For each degree mean warming we reach an increase of almost 1.2 °C in  $T_{max}$ . This linear correlation can be continued with predictions. The “High Resolution Hamburg Model” (HIRHAM4) predicts changes in  $T_{max}$  for Central Europe and the Mediterranean with + 4-8 °C in mean temperature and +8-10 °C in the extreme temperatures (Figure 2). The models predict that the number of days during which temperatures exceed the 30°C threshold will increase for example in Basel by 20 to 30 days (Beniston, 2004, Beniston & Diaz, 2004).

**Figure 2: Changes in summer  $T_{max}$  (June-July-August), Differences between 2071-2100 and 1961-1990 (HIRHAM RCM).**



Precipitation in summer time is projected to decrease, with drying out in France, Central Europe and the Black Sea area, but at the same time with increasing heavy rain events leading to an increased risk of flooding. Reference time periods are between 1961 – 1990 and 2071 – 2100, respectively (Christensen & Christensen, 2003).

#### **Discussion and comments:**

While Meteo France is in agreement with the described predictions, models developed by the Hadley Centre, United Kingdom, for example predict higher temperatures for Germany and the Czech Republic. Future climate change is projected with the help of models using different scenarios for future emissions of greenhouse gases and aerosols (IPCC, 2001). It should be noted that the prediction of “1 in 2 events” as stated above depends on the use of specific greenhouse gas emission scenarios: one in two summers could resemble the summer of 2003 under high emission scenarios. A definition of heat-waves is still lacking. Regional differences in the definitions are as important as the acclimatization process of people in one region. Indicators for heat-waves and their health impacts need to be developed.

### ***The health impacts of heat and heat-waves***

*Paola Michelozzi*

PHEWE is a European project with the overall aim to assess the acute health effects of weather in various European cities characterised by widely differing climatic conditions. The project investigates the association between meteorological variables and daily mortality, and hospital admissions in 16 cities: Athens, Barcelona, Budapest, Krakow, Dublin, Helsinki, Ljubljana, London, Milan, Paris, Prague, Rome, Stockholm, Turin, Valencia and Zurich. The synergistic effects of weather and air pollution on morbidity and mortality rates are also analysed.

In order to investigate the temperature mortality relationship a number of study designs can be used. Historically, descriptive studies and case-control studies have been used to characterise the heat-mortality relationship, while more recently analytical techniques like time-series and case crossover studies have been employed (see Basu & Samet, 2002). Time window studies allow the comparison of a heat-wave period and its excess mortality to a certain reference period. However, because there is no consensus as to what baseline for mortality to use it is difficult to have a correct estimate of the excess deaths during a specific heat-wave period.

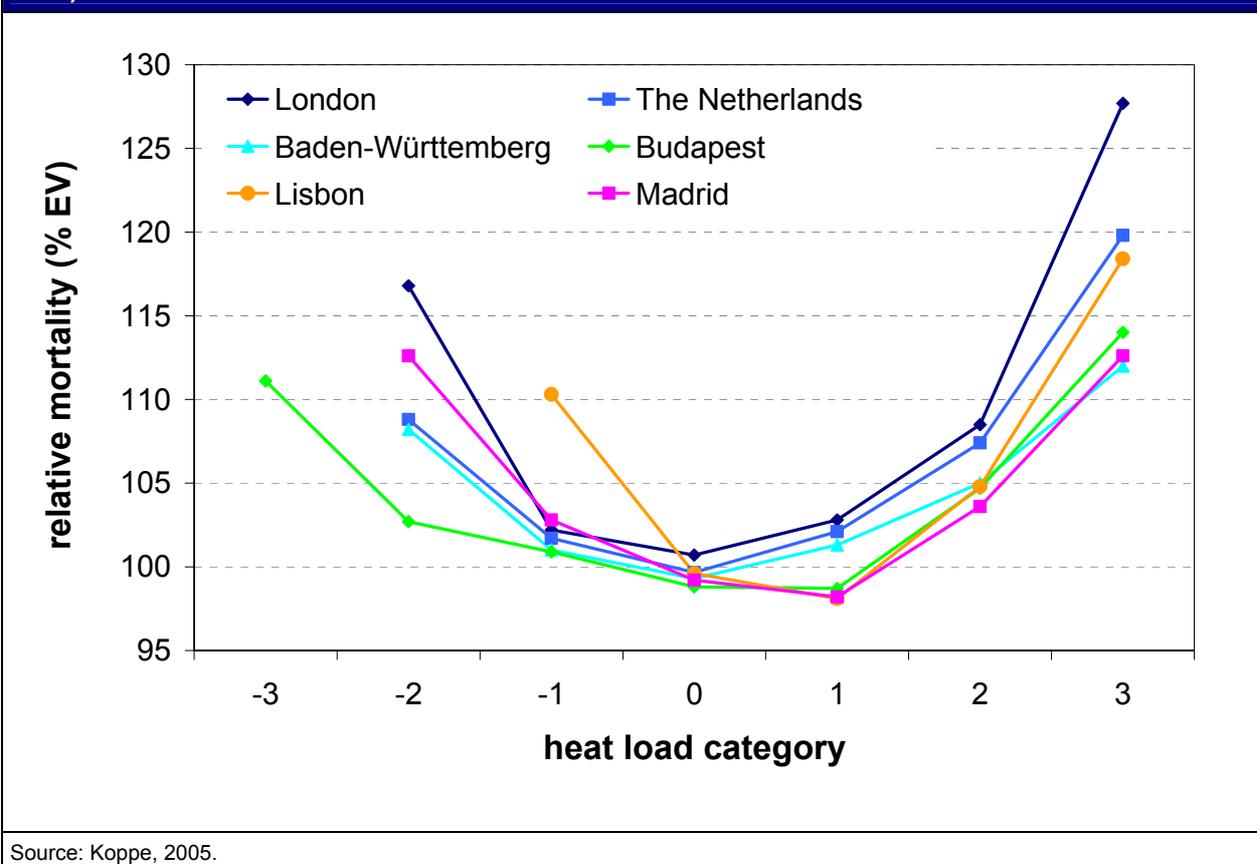
The PHEWE study showed an effect of heat on mortality in all cities except for Dublin and Valencia. The study displayed a large heterogeneity of the effect among cities: different change points in the temperature-mortality relationship (temperature at which the slope changes considerably) and differences in the lag structure have been observed. The change point for cities like Rome, Athens and Milan was observed at 30 - 32°C, whereas for northern and eastern European cities this point was lower (22 - 25°C) (Biggeri et al., 2004). A comparative analysis of the relationship between perceived temperature and mortality for London, the Netherlands, Baden-Wuerttemberg, Budapest, Lisbon and Madrid between 1986 and 1996 showed that the largest change from expected mortality occurred during periods of strong heat loads<sup>1</sup> corresponding to heat load category 3 in all regions (Figure 3, Koppe, 2005).

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<sup>1</sup> HeRATE (Health Related Assessment of the Thermal Environment) combines a physiologically relevant assessment procedure of the thermal environment with a conceptual model to describe the short-term adaptation to the actual thermal conditions of the past four weeks. Heat load categories are defined as: -3: strong cold stress (CS); -2: moderate cold stress; -1: slight cold stress, 0: comfortable conditions; 1: slight heat stress (HS); 2: moderate heat stress; 3: strong heat stress; 4: extreme heat stress (Koppe, 2005).

Studies throughout the literature analysing the risk factors linked to mortality during heat-waves, e.g. the effect of gender, age or socio-economic status showed that age is an important determinant of the effect of heat on mortality (especially in the age group >75 years). The increase in mortality seemed to be greater among females than males (Michelozzi et al., 2004a, Rooney et al., 1998), and in Italy the risk of mortality was higher in the lower socio-economic level (Michelozzi et al., 2004b). The effect of temperature on hospital admissions seems to be weaker than the effect reported on mortality. PHEWE results showed no effect of high temperature on hospital admissions for cardiovascular and cerebrovascular diseases; whereas an increase in respiratory disease was observed in several cities (Michelozzi et al., 2005).

**Figure 3: Relative mortality for various heat load categories in selected European regions (1986-1996)**



A case crossover analysis was carried out for four Italian cities to investigate the vulnerability of individuals to high temperatures (at temperatures of 30°C relative to 20°C). The overall odds ratio (OR) is 1.34 (CI=1.27-1.42). The OR increased with age, and was higher among women (OR=1.45, 95% CI=1.37-1.52) and among widows and widowers (OR=1.50, CI=1.33-1.69). Low area-based income was a weak effect modifier. Among the pre-existing medical conditions investigated, a statistically significant effect modification was detected for previous psychiatric disorders (1.69, CI=1.39–2.07), depression (1.72, CI=1.24–2.39), heart conduction disorders (1.77, CI=1.38-2.27) and circulatory disorders of the brain (1.47, CI=1.34–1.62). Temperature-related mortality was higher among people residing in nursing homes and surprisingly, a large effect was detected for hospitalised patients (Bisanti et al, 2004).

Different studies conducted in Europe and the United States have shown the geographical heterogeneity in the temperature-mortality relationship reflecting the ability of local populations to cope with extreme temperatures. Temporal variations have been explored to explain how

changes in the level of exposure and the introduction of public health interventions modify the temperature-mortality relationship.

The comparison of the temperature-mortality curves in 2003 and 2004 in different Italian cities shows the reduced effect of heat on mortality in 2004 due to lower levels of exposure. Maximum temperature is an important factor, but also other conditions, such as the minimum temperature and the number of hot days influence the impact of heat on health. The heterogeneous effects of temperature on mortality over time and between populations can be explained both by different exposure levels as well as adaptation through time induced by city-specific prevention programs and individual behaviour and physiologic adaptation.

Heat-waves in spring and early summer have a higher impact than later in the year due to the limited time for physiological and behavioural adaptation to heat. This is also confirmed in the cCASHh study (Paldy et al., 2005). Subsequent heat-waves may have a reduced effect both due to adaptation processes that render the population less vulnerable and because the pool of at-risk individuals might have been depleted during the first heat wave.

Preventive strategies to minimise adverse health effects in Europe and guidelines for public health interventions are developed based on the collected information (<http://www.epiroma.it/phewe/>).

#### **Discussion and comments:**

Data collected over 35 years demonstrate that intensity as well as the duration of heat-waves has an influence on health impacts and indicate the need for more elaborate models.

### ***Time series analysis and episode analysis***

*Annibale Biggeri and Shakoora Hajat*

Epidemiological studies assessing the impacts of hot weather on health have generally been conducted using two different methods:

- a. Heat episode analysis: The focus of the analysis is on periods of high temperature over several days. The mortality during such a heat episode is compared to the mortality during the same time period of previous and/or subsequent years.
- b. Time-series regression analysis: A general correlation between temperature and mortality over the summer months is described. Additional heat-wave effects can be modelled separately from the general heat effect.

Depending on the approach used the models need to be controlled for trend, season, humidity, and air pollution. In time-series analysis, a special indicator for heat-waves (1/0 variable) can also be considered to identify additional effects of heat-waves beyond the general temperature-mortality relationship. Instead of temperature alone a temperature index based on temperature, humidity and other bioclimatic factors can also be used in the models. The general effects of heat have been modelled using either a linear or non-linear (with natural cubic splines) relationship between heat and health effects.

To account for potential temporal shifts between the exposure to extreme heat and the corresponding health effects, different time lags, i.e. 2 or 4 days, have been considered in the models. For the cities of London, Budapest and Milan data from long time-series over 18 years are available. The additional effect of heat-wave (modelled with the heat-wave indicator) was found to be lowest for London and highest for Milan. The heat-wave effects were highest for respiratory and cardiovascular deaths. However, when the analysis was controlled for ozone, the coefficient for respiratory deaths was reduced slightly. Overall, it has been shown that the mean

temperature is a better predictor of heat-related mortality than the maximum temperature. Further, the proportion of deaths attributable to heat is small, and the majority of these deaths occur at times other than during identified heat-wave periods. Additional investigations are needed to clarify these effects.

## ***Why are people dying during heat?***

*Abderrezak Bouchama*

Recently, the heat-wave that struck Europe in August 2003 caused an estimated 14 802 excess deaths in France (Hemon & Jouglu, 2004). The main causes of these deaths were directly associated with heat: 29% were due to heatstroke, dehydration, or hyperthermia (INVS, 2004). Heat stroke is a life-threatening illness characterized by an increased core temperature ( $>40^{\circ}\text{C}$ ) and central nervous system disfunction with delirium, convulsions, and/or coma following exposure to high ambient temperature. Despite adequate lowering of body temperature and aggressive treatment, heatstroke is often fatal and those who survive may sustain permanent neurological damage.

