The Health Dimension of Climate Change

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TABLE OF ACRONYMS
TABLE OF CONTENTS

CONTEXT

I.  The Health Dimension of Climate Change
II.  Analytical time scales
III. Types of Impacts
IV. Extremes and Averages
V.  Cross-cutting Issues
VI. Timeframe for Action
VII. Assessment Frameworks
VIII. Adaptive Capacity in Health Systems
IX. Report Structure

SECTION ONE
Evidence Base for Climate Change Events and Health Impacts in ECA

1.1 Overview
1.2 Extreme Weather Events
1.2.1 Floods
Flood-related mortality in ECA
Water-borne and food-borne diseases
Vector-borne diseases
Rodent-borne disease
Others
1.2.2 Heat waves
Excess mortality
Cause-specific mortality
Heat-related morbidity
Additional Risk Factors
1.2.3 Droughts
1.3 Changing Average Temperatures & Impacts on Health in ECA
Vector-borne diseases
Water-borne and food-borne diseases
Allergies
1.4. Other Impacts of Climate Change: Migration
The Impact of Migration on Health
SECTION TWO
Country-Level Climate Change-Health Vulnerability Assessment

2.1  Overview
2.2  Toolkit proposal, definitions and rationale for indicators
2.3  Climate Change-Health Vulnerability Assessment Toolkit

SECTION THREE
Climate Change-Health Adaptive Strategies

3.1  Overview
3.2  Adaptive Strategies for Extreme Weather Events (table)
3.3  Adaptive Strategies for Changing Averages (table)
3.4  Adaptive Strategies for Migration-Related Health Effects (table)
3.5  Adaptive Strategies for Coastline-Related Health Effects (table)

Annex 1: Summary Table for Flood-Related Health Outcomes
Annex 2: Summary Table for Heat Wave-Related Health Outcomes
Annex 3: Summary Table for Drought-Related Health Outcomes
Annex 4: Qualitative Indicators

References

Table 1: Climate Change-Health Outcome Matrix
Table 2: Top Ten Flood Events Recorded in EM-DAT that Killed the Greatest Number of People; Europe & Central Asia 2000-2007
Table 3: Classification of flood disaster deaths
Table 4: Mean Change* for heat wave duration index and frost days for the period of 2031-2050 compared to 1981-2000 under emissions scenario A1B
Table 5: The reported number of morbidities as a result of heat wave events in ECA
Table 6: Malaria Incidence and Reported Cases in ECA 1990-2005
Table 7: Vector and disease projections for ECA
Table 8: Climate change health impacts and migration
Table 9: Adaptive Strategies for Extreme Weather Events
Table 10: Adaptive Strategies for Changing Averages
Table 11: Adaptive Strategies for Migration-Related Health Effects
Table 12: Adaptive Strategies for Coastline-Related Health Effects

Figure 1: Direction and magnitude of change of selected climate change health impacts.
Figure 2: Global burden of deaths and DALYs in 2000 and 2020 attributable to climate change under a no intervention climate scenario.
Figure 3: Relative Vulnerability to Floods in the Context of Flood-related Mortality; Europe and Central Asia 1980-2000
Figure 4: ECA 2000-2007 Landslides
Figure 5: Epidemic Curve of daily incidence of typhoid fever in Kulyab, Tajikistan 1996.
Figure 6: Comparison of the mortality effect of the six heat-wave events in Budapest, Hungary.
Figure 7: Precipitation Deficit and Drought in Central and South West Asia (1999-2001).
Figure 8: Projected Changing Averages in ECA according to scenario A1B
Figure 9: Migration Patterns in ECA
Figure 10: The links between climate change, migration and health outcomes.
Box 1: Climate Change effects on health
Box 2: Lessons learned - control of gastrointestinal outbreaks following 1997 floods (Poland)
Box 3: Urban Heatwaves
Box 4: Fires
Box 5: Moldova’s 2007 Drought
Box 6: Case study - Drought and Migration (Republic of Moldova)
Box 7: Case study - Floods and migration (Kazakhstan)
Box 8: Eutrophication and Human Health
CONTEXT

I. The Health Dimension of Climate Change

Along with other processes that support life, climate systems fundamentally shape conditions for most living organisms, including humans. In the Europe and Central Asia (ECA) region and throughout the planet, weather and climate variability often crucially determine societies’ livelihoods, health and well-being. This paper attempts to aggregate what is currently known of the current and projected impacts of climate system behavior on human life.

As reiterated by the Intergovernmental Panel on Climate Change (IPCC) in its fourth assessment, warming of the climate is “unequivocal” and “very likely due to anthropogenic causes.” This ongoing and future anthropogenic climate change involves a change in the radiative forcing1 of the Earth, due to the increased concentration of greenhouse gases in the atmosphere, and resulting in increased temperatures and altered meteorological variables. Other effects of this warming include an increase in heavy rainfall episodes, melting of ice sheets and glaciers, and thermal expansion of the oceans.

The global increase in average temperature of the atmosphere and the oceans is “with high likelihood” already affecting natural and human systems through regional changes in climate, notably through increased weather variability and a shift in average temperatures and precipitation. Scientists say the influence on the physical and biological systems may even be discernible on the global level in the last three decades2 – a short time span compared to the periods required, prior to now, for observable change in the action of climate factors.

Prompted by mounting evidence on the presence and extent of induced climate change, a number of researchers, institutions and international organizations have directed their efforts towards predicting and quantifying its impacts on the health of human populations. In the origins and development of most of these analytical exercises, it has proven of extreme importance to adequately frame an appropriate specification of the meteorological exposures of interest (i.e. the specific factors that may directly or indirectly harm health). This precision proves so critical because various health outcomes often show disparate lag periods between exposure and effect, with direct implications for the assessment of causality. Therefore, an overall assessment, including different types of health endpoints, call for a rigorous definition of timing in exposure factors and latency periods.

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1 Radiative forcing is the change in the balance between radiation coming into the atmosphere and radiation going out. A positive radiative forcing tends on average to warm the surface of the Earth (Source: IPCC)
2 IPCC 2007, WHO 2007
II. Analytical time scales

As used in the scientific literature, the concepts “climate” and “weather” refer to different analytical approaches to atmospheric phenomena, and can be summarized over different scales in time and space. “Weather” refers to the state of the lower atmosphere at a given time and place, described by variables such as temperature, precipitation, moisture, wind, etc. “Climate” however, refers to a statistical description of the “average weather” over a period ranging from months to thousands of years or more; a classical period of analysis is 30 years.

Predicted impacts of climate change on health will be mediated through the relevant mid and long-term trends both in climate and in weather phenomena, involving seasonal, stochastic and long-term occurrence, from the next few years to several decades in the future. Current studies suggest that effects on health will occur through increased frequency and/or intensity of extreme weather events and via factors related to a progressive increase in average atmospheric temperatures.

Changing patterns of precipitation - some regions will become drier while other areas will become wetter - will add further complexity. Furthermore, increase in precipitation will likely occur through an increase in the frequency of the heavy precipitation events. Resulting interactions and modulating influences at the local level will result in a large pool of potential impacts on human health.

III. Types of Impacts

Progressive and/or cyclical effects on health will be expected in relation to a gradual increase in average temperatures and changes in precipitation patterns. They will be mediated through effects on agricultural and ecosystems’ services (hence on livelihoods), disruption of social and behavioral systems, synergies with pollution dynamics, changes in disease transmission patterns, variations in altitudinal and latitudinal ranges of vectors, and the destructive effects of new weather extremes, among other factors. A model for the causal pathway from Climate Change to health outcomes is reflected in Box 1 below.

Certainly, a wide array of infectious vector-borne, food-borne and water-borne disease shows sensitivity to average temperature and/or precipitation. In general, warmer temperatures within a range improve the viability and shorten the maturation processes of vectors\(^2\) and pathogens. Of growing relevance in ECA are salmonella poisoning, cholera, and tick-borne and other vector-borne diseases, whose prevalence is projected to increase.

\(^2\) In epidemiology, a vector is a carrier which transmits an infective agent from one host to another, frequently an animal, such as insects, etc. (Source: CDC).
Box 1.- Climate Change effects on health

Source: Adapted from McMaster et al (2003)

Climate Change will translate into alterations of regional weather patterns, which in turn will result in increased frequency and/or intensity of extreme events as well as an increase in average temperature and changes in precipitation. Some of these factors may burden health by themselves (e.g. heatwaves) but often times they will impact health through altering transmission pathways in infectious diseases and disruption in livelihoods, food-producing systems and social and behavioral structures. Resulting health outcomes will be related to infectious (vector-, rodent-, water- and food-borne) diseases, environmental exposures (e.g. air pollution, high temperature) and diminished or damaged food and water supplies. In this complex causal chain, modulating influences related to susceptibility and concurring factors will likely have large effects depending on the local context. Attending to site-specific projected impacts, actions taken to adapt the health sector to Climate Change will also modulate the exposure-outcome relationship, in a feedback loop. Further research is needed in virtually every step of the causal pathway, including regional impacts, mediating factors, health effects, evaluation of adaptation strategies and adequacy of health-specific adaptation actions.

It must not be overlooked, however, that a sizeable part of the impact of climate change on public health will likely occur through the consequences, for health, of the disturbance of livelihoods associated with natural and agricultural food-producing ecosystems, rising
sea-levels and population displacements within and across countries. Such processes may take decades to become evident, further obscuring the underlying causal links.

**IV. Extremes and Averages**

Extreme weather events are expected to become more frequent with climate change. In some cases, severity of these events is also likely to increase. Health effects from these extremes can stem from excessively high or low temperatures, as well as of complex episodes like droughts, severe storms or floods. Although the effects of disastrous weather on health are particularly difficult to estimate in most developing countries because of poor surveillance and reporting capacity, heatwaves, floods and droughts will probably be of high relevance for ECA countries.

An episode of excessively hot days, or heatwave, can in itself cause heat-related illnesses. The biggest effect, however, will occur through an aggravation of pre-existing diseases, especially in vulnerable urban populations. Adding to the uncertainty of attributing cause-specific excess mortality in populations at high baseline risk, heatwaves can further enhance the formation and residence time of air pollutants, with resulting additional effects on cardiovascular and respiratory disease.

Floods can cause drowning, traumatic kills or injuries at the onset of the event, but may also increase morbidity and mortality through disruptions in water and sanitation systems, spread of vectors, displacement of populations and damage to livelihoods, among other factors.

Though causal links are especially difficult to establish at a population level, droughts set the conditions for a wide range of nutritional, infectious, psychological and other health consequences that usually occur after a severe disruption of basic economic systems, such as the ones likely to occur in many developing countries in most climate change scenarios.

In keeping with the inherent complexity of this subject, not all predicted health impacts of climate change will be adverse. Milder winters are predicted to smooth the seasonal winter-time peak in mortality that occurs in countries across temperate regions. In currently hot countries, an increase in average temperatures might reduce the viability of disease-transmitting vector populations or the carried pathogens themselves, a positive impact unlikely to occur in the ECA region. Overall, however, evidence suggests that most health impacts of climate change will be adverse, and of much greater magnitude than that of positive impacts (see Fig 1. IPCC 2007).
V. Cross-cutting issues

Though there is some uncertainty as to the predicted presence and extent of specific risks at a sub-regional scale, upcoming impacts of climate change will share some cross-cutting characteristics which are relevant in terms of policy analysis.

Firstly, climate change will not suppose any novel type of environmental exposure; however, many of the above-mentioned current major threats to public health and environmental determinants of health are climate-sensitive, and they are predicted to worsen under most currently considered climate change scenarios.

Secondly, a substantial proportion of the World’s (and ECA’s) population will be exposed in some way, either directly or indirectly; many of these affected communities will live in the poorest countries, where health impacts are expected to be greatest. These widespread exposures over large populations would result in huge effects, with inequitably shared risks.

VI. Timeframe for action

The magnitude and relevance of recent and forthcoming impacts immediately raises a question regarding the available timeframe for action. Indeed, current evidence stresses the need for urgent decision-making. Changes in climate in the last decades are
responsible for an observable proportion of the current and recent past mortality and morbidity burden of climate-sensitive events and diseases. According to WHO, climate change effects on mortality through floods, malaria, diarrhea and malnutrition worldwide in the year 2000 accounted for an estimated total of 150,000 (0.3%) deaths and the loss of 5,517,000 (0.4%) Disability-Adjusted Life Years (DALYs) per year (Campbell-Lendrum et al. 2005, Zhang et al. 2007).

Under a “Business as Usual” (no intervention) scenario, these impacts are predicted to increase substantially by 2020 (see Fig 2). Though estimates for ECA region are comparatively mild compared to other parts of the world (e.g. Sub-Saharan Africa and Southeast Asia), the order of magnitude and worldwide increasing trend of these burdens is substantial enough for careful consideration within a precautionary approach.

**Figure 2**

![Figure 2: Global burden of deaths and DALYs in 2000 and 2020 attributable to climate change under a no intervention climate scenario. Source: Campbell-Lendrum et al. 2005.](image)

Given the probability of the risks, the size of eventual losses and the potential benefits of early action, societal response should be initiated despite uncertainties. In particular, Health services in affected areas should start building their adaptive capacity in order to adequately respond to the consequences of climate change.

**VII. Assessment Frameworks**

Acknowledging the differences in region and country priorities and issues, the World Health Organization (WHO) recently stressed the need to carry out National Assessments on human health vulnerability and public health adaptation to climate change. Other internationally relevant players have also developed different Vulnerability Assessment frameworks and guidelines on their application to country cases. The intent of these
frameworks is to understand current vulnerabilities and to evaluate the capacity of health systems to modify health infrastructure and adopt relevant measures, in light of nationally relevant predicted climate change impacts.

A lack of definition as to the plausible indicators to track progress in vulnerability aspects has been a common shortcoming for the practical application these tools. There is also a need for a deeper understanding of these vulnerability dimensions in order to facilitate the issuance of policy-relevant recommendations, tailored to the specific countries’ needs. Further research is needed, along with pilot studies. Results of the application of these analytical tools are yet to be compared systematically in different settings, but they constitute, as of today, a solid starting point for the comprehensive type of assessment that will be needed for sound health policy decision-making in the wake of climate change.

VIII. Adaptive Capacity in Health Systems

As in most other sectors, building adaptive capacity for health will require a cross-boundary dialogue between health practitioners, decision-makers, the public and the climate change science community. As a component of the overall need for adaptation to climate change, adaptive strategies in health will be based on actions that governments, institutions and the public can take to adjust to impacts, moderate their damage or cope with their consequences.

Most relevant actions for adaptive capacity will be those enabling commonly accepted good public health and development practice, beyond climate change considerations. The creation and maintenance of basic public health infrastructure in terms of training, surveillance, immunization, vector control and emergency preparedness and response will both provide development benefits and increase resiliency to health impacts of climate change. As circumstances continue to change, novel actions and strategies will develop through the appearance of new technologies, discoveries and a growing understanding of the relationships between natural and man-made systems and human health.

In this report, adaptive strategies are classified as anticipatory (planned and implemented before the onset of an event) or responsive (planned before the onset and implemented at the onset of an event). The timescale of a responsive adaptive strategy depends on the type of hazard, its duration, and its health-associated impacts. For example, a responsive adaptive strategy to flood could last up to a few days, while the flooding occurs, months afterwards, in order to control potential breakouts of vector and water-borne diseases, or even years afterwards, in order to provide psychological support for victims with event-associated trauma-induced disorders.

