Extreme Weather Events and their Public Health Relevance

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Abstract
Nowadays more and more extreme weather events occur due to climate change. Hungary is extermely vulnerable to floods, inland water inundations and droughts; they can occur almost every year in any parts of the country due to the geographical position, geological and hydrological characteristics. Other events like wildfires are not so serious in Hungary as in the mediterranean countries. As these extreme events can happen more and more frequently, there is a need to prepare for the reduction of health impacts of these events. The Hyogo Framework for Action, the WHO and the Public Health England have formulated recommendations for risk reduction and measures of prevention of health impacts of extreme weather events.

In this paper the authors give a description of the different types of extreme weather events, of their health impacts in Europe and in Hungary and the possible preventive measures based on international recommendations.

Key Words: climate change, extreme weather events, mortality, vulnerability, adaptation

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INTRODUCTION

Climate change is presumably the most serious environmental health problem of the 21st century (Watts et al., 2018). The impacts of climate extremes and the potential for disasters result from the climate extremes themselves and from the exposure and vulnerability of human and natural systems, as it was pointed out in the IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (Field et al., 2012). Climate change is occurring globally and in Europe, also; some of these observed changes (increases in temperature, changes in precipitation and decreases in ice and snow) have established records in recent years. The mean temperature increased by 0.85 [0.65 to 1.06] °C over the period 1880 to 2012, the rate of the increase was steeper at the end of the last century and at the beginning of the 21st century: 0.05 [–0.05 to 0.15] °C per decade in the past 15 years (1998–2012); this increase is of anthropogenic origin (IPCC, 2014). The length of heat waves has also increased across Europe (EEA, 2012). Scientific publications increasingly conclude that the likelihood of an event such as the 2003 European heat wave was probably substantially increased by rising global temperatures.

According to the above cited report there is a 66–100% probability that the intensity of heavy precipitation and the proportion of total rainfall will increase particularly in northern mid-latitudes and high latitudes of Europe. The highest total precipitation increases are projected to occur during the winter months. Although the IPCC states a general decrease in mean precipitation in the southern European region, rainfall may become more irregular and intense. Even in summer, when the frequency of wet days is projected to decrease, the intensity of extreme rain showers may still increase. In addition, the frequency of precipitation for several days is projected to increase.

According to the IPCC statement on droughts 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 (Pachauri et al., 2014). The most recent available data (covering drought disasters from 1900-2012) from EM-DAT[1], 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 the database it is indicated that approximately 30 per cent of the population was exposed to drought in Hungary per year between 1990-2012.

Climate scenarios produced in support of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Solomon et al., 2007) suggest changes in regional climate conditions during the twenty-first century, such as drier and hotter summers over Central Europe. The climate models using different emission scenarios show that Europe is a very sensitive region to global warming (Giorgi, 2006) and that the Carpathian Basin is located in a transition region of the precipitation change pattern (Giorgi and Coppola, 2007).

According to the observation of the National Meteorological Service (Szalai et al., 2006) the temperature increase is significant in each season. Summer is the season with the strongest warming and autumn is the least warming season. The warming tendency seems to accelerate since 90's. The summer warming has been close to 2°C in the last 30 years. The long-term precipitation trend shows a decreasing pattern, however increasing precipitation tendencies can be also found in summer and in shorter term. The largest reduction in the seasonal precipitation sum was measured in spring. The regional model simulations predict further temperature increase for the entire 21st century. For the mid period of the century (2041-2060) there is no significant difference between the more optimistic (RCP4.5) and the more pessimistic (RCP8.5) scenarios, however, the latter scenarios predict considerable changes in the last period (2080-

[1] *Centre for Research on the Epidemiology of Disasters – CRED https://www.emdat.be/database*

2099). The predicted greatest increase of the summer mean temperature is more than 6.5°C, which is twice as high as predicted by the RCP4.5 more optimistic scenario. The number of hot days (Tmax > 30°C) will increase and the distribution of the seasonal precipitation will change. During winter more precipitation is predicted while during summer there will be arid periods. These changes will affect - among others – the agriculture, forestry and water management; consequently will impact on the society (Bartholy and Pongracz, 2018*).*

Climate change increasingly affects people's health and well-being, increases the frequency and intensity of extreme weather events like heatwaves, droughts, extreme rainfall and severe cyclones in many areas, and modifies the transmission of food-borne, water-borne and zoonotic infectious diseases. New environmental, climatic and health problems are emerging and require rapid identification and response. The WHO in its Thirteenth General Programme of Work, 2019–2023 "The health, environment and climate change strategy" addresses health emergencies. It emphasizes the need to improve the resilience of the health sector and communities to climate change, to reduce vulnerabilities, and to enhance preparedness, surveillance and response to health emergencies – by these measures and actions the health impacts of environmental emergencies will be prevented and reduced (WHO, 2019).