Heat stroke afflicts many people in hot climates, as well as in temperate climate during heat-waves. In Makkah, during the August 1985 pilgrimage more than 1000 of the 2000 cases of heatstroke that were reported within a week were fatal. During a heat-wave in Chicago in 1995, 600 deaths and 7300 visits to the emergency department were recorded in 7 days (Dematte et al., 1998, Semenza et al., 1996).

Heat stress induces thermoregulatory, acute phase and heat shock responses (Figure 4; Bouchama & Knochel, 2002). Thermoregulatory failure, exaggeration of the acute phase response and alteration in expression of heat shock proteins, individually or collectively may contribute to the development of heatstroke.

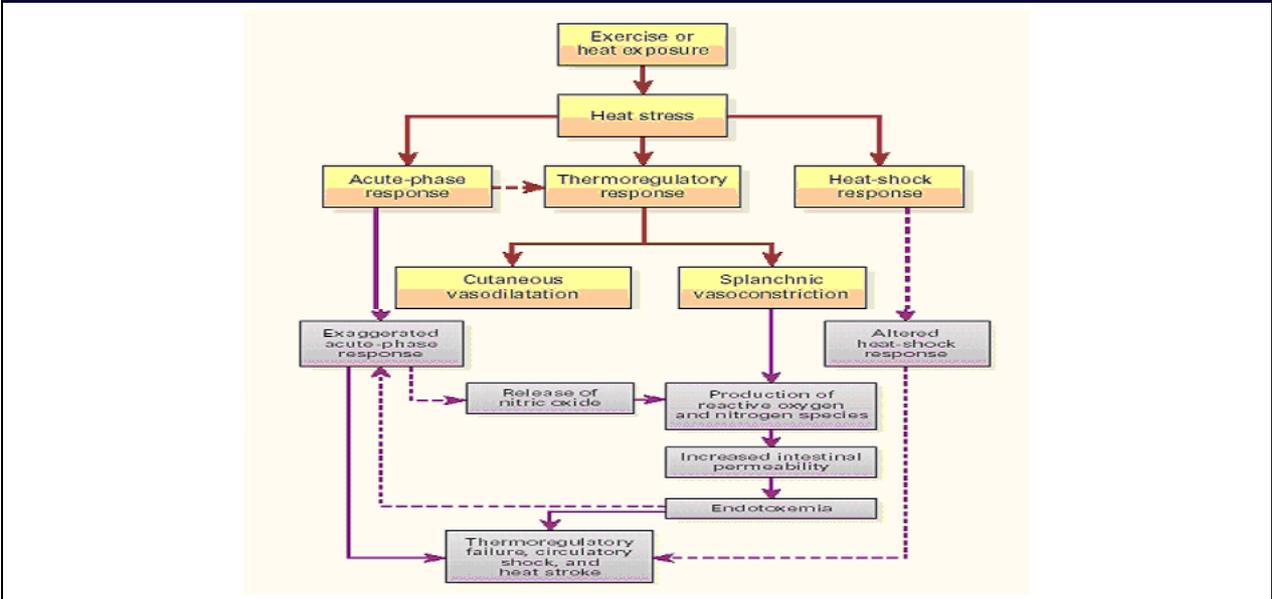
Body heat is gained from the environment and from metabolism. This heat load must be dissipated to maintain a body temperature of  $37^{\circ}\text{C}$ , a process called thermoregulation. A rise of blood temperature less than  $1^{\circ}\text{C}$  activates peripheral and hypothalamic heat receptors which signal the hypothalamic thermoregulatory centre. There are two powerful efferent responses from this centre: active sympathetic cutaneous vasodilatation and initiation of sweating. The cutaneous vasodilatation results in increased skin blood flow up to 8 litres/minute and marked increase in cardiac output up to 20 litres per minute. If the air surrounding the body surface is not saturated with water, sweat will vaporize and cool the body surface. When high humidity or drugs such as anticholinergics impair evaporation, there is a major risk of developing hyperthermia. Moreover inability to increase cardiac output due to salt and water depletion, cardiovascular disease or a medication that interferes with cardiac function, can impair heat tolerance and result in enhanced susceptibility to heatstroke.

The acute phase response (APR) is a coordinated reaction to stress involving endothelial cells, leukocytes, and epithelial cells, to protect against heat stress and to activate tissue repair. This beneficial effect of the APR may turn out to be deleterious if it becomes excessively activated as observed in heatstroke (Figure 4).

Nearly all cells respond to sudden heating by producing heat shock proteins (HSPs) or stress proteins. Increased levels of heat shock proteins in a cell induce a transient state of tolerance to a second, otherwise lethal, heat stress allowing the cell to survive. In humans, low levels of circulating HSP 70 were observed in severe heatstroke compared to controls subject to the same heat stress but without developing heatstroke, suggesting that this adaptive response is protective. Conditions associated with low expression of heat shock proteins such as aging, non-

acclimatization to heat or genetic polymorphism may favour the progression from heat stress to heatstroke (Figure 4).

**Figure 4: The Sequence of Events in the Progression of Heat Stress to Heat Stroke.** Heat stress induces thermoregulatory, acute-phase, and heat-shock responses. The solid arrows indicate pathways for which there is clinical or experimental evidence, and the broken arrows indicate putative pathways.



Source: Bouchama & Knochel, 2002.

The clinical and metabolic consequences of heatstroke include neurological abnormalities, severe hyperthermia, shock, disseminated intravascular coagulation, rhabdomyolysis<sup>2</sup>, renal impairment, hyperglycemia, and mixed metabolic acidosis<sup>3</sup> and respiratory alkalosis<sup>4</sup>. Prompt recognition of this condition and initiation of cooling dramatically improves survival. Nonetheless, despite cooling and normalization of the core temperature, up to a third of patients who survive the initial deleterious effect of hyperthermia can progress to multi-organ dysfunction syndrome. Mortality rate among these patients requiring intensive care ranges from 21 to 60 %. Moreover, up to 30 % of survivors may sustain neurological damage, which has been shown to contribute to an additional mortality at 1 year following discharge from hospital. Recent evidence suggests that heatstroke and its progression to multiple organ dysfunction syndrome is due to a complex interplay between the acute physiological alterations of hyperthermia (e.g. circulatory failure, hypoxia, and increased metabolic demand), the direct cytotoxicity of heat and the inflammatory and coagulation response of the host. This leads to alteration of blood flow in the microcirculation and injury to vascular endothelium and tissue.

### Discussion and comments:

According to Bouchama & Knochel (2002) the main protective measure against heat is to withdraw from it. During heat-waves exposed vulnerable people might need to cool the body immediately. In order to allow for these immediate measures there is a particular need for air conditioning in hospitals, retirement and nursing homes for example. The use of air conditioning

<sup>2</sup> Rhabdomyolysis: the breakdown of muscle fibers resulting in the release of muscle fibre contents into the circulation (<http://www.dpcweb.com/medical/heartdisease/glossary.html>)

<sup>3</sup> Metabolic acidosis: a state in which the blood pH is low (under 7.35) due to increased production of H<sup>+</sup> by the body or the inability of the body to form bicarbonate (HCO<sub>3</sub><sup>-</sup>) in the kidney. Its causes are diverse, and its consequences can be serious, including coma and death. Together with respiratory acidosis, it is one of the two general types of acidosis ([http://en.wikipedia.org/wiki/Metabolic\\_acidosis](http://en.wikipedia.org/wiki/Metabolic_acidosis))

<sup>4</sup> Respiratory alkalosis: alkalosis resulting from increased gas exchange in the lungs (as in hyperventilation associated with extreme anxiety or aspirin intoxication or metabolic acidosis (<http://wordnet.princeton.edu/perl/webwn?s=respiratory%20alkalosis>))

as a long lasting measure for the population was debated and should be weighted against the risks of aggravating air pollution, inducing heat- island effects, and increasing energy consumption.

Other measures that should be considered are early warning systems, simple advice such as drinking plenty of water, avoiding unnecessary exertion and taking frequent showers. As certain medications can interfere with the body's ability to thermoregulate, guidelines for the alteration of prescriptions during hot periods are needed. During the deadly heat-wave that affected France, the physicians were confronted with an epidemic of heat illnesses, with which they were neither familiar nor trained to treat. Thus, there is a need to update the curricula of the training for medical doctors and nurses and to develop a treatment protocol to face this increasing threat of severe heat-waves in the future.

### ***Review on risk factors for heat related mortality***

*Sari Kovats*

A review of the literature on personal, social, and environmental determinants of heat related mortality is being undertaken (Work package 4 of EuroHEAT Project). Risk factors for dying in a heat-wave that have been investigated include: age, sex, medical status, social isolation, deprivation, access to air conditioning and living in an institution. Age is a strong predictor for dying in a heat-wave as age highly correlates with increasing illness, disability, medication use, and reduced fitness. In the 2003 heat-wave, several countries have reported higher excess mortality in women compared to men. However, the reasons for this need to be further explored, as several confounding factors may influence these results. The information on pre-existing morbidity as a risk factor also needs further investigation. It is important to identify the physiological and clinical pathways by which heat related mortality occurs. More accurate information on pre-existing medical status (e.g. diagnoses, medications) needs to be established before it can be useful as a tool to identify individuals at risk.

Information from engineers on risk by housing type is supported by the epidemiological evidence. Brick houses, top floor rooms, and closed windows for example carry a high risk for the rooms to overheat. The thermal load of old buildings is high, they heat up (and cool down) more slowly. Also during the heat-wave in Paris in 2003, top floor flats with no through ventilation carried the highest risk for inhabitants to suffer from extreme heat exposure (INVS, 2004). In the United States, air conditioning is an important protective factor for heat related mortality. There is some uncertainty about differences between "within city" and "between city" factors that determine risk. For example, it is not yet known what role the heat island effect in determining risk at the neighbourhood level plays.

Vulnerable population groups need to be identified in order to design the most appropriate "messages" and to use the most appropriate medium for communication as part of operational heat health warning systems (HHWS).

#### **Discussion and comments:**

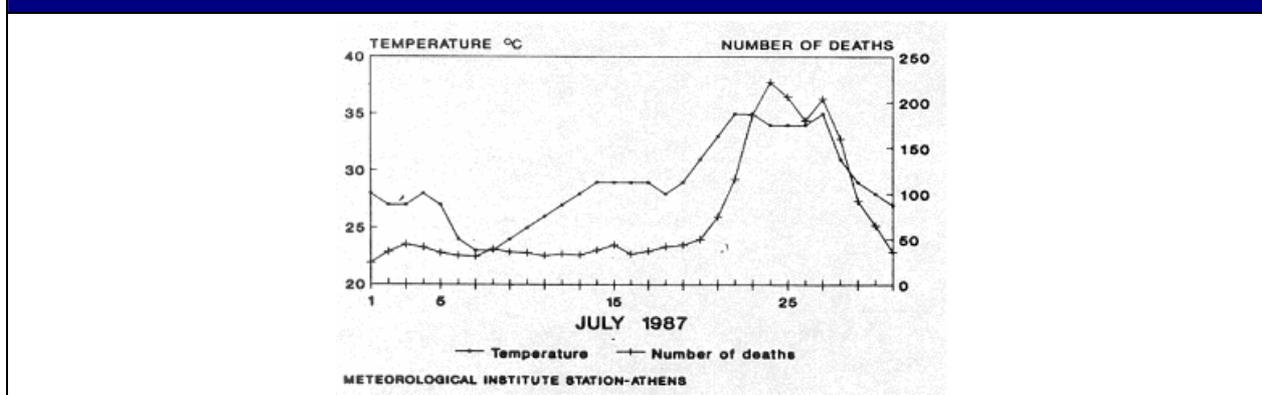
The significance of urban heat islands at day and night time needs to be further investigated. A study in Karlsruhe, Germany, for example showed effects of urban heat islands and the vulnerability of elderly in institutions (Robert Koch Institut, 2003).