Any meaningful package of nationally relevant adaptive strategies will have to be based on a comprehensive assessment of vulnerabilities, including the magnitude and nature of specific exposure, the underlying sensitivity of the population to that exposure, and the
current ability of the health-related systems to respond to the resulting impacts (i.e. their adaptive capacity).

Once evaluated for feasibility and effectiveness, risk and sensitivity will have to be addressed first by policy action. Only then can strategies be designed to deal with multiple vulnerability dimensions simultaneously, including economic resources, technology, use of information and human capital, institutional constraints, and equity, among others. Governments, health institutions and the public will have to assume responsibility in the design and implementation of these strategies, both at the anticipatory and responsive stages.

Ultimately, only an ongoing balanced and constructive dialogue among stakeholders will allow for the decisions and actions needed to enhance the ability of communities to cope with current and future climatic variability.

IX. Report Structure

This report focuses on the health impacts of climate change that are relevant for ECA countries, assessing the vulnerability of health sectors to these impacts, and providing insights into building health-specific adaptive capacity. The impacts of climate change on health are detailed and analyzed at various levels, in relation to an increased frequency and/or intensity of extreme weather events as well as those due to a progressive increase in temperatures entailing expanded disease vector distribution and other climate-sensitive factors. However, climate change also impacts health outcomes through modulating influences related to pollution, shifting coastlines, etc. and environmental changes such as water scarcity, mud slides, UV rays etc. These environmental changes impact behavior in areas such as migration, hygiene, health services seeking, water utilization, food safety, and agricultural livelihoods, including fishing.

The report is divided into three main sections: (i) discussion of climate change events and their health impacts in ECA; (ii) a country-level climate change-health vulnerability assessment; and (iii) adaptive strategies for optimizing health outcomes in the face of climate change.

Section one reviews published scientific articles and reports\(^3\) which document the direct and indirect impact of climate change on health in ECA. “Climate change” here refers to extreme weather events (floods, heatwaves and droughts) as well as to changing average temperature and precipitation. The section also reviews indirect health impacts, such as from migration and shifting coastlines. The ECA Climate Change-Health Outcome Matrix outlines the potential climate change burden on morbidity and mortality (see Table 1).

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\(^3\) A detailed description of the reviewed literature is summarized in Annexes 1-3 to include the following: reference; a brief synopsis of the study/report; location in ECA where the study/report is applicable; study design, if applicable; population affected by the exposure; documented outcomes, and measures of effect, if given or if their calculation is possible.
Section two of the report deals with country-level climate change and health vulnerability assessment tools. It builds on both the Australian Government’s *Climate Change, Risk and Vulnerability* report (ref) and the World Health Organization’s (WHO’s) framework (Ref WHO-Europe) for the assessment of adaptive capacity – a risk management tool that utilizes information on country-specific exposures and sensitivities. This section goes on to develop a *Climate Change-Health Vulnerability Assessment Toolkit*, which points up sources of vulnerability in order to actively inform health policies and sector-specific dialogue (see Fig. 3).

Section three focuses on identifying policies and measures to enable Health Systems to cope with the expected impacts of Climate change, by building adaptive capacity consistently, usefully, and manageably. Adaptive strategies are categorized as anticipatory (in advance of climate change effects) or responsive (mostly planned and at the institutional level). The main output of this section is an *Adaptive Strategy Matrix* for the different events, with recommendations for government, health institutions and the public.
Section One
Evidence Base for Climate Change Events and Health Impacts in ECA
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Evidence Base for Climate Change Events and Health Impacts in ECA

1.1 Overview and Climate Change-Health Outcomes Matrix

The health impacts of climate-related exposures in ECA are treated in this section, first in a summary matrix, followed by a closer look at the direct and indirect impacts of extreme weather events (floods, heat waves, and droughts) and the impacts of changing average temperatures. Both the sudden occurrences as well as the more gradual shift in temperatures may affect human migration behavior, with health implications both for migrants and for host societies.

The severity and frequency of extreme weather events is likely to increase, according to most projections. While effects of extreme weather events are difficult to track in developing countries because of poor capacity, they are likely to be notable in ECA. Floods, for example, in addition to causing drownings, often promote the spread of disease through rodents, insect vectors, and water and food-borne agents. Each of these can increase dramatically after a flood event. Extreme heat can harm a person’s health outright, or can exacerbate existing health conditions, especially in urban areas for those sensitive to the worsening of air pollution that is caused by heat. Droughts disrupt economic systems and weaken populations’ disease immunity through inappropriate nutrition.

Gradual climate change affects the conditions for disease vectors over time as well. The incidence of Cholera, salmonellosis, lyme borreliosis, tick-borne encephalitis, dengue fever and malaria may increase when new zones become warm enough to support their spread. Warmer temperatures over bodies of water also allow nutrients and bacteria harmful to humans to flourish.

By devastating livelihoods, all of these events and changes may spur migration. The migration process is stressful and often characterized by poor access to health and sanitation services; it puts a burden on host populations as well as migrants.

Climate change itself is difficult to predict with accuracy, with uncertainty and unknown factors, to contend with in projection models. The health outcomes that are linked to climate change depend on a host of factors as well, some quantity of which are, in all likelihood, presently unanticipated. This section represents an attempt to account for known factors and possible outcomes as related to the human health-climate change nexus.

The Climate Change-Health Outcome Matrix
As indicated above, the following matrix was developed from a review of the literature that treats the relationship between climate change and health.
Table 1: Climate Change-Health Outcome Matrix

*Includes pregnancy loss and disorder (premature delivery, missed abortion, birth asphyxia, premature rupture of membranes, intrauterine growth retardation).

‘x’ denotes evidence for association

| Denotes no evidence suggesting association |

4 Crosses (x) represent evidence of an association between defined exposures and health outcomes.

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Mortality (Cause-specific)</th>
<th>Indirect Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Extreme Weather Events</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heatwaves</td>
</tr>
<tr>
<td>Heatwaves</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Floods</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Droughts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mortality (Cause-specific)

- Drowning: x
- Physical Trauma: x
- Heat Exhaustion: x
- Fire: x
- Suicide: x

Indirect Impacts

Respiratory Diseases

- Asthma: x
- Acute Lower Respiratory Tract Infections: x

Mental Diseases

- Depression: x
- Post-Traumatic Stress Disorder: x

Reproductive Diseases

- Perinatal complications*: x
- Amenorrhea: x

Morbidity (System-Related)

Rodent/Vector Borne Diseases

- Leptospirosis: x
- West Nile fever: x
- Tahyna: x
- Malaria: x
- Dengue: x
- TBE: x
- Lyme Borreliosis: x

Water/Food Borne Diseases

- Cholera: x
- Dysentery: x
- Hepatitis A: x
- Salmonellas: x
- Acute Toxicity: x

Other

- Malnutrition: x
- HIV/AIDS: x
- Allergies: x
- Dehydration: x
- Dermatitis: x
- Gastroduodenal ulcer disease: x

Table 1: Climate Change-Health Outcome Matrix

*Includes pregnancy loss and disorder (premature delivery, missed abortion, birth asphyxia, premature rupture of membranes, intrauterine growth retardation).

‘x’ denotes evidence for association

| Denotes no evidence suggesting association |

4 Crosses (x) represent evidence of an association between defined exposures and health outcomes.
The matrix represents a simplified summary of possible associations. In reality, the mediating causal pathways between climate change and human health are highly complex, with modulating influences whose analysis is far beyond the scope of this report. Increased frequency, intensity and duration of heatwaves, for instance, would increase mortality, but would also imperil livelihoods (e.g. killing cattle and crops) and energy supplies (e.g. with blackouts), and would exacerbate urban air pollution. More frequent and severe floods would cause drownings, but would also facilitate epidemics. Droughts affect food and water supplies and thus increase malnutrition and accompanying illnesses. Changes in patterns of precipitation are predicted to decrease crop yields, but will also influence the range and distribution of vectors for certain infectious diseases.

Acknowledging the multitude of ultimate exposures, causal pathways and health endpoints, the matrix focuses on mortality and morbidity outcomes for which there is solid and consistent evidence of likely effects due directly or indirectly to extreme weather events and a gradual increase in average temperatures.

Extreme weather events and changing averages are considered to have direct effects on human health through deaths by trauma and the increased spread of disease vectors.

1.2 Extreme Weather Events

As mentioned above, and as indicated by the United Nations Framework Convention on Climate Change (FCCC) and the WHO, natural climate variability over a period of time, coupled with human activities that directly or indirectly affect and change the composition of the atmosphere are expected to increase the frequency of extreme weather events such as floods, heatwaves, and droughts, with mostly negative impacts. Hardest hit will be low income countries where health sector capacity is weak and populations are generally more vulnerable.

1.2.1 Floods

Floods account for half of fatalities due to natural disasters world-wide (Noji 1991). Flash floods are more fatal than river floods and have death rates comparable to those of earthquakes (Jonkman 2005). Most flood fatalities are due to drowning (hypothermia and asphyxiation), with the elderly at greatest risk (Ahern et al. 2005). Heart attacks, carbon monoxide poisoning, fires, electrocution, and trauma, including vehicle-related accidents, also contribute to the death toll.

While most documented fatalities are reported during the flood event, some occur before or after. Pre-event fatalities may occur under conditions of stressful evacuations. In the 2002 floods in Germany, three out of fourteen heart attack fatalities were reported during evacuation (Jonkman and Kelman 2005). Unplanned hospital evacuations prevented a hospital from extending its full services (Meusel and Kirch 2005). Loss of life during evacuations may be avoided through improved organization and preparation (Jonkman et
Post-event fatalities include accidents during clean-up, but few studies longitudinally examine the post-event mortality effects on overall mortality rates due to the challenge of ascertaining causality through the variable time elapsed between the event and outcome (Ahern et al. 2005).

**Flood-related mortality in ECA**

The relative vulnerability of several ECA countries for flood-mortality between 1980 and 2000 is listed in Fig. 4, as calculated by a UNDP natural disaster risk analysis. Relative vulnerability here is defined as the annual average number of deaths due to floods over the annual average number of people exposed x 1,000,000.

For that period, Georgia exhibited the greatest vulnerability, followed by the Czech Republic, Slovakia, and Moldova. Georgia had a severe shortage of medical supplies following independence; in 1991 the crisis required emergency international aid (OFDA 1991). An additional burden to the health system in Georgia was the internal displacement of large populations, due to ongoing civil conflict and the aftermath of past natural disasters. Between 1987 and 1989, earthquakes, floods, and landslides caused the displacement of 20,000 people in the Svanetia and Ajara regions (UNHCR 2004). In 1993, thousands were driven out of settlements; in 1998 the same population, swelling to 40,000, was driven out of a second settlement (OFDA 1998).

In 1997, 29 people were killed in flooding in the Czech Republic (OFDA 1997). Two weeks after returning to their homes, many had to evacuate again as a second wave of flooding hit the area. The same flood hit parts of Poland and killed 55 people. In the same year, 20 people were killed in a flood in Romania.

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5 Ahern et al. 2005 reviews several of these studies.
Figure 3: Relative Vulnerability to Floods in the Context of Flood-related Mortality; Europe and Central Asia 1980-2000

* Relative vulnerability = the yearly average number of people killed by flood/ Average yearly population exposed to floods * 1,000,000.
Source: UNDP

Further information on the number of deaths and the affected population for each country can be extracted from the Emergency Events Database (EM-DAT www.emdat.be), a collaboration between the Belgian Government and the World Health Organization. The EM-DAT is updated often, but information is sometimes incomplete and thus should be used only cautiously for regional analysis. Nevertheless, it does provide an excellent source of information and is increasingly being used for many different types of reports.

According to EM-DAT, the top ten most fatal flood events in ECA since 2000 have been in Russia, Turkey, Romania, Poland and Tajikistan (see Table 2).

<table>
<thead>
<tr>
<th>Year</th>
<th>Country</th>
<th>Location</th>
<th>Casualties</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>Russia</td>
<td>Novorossiisk</td>
<td>167</td>
</tr>
<tr>
<td>2002</td>
<td>Russia</td>
<td>Stavropol, Krasnodar, Karachaev-Cherkiesia, Ingushetia, Adygea, Chechnya, Kabardo-Balkaria, North Ossetia-Alania, Dagestan</td>
<td>91</td>
</tr>
<tr>
<td>2006</td>
<td>Turkey</td>
<td>Cinar, Bismil</td>
<td>47</td>
</tr>
</tbody>
</table>

6 The criteria for entering flood events, or any disaster events, in EM-DAT are one or more of the following: 10 or more people reported killed; 100 or more people reported affected; declaration of a state of emergency, or call for international assistance.
7 For example, as of Jan. 2008, the database still has not entered the event in 1998 in Uzbekistan when the Aksu and Shahimardan river floods killed 109 people (Khadjibayev et al. 2005).
Table 2: Top Ten Flood Events Recorded in EM-DAT that Killed the Greatest Number of People; Europe & Central Asia 2000-2007.

<table>
<thead>
<tr>
<th>Year</th>
<th>Country</th>
<th>Locations</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>Turkey</td>
<td>Rize, Corum, Yozgat, Kars and Mus provinces</td>
<td>34</td>
</tr>
<tr>
<td>2005</td>
<td>Romania</td>
<td>Harghita, Mures, Dolj, Bacau, Vrancea, Galati, Braila, Bistrita, Gorj, Suceava</td>
<td>33</td>
</tr>
<tr>
<td>2006</td>
<td>Romania</td>
<td>Arbore, Bistrita, Maramures, Arad</td>
<td>30</td>
</tr>
<tr>
<td>2001</td>
<td>Poland</td>
<td>Malopolskie, Swietokrzyskie, Donoslaskie, Oploskie, Slaskie, Warminsko-Mazurkie, Podlaskie, Gdansk, Slupsk regions</td>
<td>27</td>
</tr>
<tr>
<td>2005</td>
<td>Romania</td>
<td>Alba, Tulcea, Giurgiu, Vrancea, Bacau, Braila, Galati, Vrancea, Ialomita</td>
<td>24</td>
</tr>
<tr>
<td>2002</td>
<td>Tajikistan</td>
<td>Dasht, Langar</td>
<td>24</td>
</tr>
<tr>
<td>2007</td>
<td>Tajikistan</td>
<td>Asht district</td>
<td>21</td>
</tr>
</tbody>
</table>

Note that three out of the ten events were flash floods, often associated with high mortality rates. With the exception of the 2006 flood in Turkey, the ten events took place in the summer. Two of the events were associated with a secondary hazard: landslides. Thirty-one flood events recorded in EM-DAT in ECA countries between 2000 and 2007 were associated with landslides (See Fig. 4).