The adaptive capacity of the living organisms - including humans - is unique; however adaptation to quickly changing situations can be problematic. Disasters belong to this group of situations endangering basic needs, natural and built environment, human health and life. In this paper we aim to give an overview of the extreme events happened in the past 10 years in Hungary. We also describe the possible health impacts of these disasters and summarize the major tasks of the public health service based on the recommendations of the WHO and other international organizations.

The climate and topography of Hungary

Climate of Hungary is influenced by the continental and the oceanic climate[2]. The impact of these systems change very often therefore the weather is very changeable. The country is situated in the Carpathian Basin; the mountains have a modifying effect on winds and the movement of air masses. The Gulf Stream also influences the weather; due to its effect the temperature is warmer than in the neigbouring Austria. The average temperature in Hungary is 8 to 11 °C, the difference between the north and the south is only 3°C because of the relatively small distance. The prevailing wind direction is northwest, resulting in a west-to-east spatial gradient of precipitation modulated by local topography. Recently the frequency of southeast wind direction is increasing, over the river Tisza north wind prevails. The average annual precipitation across the country is 600 – 650 millimeters, however the spatial distribution of precipitation shows a great variability and the southwestern parts are more humid due to the effect of the Mediterranean Sea; while the eastern parts of Hungary are semiarid areas.

The hydrography of the country is determined by the surrounding Carpathians, Alpes and Dinarian Mountains; 66.8% of its area has a lower height than the sea level and only 0.8% is higher than 500 m. We have 22 rivers, 90% of them have a catchment area in the mountains of

[2] *https://www.met.hu/eghajlat/magyarorszag_eghajlata/*

the neighboring countries and 95% of the quantity of a flood arrives from abroad. Very often the floods occur on several rivers at the same time (e.g. on the Tisza, Körös rivers and Maros) increasing the water level in each of the rivers.

DESCRIPTION OF EXTREME WEATHER EVENTS

Severe storms

Intense stormy or hurricane-like gusts occur if the speed of gusts is above 90 km/h and up to 120 km/h. The heavy shower is defined by more than 50 mm of rainfall in a region in 24 hours. Snow drift can be characterized by the relatively high wind speed (> 72 km/h) and snow depth or/and snowfall simultaneously. Severe storms with damaging windstorm (wind speed over 90 km/h) and large hail (diameter > 2 cm) can occur in the Carpathian Basin mainly during summer. The summer weather in the Carpathian Basin is favourable for severe thunderstorms developing in every 3-5 days (changes year to year). Extremely severe thunderstorms lasting for several hours happen much rarely (in about every 3-5 years) causing very serious damages over a large area of Hungary. However it must be mentioned that severe storms became more frequent in the recent decade[3].

There is a remarkable example of a dangerouos freezing rain happened in December 2014 in the mountains of Buda, Pilis, Visegrad and some parts of the Börzsöny Mountains. The major damages could be observed above 400-500 m altitude, although damages were detected in the towns at lower levels as well. Besides the huge damages suffered by the forests (e.g. 20,000 hectares in the Pilis Mountains) there were power outages due to the damaged electric cables in Budapest and in the affected other settlements. This freezing rain event was so strong that happens only once in every 100 years (Csépányi et al., 2014; Kolláth et al., 2015).

Downpour

Severe storms with intensive downpour events with the heaviest precipitation are linked to Mediterranean cyclones, however the precipitation patterns are mostly influenced by the air masses coming from the Atlantic Ocean. In 2010 the weather in months May and June was determined by two intense Mediterranean cyclones called Zsófia (between 15th and 18th May) and Angéla (from the 31st May to 4th June[4]). During the first cyclone the four days precipitation amount was equal to the average May precipitation amount, at some places even twice as much amount of water was measured. The heavy rain brought by the cyclone caused floods at rivers Sajó, Hernád and Bódva in Northern Hungary. This type of event is typical for the summer months when a convective weather situation in small areas can cause flash flood in a very short time. Flash floods have become more frequent since the beginning of the 2000's (serious events: Apr 2005 in Mátrakeresztes, June 2010 in Kurd, and June 10 2018 in Bánkút[5]).