## ***Air pollution and heat: what do we know from epidemiology?***

*Klea Katsouyanni*

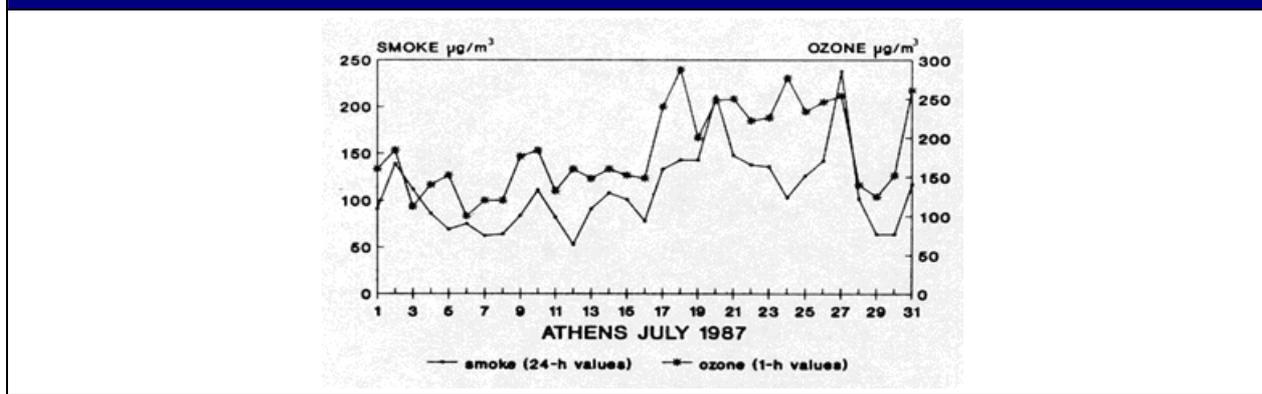
Confounding effects of temperature on the investigation of air pollution and vice versa have been described earlier. In Athens hot and dry summers are the norm and mortality peaks in winter, with some shorter peaks during heat-waves in summer. In 1987 a 10 day heat-wave hit Greece and an increased number of hospital admissions for heat-related conditions were recorded (Katsouyanni et al., 1988). Mortality was linked to the degree of urbanisation and level of air pollution (Katsouyanni et al., 1993). The effect of air pollution was more pronounced in the city of Athens than in other urban areas, the effect was smallest in non-urban areas of Greece (Figure 5a and b). A high number of risk factors were unknown except for “living alone” and having no access to air conditioning. Black smoke was used as an indicator for particulate air pollution.

**Figure 5a: Daily temperature and mortality for July 1987 in Athens.**



Source: Meteorological Institute, Station Athens (Katsouyanni et al., 1993).

**Figure 5b: Daily air pollution levels for July 1987 in Athens.**



Source: Meteorological Institute, Station Athens (Katsouyanni et al., 1993).

Investigations from several cities showed an increased risk of death to be due to an interactive effect of high temperatures above 40°C together with air pollution, particularly SO<sub>2</sub> and O<sub>3</sub>. In Belgium an investigation of the number of deaths in the elderly, mean temperatures and ozone concentrations showed that adverse health effects of ozone were higher at high temperatures (Sartor et al., 1995). Toronto has lower temperatures overall, however, a small interactive effect with air pollution could be recognized, taking into account increases in humidex<sup>5</sup> (Rainham &

<sup>5</sup> The heat index (HI) or humidex is an index that combines air temperature and relative humidity to determine an apparent temperature — how hot it actually feels, <http://en.wikipedia.org/wiki/Humidex>

Smoyer-Tomic, 2003). The effect of temperature was overestimated when the results were not adjusted for air pollution and particles as seen in Monterrey, Mexico (O'Neill et al., 2005). Here, particulate matter seemed to be more important than ozone when addressing the contribution of air pollution. During the summer of 2003, 1000 – 1400 excess deaths were documented in the Netherlands, 500 of which were described to be due to ozone and PM<sub>10</sub> (Fischer, Brunekreef & Lebrecht, 2004).

PHEWE (see above) allows the comparability of results from 16 European cities. Questions that are important to be addressed include how the effect of heat-waves is estimated. It needs to be investigated whether we observe the effect of heat or a heat-wave and to define the term heat-wave. Evidence for synergistic effects of high temperatures and high air pollution is accumulating. The inclusion of specific air pollutants and the definition of the air pollution variable is important for the analysis. Public health questions associated with heat and air pollution arise in view of climate change scenarios. Results from the PHEWE project will help to understand the interaction between air and temperature. The evidence from this European study will be an important starting point for the EuroHEAT project and the assessment of heat wave events. Preliminary results will be presented at the PHEWE meeting in February 2006.

Currently available data on air pollution and heat and possible synergistic effects are too limited to actually take measures. More research taking into account air pollution under different climatic conditions needs to be undertaken in order to identify effects of synergy or confounding. Standardized protocols as used in the PHEWE project with regard to exposure variables (e.g. heat), pollutant variables and a modelling approach would allow comparison across geographic locations and contexts. In the EuroHEAT project, adjusted estimates would need to be taken into account if a synergistic effect can be demonstrated. Emergency measures to lower air pollution during heat-waves would then be indicated!

#### **Discussion and comments:**

Most deaths during a heat-wave occur indoors; however, air pollution and high ozone concentrations are measured outdoors. This makes it difficult to assess the attributable effect of air pollution and ozone to heat related deaths. Particles need to be included in the analysis of the effect of air pollution.

### ***The heat-wave of 2003 in France: A critical review of the actions taken during and after the heat-wave***

*Patrick Lagadec*

The events of the summer 2003 were a surprise with respect to magnitude and impact to many policy and decision makers as well as the health system. The next crisis, however, may be different once again. An analysis of the summer 2003 events in France identified a four-layered approach to emergency management:

- the *emergency culture*: a set of principles, procedures and tools to deal with specific, known and limited breakdowns is established;
- the *crisis management culture*: management principles and approaches have been identified;
- the *unconventional crisis culture*: a set of visions, organisations and procedures to deal with unknown, fuzzy and chaotic breakdowns (for example a global culture to approach a pandemic) are discussed and foreseen;

- the *texture crisis culture*: a set of visions, organisations and procedures to deal with breakdowns affecting the in-depth social fabric (for example the ability to deal with something like a heat-wave threat) are available.

During the 2003 heat-wave the emergency culture existed only partly, as heat-waves were not considered a risk. The crisis management culture was extremely limited and the unconventional crisis culture inexistent. The chronic of the 2003 heat-wave in France (4<sup>th</sup> to 11<sup>th</sup> of August) revealed that most press releases concerning the event contained denial and excuses: where no problem exists no responses are triggered. A review of 509 media reports and articles on the heat-wave in France revealed that up to the 9<sup>th</sup> of August the public health dimension and concerns were neglected and no information or advice was published for vulnerable groups of the population (Boyer, Robitail & Auquier, 2003). When the rising number of deaths was published after the 9<sup>th</sup> of August, main focus of the press was on the political discussion and consequences caused by the inability of the health care system to respond to the crisis. Responses followed the pattern “deny, deflect, defend” that was also observed during the Chicago heat-wave in 1995 (Klinenberg, 2002). Certain warning signs brought forward by an emergency doctor, the Service d’Aide Médicale Urgente (“Service of Medical Emergency Help”, SAMU) and the fire brigade were silenced or interpreted as a normal problem due to the traditional closure of hospital beds during the summer by national public health authorities or ministerial cabinets (Sénat, 2004). Once the extent of the crisis became clearer, the failure of the monitoring institute to identify the health problem was stressed and the General Director of Health resigned (Sénat, 2004). The main conclusion of the French Senate’s inquiry in 2003/2004 was that the system had failed due to lack of communication among the central administrative bodies, their disconnectedness, a mix-up of competences, the high number of health agencies and the traditional organisation of the summer months (Sénat, 2004).

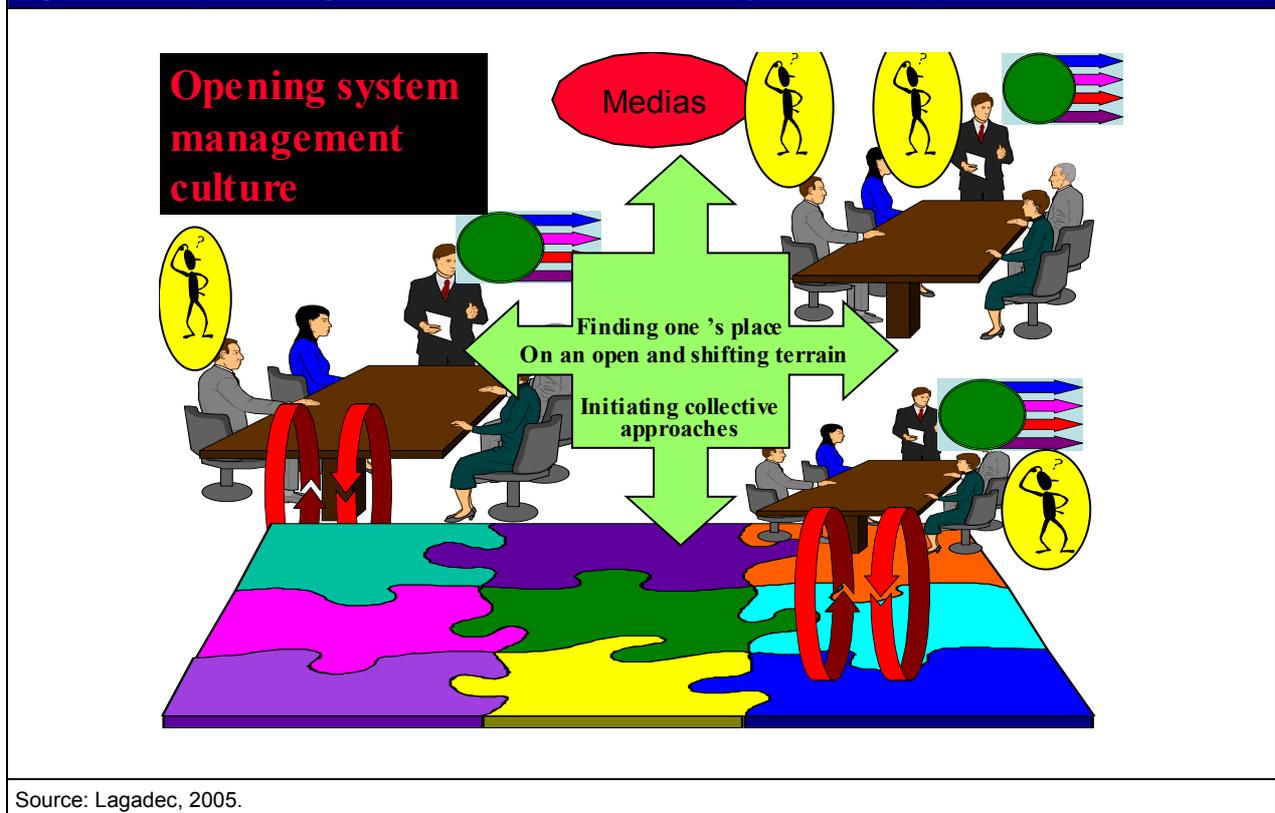
Lessons learnt from previous heat-waves in other countries - including France - seemed not to have been taken into account in the preparation for a major heat-wave event as encountered in 2003 (Sénat, 2004). As the situation during the summer 2003 was perceived as unprecedented the “right” to be unprepared seemed justified. According to the former Director-General of Health, this fact explained the delayed response of the public bodies to the crisis (Sénat, 2004). The situation “did not correspond to the traditional emergency culture or the recent crisis management codes” (Lagadec, 2004). This might just be the same the next time an extreme and different event happens. Difficulties with unconventional situations pressure us to change the way we view them and the way we work together. As observed by foresighted military strategists, the warning is clear: "Do not prepare to fight the last war!". A paradigm shift towards an open management culture is needed as we are dealing with a new arena and challenges, shattering dynamics, and an overwhelming media situation akin to the “Larsen” effect<sup>6</sup>. An open management culture is characterized by collective approaches and the challenge is to find a position in an open and shifting terrain (Figure 6).

Strategic management is traditionally focusing on “running the organizational machine in as surprise-free a way as possible”, whereas the real management task is that of handling the exceptions, coping with and even using unpredictability and clashing counter-cultures. The task is to deal with instability, irregularity, difference and disorder (Stacey, 1996).

