



# Heat Wave Events in Europe: A Public Health Concern

*Global Climate Change - 2013*

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## **Abstract**

As a result of the climate change that Earth is experiencing nowadays; the global average temperature is increasing leading to an increase of extreme events such as heat waves. The Europe region is most affected by heat waves due to the climate conditions that prevail and favor the increase of temperature. The heat wave of 2003 in Europe was the worst in history leading to approximately 70,000 deaths. Scientists estimated that the global temperature will increase by 2-4 °C until the end of this century. This indicates that the intensity, duration, and frequency of heat waves will increase. So, there is a need for action to prevent the serious consequences. Better monitoring, education, and new more effective policies are needed in order to face heat waves in the future.

## **Introduction**

Climate is always changing. Earth has experienced warm and cool periods during hundreds of millions of years ago as a part of a natural and recurring cycle. During the last century, Earth experienced a warming period with a higher global average temperature than normal. Scientists express their concern because nowadays the Earth's temperature is increasing at a faster rate than in the past. Global warming is leading to many problems both in the environment and for humans.

The global average temperature is attributed to the natural greenhouse mechanism by which the atmosphere traps solar energy and heats the Earth to support life. The atmospheric composition determines this energy balance; some gases (greenhouse gases) trap energy in the planet, and as a result, the Earth is getting warmer. These gases are carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), ozone (O<sub>3</sub>), and chlorofluorocarbons (CFCs), and are emitted mainly from anthropogenic sources. Global warming is caused due to increased concentrations

of heat-trapping gases in the atmosphere which are emitted from human activities, especially from the burning of fossil fuels and deforestation. The concentration of CO<sub>2</sub> and CH<sub>4</sub> in the atmosphere was increased by 31% and 151% since the beginning of industrialization (1,750), respectively [1, 2].

### ***The increased of Global Temperature***

During the last century, the average global temperature increased by 0.74°C and the linear warming trend over the last 50 years is almost double than the first half of the century. What is more, since 1880, the 10 warmest years have occurred in the past 12 years and 2010 was the year with the highest global average temperature (14.52°C).

There is no universal definition of heat wave but scientists describe it such extreme events associated with particularly hot sustained temperatures that have been known to produce notable impacts on human mortality, regional economies and ecosystems.

Heat waves are associated with specific atmospheric circulation patterns represented by semi stationary 500 hPa positive height anomalies that dynamically produce subsidence, clear skies, light winds, warm air advection and prolonged hot conditions at the surface. Usually the 500 hPa height anomalies are most strong related to warm seasons with precipitation anomalies (Indian monsoon) and heating anomalies that drive mid-latitude patterns. As a result areas that already experience heat wave events will experience more intense and frequent heat waves in the future. But due to climate change and the subsequent global warming, other areas that did not experience heat waves yet, will suffer from that in the near future. What is more, the impacts on those areas will be greater due to are not currently as well adapted to heat waves [3].

According to World Meteorological Organization (WMO) during the summer of 2003 the maximum temperature records exceeded for the first time in many locations in Germany, France, United Kingdom and Switzerland the records that had stood since the 1940s.

Heat waves leads to severe impacts on a range of environmental and socioeconomic sectors. The most dramatic impact, at least partially attributable to heat wave is the large number of

deaths. In 2003 heat wave approximately 15,000 people lost their life in France. The number of deaths in Paris increased by 140%. The sustained period of extreme high temperatures, unique in the recorded history of Paris, together with housing designed for cooler summers, caused a major public-health crisis [4, 5].

Heat waves also impacted severely upon the agricultural sector. Italy, Germany and United Kingdom and France lost several hundred million euros as a result of damaged crops due heat waves. Many major rivers in Europe such as the Rhine in Germany and Loire in France were at record low levels, resulting in many problems related to irrigation, cooling of electricity power generating stations and toxicity through the proliferation of cyanobacteria. During the summer of 2003, mountain glaciers in the Alps lost up to 10% of their mass. What is more, an unusual huge number of rocks fall in the mountains due to melt of permafrost from the exceptionally warm and persistent temperatures recorded at high elevations during the summer [4].

In 2010, Russian experience the hottest summer in record history, with average temperatures +18°C and +16°C above normal for the months July and August, respectively. The combination of high temperatures with dry conditions led to massive fires across the country. These dry conditions were the reason for a 30% decrease of Russian grain production. What is more, the heat along with the drought conditions had huge impacts on lakes, rivers and fish production. This heat wave in Russian would not have occurred without climate warming by a probability if 80% or alternatively the probability increased by a factor of five according to Otto et al [6, 7].