[3] *https://www.met.hu/ismeret-tar/erdekessegek_tanulmanyok/*

[4] *Meteorological description of the "Angéla" cyclone between 31st May and 4th June 2010 by Horváth Á, Zsikla Á, and Kovács A (in Hungarian) can be found at http://owww.met.hu/pages/Angela_ciklon_20100531-0604.php*

[5] *https://www.met.hu/eghajlat/magyarorszag_eghajlata/csapadek_szelsoertekek/Magyarorszag/index.php?ful=8#aktp*

Severe storms – usually in wintertime - can lead to blizzard characterized by snow cover and/or snowing at the same time. Severe blizzards can cause wide snowdrifts on the roads, and the wet-snow icing deposit may cause problems or even damages in the electric cables. The strong wind gusts increase the hazards during a blizzard. The strongest blizzard in the recent years raised in the Transdanubian region on 14th March 2013. The snowfall was intensified by north and north-west winds associated to a severe storm. The bank of snow, the whistling wind, low visibility and cold temperatures caused critical situation on the roads. In the north-eastern part of the region the split off electric cables resulted in prolonged power outages. Although similar situation with snowfall and strong wind simultaneously happened in the past as well, the above mentioned blizzard event caused the most dangerous situation in the 21st century (Horváth, 2013).

There are a lot of publications supporting the fact that human health can be severely affected by windstorms. Direct effects occur during the storm, causing death and injury due to the strenght of the wind. The main direct dangers are hits by flying debris or falling trees and road traffic accidents. Indirect effects, occurring during the pre- and post-impact phases of the storm, including different types of accidents like falls, lacerations and puncture wounds, and may occur during the cleaning up after a storm. Power outage is a key issue and can lead to electrocution, fires and burns and carbon monoxide poisoning from gasoline powered electrical generators. Furthermore chronic illnesses can worsen due to lack of access to medical care or medication. Last but not least the risk of infections and vector borne diseases should also be mentioned (Goldman et al., 2014).

Floods

European vulnerability to flooding has been highlighted by recent flooding events; most notably, the 2010 flooding in Southern France, the 2007 flooding in several areas in the United Kingdom, and the Central European floods in 2002 and in 2010, 2013 (EEA, 2016). Over the twentieth century, annual river discharges decreased considerably in many southern European basins, while large increases occurred in Eastern Europe. Human activity contributes to an increase in the likelihood and adverse impacts of extreme flood events. Inappropriate river management and construction in flood plains reduce the capacity of rivers to absorb flood waters. Secondly, the number of people and economic assets located in flood risk zones continues to grow.

Risk of floods, flashfloods and inland water inundations in Hungary

Hungary has an unfavourable topographical position in relation to flood risk. The flow of the water transported from the surrounding mountains slows down in the lowlands of the country producing a lot of curves of the rivers. Following a sudden melt of snow or heavy precipitation a huge amount of water inflow occurs, resulting in a drastic elevation of the water level and floods. Due to the small declination of the land surface floods move slowly on the rivers in the Great Hungarian Plain so the areas along the rivers remain under water for several weeks or months.

Looking at the map showing the flood risk in Hungary (*Figure 1.*) the greatest risk of the Little Hungarian Plain, Great Hungarian Plain and at the foot of the Northern Mountains catches the eyes. These are the areas where the flow of the bigger rivers slows down. In the previous centuries the central parts of the settlements of the Great Hungarian Plain were placed on natural hills being even some meters higher than the surrounding areas ascertaining protection for the population in case of floods. After controlling the flow of the bigger rivers the flood prone areas considerably decreased. However the control had some negative impacts as well. The amount of water brought by the flood runs off in a short period and afterwards we have to face droughts. The new challenge is to find the best solution to reserve the water for irrigation purposes.

The inland water inundation risk is the highest in the Great Hungarian Plain, affecting not only the shallow parts, but also the areas between small hills and at the bottom of the Northern Mountains. The rise of inland water inundations depends on the water permeability of the upper layer of the soil, on the ground water level and the position of the first aquiclude layer. These layers down to 2 ms are widespread in the Great Hungarian Plain (Rakonczai et al., 2011), therefore greater amount of water following heavy precipitation or melting of snow the soil is not able to drain off the water. Flash floods occur typically in the mountainous areas due to the restricted capacity of streams and small rivers to drain off the sudden precipitation. The level of water increases in a very short time resulting in floods. The rush down can cause huge damages in the natural and built environment.

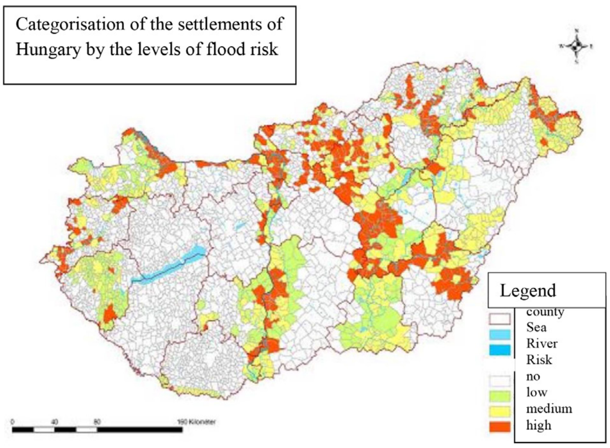


Figure 1: Map of flood risk of Hungary (white: no risk, green: low risk, yellow: medium risk and red: high risk) (http1, with permission of the publisher)

