Health impacts of climate change with special regards to droughts

Anna Paldy MD PhD
Scientific adviser
National Public Health Center

Underlying facts

Climate change and its impacts have been supported by evidence (IPCC ARs)

Impact of extreme weather events (incl. heat waves) is a great challenge

Adaptation to these effects has become a major issue (for public health and other sectors)

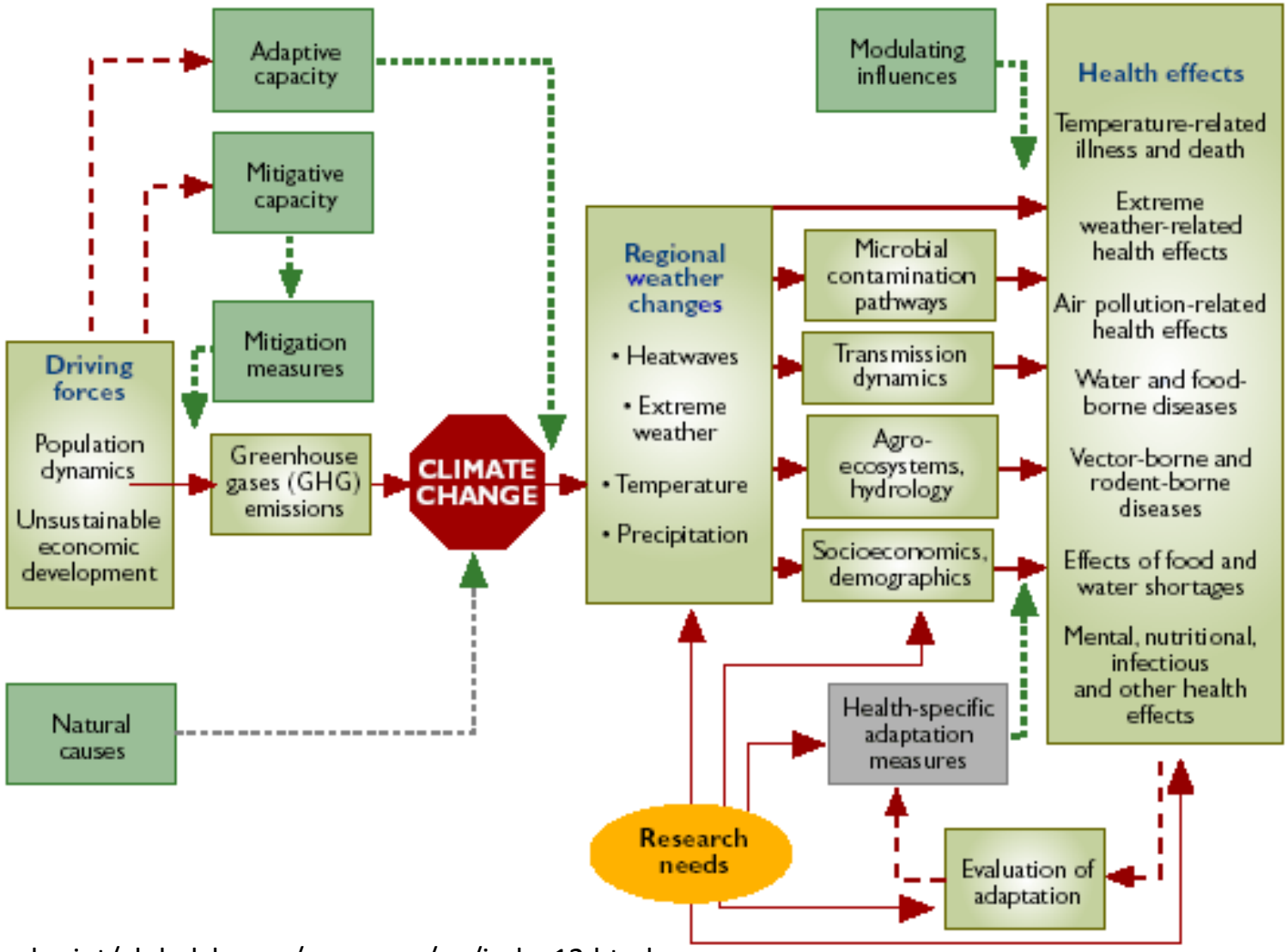
- Awareness raising and communication are crutial for short- and long term adaptation

Projections of different scenarios

- High-end climate scenarios **project warming of 4–7°C** (on average) over much of the global landmass by the end of the 21st century.
- The hottest days will exceed present temperatures.
- The number of people living in extreme conditions will increase.
- The ability of the human body to maintain heat balance during physical activity is compromised for parts of the year.
- Unprotected outdoor labour is no longer possible.
- Other risks associated with high-end scenarios: impact on urban settlements, food production, and water resources.

The Lancet Volume 383, Issue 9924, 5–11 April 2014, 1185–1189

Figure 13.1. Climate change and health: pathway from driving forces, through exposures to potential health impacts. Arrows under research needs represent input required by the health sector. (Modified from reference 4)



http://www.who.int/globalchange/summary/en/index12.html

Overview

Drought can affect areas or communities differently depending on several additional variables. These variables include

- the structure and capacity of existing water systems,
- local governance of water use,
- economic development,
- the at-risk populations living within the affected area, and
- other societal factors, such as the presence of local social networks.

Public Health Implications

The possible public health implications of drought include

- compromised quantity and quality of drinking water;
- effects on air quality;
- diminished living conditions related to energy, air quality, and sanitation and hygiene;
- compromised food and nutrition; and
- increased incidence of illness and disease.
- increased recreational risks;

- The health implications of drought are numerous and far reaching. People sometimes experience health effects in the short-term. Effects are directly observable and measurable. However, the slow rise or chronic nature of drought can result in longer term, indirect health implications. These health effects are not always easy to anticipate or monitor.

IPCC statement on droughts

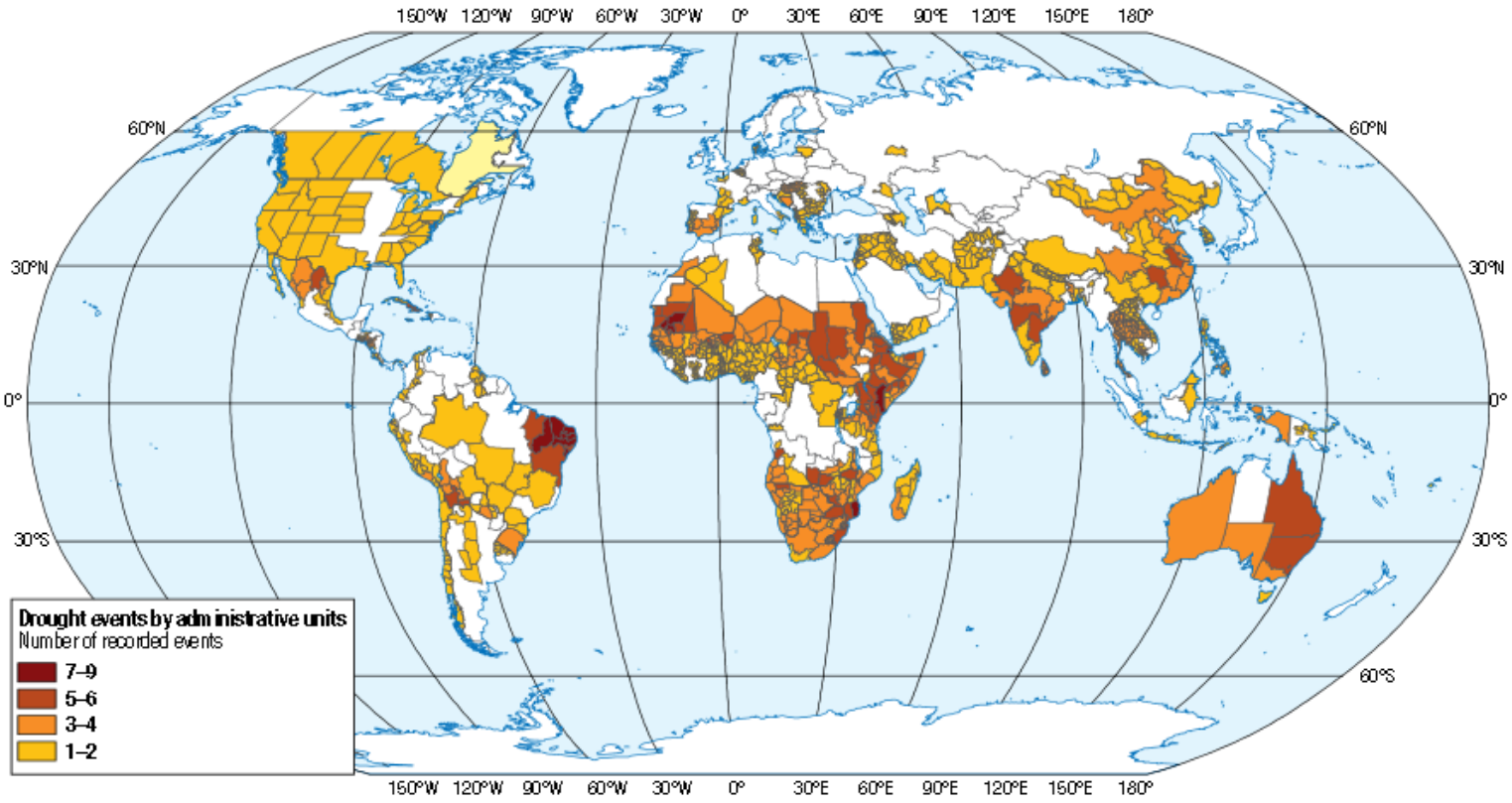
- While there are uncertainties about global-scale trends in droughts, the Intergovernmental Panel on Climate Change (**IPCC) has identified some worrying projections on the future of drought events worldwide.**
- Some regions of the world have experienced longer and more intense droughts (southern Europe and West Africa) while in other regions droughts have become less frequent, less intense or shorter (central North America and northwestern Australia), and it is more likely than not that human influence has contributed to the increase in droughts in the second half of the 20th century.
- **Because of reduced precipitation and/or increased evapotranspiration, there is medium confidence that droughts will become more intense in the 21st century** in some areas including southern Europe and the Mediterranean, central Europe, central North America, Central America and Mexico, northeast Brazil and southern Africa. Elsewhere in the world there is low confidence because of inconsistencies in drought change projections.