### ***Health***

Several studies have reported increased mortality during heat waves and especially in large developing cities. Heat exposure is over-loading cardiovascular and respiratory systems leading to some reactions that increase the core body temperature, increase heart rate, shift the blood flow from central organs to skin and increased sweating. Studies have shown increased risk of cardiac thrombosis as a result of dehydration during high temperatures in Finland. Another one study in Belgium identifies endothelial dysfunction as a potential mechanism for the cardiovascular effects. In Paris, mortality was up to six times higher than normal during the heat wave of 2003. Except from mortality, the emergency admissions to hospital and attendance at

health services also increased during heat waves. The heat wave of 2003 in Europe resulted in large increases in hospital admissions from cardiovascular and other illnesses.

Heat waves are also related with the increase in the occurrence of kidney stones. Dehydration increases the concentration of calcium and other compounds in the urine, which lead to formation of kidney stones. Currently, it is estimated that high temperatures account for 70% of kidney stone disease. It is predicted that until 2050, 1.6 – 2.3 million new cases with kidney stones will occur [8].

Heat waves are also related with increase in hospitalizations for acute renal failure and other kidney diseases. Heat waves are causing heat exhaustion at work or generally in daily life, accidents that related to heat exhaustion, clinical effects of heat on persons with chronic diseases, heat stroke illness and death. Human body has the capacity to cope with a temperature range. Once this temperature is exceeded, the body experience thermal stress which increase the risk of homeostatic failure, disease exacerbation and death. What is more, ground level ozone levels rise with temperature and as a result human's health is also affected (ozone is related to asthma). Elderlies, people with cardiovascular or chronic respiratory disease are affected to a greater extent. Furthermore, people who work outdoors are particularly vulnerable (are heat exposed). During the heat wave of 2003 in Europe approximately 70,000 people died. In the Russian heat wave during July and August of 2010, 54,000 deaths recorded. A high percentage of them was elderly people or were suffer from cardiovascular and respiratory problems [9-11].

The increased temperature acts as a force multiplier, strengthening the negative health impacts of other environmental stressors such as land degradation, ocean acidification and biodiversity loss. Environmental variables that characterize heat waves such as temperature, humidity, rainfall, and wind speed affect the development and transmission of infections (such as malaria, cholera and lymphatic filariasis) either by changing the duration of mosquito and parasite life or by influences on human, vector or parasite behavior. Up to date in the literature there is not strong evidence about human vector borne diseases but scientists estimated that until the end

of this century will occur. In northern Europe there have been latitudinal shifts in ticks that carry tick-borne encephalitis [5, 12].

In Paris 2003, a lot of nursing homes and other assisted living and retirement communities were not air-conditioned. This situation contributed to the increased number of death. Urban cities are affected to a greater extent because of the urban heat island effect, which results in the temperatures being somewhat higher than the surrounding suburban and rural areas. What is more, air pollution concentrations rise during heat waves and contribute to the raised death rates. The heat wave of 2003 in Europe shown that even in high income countries, such events can cause large numbers of deaths in the absence of a coordinated response to ensure that elderly people are kept cool and well hydrated [5].

### ***Future projections***

The Intergovernmental Panel on Climate Change (IPCC) using meteorological models predicts that until 2100 the global average temperature will increased by 2-4°C.

Climate scientists projected that over the next century, heat waves will become more frequent, intense and will last longer, not only in South Europe, but also in areas that and not characterized by heat wave events such as the Northern areas. As a result the burden of disease and premature deaths will be expanded, especially in vulnerable populations with limited adaptation resources. It is estimated that global warming has already approximately doubled the probability that a heat wave such as in Europe (2003) will occur [13, 14].

### ***Adaptation/Mitigation***

Scientists estimated that the global average temperature will increased resulting to more intense and frequent heat wave events. So, populations have to adapt to warmer climate and face the problem. This can happen via behavioral, physiological and technological adaptations. The physiological adaptation would take several years to occur (Evolutionary Theory – Human physiology change naturally in order to adapt in a new environment). The summer of 2003 demonstrated a lack of public health capacity in Europe to deal with heat waves. WHO

published a recent report in which encourages public health decision makers to act now to address climate hazards.

Up to date the forces for adaptation failed, leading the nation poor to face the severe consequences. During the design of new strategies some aspects must be taken into consideration: the variation of effectiveness of adaptation options by region, how to exploit the opportunities to reduce the risk, the cost of adaptation, the systemic nature of climate impacts (many sectors will need to be involved to reduce public health impacts). Some examples of public health adaptation strategies are the education for protection (drinking more water, not exposed to sun etc.), enhance health surveillance of routine data for early detection of heat wave effects (calls to hospital services direct), heat health warning systems, emergency preparedness, reinforcement of hospitals with more staff during heat waves etc [5].