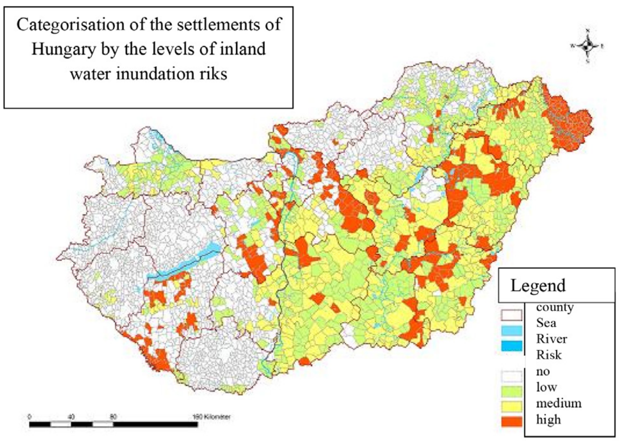


Figure 2: Risk map of inland water inundation of Hungary (white: no risk, green: low risk, yellow: medium risk and red: high risk) (http1, with permission of the publisher)

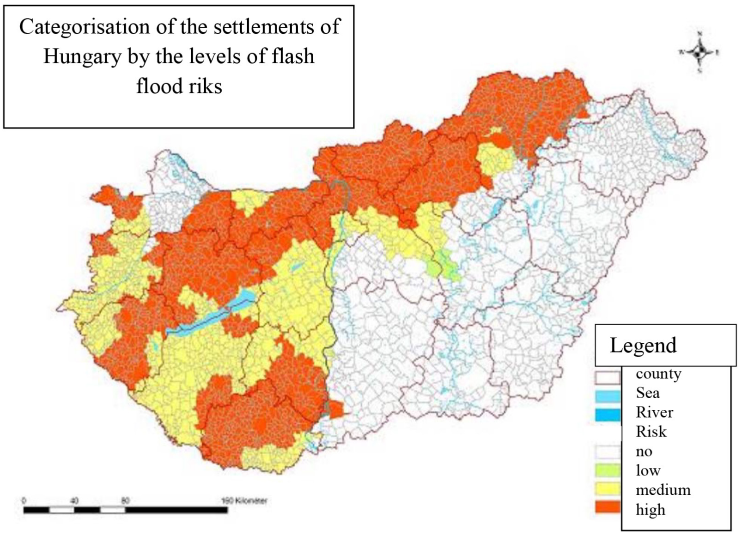


Figure 3: Flash flood risk map of Hungary (white: no risk, green: low risk, yellow: medium risk and red: high risk) (http1, with permission of the publisher)

Major floods and inland water inundations in Hungary

The major flood events before 2010 are summarized in *Table I.*

Table I.

Description of the major floods in Hungary between 1970-2010

Place and type of flood event	Date
Tisza-valley	May- June 1970
Körös- valley	June 1974
Körös- valley	July 1980
Northern Hungary	May 1989
Flood flow on the Hungarian rivers	Oct. – Nov.1998
Flood flow on the Hungarian rivers	Febr. – March 1999.
Flood flow on the Hungarian rivers	June – August 1999
Flood on the Tisza and its influent rivers	Apr. – May 2000
Flood on the upper section of the Tisza	March 2001
Flood on the Danube	March 2002
Flood on the Danube	August 2002
Flood flow on the Hungarian rivers	August 2005
Flood flow on the Hungarian rivers	April 2006
Flood flow on the Hungarian rivers	May- June 2010

Inland water inundations showed a cyclic pattern, reflecting the cyclicity of the weather. In dry years this type of inundations does not occur, but in wet years the area of land covered by inland waters can be huge.