- The most recent available data (covering drought disasters from 1900-2012) from EM-DAT, a worldwide disaster database maintained by the Centre for Research on the Epidemiology of Disasters, gives an indication of the devastating effects of drought on countries around the world.
- **In 2011, it is estimated that 35 million people were affected by drought** in China, while 17 million people were affected in Ethiopia, Kenya, Somalia, Uganda, Djibouti, Burundi and Niger.
- **Droughts in the United States and Mexico were estimated to have resulted in $8 billion in damages**, while droughts in China resulted in $2.4 billion in damages. Reported damages are often underestimated because of a lack of standardization methods for reporting and quantifying losses.
- For the period of 1900-2012, the countries with the greatest number of people affected by drought were India and China; for the same period, the countries with the greatest number of recorded drought-related mortalities were China, Bangladesh, India, Soviet Union, Ethiopia and Sudan.

Number of drought disasters 1974-2004

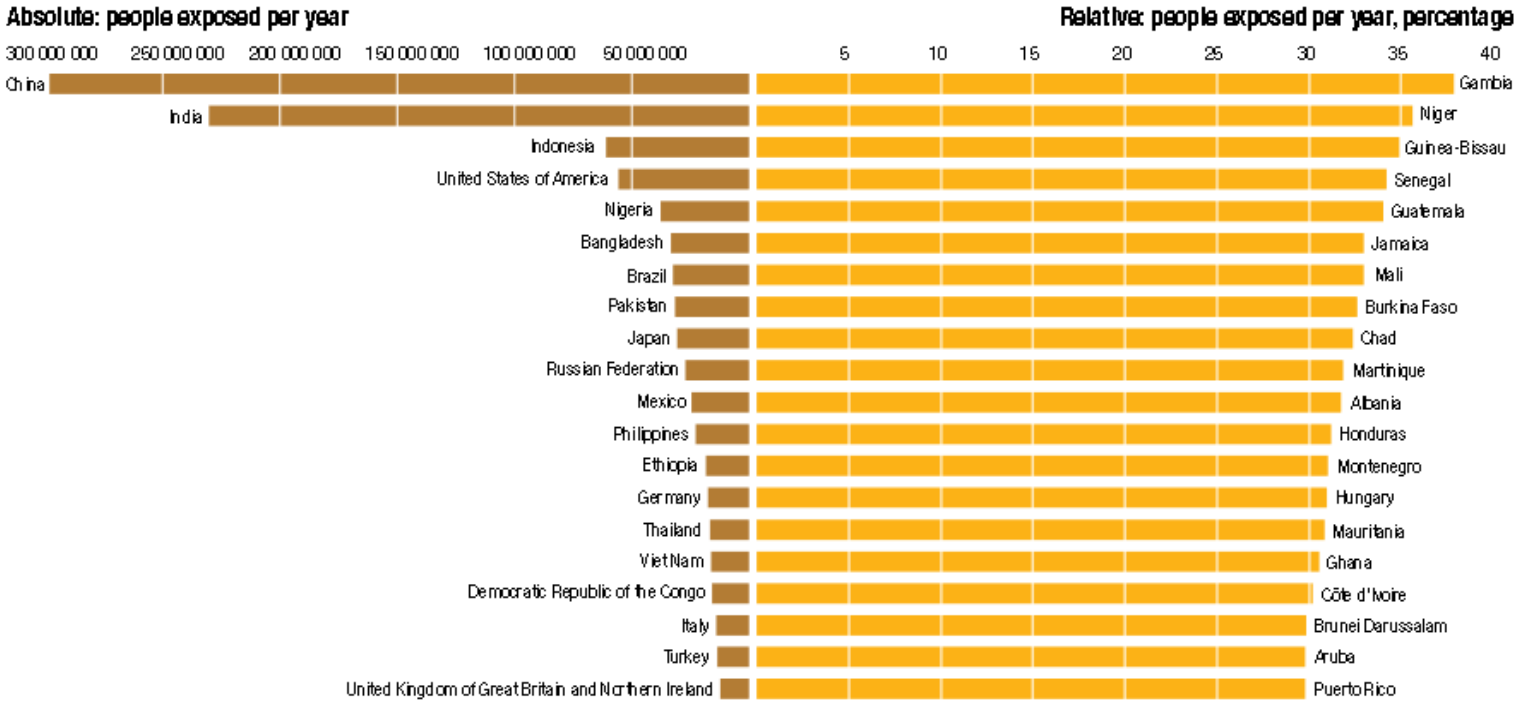
Figure 2.26: Number of drought disasters as recorded by EMDAT (1974–2004)

Data source: EMDAT: The OFDA/ CRED International Disaster Database: www.emdat.net; *GIS analysis:* IRI, Columbia University; *Cartography:* UNEP/ GRID-Europe, 2009.