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<sup>6</sup> The “Larsen effect” is an electro-acoustic phenomenon of feedback between microphone and amplifier. In the context at hand, it is used to describe the situation when each and every “noise”, i.e. item of information, is “recycled” in real time, and stretched to the limit. Very rapidly a mingled bulk of confusing data emerges in the media.

Figure 6: An open management culture is characterized by collective approaches.



Source: Lagadec, 2005.

Key elements to improve our chances of successfully coping with today's crises are:

- Anticipation and surveillance: traditional monitoring should be complemented by looking out for emerging phenomena;
- Rapid information, even with weak signals;
- Communication around questions and processes rather than answers and results only;
- Effective (decision making) and creative teams (as part of mobilized expertise in crisis);
- Post-crisis healing initiatives;
- Training (for the unknown);

These elements are not only theoretical but have been used, at least to some extent, by the organizations that reacted adequately during the heat-wave of 2003 in France (SAMU and some hospitals). The wider application of these elements will lead to a new crisis culture and create links and trust with the aim not to train to foresee the unpredictable and unconceivable, but to be able to face it. The lesson to be learnt from the extreme heat event of 2003 in France is that texture crises will demand new and large efforts, of the traditional bodies engaged in disaster management, but also of many others, who need to be involved and included in the network. Lagadec (2004) calls for a new cultural capacity: "The challenge is to invent a new cultural capacity to recognise, understand and tackle these new texture crises, profoundly embedded in the very fabric of our society."

#### Discussion and comments:

Several issues have been raised during the meeting and were partly discussed in group sessions:

- Heat-waves are not really unknown. If a crisis is really as expected, it needs to be checked if the available emergency plan fits the situation. Flaws and barriers but also forces from outside that may be able to help should be identified. If the situation is not

exactly the same as expected, as the world is extremely unstable and one crisis might trigger another one, there is much need for open thinking.

- The magnitude of the heat events in 2003 did come as a surprise and the reaction of the public as well as the politicians was surprising to scientists. The final report of the cCASHh project describes in detail measures and interventions in case of heat-waves (Menne & Ebi, 2006).
- The consequences of the heat-wave 2003 in France include the design of the “plan canicule” (heat-wave plan in France) and measures to improve the health surveillance system and training for staff taking care of the elderly. Expert suggestions for improvement of the plan included more precise advice as to where people can actually go in case of another heat-wave to keep cool. Fears were expressed that the difficulty of the system to exercise leadership might remain.
- There is information in abundance in order to take historical experience into account for better preparedness, some of it is useful, some useless. Therefore, valid information needs to be identified and applied.
- The role of scientists could be seen as not taking decisions, but simply providing information through publications while decision makers often try to erase what happened. This system needs to be penetrated to avoid that nobody feels responsible for actions.
- The perception of risk is correlated with the extent to which people are affected themselves or perceive others to be affected. In the case of heat-waves however, the effects are usually not perceived as strong as during earthquakes, floods, fires etc.
- Imagination versus evidence: should public health responses be based on imagination? Exceptional situations appear every day, the emergence and rapid distribution of the Severe Acute Respiratory Syndrome (SARS) in 2003 is only one example. Is it safe to switch off imagination? International organizations have proven to be able to mobilize forces rapidly. People should be trained to reflect and imagine and to deal with the unthinkable, to be rational and responsible.

### ***Real-time health data for better heat-wave responses***

*Giovanni Leonardi*

Reducing the exposure known to be hazardous to human health is one activity of public health and includes the monitoring of the hazardous exposures. Routine air pollution management for example needs real-time monitoring of air pollution data, not health data, because we understand the basic relationships between air pollution and health. In the context of heat-waves however, knowledge about the exact relationships between exposure and health impacts is not yet as advanced as for air pollution. Two strategies are being used today to reduce the mortality and morbidity due to heat-waves. One strategy is Heat Health Warning Systems (HHWS). Such systems use meteorological forecasts to reduce heat-related impacts on human health. The essential components are the identification of specific weather situations that adversely affect human health, the monitoring of meteorological forecasts, mechanisms by which alerts are issued when a weather situation that could adversely affect health is forecast, and public health activities to reduce or prevent heat related illness and death.

Another way to trigger responses to health problems related to heat-waves is to monitor real-time health data sources to detect the health effects directly. This has to happen in a quick fashion (preferably real-time) in order to be able to give rapid responses to the heat-wave threat. The use of real-time health data is not a new thing in public health issues. This type of data monitoring is a wide-spread method in public health for early detection of outbreaks and health-related events. It is also used for building up a surveillance system for estimating the impact of a disease, determining the distribution of illness, and evaluating prevention and control measures, and other public health interventions.

Examination of health data in general is further used in to improve definitions of thresholds to trigger preventive actions and to estimate the health burden (and avoidable burden) of heat-waves.

Following the heat events in 2003 the United Kingdom developed a heat-wave plan (<http://www.dh.gov.uk>). Different levels of the health care system are involved. The primary trigger needs to be given by the Met office. The Health Protection Agency as well as the primary care trust are involved at subsequent stages. The heat plan spells out specific advice for different levels and sectors and assigns responsibilities. Real-time health data are used for early detection of health problems related to heat. The plan follows a generic emergency situation and it is difficult to adapt to particular circumstances.

Theoretically, real-time data are updated and available for interpretation every few minutes. In practice, they are available on a daily basis with the potential to move to a more frequent updating pattern. The timeliness of surveillance in the United Kingdom is currently being reviewed. Today, the mortality based early warning system in England and Wales takes 2-3 weeks for the data to be ready. This is too slow for the timely detection of effects of hot and cold weather events as well as for outbreaks of influenza for example, if appropriate health interventions are to be triggered and guided by this information. Enhancing the current system to work faster would also allow for weekly evaluations of impacts and interventions. If the health data is not available fast enough to trigger interventions, it can still be used for other purposes such as the assessment of the effect of heat on health in retrospective analyses of time series data.

NHS Direct (National Health Service) offers a telephone help line for the public. Hazards are registered as raised by concerned callers. The capacity of NHS Direct as a health protection tool still needs to be assessed and algorithms for signs and symptoms to detect hazards are not yet included. The health data which was gathered through NHS Direct was examined with the focus on morbidity associated with high temperature and on identifying vulnerable subgroups. More calls come in on weekends than during the week when general practitioners and health centers are available. During the heat-wave many calls for fever particularly in the very young and very old were registered. The proportion of heat stroke calls and severe heat periods were correlated (Leonardi et al., 2006). In general, the morbidity data from NHS Direct was not as sensitive to temperature as the mortality data.

In regard to using real-time health data from NHS Direct to detect health impacts from heat-waves the following difficulties were mentioned:

- a) The data has a narrow focus on emergencies (acute events). It ignores harm caused by hot days in general.
- b) It is not focused on most sensitive health outcomes of vulnerable population groups.
- c) It is not satisfactorily coupled with effective interventions.

There is a need to link epidemiology and public health responses. The use of real-time data is suggested for impact studies on “ignored endpoints” (e.g. neurological symptoms). In addition, non emergency dimensions need to be included.

### **Discussion and comments:**

In addition to mortality data and NHS Direct morbidity data the number of ambulance calls is analyzed retrospectively on a yearly basis. Mortality data are recorded with a specific cause of death. To complete this data requires time from a few months to up to one year. However, experts suggest that with a strong political will this could be accelerated.

Portugal has experience with an automatic registration mechanism that registers health problems of certain age groups. However, difficulties with this system during public holidays were described. Still, this system works also for extended heat-waves for more than 5 days.

## ***Climate information as input for decision-making tools***

*Renate Hagedorn*

The purpose of the paper is to introduce currently available weather/climate prediction systems on timescales from medium-range to seasonal forecasting and to discuss current levels of skill on these different time-ranges.

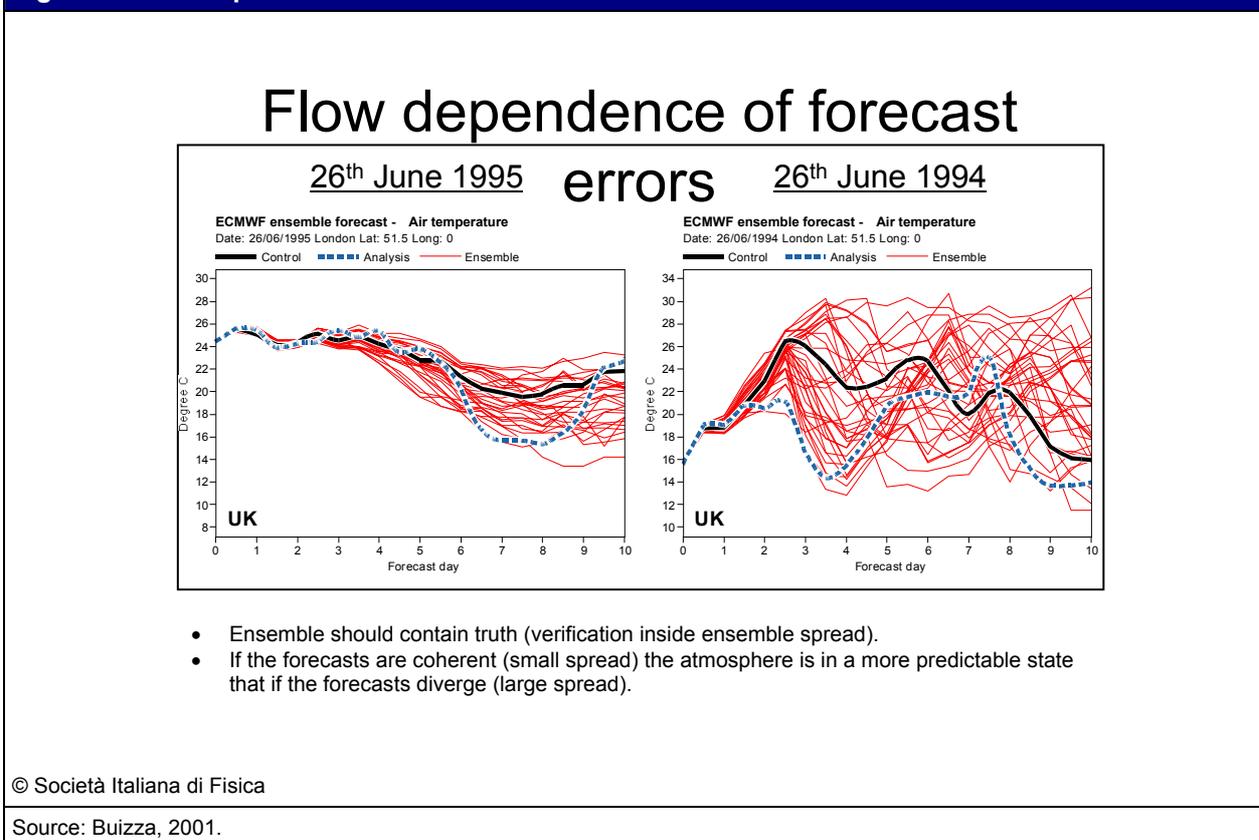
The European Centre for Medium-Range Weather Forecasts (ECMWF) runs a suite of deterministic and probabilistic models comprising a

- high-resolution deterministic model with a forecast-range of 10 days ahead, a horizontal resolution of ~40 km and two forecasts per day, and the
- Ensemble Prediction System (EPS) with three systems covering the following time ranges
  - Medium-range (10 days ahead, ~80 km horizontal resolution, two forecasts per day)
  - Monthly forecast system (4 weeks ahead, ~125 km resolution, 1 forecast per week)
  - Seasonal forecast system (6 months ahead, ~200 km resolution, 1 forecast per month).