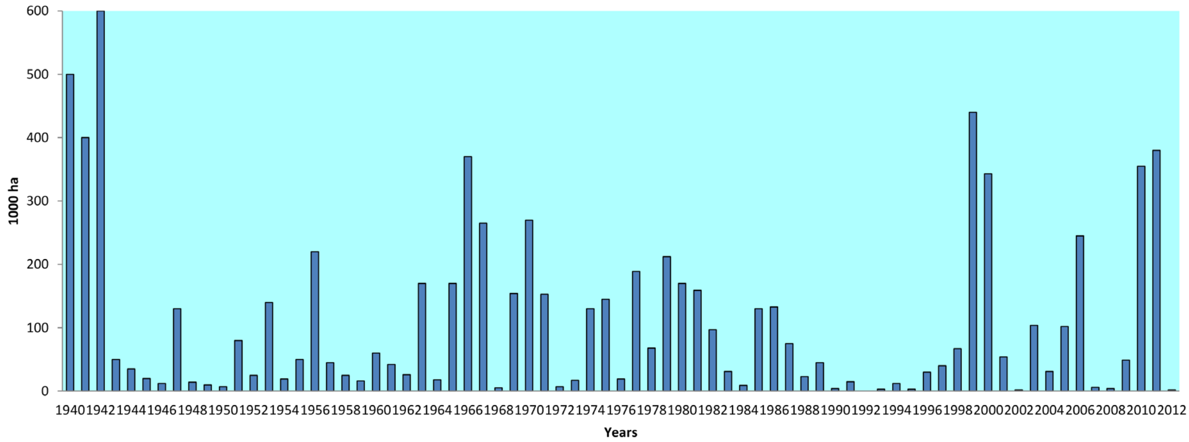


Figure 4: Inland water inundations in Hungary between 1940 and 2010 (http1)

Major floods in Hungary 2010-2018

In the year 2010 the amount of precipitation in Hungary was extremely high, the national average of yearly sum was 959 mm, breaking the last 110 years record (824 mm in 1940). There were only two months (March and October) when the monthly sum of precipitation was below the long term average. In May the amount of rain was three times as much as usually. On 15th May an extreme rainstorm with a windspeed over 90km/h hit the whole country resulting the flooding in a lot of streams (Boldva, Szinva, etc.) and smaller rivers (Ipoly, Zagyva Hernád, Sajó, Bodrog, etc) in the Northern part of the country. The flood prone settlements (altogether 842) are shown in *Figure 6*. The maximum number of evacuated population was 5,259; out of them 4,222 had to leave their homes in County Borsod-Abaúj-Zemplén. 271 real estates were destroyed totally.

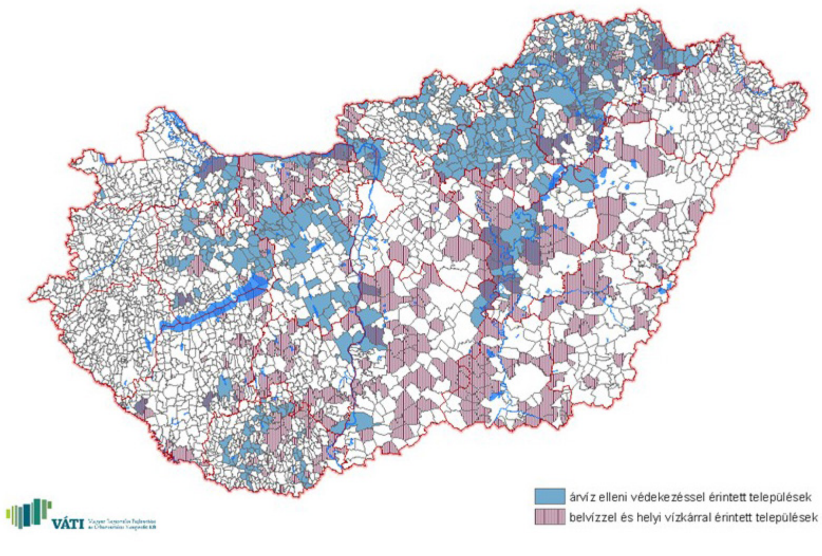


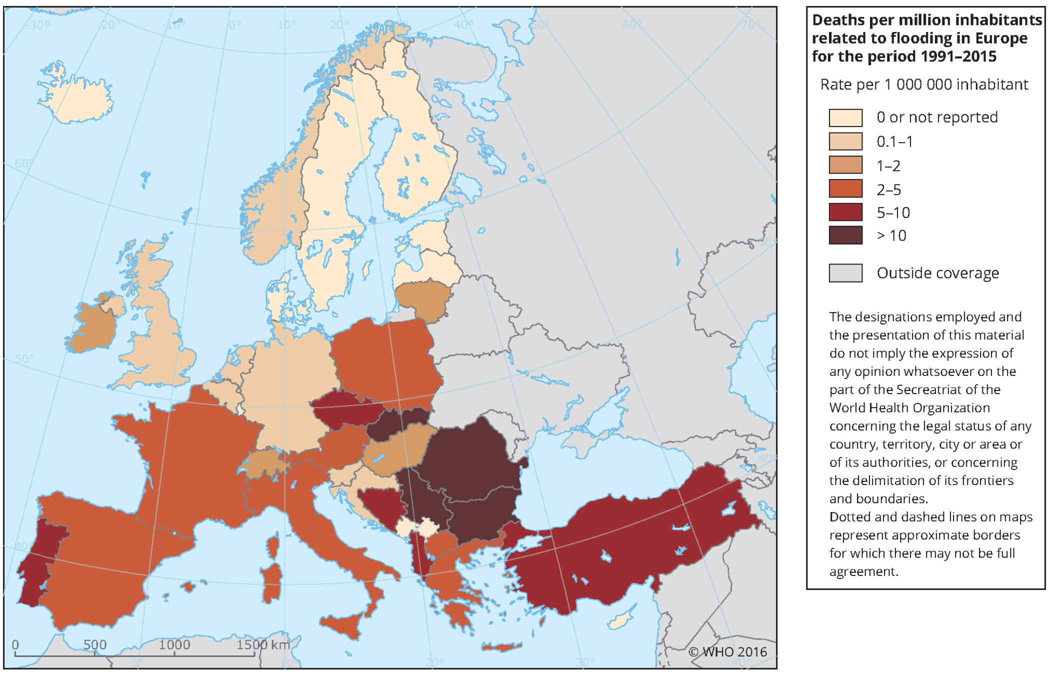
Figure 5: Settlements affected by the floods (blue) and inland waters (purple) inundations in 2010, Hungary (http2, with the permission of the publisher)