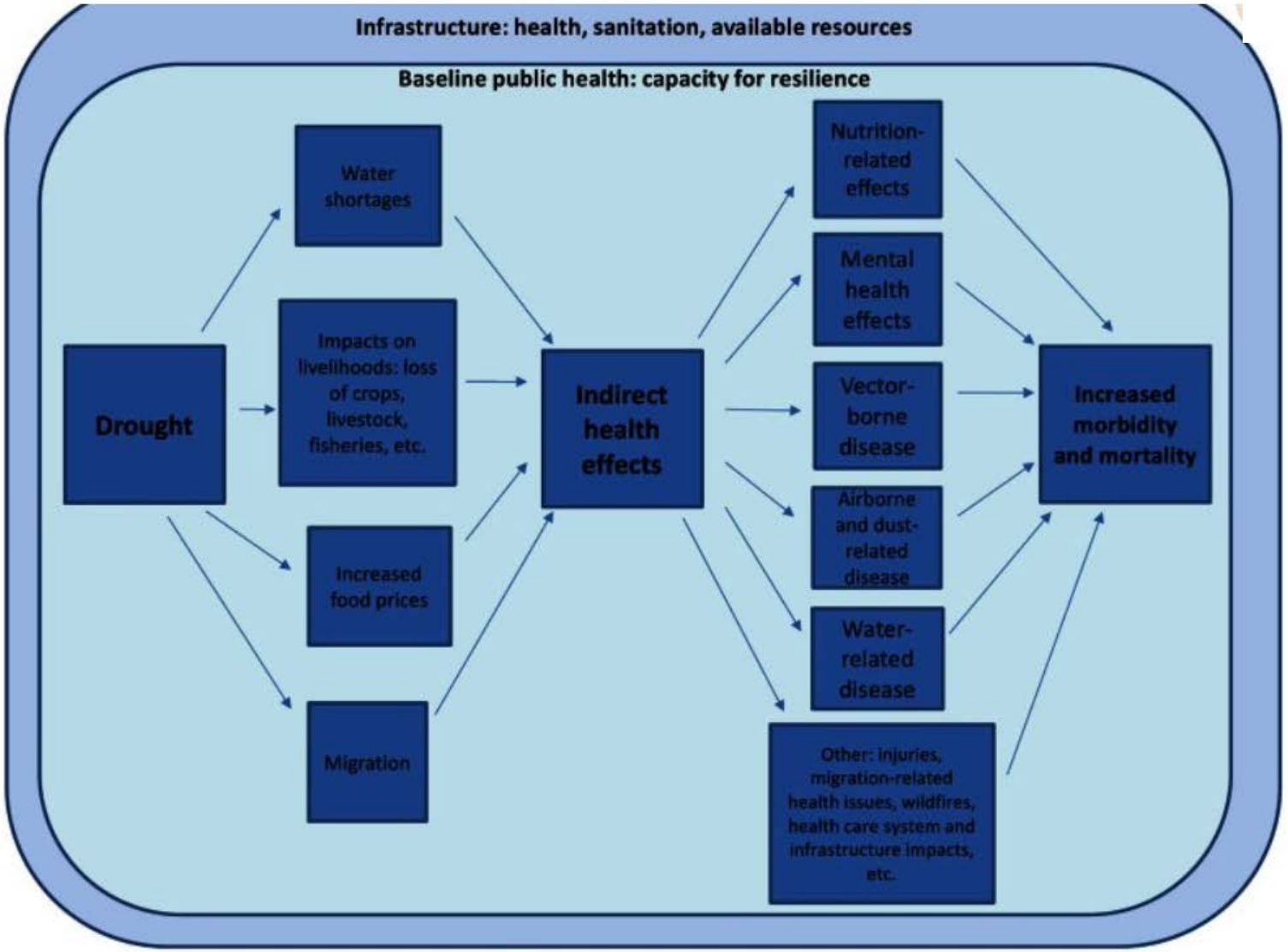
People exposed to droughts

Figure 2.27: People exposed to drought



- The impacts of drought are usually indirect. Being a slow-onset, long duration, spatially diffuse emergency, rather than a sudden, high-impact event (such as a flash flood or earthquake), drought differs from other natural hazards and has many multiple 'downstream' effects.
- In the published literature, original links to drought are easily overlooked, e.g. wildfires are more common during times of drought, but resulting burn injuries are often attributed to the fire alone.
- The effects of drought are critically dependent on context and underlying population vulnerability.
- Drought development and severity depend on the background level of water use (which might aggravate drought onset, duration and end) and infrastructure (which aims to mitigate the consequences of water deficit).
- The impact on health is particularly dependent on the socio-economic environment that can influence the resilience of the population. Poor health, poverty, and conflict are additional contributing factors to the impact of drought .

Identified health impacts of drought and related influencing factors



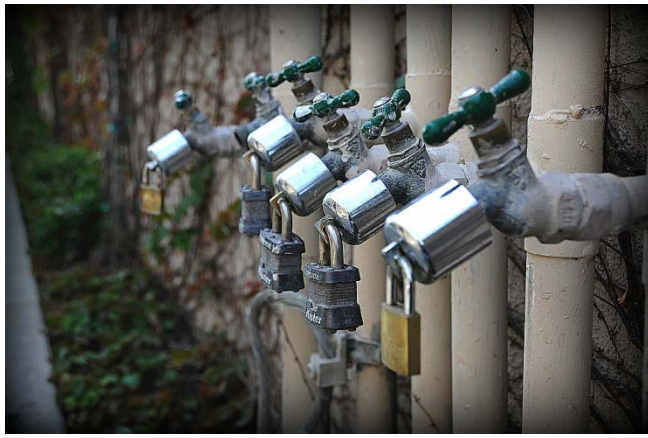
Health Effects of Drought: a Systematic Review of the Evidence

Carla Stanke, Marko Kerac, Christel Prudhomme,* Jolyon Medlock, and Virginia Murray* PLoS Curr. 2013 June 5; 5:

Problems of food and nutrition

- The malnutrition/mortality impacts of drought are often indirect and complex. In the simplest case, drought
  - affects ecosystems, thereby reducing food supplies (principally crops and livestock). This in turn reduces
  - quantity and/or quality of nutrient intake, which leads to greater vulnerability to illness, which can increase
- mortality risk:
  - Causes of mortality diarrhea, pneumonia and other infectious disease
- Morbidity risk: micronutrient deficit (Fe, Vit A, C)

Water related diseases



- As water discharge and water levels associated with droughts are typically low, dilution capacity is reduced
- and secondary impacts on freshwater systems emerge such as poorer water quality
  - e.g., higher concentration in chemical, nutrients and solid particles, lower dissolved oxygen

- Water quality can further worsen when intense rainfall follows a long dry spell (typically from convective storms associated with high summer temperature) and chemicals accumulated on the ground or roads wash out to the rivers

- When dry spells are associated with anticyclonic conditions and high temperatures, this can speed up
  - the development of droughts and increase the *risk of secondary impacts.*
- In particular, high temperatures result in **high evaporative** losses, drying up soil and plants; this can trigger agricultural droughts and
- increase **wildfire risk**.
- With dryer soils, infiltration capacity can also reduce and flooding risk can increase.
- Both resource-rich and poor countries have a risk:
  - people may switch their water source during drought, often to a lower quality supply (local wells)

- *Water-related diseases caused by faecal/urine pollution*
  - Diseases which are transmitted by water and hence potentially affected by drought include
  - amoebiasis, hepatitis A, salmonellosis, schistosomiasis, shigellosis, typhoid and paratyphoid (enteric fever).
- *Water-related diseases caused by poor handwashing/ hygiene*
- *Skin, eye and louse-borne disease that occur when there is lack of water for personal hygiene*
- *Disease caused by chemical and pollutant concentration*
- *Water-related disease caused by algae*
- *Cyanobacteria:* acute neurotoxicity and hepatoxicity

AIRBORNE AND DUST-RELATED DISEASES

- Dust can be harmful via two mechanisms:
  - pathogen carriage and direct trauma from inhaled particulates.
    - A 2012 review of health impacts of desert dust found 50 studies describing a range of health effects including respiratory, cardiovascular and cardiopulmonary disease
- Coccidioidomycosis (Valley Fever) - a fungus related disease -shows the complex relationship with drought and other environmental events. Outbreaks can be associated with heavy rains following a drought.

Climate Change impact on Vector-borne diseases

- Vector-borne diseases (VBD) are diseases transmitted by the bite of infected arthropod species, such as mosquitoes and ticks.
  - The term *vector* refers to an organism (an insect or a tick in most cases) capable of carrying and transmitting a disease-causing agent from one host to another
- WHO estimates that VBDs account for more than 17% of all infectious diseases, with more than half of the world's population at risk.
- Every year, more than one billion people are affected, of which a large proportion is due to diseases transmitted by mosquitoes

Source: WHO Fact Sheet No387; Campbell-Lendrum et al., 2015

Vector-borne diseases

- Droughts followed by re-wetting can have a substantial effect on water table levels, vegetation, and aquatic predators; all factors which influence mosquito populations.
- The **mosquito** is one of the most important arthropod vectors involved in the transmission of various vectorborne pathogens, and increased precipitation can cause mosquito densities to increase through provision of additional aquatic habitat
- *Ae. aegypti* and create a high potential for dengue transmission during warm summer months. They are adaptable by nature and are able to exploit a multitude of additional aquatic habitats created as a response to drought (i.e. water storage containers).