The forecast performance has increased steadily over the past years, with an average gain in skill of 1 day per decade, i.e. the skill of today's 5-day forecast is as good as the skill of a 4-day forecast 10 years ago. However, skill levels not only depend on the lead time of the forecast but also vary with the parameter forecasted. The general circulation, represented by the height of the 500 hPa geopotential is forecasted with a higher skill than other parameters like near surface temperatures or cloud cover. In particular, the skill of forecasts near or beyond the deterministic predictability limit can drop to levels below usefulness. However, meteorologists have found a way to address the chaotic behaviour of the atmosphere (the so-called butterfly effect). When running the model not only once and producing only one deterministic forecast, but running the model many times with slightly perturbed initial conditions, one gets a probabilistic distribution of possible outcomes. The two main benefits one can achieve with this concept is firstly to cover the range of possible outcomes in such a way that the truth always lies inside the probability distribution, i.e. the probabilistic forecast enables a statement in which range the outcome will be, or the other way round what outcome can be excluded. The second main advantage of an EPS is that it can distinguish between highly predictable and less predictable situations (Figure 7). Depending on the atmospheric conditions themselves, the spread of possible solutions can be wide or narrow so that one is able to make a statement on the level of predictability of this particular situation. Applying a simple economic cost-loss model to deterministic and

probabilistic forecasts, it has been demonstrated that probabilistic EPS forecasts have a higher potential economic value than single deterministic predictions.

**Figure 7: Flow dependence of forecast errors.**



The rationale for producing skilful extended-range forecast is based on the fact that the average climate distribution can change under the influence of an external factor. In the case of monthly and seasonal predictions, the El Niño Southern Oscillation (ENSO) phenomenon is such an external factor. Predictions made with a coupled ocean-atmosphere model which include ENSO predictions, are quite skilful, in particular in areas with strong tele-connections with the tropical Pacific like e.g. the Tropics itself, South- and North-America, or Australia. Unfortunately, over Europe the performance is not yet very reliable, though in the early monthly forecast range of 12-18 days first encouraging signs of positive skill can be found.

### Discussion and comments:

More information is needed for decision-making as 4-5 different components are needed for a decision tool, climate information being one important input. Patience is still needed with reliable seasonal forecasts.

A warning system with different levels of alert for extreme weather events should be introduced. The expected costs for a decision-making tool need to be estimated and specified who is financially contributing for the forecasting system. Generally, among the 25 ECMWF member states, the use of data has to be paid for, however, agreements on co-operations, e.g. in flood protection also exist.

It can be assumed that there is some degree of understanding and a lot of emphasis needs to be put on how the information is presented to the user. Information should be presented in a simple way and be based around practical advice. In addition, a second strand of information

specifically for health staff should focus on risk based information. In ECMWF user meetings, the applicability of probabilistic forecasts for the public should be discussed. In order to train for surprise probabilistic forecasts and alarm maps are high on the agenda for improvement.

## **Section III: Methodological Development**

### ***Work Package 1: Project Management and assistance in development and acquisition of data and information***

The main objectives of this work package are in particular to share information and data between project partners and networks. Harmonized guidance will be developed at the European level through the contribution to national and EC policy on extreme weather/heat-wave protection and response and guidance on effective health care system and public health interventions.

Work package (WP) 1 will incorporate all the necessary managerial tools needed to successfully lead the EuroHEAT project and combine and communicate the results from the various work packages. A dissemination strategy will be developed and the communication of results to the public/stakeholders/client coordinated.

First, a network of a variety of stakeholders from areas such as health care, public health, epidemiology and meteorology, who have been involved in the assessment of past heat-waves and development of responses, will be initiated. All existing public health, meteorological and civil defense networks will be identified inter alia through the "WHO/EEA Bratislava working group", the WHO national focal points, international organizations and other health networks. Secondly, a scientific and a country advisory committee will be created and internal data sharing mechanisms established. Further, the development of a communication and issue management plan will guarantee an efficient flow of information between the project partners and the quick resolving of emerging issues. The project participants will communicate through a password protected website.

Overall, WP1 is co-organizing three project meetings: The inception meeting, which brings together selected experts in climate, public health, and epidemiology and the 8 PHEWE cities, scientific advisors and MOH focal points in month 2. The objective is to review the status of knowledge, to discuss data needs of WP2 and 3, to assess which information on climate indices is necessary for public health officials, and to plan the work of EuroHEAT. The second meeting in Budapest will be organized in collaboration with WP5 in month 12. The main focus will be on real time health alerts and risk factors. The third meeting in Paris in month 22 will be organized together with WP4 in order to finalize and discuss the developed European guidance material.

General scientific and administrative coordination of the other 8 work packages will be performed through WP1 as well as the project's outreach and coordination through links to public health policy structures in coordination with the European Commission.

### ***Work Package 2: Health impacts of extreme weather / heat-waves, 1990-2004***

Assessing the epidemiology of heat-waves is expected to enable researchers to evaluate the impacts of heat-waves on mortality and provide evidence-based prevention information for public health purposes. Analyses will be based on data from the PHEWE project that will be expanded using the PHEWE protocol to include the years until 2004 with additional time-series data from Baden-Württemberg, Athens (heat-wave in 1987) and possibly Basel. The longest possible time-series should be included in the analysis.

The first step in this work package concerns the data collection. In collaboration with WP3 data from 9 European cities previously involved in the PHEWE Project (Athens, Barcelona, Budapest, London, Milan, Paris, Rome, Valencia plus one German city) will be collected. Data will include daily mortality (outcome), meteorological and air pollution data (exposure) for the

period 1990-2004, as well as demographic and population information. For each city the possibility to include also years prior to 1990, if relevant heat-wave episodes were registered in the city, will be evaluated. The mortality data will be collected by age groups and where available also by gender. Certain morbidity data could be included as well if they are available (e.g. from NHS in the United Kingdom). The detailed data needed to conduct the analyses are:

- (1) Meteorological data: temperature, humidity, wind speed, wind direction, precipitation, and cloud cover registered every 3 hours; from one station near the airport and one station near the city centre.
- (2) Health data: daily mortality by age group (0-14, 15-64, 65-74, 75-84, 85+), total mortality by gender; causes of death for total mortality (cardiovascular, cerebro-vascular, respiratory, other).

The cities that will be included in the analyses have been selected based on the following criteria: (1) large cities which suffered the strongest effects of the 2003 heat-wave, (2) cities with differing climatic conditions (geographical location), (3) cities with heterogeneous exposure, and (4) cities with good data availability.

Secondly, a detailed protocol for the methodology to be applied in the project will be developed. The protocol will include:

- Development of an operational heat-wave definition to be used for the individual city analyses;
- Definition of baseline mortality and of a standardized methodology to evaluate excess daily mortality associated with heat-wave episodes;
- Analysis of a possible harvesting effect;
- Analysis of variations of the heat-wave effect during a summer season;
- Analysis of geographical and time variations of the heat-wave effects;
- Analysis of effect modifiers (background climatic conditions, socio-demographic characteristics, adaptation mechanisms).

Thirdly, for a subset of cities, an evaluation of the association of forecast variables and daily mortality during heat-wave episodes will be conducted according to the agreed analysis protocol. This work package will provide input for public health authorities to reduce heat-wave related mortality. Results of this work package will be useful for WPs 1, 5, 7, 8, and 9. Results will be further communicated by journal articles and a draft book chapter for a scientific and professional publication.

#### **Further discussion and comments:**

In order to develop an effective heat-wave warning system, high risk populations need to be identified. The definitions of “heat-wave” as well as of the baseline of mortality are two crucial steps in this work package. Different sources of information could be combined to an index of morbidity.

### ***Work Package 3: Epidemiology of heat-waves: synergies with air pollution***

The aim of the research of this WP is to assess the interactions between heat and air pollution and the combined effects on human health. This will allow for the development and provision of Europe wide information relevant for reducing health effects of heat stress. The major questions

which affect public health during hot periods and heat-waves addressed in this work package are: (1) to what extent may high concentrations of air pollutants have synergistic effects with heat stress and enhance the effects on health? (2) Is the effect of heat stress estimated without considering air pollution concentrations confounded by air pollution? (3) Are the heat stress health effects over- or under-estimated when air pollution concentrations are not taken into account?

This field of research is relatively new and has not been investigated much. In this work package an interdisciplinary team will be formed bringing together air pollution scientists, epidemiologists who work in air pollution and on climate/meteorology and health, statisticians and meteorologists who can collectively develop innovative approaches for the relevant issues.

The objectives and methods of WP3 are closely linked to those of WP2. Whilst in WP2 the effects of heat stress on human health will be investigated, in WP3 the possible confounding and/or synergistic effects of important air pollutants and heat will be assessed. Thus this WP will share the data base with WP2. The work is building upon methods used and analyses carried out within the framework of the PHEWE project. However, the PHEWE project was using an older data base (not including the year 2003, which is of particular interest because of the major heat-wave that hit western Europe in 2003) and is not confined to heat stress only. Thus, the PHEWE data base will be updated and the methods will be developed to investigate heat stress and heat-waves in particular.

The data base will be compiled within the scope of WP2 and used by WP3. It will include time series of daily number of deaths by age and cause up to the year 2004. An effort will be made to collect data by gender. The age groups to be considered are  $\leq 64$ , 65-74 and  $\geq 75$ . Respiratory, cardiac and cerebro-vascular causes of death will be analyzed. We will investigate the possibility of collecting other causes of death depending on the availability and on adequacy of daily numbers. We will aim at including earlier time periods in the data base if time series are available that are of importance because of major heat-waves (e.g. Athens 1987, London 1976). Whether this will be possible depends on the quality of available data (i.e. whether the air pollution characterization was adequate in earlier time periods).

WP3 will concentrate on evaluating the effects of Particulate Matter (PM- using  $PM_{10}$  and, to the extent possible,  $PM_{2.5}$ ), ozone and  $NO_2$ . The methodology used will include time series analyses and case crossover analyses. This work package will contribute to and share the crucial definition of heat-waves to be developed by WP2 and used by other work packages. Furthermore, in the context of “harvesting”, the impact of diseases and other public health related events (e.g. flu in the preceding winter) on the mortality during heat-waves will be taken into consideration.

As a first step, a literature review on the interaction between air pollution and temperature will be conducted in order to better understand the influence of temperature on the composition and quality of air pollution. It will cover attempts to assess synergistic effects of heat and air pollution in real situations and estimates based on scenarios. It will also cover studies assessing confounding. In order to develop a deep understanding of the mechanisms through which heat affects concentration and mix of air pollution we will seek the advice of experts within and outside of EuroHEAT. Further, literature will be searched on identifying harmonization of current policies to reduce air pollution during heat-waves. Gaps in knowledge will be identified through these extensive literature reviews. Further steps within this work package aim at filling these research gaps and will contribute to the formulation of prevention measures to adequately reduce effects of air pollution on human health during heat-waves.

Describing the effects of air pollution on health during heat-waves, this work package will provide input for public health authorities on measures to reduce exposure to air pollution, to reduce health impacts of air pollution during heat-waves and to reduce heat-wave related mortality. Results of this work package will be useful for WP 1, 5, 7, 8, and 9. Results will be

communicated by journal articles and a draft book chapter for scientific and professional publications.

### ***Work Package 4: Social and environmental determinants of heat-related mortality***

The goal of this work package is to describe the social and environmental determinants of heat-related mortality. Through the identification of groups of people that are at higher risk of dying during heat-waves due to social and/or environmental factors they can be targeted through adequate prevention measures. Such targeted actions can be much more effective than general warnings to the whole population. Elderly people, for example, are known to be at greater risk of dying of exposure to heat. However, it will not be feasible to intervene actively with all elderly. For example, 400'000 elderly people live in Paris alone and even more in London. It is very expensive for health and social care professionals to actively contact these people. Thus, further criteria need to be identified in order to narrow down and select the groups of people in the population that need to be primarily focused on in heat-wave response plans.

Heat-wave plans generally focus on three areas. Each of them is associated with different target groups for their messages:

1. General public communication strategy:
  - a. Leaflets, posters (like in Budapest and the United Kingdom)
  - b. Media warnings on television and teletext, etc.
  - c. Information addressed to individuals at risk (e.g. elderly and people who are at home alone) and their care givers
2. Groups: intervention via general practitioners (GPs)
3. Individuals, who will be actively contacted during a heat-wave

There are 3 main categories of risk factors – with complex interactions and co-linearities (Table 1).

<b>Table 1: Risk factor matrix.</b>		
Risk factor group	Examples	Comments
<b>Personal</b>	Age, sex, medications, previous admissions	Only age/sex reliably reported on death certificates
<b>Social</b>	Living alone, income, education	Not reported on death certificates
<b>Environmental</b>	Air pollution, urban heat island	Meteorological and air pollution data need to be connected to time of death

A possible approach to identifying individuals that are at high risk from dying during a heat-wave is:

- Inventory (experiences with what has already been done in Paris or Rome to identify and contact susceptible people can be used)
- In some countries, people are already registered in a health system. E.g. in the United Kingdom, an assessment of everyone over 75 has been carried out. However, such a system would not be possible for example in Denmark.