Figure 4

Europe & Central Asia 2000-2007 Flood Events Associated with Landslides and the Number of Deaths

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azerbaijan</td>
<td>1</td>
</tr>
<tr>
<td>Bosnia-Herzegovina</td>
<td>1</td>
</tr>
<tr>
<td>Somalia</td>
<td>1</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>2</td>
</tr>
<tr>
<td>Kyrgyzstan</td>
<td>1</td>
</tr>
<tr>
<td>Macedonia FRY</td>
<td>1</td>
</tr>
<tr>
<td>Russia</td>
<td>2</td>
</tr>
<tr>
<td>Turkey</td>
<td>2</td>
</tr>
<tr>
<td>Georgia</td>
<td>2</td>
</tr>
<tr>
<td>Romania</td>
<td>1</td>
</tr>
<tr>
<td>Tajikistan</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 4: ECA 2000-2007 Landslides
Source: EM-DAT. Based on information obtained from database on January 2008.
In addition to EM-DAT, several databases\(^8\) have been developed to record flood-related deaths. To date, they also do not record epidemiological information on cause of death, nor demographic data on victims. This lack of detailed data makes well-supported risk-assessment difficult.

Records on behavioral factors are also scarce; there are, however, studies and records on the influence of behaviors in flood-related mortality and morbidity. In 2002, 8 of 19 fatalities in German floods were due to unnecessary behavior such as going into the house to pick up laundry or crossing a flooded street (Reimer 2002; Jonkman and Kelman 2005). With better public awareness of safety precautions, these fatalities can be reduced.

**Water-borne and food-borne diseases**

**Diarrhea and dysentery**

An outbreak of dysentery – an infectious disease caused by the bacterium *Shigella dysenteriae* - followed a series of severe floods that hit parts of Tajikistan in 1992 (OFDA). A significant burden on the health system at that time was the effect of civil unrest; displaced people from floods had to keep moving from place to place due to civil strife. The flooding affected water and irrigation systems and the outbreak resulted in increased childhood mortality in the villages of Kykyab and Kurgan Tyube (now known as Qurghonteppa) (OFDA).

**Typhoid fever**

Typhoid fever is an infectious disease that spreads through ingestion of food or drink that is contaminated with the bacterium *Salmonella typhi* from an infected person’s urine or feces. Flooding may lead to the contamination of water supplies with sewage water that contains the bacterium.

In late May 1996, following heavy rains and flooding in Tajikistan, the already poorly-maintained sewage system, contaminated with *Salmonella typhi*, mixed with drinking water supplies. An outbreak of typhoid fever followed, with up to 7,516 cases reported in August, of which 34% were children under 14 years of age (WHO 1996). The situation was aggravated by flood damage to public facilities; the OFDA reports that 50 health clinics and schools were damaged. Tarr *et al.* report that the open toilets that served as a sanitary facility for the main hospital in Kulyab were inundated. By the end of that month, many of the hospital’s typhoid cases came from a 200-meter radius around those toilets (Tarr *et al.* 1999).

Conditions favorable to the Tajikistan outbreak were present before the May floods. Due to civil unrest, government funding of public health faltered. In 1995, soap was not easily

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\(^8\) Examples of such databases can be found at the Dartmouth Flood Observatory (www.dartmouth.edu/~floods/), the Asian Disaster Reduction Center (ADRC http://www.adrc.or.jp), the International Strategy for Disaster Reduction (ISDR www.unisdr.org), and Swiss Re (www.swissre.com).
available and chlorination of water was discontinued due to lack of supplies (Tarr et al. 1999). In some parts of the country, people relied on open canals for water supply (Tarr et al. 1999). When the flood hit in 1996, a total of 300 canals and irrigation systems were ruined (OFDA). Finally when the outbreak happened in May 1996, an additional burden to the health system was a shortage of diagnosis materials and treatment drugs (WHO 1996).

Box 2: Lessons learned from the control of gastrointestinal outbreaks following the 1997 floods in Poland.

As a measure to reduce the spread of hepatitis A following the major floods in 1997 in Poland, annual vaccination against the disease increased from between 13 and 23 thousand people to 166 thousand people per year. In 1996 the endemic level of the disease was considered medium. By 1997 the level was low, and by 2002, very low despite the occurrence of another major flood in 2001. An intervention such as increasing vaccination levels at appropriate times seems to be effective at preventing the spread of disease (Magdzik and Czarkowski 2004).

Additionally, Plonka and Dzbeński (1999) show that there was no increase in the frequency of intestinal infections in 7 year-old children from 25 affected provinces in Poland following the 1997 floods.
Figure 5: Epidemic Curve of daily incidence of typhoid fever in Kulyab, Tajikistan 1996. Epidemic peaks occurred after heavy rainfall. Source: Tarr et al. 1999.

Vector-borne diseases

West Nile Virus

West Nile Virus (WNV) spreads most commonly through the bite of an infected mosquito. Fatality rates are relatively high for the elderly. Flooding creates favorable conditions for vector increase, as larvae thrive in standing water.9

Following the 1999 flood in the Czech Republic, Aedes mosquitoes rapidly increased in flood-affected areas (Gratz 2006). Central Europe’s first WNV outbreak followed; thirteen of 619 patients screened had WNV antibodies (Hubálek and Halouzka 1999), and a new strain appeared (Bakonyi et al. 2005).

To date, the greatest recorded outbreak of WNV in Europe, and the first in an urban area (Han et al. 1999), was in Romania in 1996, with 527 cases of meningitis or encephalitis. The likely principle vector was Culex. pipiens (Gratz 2006). A study on the risk factors for obtaining WNV among apartment residents in Bucharest showed that a flooded basement was a significant risk factor [OR= 3.94 (1.16-13.7)] (Han et al. 1999).

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9 According to Hubálek: “[WNV] Outbreaks are associated with high populations of mosquitoes (especially Culex spp.) caused by flooding and subsequent dry and warm weather, or formation of suitable larval breeding habitats (Hubálek and Halouzka 1999).”
WNV is a growing public health concern in Europe, (Gratz 2006), and a likely increase in flooding as climate change continues will exacerbate this risk.

**Tahyna**

Tahyna is the most common California group virus in Europe and Asia. Vectors include *Oc. sticticus*, *Oc. cantans*, *Ae. vexans*, and *Ae. cinereus* (CDC year; Hubálek et al. 2005). Following the floods of 1997 in the Czech Republic, antibodies to Tahyna were detected in 333 (53.8%) out of 619 inhabitants of a flooded area (Gratz 2006), and after the 2002 flood, in 82 (16.5%) of 497 inhabitants of flooded areas (Hubálek et al. 2005).10

One study categorized serum samples according to the residential region of the Tahyna patient. Risk zones were designated based on the number of mosquitoes in each region following the floods; one control zone was also included. It was found that there was a positive correlation between flood risk zone and seroprevalence of Tahyna. Tahyna seroprevalence was significantly higher in risk zones than in the control zone ($\chi^2 =14.57$; $p=0.002$). Seroprevalence also increased as residential distance to floodplain forests decreased ($\chi^2 =8.51$; $p=0.003$) (Hubálek et al. 2005).

**Malaria**

Although malaria has been eradicated in most countries in Europe, cases have been reported in the past 10 years in Armenia and Central Asia. The WHO (year) reports that in Azerbaijan in 1997, mudslides worsened malaria prevalence. Although reported incident malaria cases in Azerbaijan decreased from 13,135 cases in 1996 to 9,911 cases in 1997, prevalence remained high, denoting further need for widespread treatment. The mudslides may have made it more difficult to control the disease spread as it increased mosquito breeding sites considerably.

**Rodent-borne diseases**

**Leptospirosis**

Leptospirosis is an infectious disease that spreads through contact with moist soil, mud, vegetation, or fresh water contaminated with the bacterium *Leptospira interrogans* from the urine of infected rodents or other animals. Flooding helps spread the bacteria as water saturates the soil, pushing the bacteria to the surface.

At least three flooding-related outbreaks of leptospirosis have been reported in ECA. In Krasnodar Territory, Russia in 1997, defects in sanitary and veterinary measures after a flood event led to an outbreak (Kalashnikov et al. 2003). Most of those infected were

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10 A study by Hubálek Z et al 2005 categorized serum samples according to the residential region of the patient, with risk zones designated in the order of the number of mosquitoes that followed the floods, and one control zone.
exposed to contaminated freshwater, soil, or animals through “fishing, work on plots of land adjoining their summer cottages, [or] dog breeding.” (Gol'denshteĭn ZA et al. 2001).

In Ukraine, leptospirosis followed floods in 1997 (Githeko and Woodward 2003) – 102 people were affected, according to EM-DAT. Registered cases continued to increase, from 2.75 to 3.17 per 100,000, between 1997 and 1998 (National Report on the State of the Environment in Ukraine, 1998).

After two major floods in the Czech Republic in 1997 and 2002, cases of leptospirosis increased from .3 to .9 per 100,000, with at least 92 infected in 1997 and 94 in 2002. Prior to this, the disease had been extremely rare (Zitek and Benes 2005).

Leptospirosis seems to be a re-emerging infectious disease in some parts of ECA (Pappas et al. 2007). Floods, if not well managed, may create favorable conditions for the spread of the disease.

*Other water-borne and food-borne diseases*

Other water-borne diseases were also reported following the May flooding in Tajikistan; a 3-fold increase in *S. paratyphi* infections, and a less than .5-fold increase in hepatitis A and shigellosis (Tarr et al. 1999).

Increase in cholera, hepatitis A, and salmonella in Ukraine followed the 1995 flood that was caused by the heaviest rainfalls in over a century (OFDA). The floods inundated the sewage system and hundreds of thousands of cubic meters of sewage water were being released into rivers daily (OFDA).

In 2004, heavy rains caused the flooding of the Varzob river in Tajikistan which led to the pollution of 60% of the municipal water supply (OFDA).

The international community is aware of the indirect threats that floods pose to health. For example, in April 2006, a warm winter caused snow melt, which, compounded by heavy rain, flooded half the regions of the Czech Republic. Amidst concern over the spread of vector-borne diseases, US-AID donated $30,000, for the transportation of larvicide (OFDA 2006).

*Other Flood-related health effects*

**Mental Health**

Experiencing a major flood event, losing loved ones and precious belongings, sustaining injuries, and dealing with cleanup of damages and insurance may create stress with effects that linger long after the flood waters recede. Ohl et al. report that “being evacuated [during a flood] from home and losing personal possessions may undermine people’s sense of place as well as their sense of attachment and self-identify.” (Ohl et al. 2000). Mental health issues were observed following most major flood events in Europe, notably in Poland after the 1997 flood.
In 1997, heavy rains caused the flooding of the Oder River, affecting 86 cities and towns, 875 villages, and 450,000 farms (OFDA 1997). The economic toll amounted to $3,500,000,000, compared to a loss of $500,000,000 in a 1987 flood (EM-DAT). These losses are the highest sustained from any flood event in all of ECA, as recorded in EM-DAT. The International Federation of Red Cross and Red Crescent Societies reported a study of 50 flood-linked suicides in Poland in the two-month period following the flood event (Hajat et al. 2005).

Numerous studies were conducted in Poland on depression and post-traumatic stress disorder (PTSD) in children, adolescents, and adults affected by the 1997 flood (for examples, see works by Bokszczanin and Norris). A study by Bokszczanin shows an 18% prevalence of long-term PTSD in a group of children and adolescents 28 months after the flood event (Bokszczanin 2007). The study shows that PTSD symptoms and the level of trauma experienced - an indicator of flood severity - are positively correlated. This latter result was also found in a study by Norris et al. on adults one month after the flood event (Norris 2002). Both studies highlight the need for mental health interventions and programs immediately following a flood disaster as well as during the few years afterward.

Others

Other outcomes or diseases that are related to flood events are discussed in several studies by Neuberg et al. on the 1997 flood event in Poland, which show the indirect effects of floods on physical health through increased stress levels. Neuberg looked at the consequences of flood-induced stress on physical health. One study found that stress experienced during the flooding period caused hypogonadotropic hypogonadism amenorrhea – the absence of menstrual bleeding – in adolescent females (Neuberg et al. 1999). Another found that, among pregnant women stressed during the flood event, pregnancy loss and perinatal complications, including premature delivery, were relatively high (Neuberg et al. 1998). These studies highlight the need for additional medical attention for stress and non-physical trauma.

1.2.2 Heatwaves

Heatwaves are events characterized by higher than average temperatures that last for one day or more. To date, there is no international standard definition of a heatwave; the term is relative to the usual weather of an area. One challenge for creating a standard definition is that threshold temperatures across nations and within a nation are not the same through time and place. A temperature that is normal in one climate may be considered a heatwave if it is outside the normal pattern for another climate.

The long-term trend of warming average temperatures is predicted to increase the frequency, intensity, and duration of heatwaves. It is also predicted to decrease the number of frost days. Below (Table 4) are projections for heatwave duration index and frost days in ECA for the period of 2031-2050, under emissions scenario A1B, where it is
assumed CO2 emissions will continue to increase until 2050, and then begin to decline.

**Table 4**

<table>
<thead>
<tr>
<th>Region/Country</th>
<th>Heatwave duration index mean change (spatial variation min;max)</th>
<th>Frost days mean change (spatial variation min;max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siberia and Far East Russia</td>
<td>29 (8; 50)</td>
<td>-14 (-33; -11)</td>
</tr>
<tr>
<td>South Siberia</td>
<td>23 (18; 30)</td>
<td>-14 (-18; -11)</td>
</tr>
<tr>
<td>Urals and Western Siberia</td>
<td>31 (19; 35)</td>
<td>-18 (-22; -15)</td>
</tr>
<tr>
<td>Western Arctic Russia</td>
<td>35 (31;43)</td>
<td>-20 (-25; -14)</td>
</tr>
<tr>
<td>Central and Volga Russia</td>
<td>34 (31; 36)</td>
<td>-23 (-27; -18)</td>
</tr>
<tr>
<td>North Caucasus Russia</td>
<td>37 (21; 33)</td>
<td>-20 (-26; -14)</td>
</tr>
<tr>
<td>Baltic Russia</td>
<td>31 (21; 34)</td>
<td>-23 (-27; -20)</td>
</tr>
<tr>
<td>Baltics</td>
<td>25 (17; 31)</td>
<td>-30 (-33; -24)</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>29 (19;35)</td>
<td>-22 (-27; -12)</td>
</tr>
<tr>
<td>Central Asia</td>
<td>22 (16;29)</td>
<td>-21 (-36; -10)</td>
</tr>
<tr>
<td>Caucasus</td>
<td>23 (15;27)</td>
<td>-22 (-29; -9)</td>
</tr>
<tr>
<td>Central Europe</td>
<td>28 (19; 32)</td>
<td>-26 (-33; -11)</td>
</tr>
<tr>
<td>Southeastern Europe</td>
<td>25 (20; 31)</td>
<td>-17 (-31; -5)</td>
</tr>
</tbody>
</table>

**Table 4:** Mean Change* for heatwave duration index and frost days for the period of 2031-2050 compared to 1981-2000 under emissions scenario A1B

1 Heatwave duration index= a period of more than 5 consecutive days where the maximum temperatures are 5°C greater than the normal daily maximum summer temperatures for the period of 1961-1990.
2 Frost days= the number of days where the absolute temperature is less than 0°C.
* Results are based on 8 General Circulation Models (GCMs). All results display model concordance where over 75% of models run show same sign of change.


While the projections show an increase in warm days and a decrease in cold days, this is only as related to anthropogenic climate change. Natural climate variations, such as La Niña and El Niño, may add more days of extreme ambient temperatures.

A review of the known health effects of heatwaves in ECA follows.