VECTOR-BORNE DISEASES

- Transmission of malaria – may be related
- Antecedent drought followed by wet conditions facilitated the amplification of the St Louis encephalitis (SLE) virus among *Culex nigripalpus* mosquitoes and a portion of wild birds, resulting in subsequent transmission to humans
- Transmission of **West Nile** virus: an inverse relationship was identified between precipitation levels of the previous year and the relative risk of human WNV, suggesting that drought acts as a potential mechanism for increased risk of human WNV transmission;
  - given climate change projections for increased drought in certain areas of the world, the risk of human WNV will also increase
- Tick populations are likely to be negatively affected by drought as they are dependent upon high levels of humidity and soil moisture

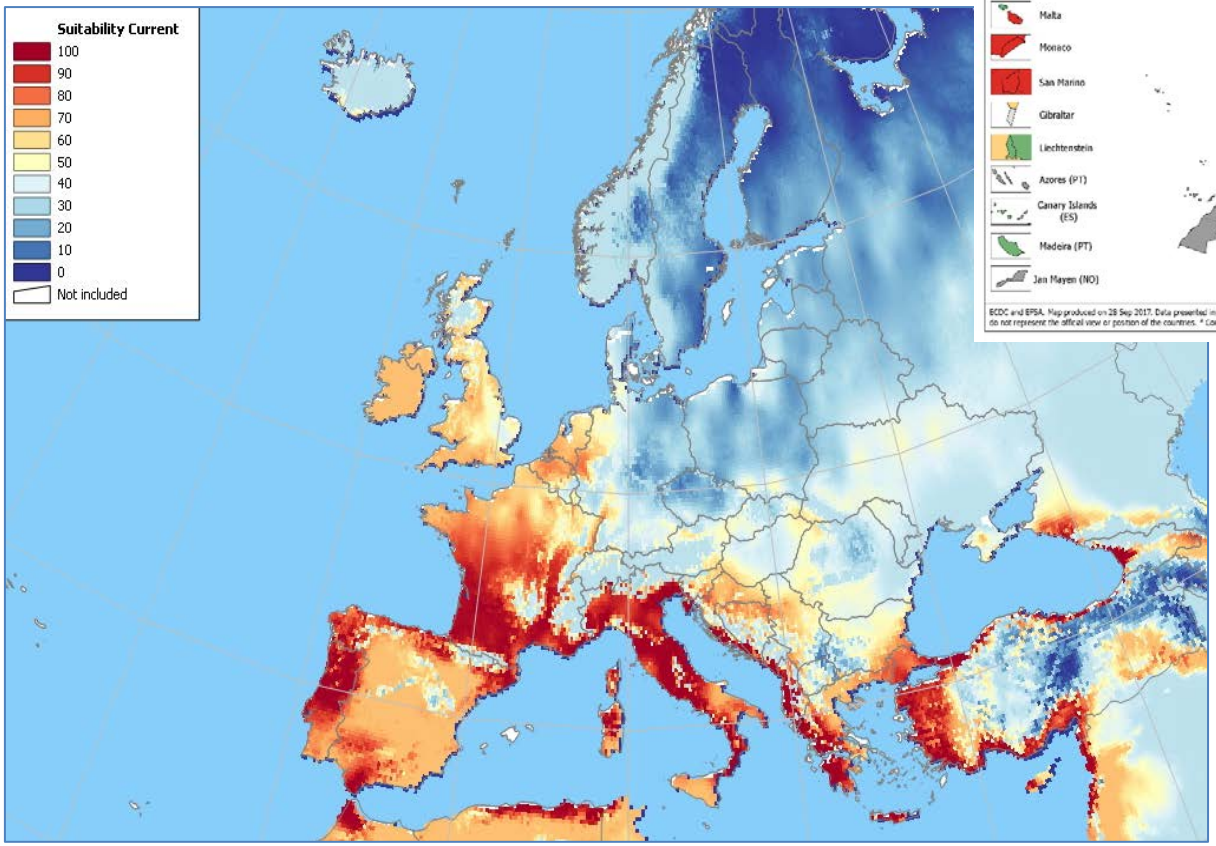
Behaviour of *Aedes albopictus*

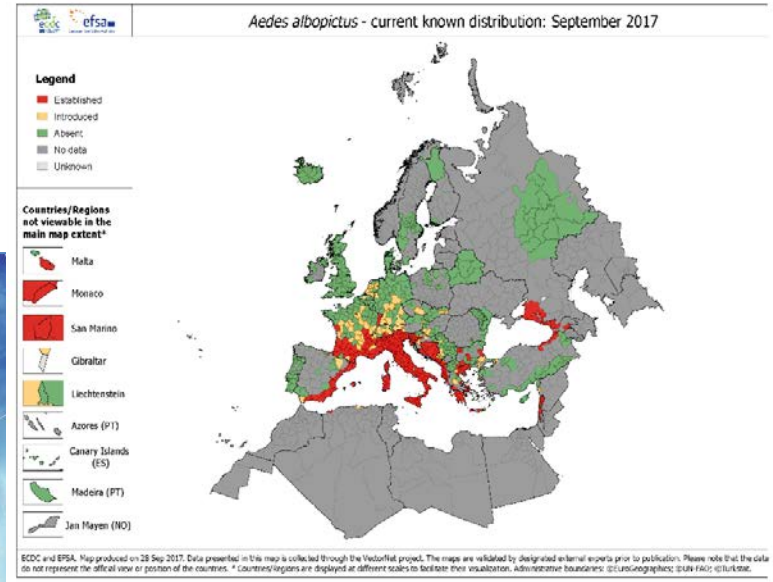
- Usually breed in stagnant water
- Usually active in dark or shaded places outdoors, but indoor activity is also possible
- Distance of flight：less than 100 meter
- Most active: 2 hours before sunset (5-6pm) and morning (8-9am)