Flood on the river Danube in 2013

Between 30th May and 3rd June 2013 intensive rainfall happened in the catchment area of the Danube in Bavaria and Austria, resulting in a rapid increase of the water level in the upper part of the Danube. The water level increased in a very short time breaking records almost on the entire Hungarian section, reaching the ever highest water level in Budapest 891 cm on 9th June. The peak of the flood was on 14th June. The flooding endangered more than 200,000 people, out of them 1,570 had to be evacuated. The inundated area along the Danube covered around 93,600 hectares. Thanks to the well-arranged technical defense no toxic or hazardous material flew into the Danube. During the flood event the risk communication was very effective, no personal lost occurred.

Health effects of floods

Estimates of the World Health Organization (WHO) European Region based on a combination of data from the Emergency Events Database (EM-DAT) and the Dartmouth Flood Observatory (DFO) indicate that coastal and inland floods killed more than 2,000 people and affected 8.7 million in the period 2000 – 2014. *Figure 6* shows the number of deaths related to flooding in each European Environment Agency (EEA) member and cooperating country for the same period, normalised by their population. The largest numbers are found in South-Eastern Europe, Eastern Europe and Central Europe. It should be mentioned that, because of the relatively short time period of 15 years, the mortality rate is significantly affected by a single catastrophic event. For example, at least 50 people were killed in massive floods in the Balkan countries in May 2014.



Data source:
Eurostat statistics on population provided by Statistical Office of the European Union (Eurostat)
EM-DAT: The International Disaster Database provided by Centre for Research on the Epidemiology of Disasters (CRED)

Figure 6: Deaths related to flooding in Europe 1991-2015

Besides deaths from drowning flooding poses multiple risks to people's health ranging from heart attacks, hypothermia, trauma and vehicle-related accidents to increases in waterborne, vector-borne and rodent-borne diseases as well as effects on mental health. In the long-term, chemical contamination of food and water stocks, damage to water and sanitation infrastructure, damp housing can further exacerbate the adverse public health effects of flooding.

Medium term effects relate to diseases that require a vehicle for transfer from host to host (water-borne like Hepatitis A, Giardia, Cryptosporidiosis) or a host/vector as part of its life cycle (vector-borne) [i.e. West Nile fever (WNF), Malaria, Dengue fever] and rodent-borne transmission of diseases (like Leptospirosis) (Brown et al., 2013).

There were endemics in several countries in Europe following flood events like Leptospirosis: in France in 2009 (Socolovschi, 2011); in Austria 2010 (Radl et al., 2011); in the Czech Republic in 1997 and 2002 (Zitek and Benes, 2005). In 2014 fourty-one people were infected in Jász-Nagykun-Szolnok County[6] after a long period of heavy precipitation causing an inland inundation.

Flood-affected areas serve as ideal breeding grounds for pathogens and may alter vector breeding grounds and zoonotic reservoirs. Where infectious disease transmission is endemic, it can present a major public health concern following flooding (Semenza and Suk, 2015).

Floods have a very important role in modifying the mosquito abundant rivers which have a major water running as the river Tisza and have more or less preserved floodplains offering better conditions for mosquitos than the highly regulated rivers. Recently it is possible, that birds reintroduce WNF into Hungary from year to year. The relative risk to the above-average number of WNF cases was 4 times higher when the mean level of the river Tisza was higher (in 2010) than the mean of the studied six years (Trájer et al., 2014).