**Excess Mortality**

Heatwave related mortalities are generally more thoroughly documented than related morbidities. In epidemiological studies, the mortality effects of heatwaves are usually discussed in terms of attributed deaths and deaths in excess of the norm. A variety of methods are used to obtain these numbers. Excess deaths are sometimes measured by

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11 While the positive correlation between high ambient temperatures and mortality have been examined and established in many cities (e.g. Pattenden et al. 2003 for the city of Sofia, and Ravich et al. 2007 for the city of Moscow; see appendix), the added affect of heatwave events on mortality have also been examined specifically (e.g. Kysely 2004 for the Czech Republic and Páldy et al. 2005 for Budapest; see appendix).
subtracting observed mortality from expected mortality, the latter usually estimated using regression models.

For example, in July 2001, Moscow experienced a heatwave resulting in more than 276 deaths (EM-DAT). The heatwave was unusually long, with temperatures above 25° C lasting for 9 consecutive days, as contrasted with the long term average of 3 days per year. Mortality for that July in Moscow was 93% higher than the multiyear average mortality for the month of July (Granberg et al. 2008). The heatwaves in Croatia, Slovenia, and the Czech Republic that summer caused 788, 289 and 418 excess deaths, respectively (EM-DAT).

Methods for calculating the excess deaths from heatwaves are under constant revision. The initial estimates for the 2003 heatwave in Europe were 22,000-45,000 excess deaths; the latest estimates are 70,000 (Robine 2007).

The timing, the duration, and the magnitude of a heatwave event all impact mortality. A study by Páldy et al. for 3 pairs of heatwaves in Budapest, each pair occurring in the same year (for the years 1994, 1998, and 2000) shows that the mortality effect of the first heatwave during each year was greater than for the second, regardless of the duration and magnitude of the event.

There are two possible explanations for this finding. In one, the population may not have been acclimatized to heat earlier in the season, or may have been better prepared for the second wave. In the second, those most vulnerable within the population may have died during the first wave; this is known as the mortality displacement effect (Páldy et al. 2005). The stronger mortality effects of heatwaves that occur earlier in the season have also been noted elsewhere; see Hajat et al. 2002.

**Cause-specific mortality**

Heatwaves can cause death (1) directly through causing heat illnesses, (2) by aggravating pre-existing heat-sensitive medical conditions, (3) by placing pressure on water and electrical systems, (4) through risk-associated behavioural responses (5) through worsening environmental conditions, especially air quality. The following is a discussion of each of these factors.
Figure 6: Comparison of the mortality effect of the six heat-wave events in Budapest, Hungary. X-axis time of year. Y-axis excess mortality, all cause, all age (%) with 95% confidence intervals

Heatwave-related Morbidity

One of the indicators for increased morbidity during heatwaves is increased ambulance call-outs. During the 2003 heatwave in Europe, there was such an increase, for example as reported in Budapest (Páldy et al. 2005). Similarly, during the 2007 heatwave in Europe, emergency clinics throughout Bosnia-Herzegovina experienced twice as many emergencies as usual, and in Bucharest in Romania call-outs reached nearly 20,000 during the heatwave period (DPA 2007, Salzmann 2007).

The EM-DAT reports an increased number of people requiring medical attention as a direct result of heatwave events (see Table 5). However, detailed information on the type of medical assistance required is not recorded.

Table 5

<table>
<thead>
<tr>
<th>Year</th>
<th>Heatwave Temp. Record °C</th>
<th>Country (Location)</th>
<th>Number of heat-wave related morbidities*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>36</td>
<td>Romania (Bucharest)</td>
<td>500</td>
</tr>
<tr>
<td>2000</td>
<td>46</td>
<td>Turkey</td>
<td>300</td>
</tr>
<tr>
<td>2000</td>
<td>35</td>
<td>Croatia (Zagreb, Split, Osijek, Rijeka)</td>
<td>200</td>
</tr>
<tr>
<td>2006</td>
<td>36</td>
<td>Romania</td>
<td>200</td>
</tr>
</tbody>
</table>
Table 5: The reported number of morbidities as a result of heatwave events in ECA

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
<th>Country</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>40</td>
<td>Romania</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>43</td>
<td>Romania (Bucharest, Bechet)</td>
<td>100</td>
</tr>
<tr>
<td>2007</td>
<td>40.3</td>
<td>Slovakia</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>42</td>
<td>Serbia Montenegro</td>
<td>70</td>
</tr>
<tr>
<td>2007b</td>
<td>45.5</td>
<td>Bulgaria</td>
<td>50</td>
</tr>
</tbody>
</table>

* Reported in EM-DAT as number of injured, the people suffering from physical injuries, trauma or an illness requiring medical treatment as a direct result of a disaster.
  a Heatwave associated with drought event.
  b Heatwave associated with wildfires and drought event.

(Source: EM-DAT. Based on information obtained in January 2008).

**Heat Illnesses**

*Heatstroke* is the most severe heat illness. It occurs when the body, exposed to ambient heat, is overexerted and stops sweating; body temperatures rise to dangerous levels. Fainting, organ dysfunction, or death may occur.

*Heat cramps* and *heat exhaustion* are other heat illnesses that may result in serious complications. Heat cramps occur when the body sweats vigorously, increasing heart rate, and causing muscular pain due to loss of body salt. Heat exhaustion, similarly, increases heart rate and is characterized by symptoms of nausea. If left untreated, it may develop into heatstroke.

Those most at risk for heat illnesses include those who work outdoors and the very young and old. Infants and children are at greater risk than adults for dehydration and heat illnesses as they have fewer fluid reserves in their body and a greater ratio of body surface area to overall body weight. The elderly are at greater risk than other adults because they are more likely to be ill and on medications, such as diuretics, anticholinergics, and tranquilisers, that suppress the body’s thermoregulation. Living alone is another identified risk factor.

**Exacerbation of Pre-existing Illnesses**

Heatwaves cause mortality and morbidity by aggravating medical conditions that are heat-sensitive, such as cardiovascular, cerebrovascular, renal, respiratory, and mental diseases. This type of indirect effect is typically even more common than the direct effect of heat illnesses. During exposure to high ambient temperatures, strain on cardiac output from excessive sweating, which in turn causes blood clots, may lead to fatal outcomes. Also due to excessive sweating, the body loses the salts that help regulate heart, kidney, and brain functions. Finally, and when high temperatures are accompanied by dry conditions, lung tracts are more easily irritated.

Some studies have investigated lower physical performance and increased medical complications in patients with cardiovascular diseases during exposure to high temperatures. During the 17 heatwaves that occurred in the Czech Republic from 1982 to
2000, there was an average total increase of 13.6% in cardiovascular mortality (Kyselý 2004).

When comparing ischemic heart disease patients exposed to comfortable summer temperatures (18-24 °C) to high summer temperatures (25-30° C) in Uzbekistan, Zummonov (1998) found significantly reduced physical performance by those in uncomfortable temperatures. The Urgent Medicine Institute of Zagreb in Croatia reported that during periods of high temperatures, especially those that last for several days, there is increased incidence of neurovegetative disorders in patients with cardiovascular disease (Croatia Communication Report under UNFCCC 2006).

**Box 3: Urban Heatwaves**

Heatwave location also plays a role in heatwaves; land cover and use may exacerbate temperatures. In the “urban heat island effect,” cities show a 5-6° C greater average temperature than rural areas, most likely due to practices such as: dark asphalt cover and lower vegetation cover, which decrease albedo; high rise buildings, which create imbalanced wind turbulence, and crowdedness and traffic, which create heat. The effect can worsen a heatwave and raise temperatures by 3-12 °C (Kovats et al. 2005). Type of housing and ventilation also makes a difference; one of the most effective ways to reduce health impacts during heatwaves is to use air conditioning (Bouchama et al 2008). Heavy and widespread use of air conditioners also, however puts a strain on power supplies and may lead to outages.

**Additional Risk Factors**

**Overburdening Infrastructure**

Heatwaves often affect mortality or morbidity rates because of the pressure they place on electricity and water systems. Water hydrates and cools the body, and its use goes up during heatwaves, reducing available quantities. Some rural areas in ECA rely on wells, which dry up during heatwaves. In Bosnia, the government provided water, but many could not afford to travel to the free cisterns (IFRC 2007a).

The electricity shortages experienced during heatwaves affect water pumps. During the 2007 heatwave in Albania, an electricity shortage affected water supply for two weeks (IFRC 2007b). This was the result of several years of low precipitation, such that hydroelectric power generation was unequal to the sudden increase in demand.

**Behavioural components**

Heatwaves may result in mortality or morbidity through individual responses associated with risky behaviour – or maladaptive strategies. During the 2007 summer heatwave in

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12 As was reported in the 2007 heatwaves in Romania and Bosnia-Herzegovina (Salzmann 2007, IFRC 2007a)
Moscow\textsuperscript{13}, citizens swam in open canals, city fountains, and other non-designated sites to cool off. At least 28 drowning deaths were reported. In most cases, the victims were not sober (Baltantis 2007). Similarly, during the 2007 heatwave in Sakarya province in Turkey, two young boys drowned while attempting to cool off in a lake (Grohmann 2007). This type of death during a heatwave is absolutely avoidable through improved public swimming facilities and avoidance of individual risky behaviour.

\textit{Smog and Fire}

Finally, heatwaves may result in mortality or morbidity by contributing to environmental conditions, such as air pollution or the outbreak of fires\textsuperscript{14}, which increase adverse health impacts in the population.

Any study on the effects of temperature on mortality should consider pollution as a potential confounder or modifier. A study in Sofia, Bulgaria found that particulate matter (TSP, or total suspended particulates) is a significant confounder for temperature/mortality models; for every increase of 1 $\mu$g/m$^3$ in TSP, there was an increase of 0.06% (0.03-0.10) in mortality (Pattenden \textit{et al.} 2003). Ozone and other air pollutants are clearly aggravated by high ambient temperatures (IPCC Human Health 4\textsuperscript{th} Assessment Report). Air pollution has been found to be higher during the summer season in many areas in Europe (Michelozzi \textit{et al.} 2007).

This intensified pollution raises mortality figures. According to a study by Alebić-Juretić \textit{et al.} 2007, 50\% of the excess deaths observed during the 2003 heatwave in Croatia were attributed not to the heat exposure, but to air pollution by ozone and particulate matter. In the summer of 2002, excessive heat and dry conditions in Moscow, an anticyclone, fires, and industrial and vehicle emissions created a smog event. An increase in cardiovascular and respiratory mortality and hospitalizations were noted as a direct result of increased exposure to ozone\textsuperscript{15} (Kislitsin \textit{et al.} 2005). The IPCC also reports health impacts from particulate matter (IPCC, 2007).

\textbf{Box 4: Fires}

According to USAID, during the months of July-September 2007, extreme hot temperatures and reduced rainfall across southeast Europe led to wildfires in many countries in the region. These were associated with reduced firefighting capabilities and

\begin{itemize}
\item Temperatures reached 32.7° C, the highest temperature recorded in the month of May since 1891. Temperatures were above 30° C for 5 consecutive days. Increased demand for air-conditioning forced the electricity grid into a state of emergency (WMO).
\item IPCC 4\textsuperscript{th} Assessment Report, Human Health
\item Ozone mean daily concentration went from 0.034 to 0.042 g/m$^3$. The study also examined the health effects of carbon monoxide, nitrogen dioxide, PM2.5 and PM10 during the smog event, concluding with the greatest health effects from particulate matter (PM).
\end{itemize}
Recent heatwaves in Europe have been blamed for the 2006 fires in Turkey, and the 2007 fires in Albania, Bulgaria, Croatia, and Macedonia (Turkish Daily News, ReleifWeb). In summer 2007, heatwaves hit southern and central Europe. Dry conditions helped trigger fire breakouts throughout the region, and several people were reported dead directly from the fire, including 12 fire fighters encircled by flames in Croatia (USAID).

Others experienced health effects from smoke. In Albania, 60 people sought medical attention as a direct result of smoke inhalation (IFRC, 2007). Smoke affects health by irritating lungs and eyes, and aggravating cardiovascular and respiratory diseases such as asthma and chronic obstructive pulmonary disease (CDC). Wildfire smokes contain chemicals, gases and fine particulate matter that can be easily inhaled. Turqueuty et al. 2008 tracked pollutant transfer from the fires through satellite observations and identified carbon monoxide and ozone, both presenting a health burden.

1.2.3 Droughts

Drought, defined as decreased precipitation over an extended period, results in water shortages associated with a number of direct and indirect health impacts, including: direct loss of human life as a result of heat stress or suicide; mental and physical stress, such as anxiety, depression and domestic violence; malnutrition as a result of limited or unaffordable food supply; increased respiratory-related sicknesses; diminished sewage flows; increased concentrations of pollutants, and jeopardized fire-fighting capacity.

Data scarcity, particularly in ECA, makes it difficult to specify the exact health impacts of droughts. In 2004, an extensive literature review on the health impact of droughts revealed that impacts on the Canadian Prairies ranged from respiratory illnesses as a result of inhaling dust or smoke, to mental health concerns arising from economic stress, particularly among farmers. The review organized the health outcomes associated with droughts into four categories: farming and mental health; dust and respiratory health; fires and respiratory health; and other health outcomes.

While large agricultural enterprises normally have the resources to mitigate the impact of drought, small household farmers experience a great deal of pressure and insecurity during droughts, making them vulnerable to stress diseases, such as heart disease.

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16 US Agency for International Development-Bureau for Democracy, conflict and Humanitarian Assistance- Office of the U.S. Foreign Disaster Assistance-Southern Europe. Wildfires and Drought Fact Sheet #1, Fiscal Year (FY) 2007 September

17 In Bulgaria, despite the forest cover, fire-fighters have no basic equipment, such as planes, and were not prepared for the approximately 1,800 fire breakouts during the 2007 heatwave. The country was forced to declare a state of emergency and seek foreign aid (Salzmann 2007).

The review found that agricultural activities coupled with dry weather conditions generate dust, which can contain molds, pollen, plant materials, animal-derived particles, bacterial, fungi, mites and aerosolized particulate matter. When inhaled, the dust and particulate matter inflame bronchioles, causing asthma and bronchitis.

Forest fires also tend to increase during drought, with attendant symptoms and illnesses associated with inhalation, as discussed in previous sections.

Other health outcomes observed during drought include injuries as a result of diving in shallow waters; child diarrhea as a result of restricted water access; gas exposures from grain fermentation, and increased mycotoxins in human food and animal feed.

Other impacts are indicated in the fourth assessment report of Intergovernmental Panel on Climate Change (IPCC), which suggested that the impact of drought on human health include malnutrition, infectious and respiratory diseases. Droughts can reduce protein and micronutrient intake, leaving the body vulnerable to diseases like diarrhea and meningitis.

In addition, loss of livelihoods due to drought triggers population movement from rural to urban areas, where overcrowding, unsafe drinking water and compromised shelter conditions present disease risks. These indirect effects will be treated in depth below. Drought is also associated with increases in incidence of food poisoning, particularly salmonellosis and shellfish reactions.

**Drought Health Impacts in ECA**

Due to climate change, rising temperature and reduced rainfall, many ECA countries are witnessing droughts that vary in severity, frequency and duration. The duration of a drought plays an important role in its health impacts, because of its potential to disrupt livelihoods (e.g. in Tajikistan –where 80% of the population lives below the poverty line-an estimated 1.2 million people are at risk of famine through food shortages and loss of livestock).