Source of photo:
Food and Environmental Department

Climate Change

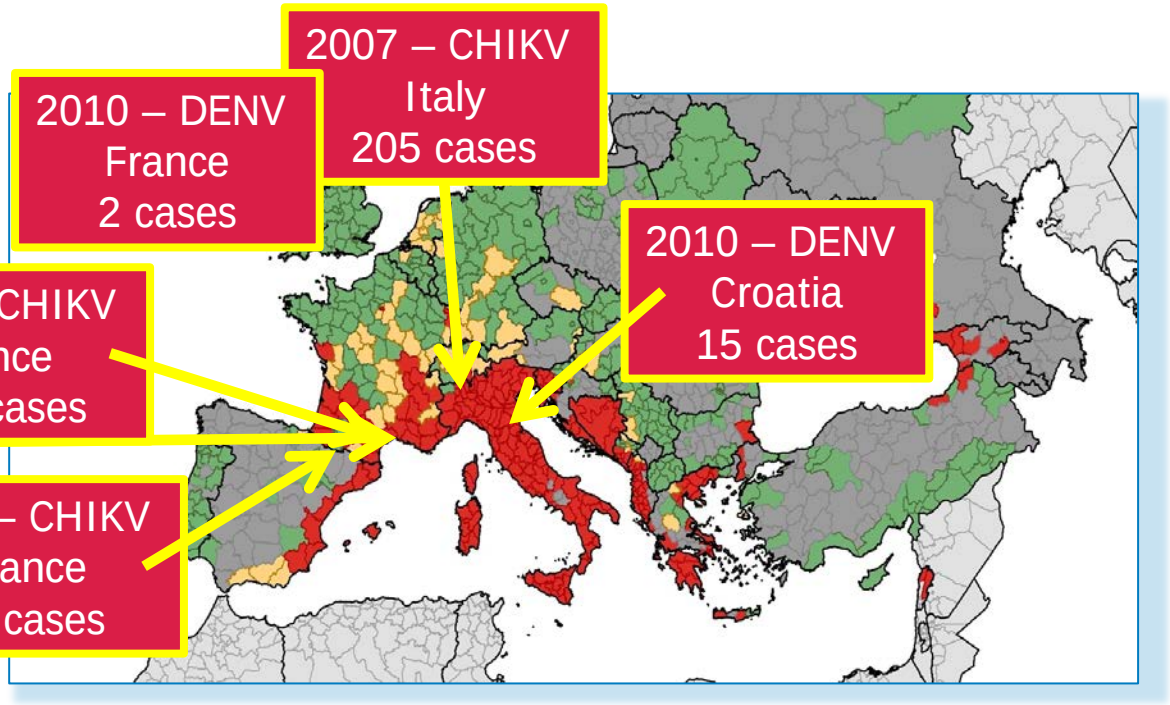
The invasion of the tiger mosquito

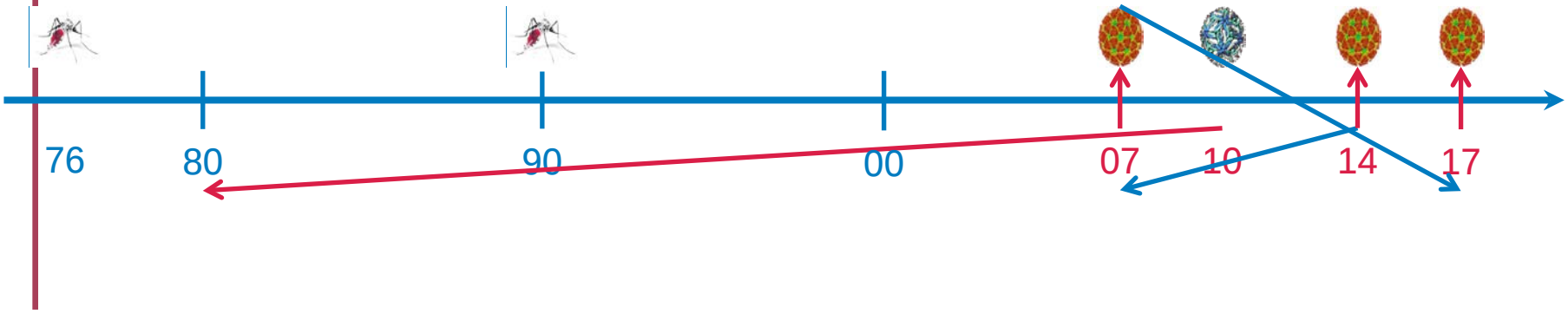




Climate Change

Related disease outbreaks





Mental health

Drought

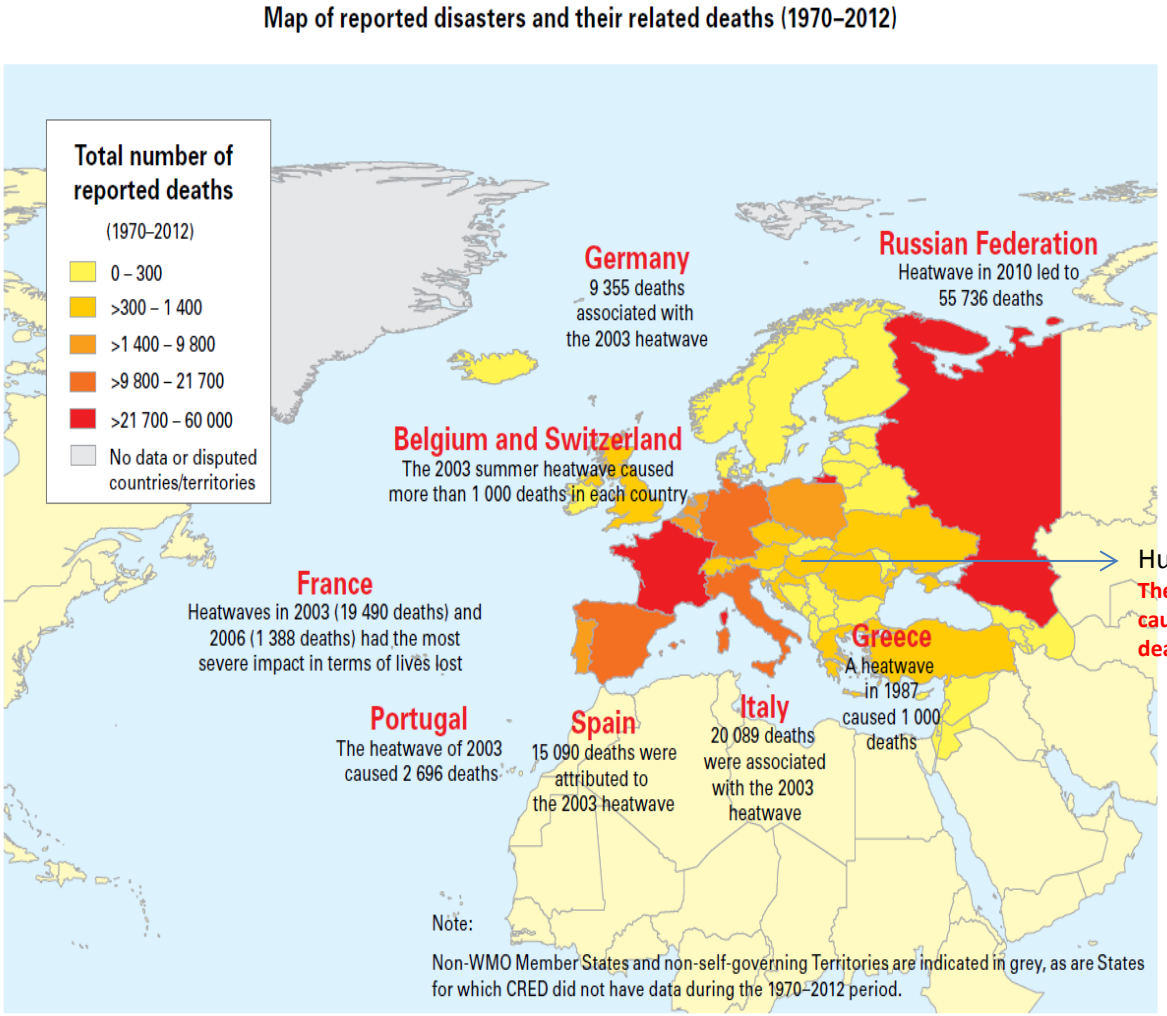
- causes stress, anxiety, and depression, anxiety and post-traumatic stress disorder
- Increased alcohol consumption
- causes economic losses to businesses that rely on water
- (for example, farms and landscape companies) and job loss for people who work in these areas.

- Intensifies the effects of heatwaves causing increased risk of injury and death from heat exhaustion or heat stroke.
- Stress city- or county-wide water systems that supply water not only to households but also at-risk populations such as people in hospitals and nursing homes.

Heat waves

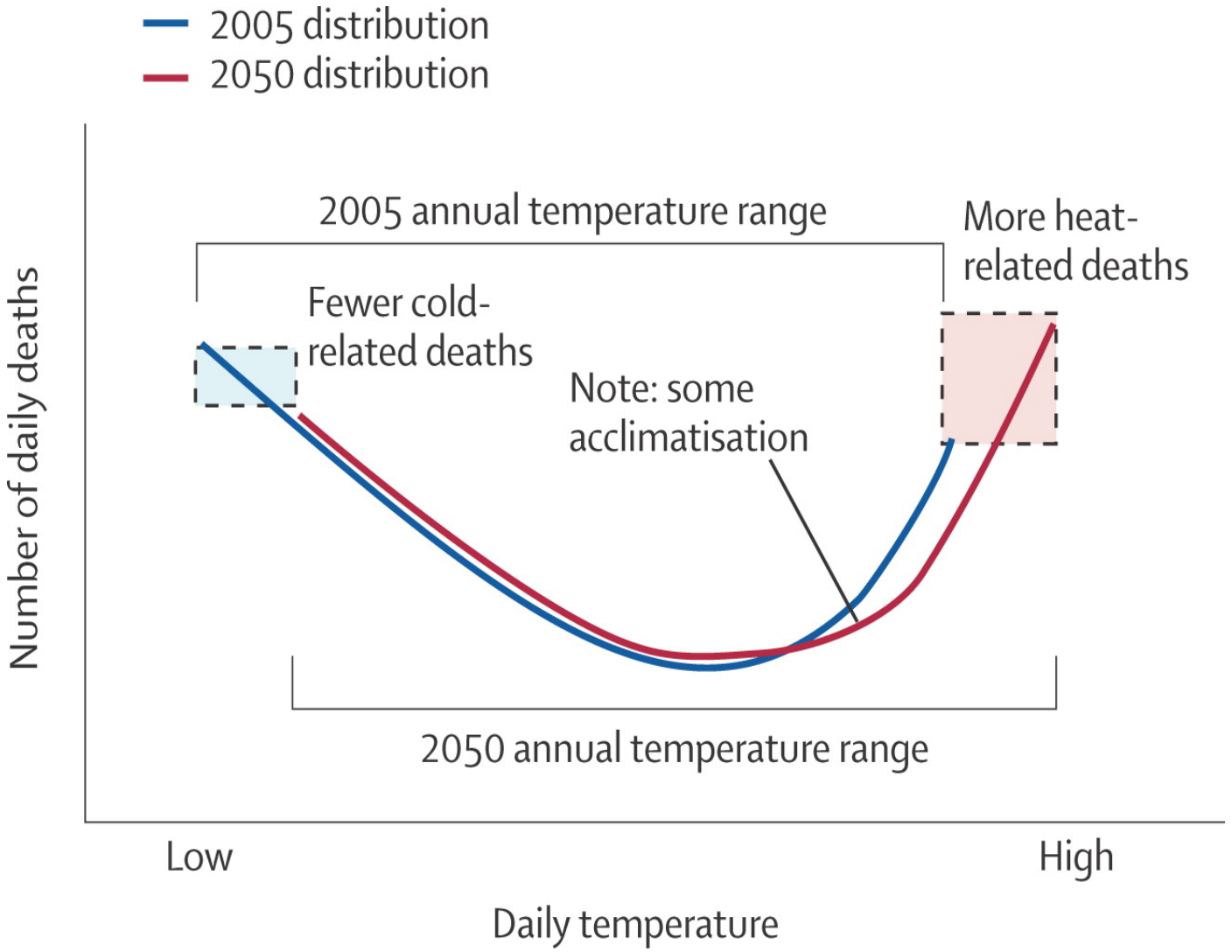
- In temperate areas, long droughts can be associated with heat waves during the summer, especially when
- anti-cyclonic conditions (high pressure usually associated with clear skies and in the summer increased temperature due to increased radiation) remain on land masses over an extended period.
- This was the case in August 2003 when Western Europe experienced some extreme temperatures: 70,000 additional deaths occurred during the summer period, with over 30,000 of these occurring during the heatwave, and over 25,000 wildfires were recorded