The behavioral adaptation (includes use of air conditioning, improves health care and public awareness) can reduce the risk of mortality and morbidity. Even so, under extreme conditions, in cities that are accustomed to heat waves and have high levels of prevention awareness and air conditioning, the number of deaths can be increased. There is a need to assess and identify cost-effective adaptation options. The mitigation strategies such as the renewable energy sources can improve health by reducing air pollution and restrict the increase rate of global temperature [15].

### ***Conclusion***

Up to day, heat waves cost the life of a major number of people and resulted in many other negative impacts such as the shortage of food and water due to damage of crops and droughts. The heat wave of 2003 in Europe was the worst in history leading to approximately 70, 000 deaths. Scientists estimated that the global average temperature will increased by 2-4°C until the end of this century. As a result the intense, duration and frequency of heat waves will increase, especially in Europe and North America. So, governments must take some measurements to face the devastating consequences, including education of people to face the heat events, regulations about the conditioning of public places and new strategies for renewable energy sources (restrict air pollution and global average temperature). Global

warming is the biggest challenge of 21<sup>st</sup> century and governments at least have to provide public health protection, especially during heat wave events.

## **References**

[1] M. Adams, R. M. Amasino, E. Anders, D. J. Anderson, W. W. Anderson, L. E. Anselin et al, 2010, "Climate change and the integrity of science", *Science*, vol. 328, no. 5979, pp. 689-690.

[2] V. Ramanathan, Y. Feng, 2009, "Air pollution, greenhouse gases and climate change: Global and regional perspectives", *Atmospheric Environment*, vol. 43, no. 1, pp. 37-50.

[3] G. A. Meehl\*, C. Tebaldi, 2004, "More Intense, More Frequent, and Longer Lasting Heat Waves in the 21st Century", *Science*, vol. 305, no. 5686, pp. 994-997.

[4] Martin Beniston, The 2003 heat wave as an example of summers in a greenhouse climate? Observations and climate model simulations for Basel, Switzerland, *Global and Planetary Change*, Volume 44, Issues 1–4, December 2004, Pages 73–81.

[5] Prof A Haines, MDa, , , RS Kovats, Climate change and human health: impacts, vulnerability, and mitigation, *The Lancet*, Volume 367, Issue 9528, 24–30 June 2006, Pages 2101–2109.

[6] F. Otto, N. Massey, G. J. Oldenborgh, R. G. Jones, M. R. Allen, 2012, "Reconciling two approaches to attribution of the 2010 Russian heat wave", *Geophysical Research Letters*, vol. 39, no. 4, pp.

[7] G. Richard, 2011, "The central European and Russian heat event of July-August 2010", *BAMS*, vol. 92, no., pp. 1285-1296.

[8] T. Kjellstorm, A. J. Butler, 2010, "Public health impact of global heating due to climate change: potential effects on chronic non-communicable diseases", *Int Journal Public Health*, vol. 55, no. 2, pp.97-103.

- [9] R. Jean-Marie, S. K. Cheung, S. Le Roy, H. Van Oyen, C. Griffiths, J. Michel, F. Richard Herrmann, 2008, "Death toll exceeded 70,000 in Europe during the summer of 2003", *Comptes rendus biologiques*, vol. 331, no. 2, pp. 171-178.
- [10] V. A. Revich, 2011, "Heat-wave, air quality and mortality in European Russia in summer 2010: preliminary assessment", *Yekologiya Cheloveka/Human Ecology*, vol, no.7, pp. 3-9.
- [11] M. Michael, H. Montgomery, A. Costello, 2012, "Health risks, present and future, from global climate change" *BMJ*, vol. 344, doi: 10.1136/bmj.e1359.
- [12] P. P. Edward, E. Michael, 2010, "Modeling the effects of weather and climate change on malaria transmission", *Environmental health perspectives*, vol.118, no. 5, pp. 620.
- [13] D. D'ippolity, P. Michelozzi et al, 2010, "The impact of heat waves on mortality in 9 European cities: results from the EuroHEAT project", *Environmental Health*, vol. 9, no. , pp. 37.
- [14] Y. Mu, M. Xinzhi, 2013, "Energy conservation in the Earth's crust and climate change", *Journal of the Air & Waste Management Association*, vol. 63, no. 2, pp. 150-160.
- [15] A. J McMichael, 2006," Climate change and human health: present and future risks", *The Lanset*, vol. 367, no. 9513, pp. 859–869.