A June 2007 report from the Directorate General of Environment of the European Commission made an in-depth assessment of water scarcity in the EU and found that while 6% of all EU members were affected by drought between 1976 and 1990, 13% were affected between 1991 and 2006.

The economic impact of all of these droughts together was estimated at €100 billion over the thirty years. The annual average impact doubled between the two periods, reaching an average of €6.2 billion/year in recent years. The report did not calculate environmental, social, or health-related costs due to lack of available data.19

During 2000 and 2001, the lack of rainfall and the melting of glaciers affected the water flow of the Amu Darya River, which flows from Tajikistan to Uzbekistan, resulting in a severe drought and reduced availability of drinking and irrigation water. Within Uzbekistan, the regions of Khorezm and Karakalpakstan were heavily affected because of their reliance on agriculture. Although at the time, health impacts were not considered severe, as assessed by low rates of communicable disease and acute malnutrition, chronic forms of malnutrition were reported among children of poor households, who were forced to drop meat and dairy. The same drought severely affected Azerbaijan. While no health impacts were reported, the FAO suggested that crop loss presented malnutrition risks.

The health outcomes related to drought exposures during 2001-03 in some countries in ECA are featured in detail in Annex 3, and include decreased immunity; dehydration; malnutrition; iodine deficiency; acute intestinal and respiratory tract infections; cholera risk (Uzbekistan); mental health problems (Georgia), and food shortages (Uzbekistan, Tajikistan; Armenia; Georgia and Azerbaijan.) The impacts of the latest 2007 drought in Moldova are featured separately, in Box 5.

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20 The exact types of food consumed in Uzbekistan during the drought are not known, however alteration in dietary intake during drought is well established. During the 2000 drought that affected most of the states of the Indian sub-continent, daily consumption of cereals and millets remained well above the Recommended Daily Allowance (RDA) of 460 g/person/day. However, intake of income-elastic foods, such as pulse, milk and fat was lower than the RDA. A similar shift in dietary intake, from reasonably nutritious to less so, was noticed during the drought period of 1999-2003 in Pakistan, where most of households went from a staple diet of Roti - lentils with bread- to Lassi - a yogurt drink and pickle of red chilies. (Ref?)

### Box 5: Moldova’s 2007 Drought

#### Background
Reduced rainfall and elevated temperatures during the summer of 2007 led to a severe drought that hit almost all of Moldova’s 32 regions. A joint assessment between the World Food Program and the Food and Agriculture Organization of the United Nations estimated that the drought impacted 84% of Moldova’s arable land, leading to national economic losses of approximately $406.7 million in failed crops and livestock deaths.

#### Health, Nutrition, Water and Sanitation Impacts
During September-October 2007 a survey to assess the social impacts of the drought was conducted by UNICEF in which 148 local experts and 1,114 households — covering all regions in the country — were interviewed. According to the survey the main effects of the drought were as follows:

<table>
<thead>
<tr>
<th>The Main Effects of the Drought</th>
<th>According to Local Leaders</th>
<th>According to Households</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food availability and nutrition</strong></td>
<td>“For now nutrition is within normal parameters due to the availability of fruits and vegetables in the market. The most difficult period will be from the spring of 2008 until the 2008 harvest.”</td>
<td>When asked if they were worried they wouldn’t have enough food, 72% of households said yes — 76% in rural areas, 71% in towns and 64% in Chișinău and Bălți. When asked if they were unable to eat the kinds of food they used to eat because they were no longer available, 54% of the households said yes — 59% among households with three children and 61% among households with four or more children. When asked if they ate fewer meals than they felt they needed because there wasn’t enough food, 50% of households said yes — 59% of those answering yes were households with three children and 67% were households with four children or more.</td>
</tr>
<tr>
<td><strong>Health</strong></td>
<td>Poorer nutrition will lead to weakened immune systems and to an increase in the incidence of diseases. Currently, 80% of respondents believe that the health of the population had already been affected; doctors believe that the health of 91% of the population has been negatively affected.</td>
<td>11% of families with children said the drought had affected their ability to take their children to the doctor when there was a need to go.</td>
</tr>
<tr>
<td><strong>Water supply</strong></td>
<td>58% of localities were affected — 62% in the south; 50% in the north; 56% in the center; 68% in rural areas; 44% in urban areas.</td>
<td>39% of all households surveyed said their potable water source had either been damaged or had dried up — 45% in rural areas; 43% in towns; 18% in Chișinău and Bălți.</td>
</tr>
<tr>
<td><strong>Sanitation</strong></td>
<td>The drought negatively affected sanitation in 60% of the localities surveyed.</td>
<td></td>
</tr>
<tr>
<td><strong>Changes in behavior</strong></td>
<td>Doctors said that the stress people are under due to the drought has lead to aggressive behavior which will have an impact on the health of the population. Most affected in this respect will be the elderly and retired people.</td>
<td></td>
</tr>
</tbody>
</table>
1.3 Changing Average Temperatures & Impacts on Health in ECA

In addition to health effects from extreme events, the more subtle change in average temperature is projected to have health impacts. Observed long term average warming of the Earth during the 20th century has been attributed with high confidence to anthropogenic activity of greenhouse gas emissions (IPCC 2007). The effects of changing average temperatures include changing seasonal duration, an expanding tropical belt, and a rise in sea level (Seidel et al. 2008). In Europe alone, the observed warming of 0.8°C is higher than the global observed warming average. Under emissions scenario A1B, the warming trend is projected to continue in ECA, with greatest increase northwards (see Fig. 8a).

Over the past century, northern regions in ECA have experienced increased precipitation and southern regions decreased precipitation. However, while all projection models show consistency for the direction of change in average temperatures, uncertainty lies in changes in average precipitation (see Fig. 8b). This is partly due to our limited understanding of the affects of climate change on cloud formation. As Ledley et al. say “the question of whether average cloudiness would be increased or decreased in a greenhouse-enhanced world is not yet established.” Nonetheless, in order to fully understand the affect of climate change on health, all climatic factors must be considered. For example, aridity is a limiting factor for the spread of some disease vectors.

Figure 8a.

Change in Mean Annual Temperature
(2030 - 2049; 1980 - 1999; A1B; 8 GCMs)

Degrees (C)
- 1.6 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5

Figure 8b

Change in Mean Annual Rainfall
(2030 - 2049; 1980 - 1999; A1B; 20 GCMs)

% Change
- -15 - -10
- -10 - -6
- -5 - 0
0 - 5
5 - 10
10 - 15

Figure 8: Projected Changing Averages in ECA according to scenario A1B
Hatching indicates where at least 2/3 of the models agree with the sign of change. For temperature, all models are in complete agreement. 

This chapter will focus on the impacts of changing average climatic factors on human health. This includes the effects of changing average temperatures on seasonal and geographical distribution of climate-sensitive diseases such as cholera, salmonella, dengue, malaria, Lyme borreliosis, tick-borne encephalitis, as well as the effects of climate change on pollution (and consequently on health outcomes, as noted above) and allergies.

By no means does this imply that these diseases are solely driven by temperature. However, because they have been associated with temperature changes, the anticipated increase in temperatures as climate change progresses are expected to: (i) aggravate the condition of present diseases (ii) make suitable the reemergence of diseases once known to have occurred in an area (iii) make suitable the emergence of diseases previously not known to have occurred in an area. This will require the reinforcement of already existing disease control policies as well as the creation of new ones.

**Vector-borne Illnesses**

*Temporal and Spatial Shifts of Disease Vectors in ECA*

Table 7 below characterizes various diseases and their vectors that may reemerge in ECA due to changing average temperatures. It identifies the disease, the associated vector; any evidence for expansion of transmission in ECA, and projections for future expansion in ECA. Table 7 also attempts to analyze what type of expansion these diseases could expect and to project likelihood of expansion.

When considering disease expansion policies, it is important the to focus on all types of disease vectors and not solely on one; reflecting upon the lessons of failed vector control programs in the 1970s in the Americas, which led to a dengue epidemic, Gubler et al. 2005 comments that it was partly due a surveillance program that focused on Anopheline mosquitoes for malaria, and neglected to pay attention to *Ae. aegypti*. Another reason for the failure was a change in policy attitude that switched from preventive measures pre-epidemic, to an emergency response method. This proved to ineffective; the main technique applied for killing mosquitoes was low-volume, did not take into account larval control, and did not reduce the adult mosquito population sufficiently (Gubler et al. 2005).
### Table 7

<table>
<thead>
<tr>
<th>Disease</th>
<th>Evidence for expansion in ECA? (seasonal/altitudinal /longitudinal )</th>
<th>Projection models/ Expectations in ECA</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluetongue virus and African horse sickness virus</td>
<td>Potentially expand to Albania, Bosnia, Croatia, and the countries of the former Yugoslavia</td>
<td>Wittmann <em>et al.</em> 2001</td>
<td></td>
</tr>
<tr>
<td>Dengue and dengue hemorrhagic fever</td>
<td>Potentially expand to Turkey, Albania, and the former Republic of Yugoslavia.</td>
<td>Knudsen <em>et al.</em> 1996</td>
<td></td>
</tr>
<tr>
<td>Dengue virus</td>
<td>Vector reported for the first time in Croatia in October 2004.</td>
<td>Second, third, and fourth national communication of the Republic of Croatia under the UNFCCC</td>
<td></td>
</tr>
<tr>
<td>Plague</td>
<td>Expected overlap of regional expansion of the two plague rodents (creating unpredictable epidemic conditions) (Azerbaijan, Turkey)</td>
<td>First national communication of the Armenian Government under the UNFCCC 1998.</td>
<td></td>
</tr>
<tr>
<td>Malaria</td>
<td>Reports of resurfing malaria strains in low-medium elevation upland sites in rural areas in Turkey, Tajikistan, Uzbekistan, and Turkmenistan.</td>
<td>Expected altitudinal and horizontal expansion of malaria vectors</td>
<td>First national communication of the Armenian Government under the UNFCCC 1998. Beniston 2002</td>
</tr>
<tr>
<td>Cholera</td>
<td>Expected expansion of circulation areas.</td>
<td>First national communication of the Armenian Government under the UNFCCC 1998.</td>
<td></td>
</tr>
<tr>
<td>Meningoencephalitis virus</td>
<td>Expected expansion of seasonal activity of vector (reduced altitudinal limit)</td>
<td>Second, third, and fourth national communication of the Republic of Croatia under the UNFCCC</td>
<td></td>
</tr>
<tr>
<td>Encephalitis and Lyme disease</td>
<td>Disease carrying ticks have become more wide-spread all over Lithuania and the eastern Baltic region</td>
<td>Third and fourth national communication of Lithuania under the UNFCCC</td>
<td></td>
</tr>
<tr>
<td>Lyme borreliosis</td>
<td>Potentially expand to higher latitudes and altitudes in Europe</td>
<td>Lindren <em>et al.</em> 2006</td>
<td></td>
</tr>
</tbody>
</table>

#### Table 7: Vector and Disease Projections for ECA

**Malaria**

Malaria, a disease whose vectors are from the mosquito genus *Anopheles*, is the single most important vector-borne disease globally in terms of the number of cases, associated
deaths, and economic impact (Gubler and Wilson 2005). Like dengue, global efforts in the mid-20th century to eradicate the mosquito helped reduce the disease spread significantly. However, a discontinuation of these efforts helped bring back the disease in some parts of the world.

Today, malaria is endemic to three ECA countries: Turkey, Azerbaijan, and Tajikistan (see Table 6). In the early 1990s, civil unrest, population movement, discontinuation of control programs and poor health infrastructure made Tajikistan vulnerable to reemergent malaria. Cases of local transmission were reported in neighboring Turkmenistan, Kazakhstan, and Kyrgyzstan. Soon after, autochthonous cases of the disease were discovered in Kyrgyzstan and Uzbekistan (RBM 2002; WHO 2004).

In 1998, the situation reached a critical level, and the Roll Back Malaria (RBM) program was introduced in the region. Six years after its implementation, the RBM program has been able to reduce malaria cases in the region by fourfold (WHO 2005). Despite the malaria situation in the region presently being termed “generally under control,” bordering areas remain under serious threat (WHO 2005).

<table>
<thead>
<tr>
<th>Country</th>
<th>Incidence Per 100,000 population</th>
<th>Reported cases Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armenia</td>
<td>0 16 5 0</td>
<td>0 502 141 7</td>
</tr>
<tr>
<td>Azerbaijan</td>
<td>0 36 19 3</td>
<td>24 2,840 1,526 242</td>
</tr>
<tr>
<td>Georgia</td>
<td>0 0 5 3</td>
<td>1 1 245 155</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Kyrgyzstan</td>
<td>0 0 0 4</td>
<td>1 3 12 226</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Tajikistan</td>
<td>3 106 309 35</td>
<td>175 6,103 19,084 2,309</td>
</tr>
<tr>
<td>Turkey</td>
<td>15 131 17 3</td>
<td>8,680 82,096 11,432 2,084</td>
</tr>
<tr>
<td>Turkmenistan</td>
<td>0 0 1 0</td>
<td>1 10 24 1</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>0 0 1 0</td>
<td>28 27 126 102</td>
</tr>
</tbody>
</table>

Table 6: Malaria Incidence and Reported Cases in ECA 1990-2005

Climate change is one factor responsible for the ECA malaria threat. It is well-established that temperature plays a role in both malaria vector development and parasite development inside the vector. It is also well-established that there is a link between malaria transmission and climatic factors, such as rainfall or El Niño.

However, evidence showing that increased long-term average temperatures have affected vector distribution and disease spread remains unclear (NRC 2001). For example, a time-series study on the effects of temperature change on malaria incidence in Turkey shows that since the 1970s, there have been two peak periods of malaria in Turkey (1977-1984 and 1993-1999) (Ergönül et al. 2007).

The first of these periods displays significantly higher mean temperatures in areas with high malaria incidence when compared to baseline average temperatures from 1930 to 2004. Alternatively, since 2000 malaria cases have decreased in Turkey despite no observed decrease in temperatures (Ergönül et al. 2007). No doubt one of the biggest
challenges in attributing observed climate change to malaria spread is “taking into account the considerable changes in reporting, surveillance, disease control programs, population changes, and other factors such as land-use change (IPCC 2007).

Other studies examine the potential future effect of climate change on the temporal and spatial distribution of the disease. One such model, based on climate scenarios in which global average land surface temperatures increase to +3.45°C and precipitation to +0.127 mm/day by 2050, shows malaria transmission season expanding by 3 months for some ECA regions in 2080 (Martens et al. 1999). The same group reports greatly increased spatial transmission potential in temperate areas, especially in central Asia and northern Europe (Martens et al. 1999).

On the other hand, a multivariate statistical model predicts smaller malaria expansion under similar climate scenarios, and points to regions of Czech Republic, Romania, Ukraine, Turkey, Turkmenistan, and Uzbekistan as potentially new areas for the disease by 2050 (Rogers and Randolph 2000). The advantages and disadvantages of each model should be considered prior to policy development (NRC 2001).