- Some susceptible people are already identified in informal local networks, e.g. the “buddy” system in Philadelphia (note: this would be the same agency that will do the contacting)
- Evidence based criteria (based on the matrix in Table 1)

The methodology, which will be employed in WP4 to achieve this goal, can be divided into two steps:

1. A systematic literature review of published papers on the environmental and social determinants of heat-related mortality will be carried out. In the second step, epidemiological analyses of mortality data linked to environmental and social factors will be conducted in three cities: London, Budapest and Milan. Deaths during heat-waves need to be linked to environmental and social data from various sources (census, or previous hospital admissions). This data, however, can be difficult to get due to restrictions recently imposed.
2. A “vulnerability index” (VI) and an Urban Heat Island (UHI) map will also be developed. We will test the hypothesis that heat related mortality within a city is associated with UHI effects and the spatial variation of vulnerability as described by the VI.

The suggested outputs of this work package are:

1. Systematic literature review on social and environmental determinants
2. Evidence-based guidelines for general practitioners for all European countries with regard to medication and possible side effects in hot temperatures. This will help to identify patients with medications that could have harmful side effects during periods of high temperatures. Information for patients on the use of medication and the possible need to change it is required. It has to be investigated whether other medications with no effect on physiological responses to heat are to be prescribed in the long term. Special attention should be paid to widely used medications. In Europe, for example, a large proportion of the population is currently taking tranquilizers.
3. Analysis of heat-related mortality in England by social and environmental determinants.
4. Inventory of focused interventions (e.g. in Paris and London) in conjunction with WP6.
5. Development of a matrix to score individual risk for heat-wave impacts, or tools/guidance for a local public health person to identify individuals at risk.

#### **Further discussion and comments:**

Whether meteorological conditions that cause heat-waves and air pollution episodes at the same time change the high risk groups (e.g. children/persons with respiratory problems) will also be analyzed in WP3.

The target groups for public health messages in relation to heat-waves are broadly defined. A review of existing work will help to illustrate what interventions are practical and feasible at the city or national level. Interventions could specifically protect the elderly and children. It was recommended within the working group to strengthen local/community activities that support the elderly and mentally ill persons. Also homeless persons need to be considered. They are less likely to respond to public messages, are difficult to reach directly, and are generally not part of the formal health care system. The question whether tourists are at risk and whether data are available to research this question will be considered. Health protection messages should be distributed through general practitioners. The feasibility of personalized information still needs to be assessed as it is not known who might have the specific contact information and how to select the individuals to be targeted. The church and charity organizations could possibly be used to spread these messages.

The need for guidelines for general practitioners on how to protect people with chronic conditions, as incorporated in the project deliverables, was stressed once again in the discussion. Differences in regulations on confidentiality of data between countries need to be considered. Confidentiality rules are inhibiting research in this area and some countries are more affected than others. Generally, analyses of social, environmental and personal determinants depend on data availability, which can be scarce. Open questions still remain on data collection and transferability of information and data. Literature reviews – as already in process - could give further valuable information on these issues.

More clarification about the terminology used in epidemiological studies is needed. Terms like “frail” and “pre-existing disease” can be interpreted differently and even terms such as “pre-existing cardiovascular disease” are ambiguous.

Results for individual cities cannot be transferred to other cities - as observed in the PHEWE project. The differences need to be further assessed. A possible explanation may be the inability to distinguish between the following groups of persons:

- Persons, who are at home and ill
- Persons, who are at home and well
- Persons, who are in a health care institution – and are ill (they might be more protected)

### ***Work Package 5: Real-time health data for better heat-wave responses***

Heat-waves cause health problems that can be observed through the increased use of the health care system. Possible indicators of this can be phone calls to health advice services, emergency hospital admissions, emergency room visits, emergency and ambulance calls, mortality etc. By monitoring these indicators in real time, heat-waves can be detected independently from meteorological factors and appropriate response plans can be executed.

In the 1970s and 1980s researchers have already analyzed the effects of heat-waves on humans based on retrospective data collection of mortality. In the PHEWE project the retrospective data of emergency hospital admission were collected and the association of meteorological factors and the health outcome was evaluated. In the last years the use of real-time health data for forecasting health impacts emerged. Furthermore the evaluation of real time health data, like ambulance calls, help line inquiries, emergency room visits, and emergency hospital admissions by cause, may contribute to the quick assessment of the health impacts as well as the effectiveness of heat health warning systems (HHWSs).

There are two main approaches to using health surveillance data in heat health warning systems:

- To incorporate real time health data into the forecast model in order to determine the level of heat alert (e.g. systems in Rome and Milan).
- To early detect a heat-wave through the confirmation of an effect. This may also be used to increase the level of the alert.

Examples of health data being used operationally in Europe are currently mortality data from mortuaries or sentinel funeral homes in Milan and Barcelona and ambulance calls in Budapest. In London, a retrospective analysis of NHS Direct data was undertaken, and now sun/heat stroke calls are monitored each summer, with a weekly bulletin, as part of the Heat-Wave Plan for England.

Health systems and the availability of “real time” data vary between countries. Health data is collected for purposes of management and these systems are not set up as real time surveillance tools. However, they have been adopted for that purpose because the marginal increase in cost is

small compared to the benefits if this surveillance will not only be undertaken for the purpose of a heat-wave warning system but also for other types of public health emergencies.

There is a need to balance timeliness with the sensitivity and specificity of the health indicators. The problem of calling a warning when heat-wave or heat-wave effects do not appear (false positives) was also discussed.

The use of evidence of health effects in the communication strategy was also discussed. For example, in Hungary, the increased number of calls to ambulance services was publicized in the media as part of the heat-wave warning. In other cities this may not be acceptable as it is thought to possibly cause panic in the general population. The importance of differences in cultural factors between countries and cities was discussed and will be accounted for in the work.

The main goals in WP5 are (1) to conduct a literature survey on mortality and morbidity alert systems worldwide and to support the real time data collection, (2) to evaluate the questionnaire related to real time data, (3) to distribute the information among all project partners, and (4) to develop recommendations of use of real time data for HHWSs for the member states of the EU.

The first step will be to review the scientific literature about mortality and morbidity of heat-waves and about alert systems worldwide to get an overview about the information and data which can be relied upon. The data collection will cover any kind of health related problems and will not be restricted to heat-waves. Evaluation of the use of real time data should consider the data sources and the accessibility to real time data by health authorities that are responsible for actions (e.g. risk managers).

As a second step, a questionnaire survey will be carried out in selected cities of the 25 EU countries to obtain information about real time data availability (ambulance calls, help line inquiries, emergency room visits, and hospital admissions by cause), their use in rapid response of emergency situations, and evaluation of the effectiveness of the actions. Information will be collected on rapid alert systems related to heat-waves. Based on the answers a network of centers will be created where HHWSs are in use. On the basis of the evaluation of these questionnaires recommendations will be elaborated. These recommendations will be focused on the best indices of health impacts of heat-waves, use of real time data in forecasting the impact of extreme heat as well as in evaluating the efficiency of actions enhancing human adaptation to heat stress. The feasibility of the indices will be discussed within the network during 2006.

Thirdly, cooperation with all other project partners is needed to establish the “Extreme Weather/European Heat-Wave Response Network”, to contribute to national and EU policy on extreme weather/heat-wave protection and response, and to produce guidance on effective health care system and public health interventions.

The work package team will consist of epidemiologists, biologists, communication experts, and statisticians.

A guidance document on the utilization of health service data sources for early detection of health effects of heat-waves, a journal article on selected case studies, and contributions to the book and summary for policy makers will be produced.

#### **Further discussion and comments:**

The group discussion suggested that real time data from 3 days before the heat event should be included as baseline data in the analyses. It was not clear, however, from which cities these data would be available. Ethical concerns were expressed in case a reaction or intervention would start too late despite the use of real time data. It was questioned whether further resources should be invested. It was explained that the idea was to use the existing systems and simply apply them to heat-waves as just another application. In the process of triggering heat-wave warning plans in the United Kingdom, for example, real time data are only the second step in detecting an early effect. Early detection of heat-waves depends first on exposure measurements and predictions: meteorological data and weather forecasts. Excess deaths are an additional, impact-related alert.

In any case, more data does not necessarily lead to better responses. Data availability was discussed and found to be a potential problem in some cities. However, in the public health context, steps often need to be taken on the basis of data that are incomplete but conclusive.

### ***Work Package 6: Climate information decision making tool***

The goals of the WP6 are to (1) develop a web based decision support tool, (2) conduct a case study on the web based support tool, (3) present the climate information tool to the public health services, (4) prepare background material for this presentation, (5) conduct a literature review: level of information available, accessibility of information, effectiveness, communication barriers, (4) write a book chapter, and (5) provide the project partners with data.

The planned climate information decision support tool will be web based. It was agreed upon in the working group that it has to be separated between short-term heat warning and medium range heat information. The short-term warning will be issued by the national institution that is responsible for heat warnings. The medium range information will be provided by the decision making tool.

In the process of developing climate information into a useful decision making tool several questions need to be answered. The following catalogue of open question was compiled and discussed in the working group:

#### 1) Meteorology

##### *a) Which meteorological parameter should be used for public health decisions?*

The “heat-indicator” in the climate information decision support tool should be as simple as possible. The climate information decision support tool will use the air temperature at the 850 hPa level at 12:00 UTC for the medium range forecast. It was agreed on this parameter because the forecast skill of the air temperature in 2m and other parameters that are relevant for the assessment of heat load are relatively poor within the time frame of 3 to 10 days. The use of the 850 hPa temperature for the heat information will be a starting point. As the skills of the medium-range forecasts for the other meteorological parameters improve they can also be included in the future. Further it should be possible to include a measure for the adaptation of the population to local climatic conditions. The European Centre for Medium Range Weather Forecasts (ECMWF) calculates also the deviation of the air temperature at 850 hPa from normal conditions. This information will also be taken into account within the decision support tool.

The working group participants agreed to use the ECMWF ensemble forecasts instead of the country specific regional models. Nevertheless, the national heat warning systems (forecast horizons  $\leq 3$  days) will be based on the latter and on the specific national heat indicator in order not to cause any conflict of interest between the different systems.

A restricted user group (forecasters, “warners”) will be able to have a look at the raw data from ECMWF and to modify the forecasts based on local information. In addition the restricted user group that is responsible for the issuing of the national warnings will be able to indicate the “warning status” on the web site (feedback mechanism).

The audience for the climate information decision making tool is the health community as well as the general public. It was decided to give the “heat” information along with its probability (= probability that a certain threshold will be exceeded).

*b) How long is a forecast useable?*

In order to elaborate the time frame for which the ECMWF ensemble forecast is useable it will be necessary to verify the forecasts. Probably the usable time frame will be between 3 and 21 days. Seasonal forecasts will not be very useful, as the skills of these forecasts are still relatively poor for Europe.

*c) What is the forecast horizon that is adequate for the public health community?*

The forecast will be given from day 2 on (including day 3). From this starting point meteorological data are more important than real time health data.

2) Downscaling to subunits

*a) What is the appropriate method for downscaling forecasts to relevant subunits?*

The resolution of the ECMWF data is 80 km, therefore it needs to be downscaled to the relevant subunits. Due to the short time-frame of the EuroHEAT project, a simple statistical method will be used that includes orographic effects (elevation). One option to solve the downscaling problem would be to use the ECMWF raw information and only downscale if the administrative unit is smaller than the ECMWF grid.

*b) The relevant subunits need to be identified.*

The heat information will be targeted to the national public health systems. Therefore it is necessary to downscale the information to the national administrative units that are responsible for the public health interventions. Information on these relevant administrative units might be obtained from the European Commission.

3) Graphical system for weather forecasts

*a) What should a graphical system show?*

*b) Who are the users of the graphical system?*

Information will be displayed on a clickable map with a zoom-function. The heat information will be classified in not too many categories in order to keep it as simple as possible (~ 4).

Together with the heat information health advice will be given. The development of health advice for vulnerable population groups is part of WP9, lead by the WHO European Centre for Environment and Health, Rome Office, in collaboration with medical experts.