WMO Mortality and Economic losses from weather , climate and water extremes Atlas, 2014



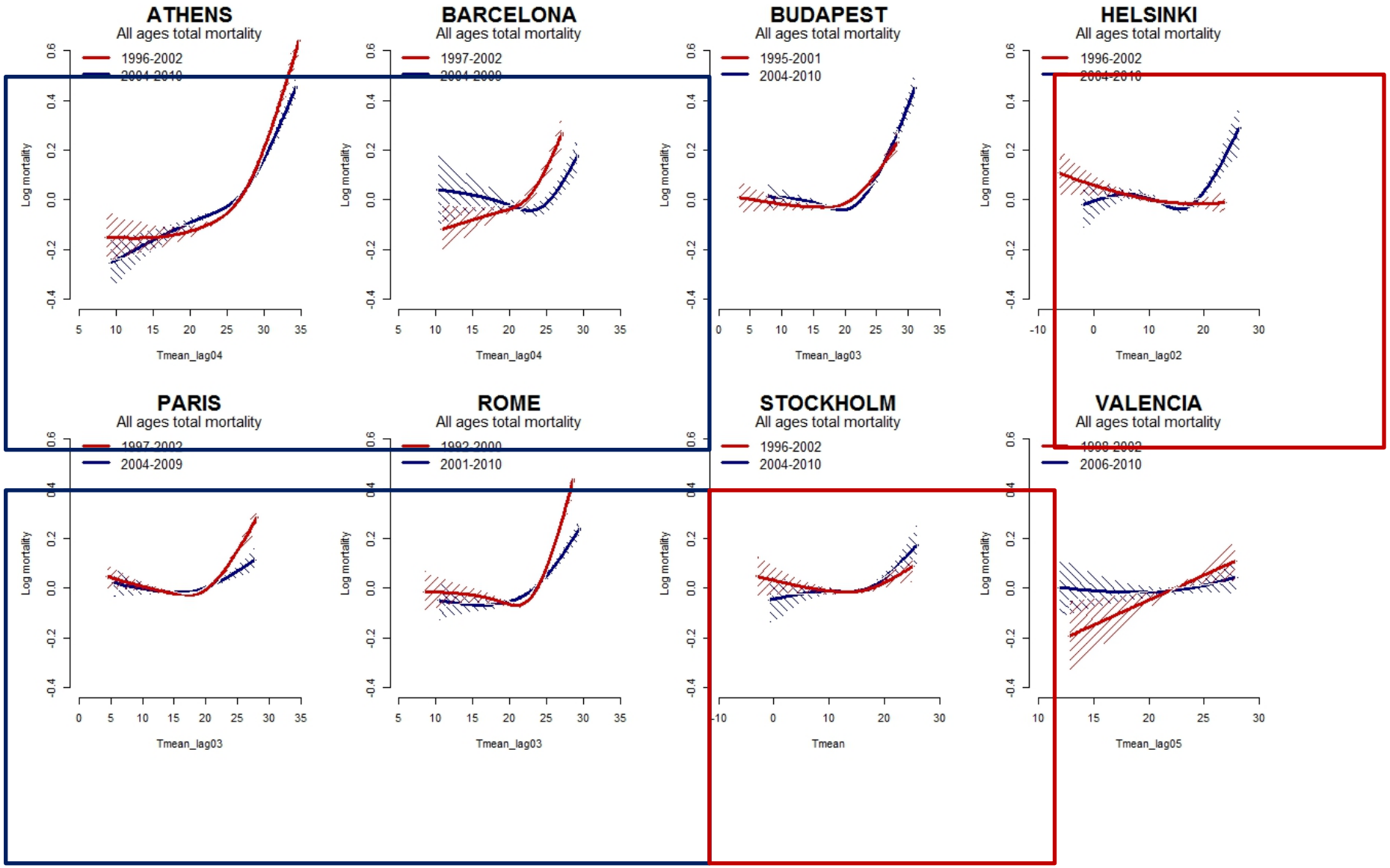
*data are not reported to the database, source: Paldy A and Bobvos J (2014) Health impacts of Climate Change in Hungary – A review of results and possibilities to help adaptation. Central European Journal of Occupational and Environmental Medicine 20(1-2); 51-67

Climate change, temperature and human health: present and future risks



McMichael et al. The Lancet, 2006

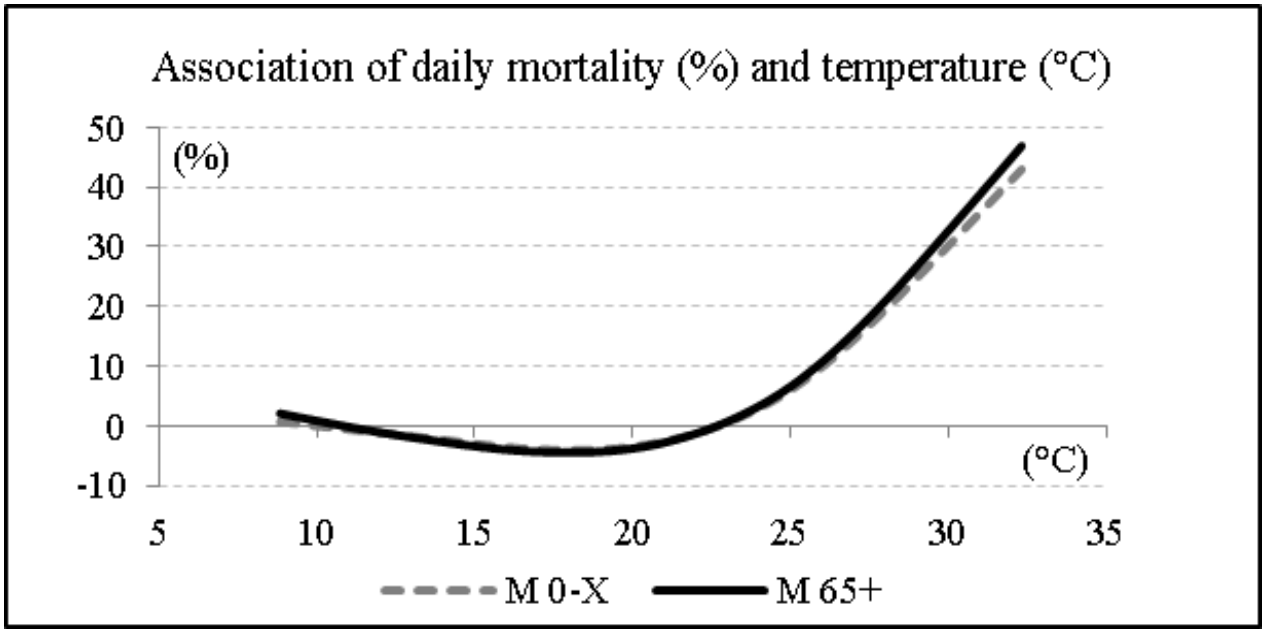
Mean temperature–mortality relationship in the years before 2003 (Period 1) (red line) and after 2003 (Period 2) (blue line) in 9 European cities



Source: de'Donato et al: Int. J. Environ. Res. Public Health **2015**, 12, 15567–15583