**Dengue Fever**

Dengue fever, a disease whose principle vector is the mosquito *Ae. aegypti* (or *Stegomyia fasciata*) is one of the most important vector-borne diseases globally in terms of cases and associated deaths (Patz et al. 1998). During the early 20th century, the *Ae. aegypti* mosquito was present in the Mediterranean region and neighboring countries, with accompanying dengue epidemics. Global programs in the 1950s to control mosquito larvae helped eradicate the disease (Adham et al. 1998, Gublen et al. 2005). However, the disease recurred two decades later in Jamaica and Puerto Rico, where *Ae. aegypti* control programs were not fully successful (Gublen et al. 2005).

Factors that may contribute to the distribution of mosquitoes include decreased public health measures, increased human migration, urbanization, and increased travel (Gublen et al. 2005). Another potential risk factor is increased average temperatures. Temperature plays a role in the all the stages of vector development. It also plays a role in the extrinsic incubation period, or time during which the mosquito becomes infectious with the dengue virus. The lower the temperatures, the longer incubation periods last, and the lower the chance that mosquitoes will become infectious (NRC 2001). Concomitant with climate change, the expected extension of warmer periods and reduction of colder periods may increase the abundance of infectious vectors.
Patz et al. 1998 show that with higher temperatures, the potential for a dengue epidemic increases – until about 40°C, after which the potential declines. Patz et al. also examine the added risk of climate change on dengue transmission assuming an average global mean temperature increase of 1.6°C by 2050, as generated by three climate general circulation models (GCMs). The results show an average increase of disease epidemic potential in areas already at risk by 31-47% (range 24%-74%), compared to baseline climatic conditions from 1930-1980.

The models also show the greatest area change for potential epidemic in temperate zones. This includes areas in Central Europe, Southeast Europe, the Caucasus, and Central Asia. The model does not take precipitation changes into account; whereas some studies have demonstrated that disease transmission is associated with high rainfall, others have demonstrated that it could also be associated with periods of drought - partly driven by the increased use of domestic water storage sites suitable for breeding (NRC 2001, IPCC 2007).

Although today dengue is not endemic in Europe, it is endemic in more than 100 countries, many of which (South America and Southeast Asia), are tourist destinations for Europeans (ECDC 2007). Since 1999, there have been 1,117 reported cases of dengue in Europeans, acquired during their travels to endemic areas.

Other

Lyme borreliosis

Lyme borreliosis, a disease whose main vectors are the tick genus *Ixodes*, is the most important vector-borne disease in temperate zones of the northern hemisphere in terms of number of cases. The primary vector is *I. ricinus* in Europe, except in Eastern Europe where it is *I. persulcatus* - also found in Russia and Central Asia.

In Europe, at least 85,000 cases are reported every year and prevalence is greater eastwards (Lindgren et al. 2006, EUCALB 2008). The disease is prevalent in Bosnia and Herzegovina, Serbia, and Montenegro. Countries with annual incidences of over 20 per 100,000 include Lithuania, Estonia, Slovenia, Bulgaria, and the Czech Republic (Lindgren et al. 2006). Factors such as changing land use practices and vegetation cover affect human-tick encounters and the incidence of the disease. Because seasonal occurrence of the disease is closely linked to tick activity, climatic factors play a role in the spread of this disease.

Temperature plays a role in all the developmental stages of *Ixodes* (Lindgren et al. 2006). Recent changes in temperature due to climate change have been linked to changes in tick abundance and incidence of disease in Central Europe. Based on several studies, the known upper limit of *I.ricinus* populations in mountainous regions of the Czech Republic was between 700-800 meters above sea level (Daniel et al. 2003). However, in the 1990s,

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22 By the Institute of Parasitology, Czechoslovak Academy of Sciences in 1957, by the Czech Government in 1960-1962, and by Daniel et al. in 1981-1983
it was reported by the health services of the Czech Republic that *I. ricinus* were being found in greater abundance, even in high altitudes.

In 2001, Daniel *et al.* performed a study and discovered that the upper limits of *I. ricinus*’ distribution had shifted up to 1,000 meters above sea level (Daniel *et al.* 2003). In 2004, Danielová *et al.* performed a study that identified changes in temperature as one of the primary reasons for the changes in *I. ricinus*’ distribution; increased average temperatures in the spring and autumn extended the seasonal activity (Danielová *et al.* 2006). During the same period, countries in Northern Europe such as Sweden experienced a latitudinal shift in tick distribution, which was also attributed to changes in the climate (Daniel *et al.* 2003).

It is anticipated that future climate change will continue to facilitate the distribution of ticks to higher latitudes and altitudes, and further extend their seasonal activity in Europe (Lindgren *et al.* 2006). In Germany, during the winter of 2006-2007, tick host-questing activity was reported for the first time due to a warm winter (Süss *et al.* 2008). In places with expected lower humidity, tick habitats are expected to diminish, as aridity is a limiting factor for tick growth (Lindgren *et al.* 2006).

**Tick-borne Encephalitis**

Tick-borne encephalitis (TBE) is the most common tick-transmitted arbovirus in Europe and Russia, accounting for 3000-4000 and 6000-8000 cases per year, respectively (Daniel *et al.* 2006b). Like Lyme borreliasis, it is transmitted mostly through the tick *I. ricinus* in Europe. During the 1990s, TBE became more widespread, emerged, and re-emerged in some parts of the Czech Republic, causing a twofold increase in national incidence as compared to the 1980s (Daniel *et al.* 2003).

Since the observed shift in the upper limit altitudes of *I. ricinus* habitat, two cases of TBE have been reported as a consequence of tick bites at altitudes previously known as disease risk-free (Daniel *et al.* 2003). Daniel *et al.* 2006 also performed a study on TBE occurrence 1993-2002 in the Czech Republic that shows a significant positive correlation with ambient temperatures (r² = 0.95, n = 5,873). All this suggests that climate change may be responsible for the increasing incidence of the disease in Central Europe. In the Baltics, climate change is explained as only one of the many factors affecting the increased incidence of disease (Sumilo *et al.* 2007).

**Other tick-borne diseases**

*I. ricinus* is a transmitter of many other diseases, including human granulocytic ehrlichiosis. The ticks’ increased range may pose the risk of spread of new diseases; in 2006, three patients met the criteria for a clinical diagnosis of anaplasmosis, a tick-borne disease, for the first time in Croatia (Misić-Majerus *et al.* 2006).
**Water-borne and food borne diseases**

**Cholera**

Cholera, a diarrheal disease caused by the ingestion of water contaminated with the bacertia *Vibrio cholera*, is the most common vibrio disease in humans (NRC 2001). Improvements in water sanitation through chlorination and filtration helped eradicate the disease in many countries. However, in 1961 the most recent pandemic began in southeast Asia, spreading to Africa in the 1970s, and to Central America in the 1990s (Giffith *et al.* 2006).

During 1998, a year that coincides with high temperature records, the number of cases worldwide almost doubled (NRC 2001). Recent cases in ECA include an outbreak in Armenia in 1998 and in Russia in 2001 (WHO, BBC 2001). In Europe, a total of 8 outbreaks were reported between 1995 and 2005 (Giffith *et al.* 2006). The cholera situation remains unstable in Azerbaijan, Russia, and Kazakhstan, due to imported cases and the isolation of infective agents (Onishchenko *et al.* 2005). Climate change may exacerbate these factors.

Temperature plays a role in the abundance of vibrio in the ocean, freshwater, or estuaries, while precipitation plays a role in intensity. *V. cholera* attaches and feeds on the polymer chitin (Bartlett *et al.* 2005). Warm sea surface temperatures increase phytoplankton blooms, which in return, increase zooplankton and shellfish – two sources of chitinous substrate for *V. cholera*.

The relationship between sea surface temperatures and cholera prevalence has been suggested in collected data from in Issyk-Kul Lake, Kyrgyzstan (Kokorin 2008). Other studies have also shown a relationship between sea-surface height and cholera outbreaks (Lobitz *et al.* 2000), and epidemics in Bangladesh have been attributed to seasonality of sea surface temperature during El Niño events (Rodó *et al.* 2002). Hence there is concern that increased sea surface temperatures, caused by climate change, may create favorable conditions for cholera outbreaks.

In its national communication report to the United Nations Framework Convention on Climate Change [UNFCCC], the Armenian government raises a flag of concern that climate change may have already begun affecting the incidence of cholera outbreaks in the country. According to the report, this is due to 1) expansion of *El Tor* strain circulation areas and 2) temperature increases -that will optimize the transmitter’s enzymatic activity- in places such as reservoirs of drinking water. Both of these possibilities have been detected as potential causes of the aggravation of cholera in Armenia (Armenia UNFCCC 1998).

Similarly, in its national communication report to the UNFCCC, the government of Tajikistan reports a concern about cholera outbreaks related to climate change, stating: “Alterations in the hydrological cycle will lead to a water shortage and an increase of water temperature in the rivers. This favors the formation of potential choleric water
reservoirs, especially in the lower reaches of the rivers Vakhsh, Kafirnigan, Syrdarya, and others” (Tajikistan UNFCCC 2002).

*Salmonellosis*

Salmonellosis, a diarrheal disease caused by the ingestion of the bacteria *Salmonella*, is the most important foodborne disease in Europe, accounting for 71% of all laboratory confirmed foodborne diseases (Kovats *et al.* 2004). Food handling behavior, especially during storage and cooking, are important factors in disease spread. While there are policies in place to effectively control salmonella outbreaks, there is a need for policies that specifically target climate-attributable salmonella cases (Kovats *et al.* 2004).

Temperature plays a role in the development of salmonella in food, and cases are more often reported during the summer season than any other season (D’Souze *et al.* 2004). A time-series study tested for a relationship between salmonella cases and ambient air temperatures. After accounting for a 0-9 week lag and controlling for season and holidays, the results showed the % change of *Salmonella* cases per °C above common threshold temperature of 6 °C. Temperature did in fact have a significant influence, reinforcing the concern that increased average ambient temperatures may create favorable conditions for salmonella outbreaks.

In a report by Kendrovski to the UNFCCC on the effects of climate change on health in Macedonia, the results show that the % change of *Salmonella* cases per °C above common ambient temperature of 5 °C is 5-10%. In addition, Kendrovski’s study projects that the seasonal index for salmonella in Macedonia will shift in 2030, as compared to 1980-2005 with greater seasonal duration and intensity.

*Allergies*

There is evidence that links climate change to increased incidence of allergies. For example, the observed onset of pollen season during earlier times in the spring has been linked to climate change (IPCC 2007). Experimental studies have also demonstrated pollen concentration increases with temperature and CO₂ concentration (IPCC 2007).

In ECA, one of the main sources of pollen allergies is the ragweed *Ambrosia*. In Central Europe, the concentration of ragweed is higher than in many other regions of the world (Kasprzyk 2007). In Croatia, approximately one-tenth of the population suffers from pollen allergy by *Ambrosia*. The government of Croatia predicts a greater number of people becoming “sensitized to and affected by respiratory allergies: seasonal allergic

23 The study was by Kovats *et al.* 2004 for 10 European countries, including the Czech Republic (1993-2001), Estonia (1990-2001), Poland (2000-2002), and the Slovak Republic (1983-2000). Changes were as follows: for the Czech Republic, 9.2 (7.8-10.7), for Estonia 9.2 (– 0.9-20.2), for Poland 8.7 (4.7-12.9), and for the Slovak Republic 2.5 (–2.6-7.8). Temperature appears to significantly influence transmission of infection in the Czech Republic (% Population Attributable fraction 29.1 (37.4-33.4)) and Poland ( % Population Attributable fraction 33.8 (20.2-45.1), with positive but non-significant results for Estonia and Slovak Republic.
rhinitis and allergic asthma caused by pollen from the trees, grasses and weeds,” as consequence of changing summer average temperatures and vegetation (Croatia UNFCCC 2006).
Box 5: Eutrophication and Human Health

The Baltic Sea

Climate change will have a singular indirect impact on health near the Baltic Sea. Eutrophication refers to an increase in nutrients, usually nitrogen and phosphorus. It is commonly a trigger for algal blooms, which often lead to hypoxia or anoxic conditions and to a degradation of environmental quality. Cyanobacteria can naturally fix nitrogen, contributing directly to eutrophication (HELCOM, 2007).

Extensive blooms of cyanobacteria (*Nodularia spumigena, Aphanizomenon sp., Anabaena sp.*) have been reported in the Baltic since the 19th century, but in the last decades they have increased in duration, frequency and biomass (Bianchi *et al.* 2000). *Nodularia spumigena* produces toxins called nodularins that have hepatotoxic effects, causing gastrointestinal illnesses, and liver damage in cases of persistent exposure (Hallegraeff *et al.* 2003). Cattle and pets have been reported dead after ingestion of water or scum containing *Nodularia* (WHO 2003).

Although there are no reported cases of human poisoning by *N. spumigena* to date, the possible increase of *Nodularia* blooms represents a hazard to human health, and the risk of exposure could be particularly high for children (WHO 2003). It is hypothesized, for example, that “cyanobacterial toxins are part of a complex of risk factors” that determine the high incidence of human hepatocellular carcinomas registered in China (WHO 1999).

By the end of the century, freshwater run-off into the Baltic Sea is predicted to increase due to enhanced precipitation related to climate change (HELCOM 2007). ECA countries south of the Baltic basin are expected to be exposed to a higher risk of flooding, which will contribute to leaching of nutrients into the sea. Because run-off accounts for up to 97% of Baltic Sea nutrient influxes (HELCOM 2007), it is possible that increased run-off will translate into a greater input of nutrients and exacerbate eutrophication events - excessive growth of algae and other plants resulting depletion of oxygen and consequent extinction of animal life.

In addition, surface sea water in the Baltic has been warming for the past fifteen years and the trend is projected to continue over this century (HELCOM 2007; Alcamo *et al.*, 2007). The growth of diatoms and dinoflagellate species is optimal only at temperatures just above the freezing point, while blooms of cyanobacteria occur only at temperatures higher than 16ºC. Temperature increases alone may enhance the frequency and intensity of these blooms, exerting selective pressure and limiting the growth of cold-water species while favoring warm water species like the toxic *Nodularia*. The combination of the two factors – run-off and surface warming - may result in an enhancement of phytoplankton growth, see Table 9, below.
1.4 Other Impacts of Climate Change: the migration-health nexus

Evidence shows that severe weather events and an increase in the average temperature due to climate change have an impact on livelihoods, and can become push factors for communities to leave resource-dependent rural areas and create new migration patterns (Koziell and Saunders, 2001). Especially in rural areas, households rely heavily on climate sensitive resources, such as water, and feel the impacts of severe weather events in farming and other activities on which they depend for livelihood. Migration caused by increase in average temperature tends to be permanent, especially for those dependent on subsistence agriculture (Raleigh et. al, 2007).

Economic and Distress Migration

Drought, the direct impacts of which are discussed in full above, decreases the amount of land that can be cultivated and makes self-sustainability through agricultural production limited. Individual family members may then migrate to urban or other rural areas in order to seek seasonal work while the rest of the family stays behind. This type of migration is known as economic migration. Economic migration can be internal or cross-border, depending on where economic opportunities appear.

Disasters such as floods cause distress migration, in which an entire population is forced to leave an affected area and seek temporary asylum at relief sites. Distress migration may cause internal or international displacement of people.

Migration in ECA

Migration in ECA has been historically high. ECA accounts for more than one third of total world emigration and immigration, if movement between industrial countries is excluded. The breakup of the Soviet Union triggered a large increase in migration in ECA, including internal movement, cross-border movement within the region, emigration from ECA and a small amount of migration into ECA from other regions (Mansoor and Quillin, 2006).