Climate change may increase the incidence of waterborne diseases due to extreme rainfall events, and consequent microbiological contamination of the water source and supply. The case of heavy precipitation in Miskolc 2006 called the attention to the vulnerability of karstic drinking water resources. During the event a large amount of precipitation fell on the catchment area of the karstic water source, causing an unusually strong karstic water flow and flooding, and subsequent microbiological contamination. More than 3,000 people were infected by the polluted drinking water. This case underlines the increasing importance of preparedness for extreme weather events in order to protect the karstic water sources and to avoid waterborne outbreaks (Dura et al., 2010).

The impacts of floods on health depend on many factors, but mostly on the nature of the flood and the vulnerability of the population. Vulnerability assessments both in terms of flood zones and, even more importantly, population groups are needed to provide insights in the policy and risk management actions and mitigation responses. Mapping of flood risks and characterizing populations at risk is an important part of the EU Flood Risk Directive 2007/60/EC.

[6] *https://www.informed.hu//betegsegek/infections/spirocheta/eddig-41-ember-betegedett-meg-feltehetoen-leptospirozisban-jasz-nagykun-szolnok-megyeben-193391.html?_articlemodify_site=930*

As with extreme weather events in general, the initial health risks depending on where and how people live i.e. populations living in flood-plain determine the “starting-point vulnerability”. Even more, people who live in areas that have experienced little or no flooding in the past are often more vulnerable to health impacts because they are less prepared and less experienced in dealing with floods (Barredo et al., 2007).

Population groups such as the elderly and the poor are particularly vulnerable to flooding: the elderly as they are more “fragile”, the poor as they tend to live in houses less able to withstand floods, both groups having difficulties to evacuate from a flood-prone area. Other groups with increased vulnerability include infants, immunocompromised, those with chronic diseases or receiving drug treatment (Ebi et al., 2006).

Droughts

Drought is a complex phenomenon. One possible definition of the drought is based on dry spell. In the case of precipitation amount less than 10 mm at least for 30 consecutive days in total (Law CLXVIII/2011). Drought is a physiological water stress causing irreversible changes in live structures (Várallyay, 2006; Vermes, 2011; Jolánkai et al., 2012). Generally, this occurs when a region receives precipitation consistently below the average. It can have a substantial impact on the ecosystem and agriculture of the affected region. Although droughts can persist for several years, even a short, intense drought can cause significant damage and harm the local economy. In Hungary there are various methods applied in the field of drought evaluation, however the most widely used method is based on the Pálfai Aridity Indices (PAI), processed on the bases of the annual precipitation and temperature data (Pálfai, 2010).

Heatwaves frequently cause droughts. The long-term drought periods are generally connected to situations when the Siberian and Azorean anticyclones are merged for a longer period. Extremely dry conditions were experienced in recent years, in 2011 and in the first half year of 2012. The drought – lasting for almost two years – caused severe damage to agriculture; the total losses due to the drought in 2012 were estimated to be more than US$ 1.8 billion in Hungary. Hungary is highly exposed to the risks of droughts. As an average in four years out of ten we have to count for water scarcity; between 1976-1985 there were three years with droughts and in 1986-1995 there were seven years with water shortage. Between 1990-2002 droughts were recorded in the years 1990, 1992, 1993, 1994, 2000, 2001. In 2002 parallel with a flood on the Danube there was severe water scarity in the area of the river Raba and on the Great Hungarian Plain.

These data call the attention on the necessity of the prevention of losses due to droughts. We had to face the extremely dry spring in 2019, moreover similar lack of precipitation in the autumn period of 2018. Based on the analysis of the 110 year time series of meteorological data it was concluded that serious droughts with high economic burden occur once in 30 years. Such severe event was recorded in 1992. Droughts cause a lot of damage to the agriculture, water scarcity results in an extereme low water level of the rivers hindering the water transport and traffic which leads to the decrease of e.g. water tourism. During long lasting drought periods the risk of sand storms and wildfires increases.

Wildfires

The relative frequency of forest fires has increased in the past years in Hungary due to the more frequent extremes, less precipitation and higher mean temperatures. In Hungary there are no uncontrolled wildfires affecting huge areas like in the tropics and boreal regions. However we experience smaller wild- and vegetation fires in spring and summer.

Forest fires can occur during dry summers in older deciduous and coniferous woods. In the former type of forests surface (ground) fires occur commonly, in coniferous (pine) forests the fire extends to the crowns in a short time. Peat fires are a type of underground fires, which occur during droughts in summers and are usually caused by ground vegetation fires that ignite above the peat. This type of fire happens rarely in Hungary. The fires in Hungary affect not more than 50 hectares, in average they cover 6 hectares. In the latest years there were 500-600 fire events per year. Some remarkable fires occurred in Bács-Kiskun County[7] (Orgovány 2000, Jakabszállás 2003, Késleshalom 2007).