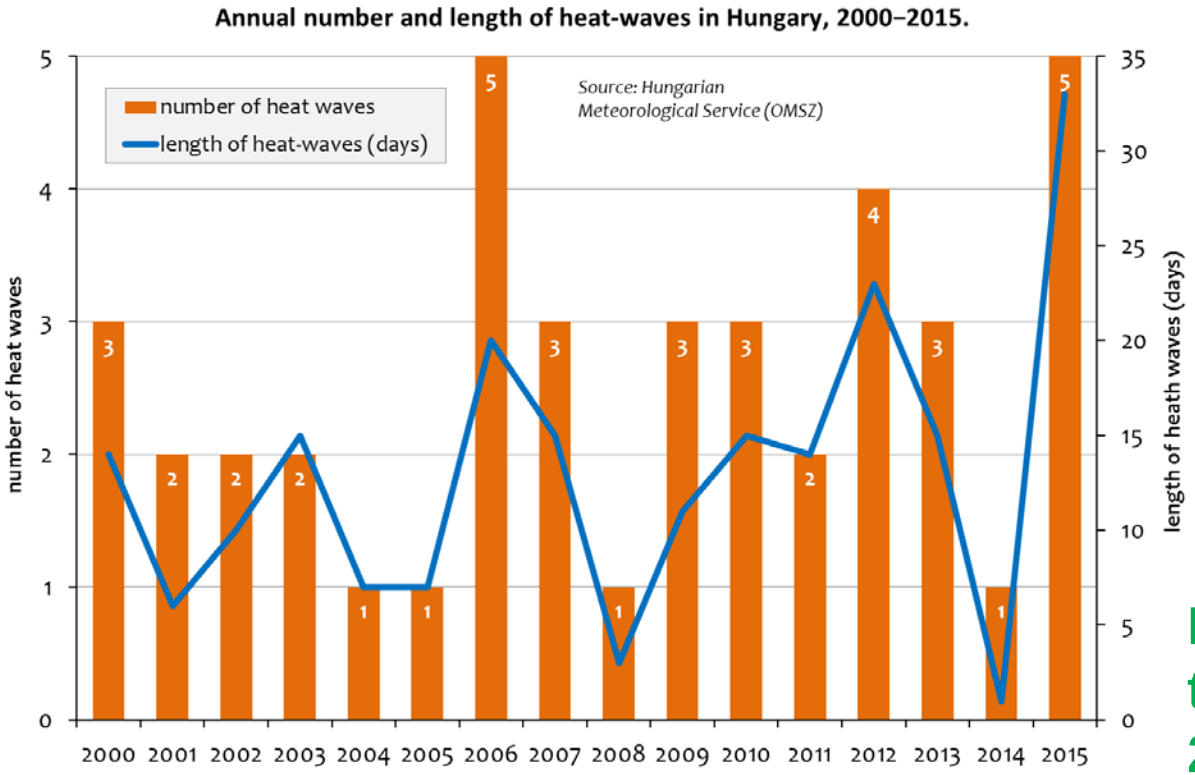
Association of daily mortality and temperature, Hungary, 2000-2010.

The association of daily total mortality (%) and the daily mean temperature (°C) can be characterized by a J shape curve at higher temperatures. The impact of heat is more prevalent in the elderly gorup over 65 years.

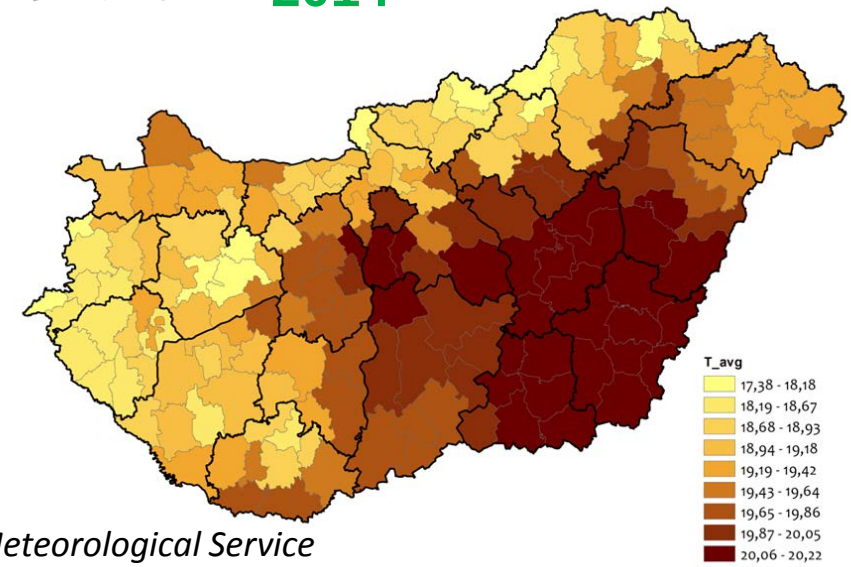


Characteristics of association of daily mortality (percent differences from mean total and above 65y mortality and daily mean temperature between 2000 and 2010 in Budapest.

Source: Assessment of heat-related mortality in Budapest from 2000 to 2010 by different indicators
János Bobvos, Balázs Fazekas, and Anna Páldy
IDŐJÁRÁS Vol. 119, No. 2, April– June, 2015, pp. 143–158



Mean temperature during the summer period, 2005-2014

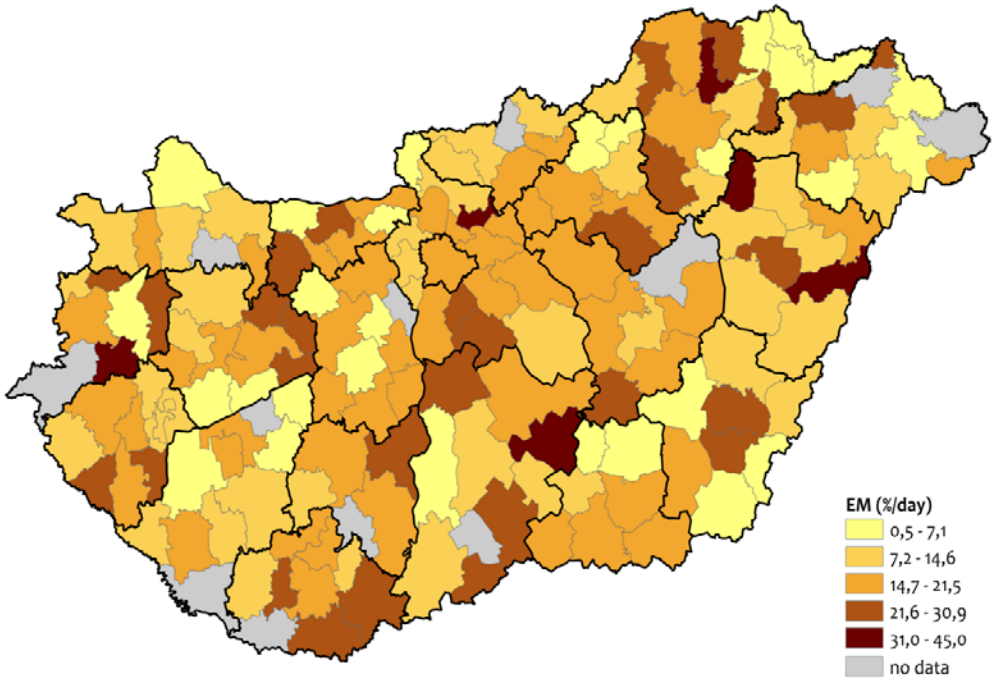


Bobvos et al IDŐJÁRÁS *Quarterly Journal of the Hungarian Meteorological Service*
Vol. 121, No. 1, Januar – March, 2017, pp. 43–62

Mean excess mortality (%) on days above threshold temperature on NUTS4 level in Hungary, 2005-2014

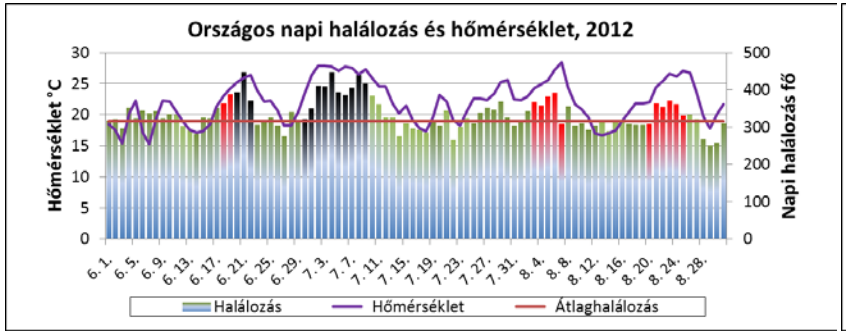
The mean excess mortality during days over the threshold temperature increase by 14.9%.
In some small areas excess mortality was not detected, while in others it was over 30%.