ECA consists of two main migration streams. One links the eastern part of the region to Western Europe (42 percent of total migration) and the other flows within the countries of the Commonwealth of Independent States (80 percent of total migration), with Russia being the primary destination country (Mansoor and Quillin, 2006).

Between 1989 and 2004, the top three receiving countries in the region, relative to their population size, were Russia with a net migration of 3.9%, Belarus with a net migration of 0.3%, followed by the Czech Republic and Hungary with a net migration of 0.2% each.
The top three countries in terms of outward flow of migrants, relative to their population size, were Albania, with a net migration of -23.9%, Kazakhstan, with a net migration of -20.7%, and Georgia, with a net migration of -20.4% (Mansoor and Quillin, 2006).

Figure 9 shows major migration patterns in ECA from 1989 to 2003. The sizes and directions of the arrows represent the sizes and directions of the migration streams they indicate. Most of the flows go to Russia, however Germany is the main receiving country for Russian migrants. The largest stream of migrants (1.7 million persons), coming to Russia, originates in Kazakhstan (Mansoor and Quillin, 2006).

**Figure 9**

![Figure 9a: Largest Migration Flows Involving Major Migrant Stocks from Western ECA Countries](image)
ECA has clearly been experiencing a considerable amount of displacement. The main migration patterns within and from outside ECA are labor or economic migration, ecological migration, and conflict-related migration. Conflict can be a cause of both economic and environmental disruption.

Internal migration due to damaged environment has continued to increase in the ECA region and is predicted to further increase in future (IOM, 2002; Christian Aid, 2007). Analyses of the future sensitivity of ground water recharge to climate change for three time periods (2020s, 2050s and 2080s) imply that southern Europe will experience a potential decrease in groundwater recharge that will seriously impact the availability of fresh water resources for drinking and agricultural cultivation (Hiscock et al., 2008). Such a scenario may force communities that had been self-sustaining to migrate (Hunter, 2007).

Since there are already many different migration patterns within and from outside the ECA region, migration due to climate change may overstretch receiving countries’ capacities, especially in the health sector, and may lead to greater social vulnerability of migrants. Note, of course, that the EU 15 countries have more capacity to absorb migrants than do the countries of Central Asia. Although ECA migration flows have tended to decrease, the importance of identifying the effects of climate change on migration cannot be dismissed.

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24 Azerbaijan and Georgia experienced the largest flows of internal displacement due to conflict (Mansoor and Quillin, 2006). However, migration flows have continued to decrease compared to the period immediately following the political transition. In 2000 there was 40 per cent less migration than in 1997 within the region, and 25-33 percent less to countries outside the region (IOM, 2002).

25 In 2000 there was 40 per cent less migration than in 1997 within the region, and 25-33 percent less with countries outside the region (IOM 2002)
**Box 6: Case study**
Drought and Migration (Republic of Moldova)

Between 1990 and 2007, the Republic of Moldova experienced nine years of droughts due to heatwaves. Between May and July 2007, Moldova experienced 36-45 days with temperatures higher than 30° C, which is three times higher than the norm, and 10-12 days of temperatures higher than 35° C, which is 11-12 times higher than the norm. These heatwaves had a severe impact on agricultural production through scarcity of water. This pushing factor caused people, mainly from rural areas, to migrate, predominantly to Russia (59%) and Italy (17%). Migrants moved to large cities such as Moscow and Rome (IOM, 2007).

**Box 7: Case study**
Floods and migration (Kazakhstan)

During the last several years, Kazakhstan has been experiencing intense flooding in the southern part of the country. In February 2008, sudden increase in air temperature and heavy rains caused flooding in 48 settlements in the south of Kazakhstan, displacing more than 13,000 people. The majority of the people were evacuated to nearby camps or to stay with relatives and friends. The flooding also had a negative impact on agriculture. In several villages, the floods covered agricultural land and irrigation canals with mud and sand, making future agricultural production difficult. In addition, the flooding remains a concern, since additional floods in the south are expected, and might displace over 250,000 people.

**The Impact of Migration on Health**

The figure below (Fig. 10) goes beyond the livelihood impact of climate change to show the links between climate change, migration and health. Migration impacts health outcomes of migrants as well as of the host population in three dimensions. First, the vulnerability of migrants’ health is affected by limited access to drugs, medical services, water and sanitation. Second, the spread of disease within and across countries and the reappearance of disease are often facilitated by migration. Third, migration places a burden on health system capacity due to limits on financial resources for service provision. Each of these three dimensions have direct impact on the health outcomes of migrants and host populations.

**Figure 10**
The following sections will discuss the three different dimensions of impacts of migration on health outcomes of migrants and host populations in more detail.

**Vulnerability of Migrants**

Migrant vulnerability to disease can often begin in the country of origin; migrants in the European Union often contract diseases in their home country (Hamers *et al.* 2006). After a stressful journey to the new host country, migrants remain vulnerable due to limited access to medical services and drugs, lack of clean water and the inadequate sanitation infrastructure associated with new migrant living conditions, as well as lack of health insurance. Migrants often work in unskilled but high-risk jobs in dangerous and unhealthy conditions. Evidence shows that rates for work accidents are two or three times greater for migrants than for the native-born population (*Bollini and Siem 1995*).

Migrants can also struggle with psychological stress. They are constantly exposed to stress due to culture shock, language barriers, fear about work insecurity and deportation, homesickness and racism (*Carballo, 2007*). Employment and income are often unstable. In addition, illness is very costly for migrants in terms of lost time at work and treatment costs (*Carballo 2005*). The adaptation to a new culture can include poor knowledge of
the local language, which leads to challenges in obtaining appropriate health care. Furthermore, cultural differences in terms of what health care should look like and at what point in time it should be sought may present as a barrier to access.

**Incidence and Spread of diseases**

Migrants seem to be more vulnerable to certain diseases, such as Type 2 diabetes, and cardiovascular diseases such as hypertension and stroke (Carballo 2007). The spread of respiratory diseases, such as tuberculosis, is a greater risk (Carballo and Mboup 2005). Migration within and across countries may lead to the spread of these diseases from other regions. According to the European Society for Clinical Microbiology and Infectious Diseases (ECSMID), several large European cities have been experiencing tuberculosis epidemics. These epidemics are related to increased migration from Asia, Africa and Latin America.

Portugal has the highest incidence of tuberculosis (31 per 100,000 inhabitants) in Europe. The average in central and eastern EU countries is 12.8 per 100,000 inhabitants. The urban epidemiology of tuberculosis is influenced by the same socio-economic factors that migrants face in host countries (EMD 2007). A survey conducted between 2004 and 2005 in Greece and found that 96 out of 1,460 legal Athens immigrants from Albania, Bulgaria, Romania, former Soviet Union countries, Africa and Southeast Asia, were positive to tuberculin skin tests (Antypa et al. 2005).

Some low incidence countries in Europe also report infections such as hepatitis B and C, and HIV/Aids to be more frequent in migrants than in the native population (Gushulak and MacPherson 2006). In 2005, in the European Union, 46% of HIV/Aids infections were diagnosed in immigrants, and most of these infections were acquired outside the EU (Hamers et al. 2006).

In addition, migrants are often carriers of malaria. Evidence from Spain shows that all of the 24 children admitted to hospitals with malaria between 1997 and 2005 were children of immigrants (Martinez-Baylach et al. 2007). In Albania, between 1992 and 2001, 114 cases of malaria were reported. All of these cases were immigrants who acquired the disease before they arrived in Albania (WHO 2002).

This evidence speaks to the urgent need to make access to health care easier for migrants, not only to decrease migrant vulnerability through early detection and treatment, but also to limit the spread of diseases throughout the country.

**The Burden on the Health System**

Migration across regions with different health and disease conditions has a strong impact on the public health systems of countries receiving migrants. The global dispersion of disease influences a country’s local burden of disease cases. Hence, when examining the spread of diseases through migration, the impact of sick and vulnerable migrants on local health systems is an important factor to consider.
Migration in low-incidence countries has immediate effects on local health systems. Data from hospitals in Spain and Denmark show that immigrants prefer to use Emergency Rooms (ER), rather than other health care services, as access points to primary health care. The study found that there was no cost difference between migrant and native populations for treatments sought, so socio-economic factors were not considered explanations for increased ER use in migrant populations. Rather, the reasons are assumed to be: lack of information about local health care systems, barriers of access to primary care, and delay in seeking medical help until it is unavoidable (Cots et al. 2007; Norredam et al. 2007).

Migration also has long-term effects related to health. A study conducted in Germany shows that health care expenditures for migrants up to the age of 40 are higher than for Germans. Reasons for higher health care expenditures in migrants under the age of 40 include bad work conditions, often difficult manual labor, more work-related accidents, and higher fertility rates, which produces more co-insured family members (Sinn et al. 2001). In the other hand, above the age of 40, health care expenditures are higher for Germans than for migrants.

In order to be able to cope with increasing migration due to climate change, host countries will be forced to consider certain policy steps. There is an intermediate enhanced need for clinical/laboratory capacities for imported disease. This capacity includes the provision of services and facilities for exotic or uncommon diseases, training in low probability but high impact diseases, and education of healthcare providers for competency in treating global health issues.

Several countries in Western Europe, such as Denmark, Greece, Norway, Germany, France, Belgium and others conduct screening tests for immigrants arriving from countries with a high incidence of tuberculosis. However, there appear to be no systematically applied screening policies across Western Europe (Carballo and Mboup 2005).

The health system of a host country must also respond to a growing number of immigrants in the long-term. This can be done through modification of training programs for health providers to focus on the diseases that migrants bring with them, increasing migration of health professionals from migrant source regions in order to obtain firsthand disease knowledge, and promotion of sensitivity training and cultural awareness campaigns in order to eliminate social and cultural barriers for migrants to health care (Gushulak and MacPherson 2006).

**Examples of the Climate Change-Migration-Health Link**

Table 8 shows direct and indirect health impacts of climate change related to extreme weather events, and the type of migration that is triggered, with real life examples. Many of these have already been discussed above.
<table>
<thead>
<tr>
<th>Climate Change</th>
<th>Direct Impact on Health</th>
<th>Impact on Livelihood</th>
<th>Indirect Impact on Health</th>
<th>Type of Migration Caused</th>
<th>Migration Time Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought such as in Moldova</td>
<td>Decrease in water availability for households, increase in health burden due to diarrheal diseases</td>
<td>Decline in agricultural production leads to famine</td>
<td>Lack of water, and therefore lack of sanitation facilities, increases likelihood of diarrheal diseases</td>
<td>Labor migration from rural to urban areas</td>
<td>Seasonal</td>
</tr>
<tr>
<td>Floods such as in Kazakhstan</td>
<td>Foster water-borne outbreaks of diarrheal diseases or cholera</td>
<td>Destruction of homes and agricultural lands leads to mass displacement</td>
<td>Urban slams and squatter settlements/camps with lack of water and sanitation facilities cause difficulty controlling disease reservoirs</td>
<td>Distress migration</td>
<td>Temporary or permanent depending on intervention</td>
</tr>
<tr>
<td>Heatwaves such as in Hungary</td>
<td>Causes severe breathing and heart problems for elderly, poor, and homeless</td>
<td>Decline in agricultural production</td>
<td>N/A</td>
<td>Permanent migration</td>
<td>Lifetime</td>
</tr>
</tbody>
</table>

Table 8: Climate change health impacts and migration
(based on Kothari, 2002:20; Raleigh et al, 2007)
Section Two
Country-Level Climate Change-Health Vulnerability Assessment
Section Two
Country-Level Climate Change-Health Vulnerability Assessment

2.1 Overview

The Vulnerability Assessment Toolkit was developed with the findings of this report in mind and is designed to evaluate countries’ vulnerability to climate change based on future projections and status of countries’ current adaptive capacities. In other words, vulnerability is assessed assuming that climate continues to deteriorate and national adaptive capacities remain at current levels.

Exposure, sensitivity and the various aspects of adaptive capacity (such as infrastructure, human capital, institutions, etc.) should be questioned on four counts: floods, heatwaves, droughts and changing averages. The tool operates as a sophisticated checklist in which data on climate can be correlated with data such as demographic and inventory statistics. Experts wishing to assess breaches in preparedness for a given country can use it to flag potential gaps in a country’s readiness, suggest areas for improvement, and help define sound policies.

Methodology

The toolkit is based on the Climate Change, Risk and Vulnerability report by the Australian Government, which defines vulnerability of a system as a function of three elements: 1) exposure 2) sensitivity and 3) adaptive capacity. Furthermore, the toolkit builds on the Climate Change Vulnerability Assessment Framework for human health developed by the WHO, by adapting its components and their applicability to the context of this report. As used in this document:

**Exposure** refers to the projected likelihood and/or probability of the occurrence of a Climate Change related event in a particular country.

**Sensitivity** includes current factors that influence the magnitude of a given Climate Change impact on health. It would be equivalent to the role of effect modifiers or confounders in epidemiology in the relationship between exposure and outcome. As used in the toolkit, sensitivity generally refers to a set of underlying characteristics or circumstances of the population that makes them more likely to suffer health impacts from Climate Change-related factors.

**Adaptive capacity** is the current capacity of the health sector to take effective actions to cope with projected locally relevant impacts of Climate Change on Health. It is the function of the health system in delivering not only curative care services but also providing public health services including preventative and promotive services both at the community and individual level. Adaptive capacity will differ according to the climate change event in question, that is to say, the different capacities are needed to deal with extreme weather events compared with changing averages.
The determinants of adaptive capacity taken into account in this report concern:
- Economic Resources
- Technology
- Human Capital
- Access to risk-spreading mechanisms
- Access to and ability to manage information
- Institutions, and
- Equity Issues.

Influence of these determinants is examined in this section through a set of quantitative and/or qualitative indicators that are consistently reported at the national level, mainly by the World Bank, various United Nations Agencies, or other relevant International Organizations. A balanced compromise was crafted, for each indicator, between descriptive value and present or future availability, in order to maximize the usefulness of the tool in the context of a broader assessment.

As mentioned, the toolkit incorporates both quantitative and qualitative indicators (in the absence of any quantitative measures). For the latter, the authors developed suggestions for wording and banding of indicators in a qualitative questionnaire to assist clients in undergoing a self-assessment on the proposed dimensions (see Annex 4 for details).

### 2.2 Toolkit proposal and rationale for indicators

Regarding the Health Sector Vulnerability Assessment toolkit, the dimensions considered are Exposure, Sensitivity and Adaptive capacity of the health sector. Economic Resources, technology, Infrastructure, Human Capital, Risk-Spreading mechanisms, Information Management and Institutional issues were considered as determinants for adaptive capacity. The choice of indicators reflected in the table was driven by prioritizing quantitative parameters reported periodically by international organizations or other highly reliable sources. Where no quantitative indicators were available, qualitative ones were proposed. An example for use of the reader and suggestions for banding are made available in Annex 4.

In the toolkit table, exposures have been classified as within Extreme events (floods, heatwaves, droughts) or in Changing Averages. Given the unpredictable nature of most extreme events, exposure is given in terms of probabilities and likelihood. The indicators of choice to reflect the long-term change in temperatures and precipitation are the change in average temperatures and precipitation in the last two decades. The rationale is that many climate-sensitive diseases are determined in part by the humidity and temperature for the viability of the pathogen or vector involved. The twenty year period of study is the minimum considered by IPCC in its fourth assessment.