There will be links to the national heat warning systems in order to make the decision support tool complementary to the national procedures. The decision support tool will be a platform that collects the available information on existing heat warning systems in Europe. If possible the warnings issued by the national heat warning systems for day 0 to day 2 will also be displayed (feedback mechanism).

The following methodologies will be applied to reach the goals of this work package. The web based decision support tool will provide the health authorities and the people who are responsible for issuing the national heat warnings with information about the likelihood of a heat-wave within the next 3 to 10 (if possible 21) days. This information will be based on the deterministic and probabilistic medium range forecasts of ECMWF. The lead time of the information given by the decision support tool will depend on the skills of the forecasts. We

assume that the skills of forecasts providing information for more than 3 weeks in advance, will not be sufficient for issuing a so called 'heat watch'.

In addition to the medium range forecasts that are developed from ECMWF forecasts and are edited in a way that they become relevant and accessible for health people, actual heat warnings from several European countries for the next 24-48 hours will be displayed on the decision support tool web page. This means that there will be some kind of feedback mechanisms from the national systems. The national heat warning systems will be linked from that page and additional information will be provided. The decision-support tool web page is thought to be a first contact point for all (health people and interested public) who want to learn more about heat warnings.

Heat information will be given on the spatial scale of the administrative subunits (e.g. Departements in France, Bundesländer in Germany). This information will be based within a first guess on the T850 (Temperature on the 850 hPa level), but minimum and maximum temperatures on the ground levels (2m over ground) will be included if possible (if the skills of the ECMWF model will turn out to be sufficient). Statistical methods will be applied for the identification of heat situations and the downscaling to the administrative subunits. If possible the HeRATE procedure which was developed within the framework of the European cCASHh project and includes short term adaptation to the local weather conditions while evaluating the thermal stress situation will be applied in a modified form.

Based on the 2003 data the system will be tested. The case study will be based on data from 2003 because in this year an extended heat-wave occurred in many European countries. It will be shown how many days in advance it would have been possible to predict the heat-wave(s) with a given probability. The results of this case study will be summarized in a report. If necessary the decision support tool will be adapted.

Further, a literature review will be carried out and all information available about the effectiveness of HHWSs, the level of information available, the accessibility of this information will be gathered and summarized in a report.

The decision support tool will be presented to interested health authorities. If possible a simulation game will be carried out, so that health authorities will become familiar with this tool. All findings will be summarized in a chapter in the final book.

#### **Further discussion and comments:**

At the moment, the 850 hPa temperature at 12:00 on three consecutive days is used to define a heat-wave. The role of the meteorologist is seen to improve the forecasts. A clickable map to visualize the forecast should be made available on the web. Existing national links to health information on web pages should be extended to more European countries, using suggestions from WMO.

Costs for the national meteorological service will be low as only a few minutes per day during summertime are necessary to check the information given by the decision support tool. If there will not be any feedback by the national meteorological services an unchecked forecast will be better than no forecast at all. Furthermore, the cost-benefit problem of triggering early interventions needs to be addressed. Information given by the EMMA system should also be checked and if possible included.

### ***Work Package 7: Indoor heat protection measures***

Within WP7, harmonized guidance for ministerial and institutional decision makers for intervention strategies at European level will be developed. These will be derived from identified cost-effective methods to keep institutional residents and patients cool during heat-waves.

In order to achieve these research goals, information and data on pros and cons, including positive and negative health effects and costs are to be collected of the various indoor heat protection measures. In part, this information already exists. The methodological approach suggested includes literature review (to identify research needs), questionnaires and expert interviews. In face of negative health impacts and high energy consumptions of conventional air conditioning systems, alternatives need to be identified (such as roof top vegetation and solar panels). In order to effectively reduce heat stress, not only temperature, but also humidity needs to be reduced by these measures. The experiences with different cooling measures in various European settings (institutional, structural, climatic, etc.) need to be assessed.

The first step in this work package will be to identify key experts in the fields of conventional air conditioning, low energy cooling measures, structural heat prevention measures, and indoor air and health. This will be achieved by a systematic literature review of the appropriate technical and health related databases. Further, previous international meetings on the mentioned topics will be identified and searched for appropriate experts as well. Up to four experts with different expertise will then be invited to collaborate in this work package. Together with the work package leader, these experts will make up the core group of WP7. A meeting will be organized for the core group in early 2006. The objectives of this meeting will be to agree on the assessment criteria, the writing tasks, timelines, and the expert review processes.

A set of criteria to be used in the assessment of the various indoor heat protection measures will be agreed upon. Among others, this will include monetary cost, energy use, health impact, technical feasibility, sustainability, and efficiency. Secondly, the various European contexts to which the guidance material will be applicable to will be identified and clearly defined. The selection of contexts will be based upon identified groups of particularly susceptible people in the population in combination with locations (e.g. elderly in nursing homes). In particular, conventional air condition systems, various low energy technologies, and structural measures will then be assessed according to the criteria that were previously agreed upon. This will be achieved by systematic reviews of global literature. The experience of new and retrofitted air cooling in European health care institutions in a variety of settings and building types will be assessed based on published case studies.

Subsequently, an expert consensus on the applicability of these experiences and the assessed measures to the various European contexts will be developed and agreed upon by the experts.

Finally, a manual for the selection of air cooling equipment and practices considering the medical needs of the resident population, building architecture and financial capacities will be derived and formulated.

Apart from appropriate funding, timely cooperation with networks, and collaboration with end-users, technicians, and scientists as well as the exchange of experience is needed to successfully carry out this research.

#### **Further discussion and comments:**

Several other parameters influence indoor climate, such as humidity and the relation between indoor and outdoor climate is important as well. Pros and cons of air conditioning were discussed and positive as well as negative health effects of air conditioning have been mentioned. Adverse effects of air conditioning are mainly found in the high energy consumption. In some countries households spend more than 10% of the household income on electricity costs. An important caveat lies in the difficulty of measuring indoor behavior.

Air conditioning may be particularly effective in hospitals and nursing homes for the prevention of heat effects on health. In housing, however, more long term adaptations to hotter climates may become necessary (structural changes). Besides buildings, mobile environments, such as public transportation, should also be included in the list of contexts to assess. Shading, green areas and orientation of buildings in cities may contribute effectively to the reduction of heat exposure

outdoors and therefore reduce heat stress in addition to indoor cooling techniques. However, this work package will focus on indoor heat protection measures.

The variability of different indoor climates and the influence of human behavior and other factors on the indoor climate were identified as possible caveat in the analysis.

As the study faces economic and time constraints it did not become clear during the group discussions what level of detail will be possible in these investigations.

### ***Work Package 8: Assessment of health system responses and capabilities***

The goal of work package 8 is to describe health system responses to heat-waves, to evaluate heat health warning systems (HHWSs) and to develop minimum requirements for the development of heat-wave responses on national and city level.

A stepwise approach will be adopted to achieve this goal:

First, a systematic literature review (search strategy to be developed) screening a range of appropriate data bases will be carried out, looking for accounts of health care system responses to extreme weather and heat-waves, respectively. This literature survey will provide basic information for the subsequent activities of WP8.

In collaboration with other work packages, in particular WP6, available information on existing heat plans and their effectiveness will be compiled from various angles: i) through a literature review (see WP6); ii) through comparing heat-waves and their health effects pre- and post intervention in cities where this is possible; iii) through results from other European studies (PHEWE and cCASHh) and iv) through contacting authorities from countries that have implemented a heat plan following the 2003 heat-wave.

Pre- and post intervention experiences from those countries will be collected with the help of a semi-structured questionnaire. The questionnaire could address the following questions:

- What exists in terms of a heat plans?
- How does it work? What is the framework, the capability to deal with crisis for extreme events?
- Did you test your heat-wave/extreme event plan?
- What were your lessons learnt?
- Who participated in the test?

A joint protocol for an evaluation to assess these interventions will be developed. This evaluation will primarily be process rather than outcome oriented at this stage. Results from evaluations that have been carried out will be taken into account. Methodologies for process evaluation will be explored, also considering possible inherent evaluation mechanisms, and a list of criteria for effectiveness will be defined. This list will be provided also for the assessment and the case study of WP6. All assessments will draw on results of the PHEWE (risk factors and temperature/mortality relationship) and cCASHh projects as well as on results of WP2, 3, 4, 5 and 6.

Results from lessons learnt, country experiences with interventions and the evaluation of implemented HHWSs will be presented at the final project meeting in Paris. A “compendium” will be compiled following the meeting. It will contain guidelines for national capacity building for developing preparedness plans for health systems. A chapter will be contributed to the joint project book and a summary for policy makers formulated.

### **Further discussion and comments:**

The possibility and feasibility of running an international simulation exercise during the meeting in Paris on managing a heat-wave emergency will be explored. During such an exercise a culture and mentality change for future preparedness could be supported and lessons learnt from each other. Local differences and context specific needs could be identified.

### ***Work Package 9: Public and medical service education tools***

Health promotion tools as well as tools for warning are considered public and medical service tools. The two best practice guidelines to be developed in WP9 are public advice and medical advice.

For this a systematic literature review on prevention measures with respect to heat and other environmental stressors will be carried out. A specific search strategy (key words) will be developed for screening selected data bases. A rated inventory of existing, evaluated measures may serve as a starting point to develop standardized recommendations for best practice.

Possibilities to extract results on heat related prevention measures from previous questionnaires on prevention measures carried out in the Czech Republic and in Italy will be explored with Anna Alberini. As a contingency option, should this approach encounter difficulties, a research tool designed in Montreal to assess knowledge, attitude and practices of vulnerable population groups with respect to heat will be adapted to the European context and applied to 200 individuals in 2 European cities (one Western European city, Italy, and one Accession city).

In addition focus group discussions on prevention measures during hot weather will be held with members of the target population in selected cities (e.g. Budapest and Paris).

European experts will be consulted for input on health advice for the elderly during hot weather. As output from this consultation a best practice guide for advice for the elderly will be drafted. This best practice guide will be translated into a model advice package suitable for communication through local media. A media and a health promotion expert need to be involved. The receptivity of the model advice package will be pre-tested in focus group discussions with selected participants in 2 European cities. These discussions are expected to identify communication barriers and gaps for finalization of the product.

For the development guidelines for treatment of patients during heat-waves the possibility to contribute a Cochrane Review was explored. However, due to the scarcity of randomized controlled trials on treatment of heat related diseases it is preferable to carry out a systematic literature review on treatment options (in collaboration with A. Bouchama). From the results of this review medical advice will be drafted. Medical associations from various European countries will be asked to comment on this draft and give further advice before finalization of the document. In a long term approach also medical training curricula and treatment protocols should be changed and adapted (e.g. treatment of heat stroke).

The development of these tools requires the results of most other work packages: temperature thresholds for different settings and vulnerable population groups (WP2); strengthening of weather forecasting (WP6); efficacy of early warning, prevention and response from different countries (WP8); strategies of existing public health services to deal with heat and related health problems (WP8)

Results of this work package will be presented at the final project meeting in Paris and consensus developed on advice for heat-wave survival and treatment among health ministries and outreach organizations.

**Further discussion and comments:**

Background information on heat-waves, health effects and responses should be made publicly available as a basis for national and local information materials directed to a specific audience (teaching and information tools). Web pages on summer and winter mortality and health already exist, for example provided by CDC. The possibility for adaptation of these existing web pages to the European context will be explored. However, it is not entirely clear on what criteria the success of these web pages has been measured. Both, general preparedness of the public and the health system and early warning are necessary. In order to put heat and health more actively on the agenda of emergency preparedness, presentations and presence at emergency conferences is suggested as well as the preparation of scientific publications.

## **Section IV: Coordination and Management**

### ***Project Management***

The WHO European Centre for Environment and Health, Rome Office, will coordinate this project. Further management tasks will be carried out by an advisory committee (see below), a well balanced and interdisciplinary group composed of different partners of the project who will regularly review and discuss the advances of the project. The advisory committee will also work closely with the different work package managers, assuring work progress and reviewing the quality of the products. Each work package manager will assure progress and quality of the products. External scientific advisors will follow closely and help developing the different work steps through neutral and critical contributions and provide a quality check.

Project management will focus on quality, timetable, budget and communication. The tools used will be the classical project management tools (Gantt chart, cost controlling) and special tools such as the moderated electronic bulletin board, electronic publication and the project newsletter. All tasks related to coordination between the work packages and to the dissemination of the results will be conducted within WP1.