The most remarkable fire event happened on 29th April 2012 in the middle of Kiskunság area, Bugac[8] where 1100 hectares of Juniperus woods set fire. The plume was blown towards Budapest by the south-east wind. The increased PM_{10} concentration was measured by the monitor at the Gilice Square in Budapest with a peak of 120 μg/m³ at 14.00 on 29.04.

Figure 7: The direction of the plume of the Bugac wildfire Aqua/MODIS Satellite image April 29. 13.40 2012 (Source: NASA – OMSZ)

7 *https://greenfo.hu/hir/feltuzelt-duna-tisza-kozi-novenyzet/*

8 *https://www.met.hu/ismeret-tar/erdekessegek_tanulmanyok/index.php?id=194*

In 2019 more than 2,000 forest and vegetation fire occurred during spring affecting more than 9,000 hectares forest and agricultural areas due to the drought[9].

Health implications of drought are numerous and far reaching. People sometimes experience short-term health effects that 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 (Stanke et al., 2013). The impacts of drought are usually indirect; 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 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 and increased recreational risks. Droughts followed by re-wetting can have a substantial effect on water table levels, vegetation, and aquatic predators; all factors which influence mosquito populations (Semenza and Suk, 2018).

Human health can be severely affected by wildfires. Wood smoke has high levels of particulate matter and toxins. Long-range transported particulate matter (PM) air pollution episodes associated with wildfires are recorded in the literature, emphasising the adverse effect even in far-living populations (Hanninen et al., 2009). Respiratory morbidity predominates, but cardiovascular, ophthalmic and psychiatric problems can also be the result. In addition severe burns resulting from direct contact with the fire require care in special units and carry a risk of multi-organ complications. The wider health implications from spreading air, water and land pollution are of concern. Access to affected areas and communication with populations living within them is crucial in mitigating risk (Finlay et al., 2012).

INTERNATIONAL RECOMMENDATIONS TO REDUCE THE HEALTH RISK AND CONSEQUENCES OF EXTREME WEATHER EVENTS

The Hyogo Framework for Action (HFA)[10] was established in 2002 in order to build the resilience of nations and communities to disasters. It was the first plan to explain, describe and detail the work that was required from all different sectors and actors to reduce disaster losses. The HFA outlined five priorities for action, offered guiding principles and practical means for achieving disaster resilience. Its goal was to substantially reduce disaster losses by 2015 by building the resilience of nations and communities to disasters. The five principles were the following:

- 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.

[9] *http://www.eumet.hu/tag/erdotuz/*

[10] *https://www.unisdr.org/we/inform/publications/1037*

The WHO has very detailed recommendation is case of the most important extreme weather event - flood discussed in the publication “Floods in the WHO European Region: health effects and their prevention”. The WHO emphasizes the need of a multisectoral approach to prevent flood health effects (Menne and Murray, 2013). A range of primary, secondary and tertiary prevention measures are recommended to minimize the health impact of flooding events.

- Primary prevention can be either structural (physically engineered interventions) or non structural (policy and organization). In many countries primary prevention include emergency plans and other methods to reduce the effects of floods, like land use management; tree planting; control of water sources and flow, including drainage systems; flood defences and barriers; design and architectural strategies; and flood insurance. These measures are normally planned far in advance.

- Secondary prevention includes identification of vulnerable or high-risk populations before floods occur, early warning systems, evacuation plans including communication and information strategies, and planned refuge areas. Secondary prevention measures for flood risk management can be taken either just before or during a flood to mitigate the health effects of the flood. Multisectoral collaboration is required between health services, early warning systems, water supply companies and emergency services for evacuation. Secondary prevention measures for vulnerable populations should account for difficulties in communication and mobility and the needs of people with chronic diseases.

- Tertiary measures include moving belongings to safe areas, ensuring the provision of clean drinking-water, surveillance and monitoring of health impacts, treating ill people to reduce the health impacts of flooding, and recovery and rehabilitation of flooded houses. Multisectoral collaboration among the military, fire department, police, water supply companies and health services is required. Robust surveillance is necessary during and after flood events to identify and control infectious disease outbreaks and non-infectious health hazards, tailor health service provision to the needs of the population, monitor vulnerable groups and provide information for research on possible associations between flooding and ill health.

CONCLUSIONS

As it was pointed out in the paper, the probability of extreme weather events are predicted to increase in the future, countries should prepare to adopt the recommendations of the international organizations in order to reduce the health impacts and economical lossess of these extreme meteorological situations. “The health, environment and climate change strategy” adopted by the 72nd General Assembly of the WHO (2019) emphasizes the need to improve the resilience of the health sector and communities to climate change, to reduce vulnerabilities, and to enhance preparedness, surveillance and response to health emergencies.

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