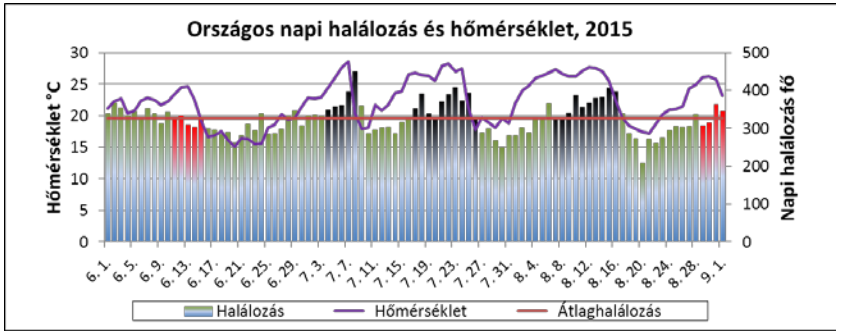
There is no typical spatial distribution of heat related excess mortality.

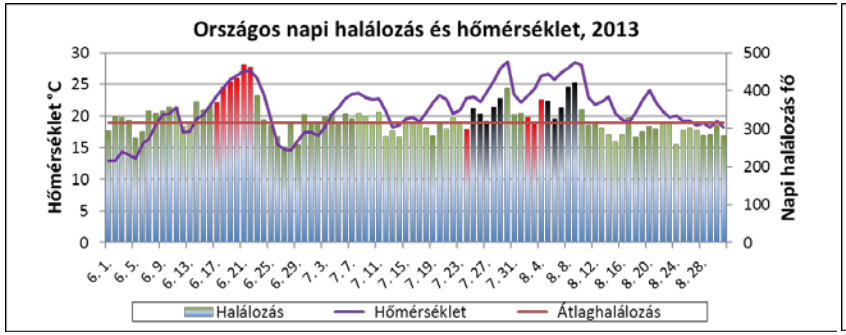


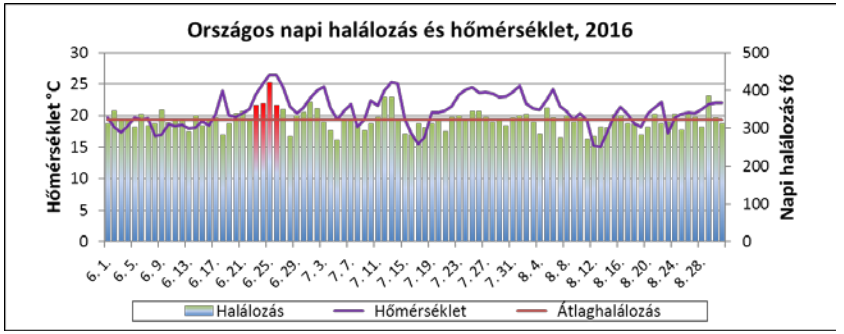
Bobvos et al IDŐJÁRÁS *Quarterly Journal of the Hungarian Meteorological Service*
Vol. 121, No. 1, Januar – March, 2017, pp. 43–62

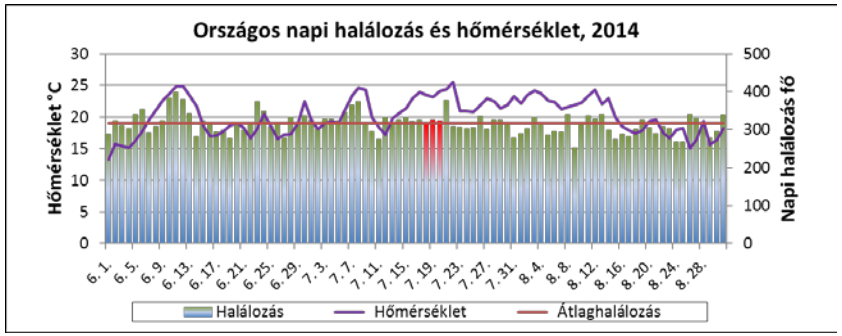
National average daily mortality and daily mean temperature 2012-2016, 2nd level heat alert marked by red, 3rd level marked by black











1 heat alert was issued in 2014 and 2016 with excess death cases of 320 resp. 370. In 2012 and 2013 4 heatwaves tackled Hungary with excess death cases of 1660 resp. 1140.

In 2015 the summer was extreme with 5 heatwaves during 34 days, daily excess mortality was higher by 17% meaning 1770 excess cases.

Wildfires

- The lack of moisture in the soil during droughts could also amplify surface temperature anomalies.
- With reduced soil moisture and increased temperatures, plants will lose some of their water content; they might transpire less to mitigate the lack of water but this is an aggravating factor for wildfires.

Famous wildfires

- In 1996, the Panhandle region of Texas (United States) experienced severe wildfires which resulted in the deaths of 12 people. Circumstances were ideal for the wildfires as the area had experienced “extreme” drought conditions in the five months prior to the fires.
- Above-average temperatures in Russia in 2010 were accompanied by extensive wildfire outbreaks in 22 regions across the Federation;
  - in an analysis of the effects of heat on mortality, 54,000 cumulative excess deaths in July and August of 2010 were observed compared to the same period in 2009.

Moscow, Yasenevo, Aivazovskogo street.
Left – 17 June 2010, 20:22. Right – 7 August 2010, 17:05.

Risk of wild fires

- Severe drought conditions can negatively affect air quality. During drought, there is an increased risk for wildfires and dust storms.
- Particulate matter suspended in the air from these events can irritate the bronchial passages and lungs.
- This can make chronic respiratory illnesses worse and increase the risk for respiratory infections like bronchitis and pneumonia.

Four main exposure pathways exist:

- Direct exposure to the flames and radiant heat;
- Exposure to smoke from burning or smouldering material dispersed through the air;
- Exposure to land/soil contaminated by the chemical products of burning vegetation, from soil erosion caused by vegetation removal during the fire, or from suspended dust dispersed through the air;
- Water contamination, caused by particulate matter deposition on water or leachates from the land directly affected by fire.

What is the public health relevance of wild fires?

- *Toxicology of wildfire smoke.* Particulate matter from wildfire differs from other sources of particulate matter.
- *Health effects.* Many systems are affected by wildfire smoke, predominantly through the **respiratory system**. **Cardiovascular** effects and **ocular problems** can also occur as well as **acute burns**. **Psychological and psychiatric effects** can be significant in relation to larger fires.
- *Water and land pollution.* Both water and soil pollution can cause longer term threats to human and ecosystem health after a wildfire.
- *Resource and access.* Serious wildfires could overwhelm local healthcare resources.
- *Communication.* It is important to communicate the health effects and how to mitigate them.

Long-term health effects associated with natural hazards

- *Effects of malnutrition and trace element toxicity*
- *Infectious disease risk*
- *Chronic systemic illness*
  - most associated with interruptions in the delivery of health care, which may be affected by disruptions in electricity supply.
- *Chronic disability/pain following physical injury*
- *Mental health outcomes*

The Hyogo Framework for Action (HFA) includes:

- ensure disaster risk reduction is a national and local priority;
- identify, assess and monitor disaster risks and enhance early warning;
- use knowledge, innovation and education to build a culture of safety and resilience;
- reduce underlying risk factors;
- strengthen disaster preparedness for effective response at all levels.

Recommended litereture on health impacts of extreme weather events

- Brown L, Medlock J, Murray V.:**Impact of drought on vector-borne diseases--how does one manage the risk?** Public Health. 2014 Jan;128(1):29-37. doi: 10.1016/j.puhe.2013.09.006. Epub 2013 Dec 14.
- Goldman A, Eggen B, Golding B, Murray V :**The health impacts of windstorms: a systematic literature review.** Public Health. 2014 Jan;128(1):3-28. doi: 10.1016/j.puhe.2013.09.022. Epub 2013 Nov 15.
- Brown L, Murray V.: **Examining the relationship between infectious diseases and flooding in Europe: A systematic literature review and summary of possible public health interventions.** Disaster Health. 2013 Apr 1;1(2):117-127. doi: 10.4161/dish.25216. eCollection 2013 Apr-Dec.
- Carmichael C, Odams S, Murray V, Sellick M, Colbourne J.**Water shortages and extreme events: a call for research.** J Water Health. 2013 Sep;11(3):377-81. doi: 10.2166/wh.2013.166.
- Grynszpan D[1], Murray V, Llosa S **Value of case studies in disaster assessment?** Prehosp Disaster Med. 2011 Jun;26(3):202-5. doi: 10.1017/S1049023X11006406
- Carla Stanke, Marko Kerac, Christel Prudhomme,[*] Jolyon Medlock, and Virginia Murray[*] . **Health Effects of Drought: a Systematic Review of the Evidence.** PLoS Curr. 2013 June 5; 5:

THANK YOU FOR YOUR ATTENTION