### ***Decision Making Structures***

To clarify the process of identifying and resolving problems within the project, an Issue Management Plan (IMP) has been developed. The IMP's purpose is to describe the process the EuroHEAT project will follow to manage project issues, i.e. how issues are to be raised, evaluate, reviewed, and resolved within the EuroHEAT project. For the purposes of this project, issues are defined as something in dispute or something to be decided. The resolution of issues may have an impact on the project's scope or schedule during all phases of the project.

The issue management process will bring visibility to issues, accountability, and timely resolution of issues. Analysis of the issue will provide data and understanding for a more informed decision. Recording and reviewing issues will prevent the team from forgetting about issues that could adversely affect the project. An overview of the general process for the management of issues within the project is provided.

### ***Coordination Structures***

#### Coordination of the Work Packages

To fulfil the objectives of the overall project 9 work packages (WPs) have been formulated. Each work package is managed by a Work Package Manager (WPM). The WP1's main task is to coordinate the eight other work packages and assure the flow of information between the work packages. Furthermore, all results from all work packages will be integrated into a final deliverable through the WP1.

#### Communication Plan

A communication plan has been developed and approved by the project partners. The purpose of the communication plan is to provide an overall framework for managing and coordinating the variety of communications that will directly or indirectly take place as part of the EuroHEAT project. It addresses communicators, audiences, messages, communication channels, feedback

mechanisms and message timing, and creates a mapping between all six. Such a framework will ensure that the EuroHEAT project provides relevant, accurate, consistent information to the organizations at all times.

The project manager appointed a communication process coordinator to develop the communication materials and to support the delivery of communications. The process coordinator will also verify distribution of communication materials. An additional and important task for the communication process coordinator is the measurement and analysis of the effectiveness of the project communication plan. Actual delivery of many of the communication messages will be through designated communicators - presenting and facilitating briefing sessions, delivering communication locally and soliciting local feedback.

Numerous stakeholders are involved in this project. By effectively communicating with them the project can accomplish its work with support and cooperation of each stakeholder group.

#### Quality Assurance and Progress Monitoring Measures

The following tools serve to assure quality and the monitoring of progress. Some are already mentioned in the communication plan.

- **Product reviews** to determine whether the products conform to the requirements of the end users.
- **GANTT control charts** produced by the work package managers will give a graphical display of the results over time.
- **Regular evaluation** of processes like communication, meetings, financial management by the project manager will identify potential efficiency improvements.
- **Intensive feedback from the work package managers** to the project manager will guarantee that the coordinating institute is informed and has an overview of what is going on in the work packages. The meetings of the advisory committee will further on guarantee the interaction, information flow, and cooperation between the different work packages.
- **Pre-conference and pre-workshop documents** will emphasize the issues to be discussed at the different meetings. It gives the work package managers the opportunity to control effectively the kind of discussions during these meetings. In addition, the participants of these meetings will be informed on the discussion topics in advance. Finally, these documents simplify the production of publications or progress reports.
- **Expert involvement:** For all the different aspects of the project, scientific experts are involved from relevant organizations in Europe.
- **The advisory committee** will have a regular critical review of the results. The committee will assess the scientific quality and relevance of the products delivered and will assist the project manager and work package managers in finding new and innovative ways to achieve the goals of the research.

### ***The Project Advisory Committee***

The advisory committee consists of a scientific advisory committee and a country advisory committee. Members of the scientific advisory committee are:

Guilio Gallo, European Commission

Hugh Ross Anderson

Luigi Bisanti

Arieh Bitan

Abderrezak Bouchama

Juhani Hassi  
Gerd Jendritzky  
Giovanni Leonardi  
Carlo A. Perucci  
Günther Pfaff

Country representatives in the advisory committee are:

Fritz Wagner, Austria  
Arne Scheel Thomsen, Denmark  
Irina Gudaviciene, Lithuania  
Peter Otorepec, Slovenia  
Neus Cardenosa Marin, Spain  
Milada Estokova-Mikulcikova, Slovakia  
and country representatives from Italy, Portugal, and France.

The committee would like to see draft versions of the overall work plan and the work package protocols and will give advice and comments on these documents. Members of the committee will attend the main project meetings. For practical reasons public health and epidemiology issues might be divided among the members of the advisory committee according to their expertise.

## **Section V: Next steps and Conclusions**

### ***Next Steps***

Project partners and representatives from Ministries need to develop a detailed plan of work including a timeframe. Public health recommendations for other extreme events such as storms and floods should be included and possibilities to form a rapid reaction task force should be explored.

The EuroHEAT web site ([www.euro.who.int/globalchange](http://www.euro.who.int/globalchange)) will inform the public about the project and will be updated every 4 weeks. Input and comments are invited on the design and use of the web page.

### **The following dates are envisaged for next steps and meetings:**

- Setting up of website and internal information exchange, October 2005
- Development of project management details, September 2005
- Implementation of the work
- 2nd meeting: Budapest, May 2006  
Focus on real time health alert and risk factors
- 3rd meeting: Paris, February 2007  
Focus on climate information tools and European guidance material
- Presentation of project results at the Intergovernmental Meeting in 2007

In addition, work package team members will meet twice between each plenary meeting.

### ***Conclusions***

*Roberto Bertollini*

Overall, designs for epidemiological studies are rather difficult in the area of climate change and heat waves for example, as the situation cannot be compared to a “control” situation. Most studies on health effects of heat, however, produce similar results and show a strong relationship between heat and impact on health. Thus, the overall focus of the EuroHEAT project will be on providing and disseminating knowledge rather than conducting basic research.

The heat-wave of 2003 created a political momentum in Europe for research and implementation of adaptation and preparedness measures for extreme weather events. The potential effect of heat-waves in Europe was clearly underestimated before. Here, the PHEWE project already made a huge difference in demonstrating the effects of heat on health. All results are coherent within Europe, with specific heterogeneity between cities. DG Sanco expects some public health advice for the improvement of responses to heat-waves from this project.

During the conference in Budapest in 2004, strong support from Ministers to address climate variability was expressed and WHO Regional Office for Europe was invited to pursue and coordinate more research in this field. The meeting report states the commitments of member states (WHO Regional Office for Europe, 2004). WHO Regional Office for Europe has provided a comprehensive analysis for the flooding events in 2002 and the heat-wave in 2003. The results will become visible at certain occasions, meetings and in numerous publications.

In the second phase of the EuroHEAT project proper promotion and communication of specific public health recommendations are necessary. Collaboration between sectors is necessary is

important for achieving this goal. The effectiveness of public health measures and complex interventions need to be demonstrated. These issues become more and more relevant and need to be addressed in a more systematic way. Case studies, analysis of health impacts and the effectiveness of interventions therefore need to be pursued.

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## Annex 1. List of Acronyms

A2 Emission Scenario	Emission Scenario for the A2 conditions: regionalization, emphasis on human wealth, regional, intensive (clash of civilizations)
APR	Acute phase response
ASL/RME	Azienda Sanitaria Locale Roma
BW	Baden-Wuerttemberg
cCASHh	EU funded Project on Climate change and adaptation strategies for human health
CDC	Center for Disease Control
CI	Confidence interval
Df	Degrees of freedom
DG Sanco	Directorate-General Health and Consumer Protection
DWD	Deutscher Wetter Dienst (German Weather Service)
EC	European Community
ECMWF	European Centre for Medium-Range Weather Forecasts
EEA	European Environment Agency
EMMA	European Multiservice Meteorological Awareness System
ENSO	El Niño Southern Oscillation
EPS	Ensemble Prediction System
EU	European Union
EuroHEAT	Project: Improving public health responses to extreme weather events/heat-waves
GCM	Global Climate Model
GP	General Practitioner
HeRATE	Health Related Assessment of the Thermal Environment
HHWS	Heat Health Warning System
HIRHAM4 climate model	High Resolution Limited Area Model
hPa	Hectopascal
HSP	Heat shock protein
IMP	Issue Management Plan
IPCC	Intergovernmental Panel on Climate Change

MOH	Ministry of Health
NHS	National Health Service
OR	Odds ratio
PHEWE	Assessment and prevention of acute health effects of weather conditions in Europe
PM <sub>10</sub>	Particulate Matter with an aerodynamic diameter of $\leq 10\mu\text{m}$
PM <sub>2.5</sub>	Particulate Matter with an aerodynamic diameter of $\leq 2.5\mu\text{m}$
PRUDENCE	Prediction of regional scenarios and uncertainties for defining European climate change risks and effects
RCM	Regional Climate Model
SAMU	Service d'Aide Medicale Urgente ("Service of Medical Emergency Help")
SARS	Severe Acute Respiratory Syndrome
SRES	Special Reports on Emission Scenarios (SRES), containing projections of climate change;
T <sub>max</sub>	maximum Temperature
UHI	Urban Heat Islands
UTC	Coordinated Universal Time
VI	Vulnerability Index
WHO	World Health Organization
WMO	World Meteorological Organization
WP	Work package
WPM	Work Package Manager

## **Annex 2. Questions arising from session II**

1. What is the definition of a heat-wave? Which parameters need to be included (duration, humidity, maximum and minimum temperatures ...)? How can geographical, cultural differences and acclimatization processes be considered? How can different needs of various sectors be considered? Can heat-waves be categorized?
2. How can air pollution episodes be taken into account that occur at same time as a heat-wave and are thus caused by the same meteorological conditions?
3. What information hold global and regional climate models, respectively, for the prediction of health effects? What other parameters could be included?
4. How can we move from regional models to more localized predictions, e.g. for urban areas?
5. What is the definition of harvesting? (need to include a time frame: short term, longer term)
6. What defines the pathway from heat exposure to health effect?
7. Why do the thresholds change, what are the underlying physiological factors?
8. What is the relevance of urban heat islands for heat related mortality and morbidity?
9. What forecast and what lead time can be used for what action? What is feasible and what is realistic in terms of forecast information?
10. What are the benefits for the national meteorological authorities to give feedback to the decision support tool that is targeted to the health community?
11. Which methodology/study type is the most appropriate to study excess mortality and morbidity attributable to heat-waves?
12. How can “ignored” endpoints of heat stroke such as neurological morbidity and attributed late mortality be incorporated in impact studies?
13. How can the need to incorporate protocols for the treatment of heat stroke and – stress into medical training be addressed?
14. What are the alternatives to air conditioning to reduce indoor temperatures?
15. What does the paradigm shift in management teach us with regard to the management of heat-wave crises?

Remarks:     Adaptation of private and public transport to heat should also be considered.  
                  Investigation of the effects of heat on “healthy” individuals (suffering, productivity, economic loss ...) may also provide interesting results.

## **Annex 3. Participants' evaluation of the expert meeting**

This section summarises the analysis of the written feedback received on the workshop (n= 27):

1. Usefulness of the project
  - Customer needs for heat forecasts
  - Understand possibilities of forecasting
  - Quantification of determinants
  - Multidisciplinary approach and broad vision
  - 12 participants perceived the project as useful (yes)
  
2. What is the most important information?
  - Vulnerability and adaptation
  - The type of information collected during the project
  - Evidence based heat-wave plans (4 respondents)
  - Health impacts of heat-waves (2 respondents)
  - Best practice guide to reduce heat stress (3 respondents)
  - Discussion around definitions of terms (2 respondents)
  - Real time health data
  - Regional differences in health impacts
  - What are the meteorological thresholds to trigger a heat alarm?
  - Synergies with air pollution
  - Exchange of experiences between countries
  - To understand what climate information is needed for public health community
  - Better understanding on what type of weather situations lead to health problems
  
3. Which type of information should be delivered?
  - Project progress and preliminary results ( 4 respondents)
  - Climate information system (long and short term)
  - How to interpret climate and weather forecasts
  - All types of scientific papers (abstracts)
  - How to tackle a heat-wave situation
  - Methods
  - Transfer functions
  - How to protect elderly tourists
  - All information on long and short term protection
  - Air pollution/heat-wave analysis
  - Guidelines for specific stakeholders
  - Exchange of experiences from different countries
  
4. In which format should this information be delivered to you and how frequent?
  - Electronic newsletter
  - Graphs and figures
  - Web updates
  - Active delivery to stakeholders

5. Which climate-weather information is most useful?
- First guess warnings
  - 72 hour and 7 day forecasts
  - Information on human energy balance models
  - Statistical analysis and frequency of heat-waves