As used in the toolkit, sensitivity generally refers to a set of underlying characteristics or circumstances of the population that makes them more likely to suffer health impacts from Climate Change-related factors. For Floods, the coastal population and past
occurrence are considered. For heatwaves, urbanization, age and diabetes are included as evidence-based risk-factors for heat-related mortality and morbidity. For droughts, sensitivity issues were related to dependence on agriculture and access to safe water supplies. The incidence of foodborne diseases was chosen as an (partial) indicator for sensitivity to changing averages mainly due to its easy availability and reliability.

Determinants of the adaptive capacity:

Because of institutional, economic and other constraints and obstacles, countries’ Health Systems often lack the capacity to effectively take action towards adapting to impacts of Climate Change. In the case of the least developed nations, a substantial “adaptation deficit” to today’s conditions adds a component of urgency to the general need to build adaptive capacity. Hence, it is useful to look at adaptive capacity building in terms of different determinants or streams affected by cross-cutting issues. The determinants considered in this toolkit and the rationale for their chosen indicators are explained below:

Economic Resources: Public expenditure on health as % of GDP was considered a good indicator for constraints in healthcare financing, given the mostly publicly paid healthcare systems and public forms of insurance in many ECA countries.

Technology: the presence of a country-wide Health Technology Assessment System implies a concern about the adequacy of technological assets within health systems, as well as a baseline benchmark to track progress in adaptation.

Infrastructure: for the extreme events, indicators relate to “hardware” in terms of supplies for an adequate Emergency Response and management. For health outcomes derived from Changing Averages, however, indicators relate to the routine reality of Access to and Structural Quality of Health Care. This is so because of the progressive and/or cyclical nature of said health outcomes, which distinguishes them from the emergency character of extreme events.

Human Capital: indicators for this dimension relate to the availability of personnel and professional standards of health practitioners, as well as research efforts and availability and implementation of continuing education that is relevant for climate change impacts (emergency response, on the one hand, and emerging or expanding infectious diseases).

Access to Risk-Spreading mechanisms: this dimension refers broadly to the risk of financial losses associated with health outcomes brought about by Climate Change. The amount of population insured thus plays a large role in the individual minimization of this risk by decreasing out of pocket expenditures on healthcare services, but so does the comprehensiveness of the Basic Benefits packages. For instance, if the BBP includes Public and Environmental Health services, minimization of risk is much larger on a population basis.
Access to and ability to manage information: this dimension has proved of key importance in multiple settings for effective decision-making and taking action in both emergency health crises and on a routine health practice. Hence, the comprehensive array of indicators ranging from basic health data transmission, public health surveillance (case reporting, etc), physical emergency communications systems and pre-set arrangements for the circulation and use of information. For the health outcomes expected from changing averages, the availability of clinical guidelines for practitioners on Neonatal and Childhood illness and malnutrition was judged a better indicator for the usual top-down flow of information.

Institutions: among other considerations, the institutional aspect of adaptive capacity for the health sector involves a body of standard procedures implemented in the form of clinical guidelines and performance or quality assessment protocols at various levels of government. The presence and functionality of a national emergency preparedness plan involves a certain degree of institutional capacity, as does the proactive, planned action on vector control.

Equity: though a general index for inequality (e.g. Gini) was considered for this dimension, the proportion of household out-of-pocket expenditure on health is probably more descriptive, given the complex systems of subsidies and differences between countries. The Urban:rural ratio reflects the fact that access and opportunity costs may differ substantially for different settings.
### 2.3 Climate Change-Health Sector Vulnerability Assessment Toolkit

#### Exposure
- Increased likelihood of event (based on standard definitions)
- Probability density functions

#### Sensitivity
- % of population on coasts
- Number of floods in the last 9 years
- % of urban population
- % of population over age 75
- % of population with diabetes
- % of rural population
- % of people working in the agricultural sector
- % of population whose homes are connected to a water supply system
- Presence of a safe water source

#### Changing Averages
- Average increase in minimum and maximum temperatures in the last two decades
- Average increase in minimum and maximum precipitation in the last two decades
- Microbiological foodborne diseases per 100,000 inhabitants

<table>
<thead>
<tr>
<th>Economic Resources</th>
<th>Flooding</th>
<th>Heatwaves</th>
<th>Droughts</th>
<th>Changing Averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
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<td>Infrastructure</td>
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<td>- Emergency rooms (per capita)</td>
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<td>- Ambulatory vehicles (air, water, and land)</td>
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<tr>
<td>- Supplies</td>
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<tr>
<td>- Emergency power generators for health facilities</td>
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<tr>
<td>- Nursing and elderly home beds per 100,000 inhabitants</td>
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<tr>
<td>- Emergency rooms (per capita)</td>
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<td>- Emergency power generators for health facilities</td>
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<tr>
<td>- Public expenditure on health as % of GDP</td>
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<tr>
<td>- Is a Health Technology Assessment System in place?</td>
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</tbody>
</table>

| Human Capital |          |           |          |                   |
| - % of physicians per 1,000 inhabitants |          |           |          |                   |
| - % of nurses per 1,000 inhabitants |          |           |          |                   |
| - Total gross domestic expenditure on R&D as % of GDP |          |           |          |                   |
| - Health professional preparedness for extreme weather event emergencies |          |           |          |                   |
| - Provider accreditation |          |           |          |                   |

| Access to risk-spreading mechanisms |          |           |          |                   |
| - % of insured population |          |           |          |                   |
| - Comprehensiveness of the Basic Benefits Package |          |           |          |                   |

| Access to and ability to manage information |          |           |          |                   |
| - Functionality of HIS in terms of quality of data flow |          |           |          |                   |
| - Functionality of the public health surveillance system |          |           |          |                   |
| - Presence of infrastructure for health emergency communication system (hardware) |          |           |          |                   |
| - Presence of coordination mechanisms for effective function of the health emergency communication system (software and facilitating factors) |          |           |          |                   |
| - Presence of IMNCI guidelines |          |           |          |                   |
| - Presence of guidelines for treatment of malnutrition |          |           |          |                   |

| Institutions |          |           |          |                   |
| - Availability and use of clinical guidelines |          |           |          |                   |
| - Availability of protocols to monitor clinical quality |          |           |          |                   |
| - National plan for health sector emergency preparedness, management, and response |          |           |          |                   |
| - Presence & functionality of a vector management program |          |           |          |                   |
Equity

Out-of-pocket expenditure as % of total household expenditure (urban: rural ratio)

Key: Indicators in green are qualitative indicator proposed by team (see annex 4 for detailed question and banding).
Section Three
Climate Change-Health Adaptive Strategies
Section Three
Climate Change-Health Adaptive Strategies

3.1 Overview

Irrespective of future developments in climate conditions and efforts to mitigate the emission of greenhouse gas, the formulation of health-specific adaptive strategies that enhance the resilience of human populations is likely to prove important. The IPCC has flagged the need for both anticipatory and responsive strategies, in which the roles of the different stakeholders are clearly identified and cross-sector collaboration is imperative, and it presents a generic framework for recommended adaptive strategies (see Matrix).

Responsive and Anticipatory Strategies

The two clusters of health-specific adaptive strategies needed according to the IPCC’s Fourth Assessment Report, are “responsive” and “anticipatory.” The responsive strategies would aim at reducing current vulnerabilities to the climate change that has already occurred, while the anticipatory strategies would aim at addressing health outcomes associated with future projections of climate change. Both strategies would be implemented by a variety of stakeholders, including: regional and national governments; health institutions and professionals, and the general public.

Roles and responsibilities

Each adaptive strategy suggested by the IPCC, has a corresponding set of general roles to be played by different implementing stakeholders. Governments’ role should be to focus on building environmental and climatic forecast systems that are able to predict diseases outbreaks. It is also a government’s responsibility to convey to its Ministry of Health and other ministries, as well as to the general public, the information relevant to predicted and expected disease outbreaks. Government’s role also includes: design and implementation of emergency preparedness polices and plans; resource allocation, and public awareness.

The major responsibility of health institutions is to strengthen their capacities and build systems that function effectively - providing primary health care and education to all citizens through a network of well-qualified and trained health professionals who understand the health impacts and outcomes of climate change. In short, this role is suggested to involve capacity building, public health surveillance, provision of services and drugs, and mobilization of human capital.

Individuals and the general public are expected to respond appropriately to government alerts about predicted health hazards and emergencies. This role is suggested to involve awareness development, behavior-change campaigns, advocacy, and social mobilization.
Cross-sectoral Collaboration

Developing health-specific strategies is by no means inclusive of only the health sector, and integration of strategies across different sectors will be necessary. For example, preparedness of the energy sector to increase power surge capacity in order to facilitate appropriate ventilation in the event of heatwaves, is as important as having a rapid response medical team to react to the medical emergencies that occur during heatwaves.

Likewise, in drought preparation, mainstreaming climate change considerations into national water and sanitation planning is as important as the stocking of medical supplies such as water purifiers and oral dehydration solutions. Another example is the cooperation between the health sector and other ministries, such as Water, Natural Resources, Meteorology, and Environment, that will be required for conducting environmental risk assessments to monitor environmental threats to public health during floods events.

Development of a Framework

The following tables represent the efforts of the team to develop event-specific adaptive strategies, using both the generic framework mentioned above and the disease matrix (Fig. ??), in which the relationship between different climate events and health outcomes, as evidenced in ECA, is summarized. As does the IPCC framework, the framework adopted here organizes the health adaptive strategies into anticipatory and responsive strategies. The developed strategies also benefited from close attention to the lessons learned in previous responses to events that took place in ECA, such as the heatwaves in France and southern Europe and the drought events in the UK and other countries.
## 3.2 Adaptive Strategies for Extreme Weather Events

### Table 10

<table>
<thead>
<tr>
<th>Floods</th>
<th><strong>Government</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>o Within broader disaster preparedness planning, design and implement systems to communicate with the general public and health professionals/emergency responders.</td>
</tr>
<tr>
<td></td>
<td>o Design education campaigns for at-risk populations on floods and evacuation processes.</td>
</tr>
<tr>
<td></td>
<td>o Set up flood-resilient emergency information systems (i.e. recursive, does not require electricity, etc.).</td>
</tr>
<tr>
<td></td>
<td>o For countries where multiple languages are spoken, prepare multilingual materials and make arrangements to deliver information in these languages.</td>
</tr>
</tbody>
</table>

**Anticipatory**

<table>
<thead>
<tr>
<th><strong>Health Institutions/Professionals</strong></th>
<th><strong>Design and test Institution-specific disaster preparedness and response plan provisions:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>o Waterproof supply repositories.</td>
</tr>
<tr>
<td></td>
<td>o Store sensitive medical equipment in protected areas rather than basements.</td>
</tr>
<tr>
<td></td>
<td>o Continue training of medical staff for emergency situations including evacuation of hospital patients and working under emergency conditions.</td>
</tr>
<tr>
<td></td>
<td>o Install flood-resilient communication systems to use during emergency (i.e. does not require electricity, reaches all ward sections in a hospital, etc.).</td>
</tr>
<tr>
<td></td>
<td>o Store back-up files of patient records in a secure computer server outside the hospital, and identify a reliable source that may deliver hard copies upon request.</td>
</tr>
<tr>
<td></td>
<td>o Back-up clean water supply in hospitals, and means of purification.</td>
</tr>
<tr>
<td></td>
<td>o Design and implement procedures and systems for a timely and effective notification of evacuation.</td>
</tr>
<tr>
<td></td>
<td>o Ensure provisions for enabling a surge in supplies and human resources upon occurrence of a flood.</td>
</tr>
<tr>
<td></td>
<td>o Put in place systems for coordination and organization of all stages of medical care (including EMS) in the event of a flood.</td>
</tr>
</tbody>
</table>

**Public**

<table>
<thead>
<tr>
<th><strong>Get educated and stay informed on:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>o Safety procedures; prioritization in the event of a flood (ensure safety of self and others before property, ensure basic needs, avoid mind-altering substances, etc.).</td>
</tr>
<tr>
<td>o Insurance provisions or risk-spreading mechanisms against losses due to floods.</td>
</tr>
<tr>
<td>o Inducing action from policy and decision-makers on flood control policies and infrastructures with mid- and long-term planning considerations.</td>
</tr>
<tr>
<td>Government</td>
</tr>
<tr>
<td>------------</td>
</tr>
</tbody>
</table>
| o Deliver educational tools to increase public awareness.  
o Work with the media and health institutions to deliver useful information post-event.  
o Take measures to ensure public hygiene is maintained.  
o Increase levels of annual vaccination of infectious diseases of national concern during year(s) of major flood event(s).  
o Conduct environmental risk assessments to monitor environmental threats to the health of the public, e.g. up-to-date information of any contaminants in water systems.  
o Divide regions into “risk-zones” for environmental health based on historical trends, vectors numbers, or other determining factors. | o Detect and contain epidemic clusters through increased surveillance of infectious diseases.  
o Increase lab diagnostic capacity by introduction of express methods (ELISA, IF, PCR).  
o Periodically educate and increase awareness about emerging or recurring vector-borne diseases.  
o Organize a functional post-event epidemiological monitoring and surveillance system.  
o Forecast epidemic processes for specific diseases using locally relevant tools.  

**To reduce consequences of stress-related diseases in the population:**  
o Apply suitable psychological tools and tests for the early detection of stress-related diseases.  
o Provide social support for vulnerable groups (e.g. pregnant women, the poor, etc.).  

**Further recommendations for health specialists and database centers:**  
o Expansion of Information: Include epidemiologically relevant data (non-immediate cause of death, observable risk factors) when reporting deaths during floods in order to better identify vulnerable groups and causes of death. This information may be synthesized to create education on safety and appropriate actions to reduce the number of deaths.  
o Standardization of Approach: Adapt a standardized reporting technique so information across time and different regions may be compared and combined into national/continental reports. | o Drink only from designated safe water supplies.  
o Boil water before consumption. Chlorinate/boil tap water  
o Discard food that is susceptible of contamination.  
o Clean up quickly (e.g. dead animals in or around the house) and disinfect.  
o During cleaning, avoid contact with mud or corpses by wearing gloves and protective gear.  
o Get educated on safety cleaning procedures to avoid accidents such as electric shock or displaced wild animal attacks.  
o Treat furniture and rooms for vectors (mainly rodents and insects).  
o Ensure that flooded basements are cleared in a timely fashion and dried on a longer time scale so as to reduce risk of mosquito viruses and mold attacks.  
o Avoid mosquito bites by wearing insect repellent, wearing long sleeves, and having screens at home.  
o For those involved in recreational activities or work related to water: minimize contact with water or mud that may be contaminated with rodent urine and wear protective clothing such as waterproof boots.  
o Seek social support if feeling stressed or depressed. |
## Heatwaves

<table>
<thead>
<tr>
<th>Anticipatory</th>
<th>Government</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Future housing and urban planning takes into account natural ventilation systems.</td>
<td>- Initiate and maintain dialogue with employers to facilitate selective condition-based absenteeism in the event of an officially declared heatwave.</td>
</tr>
<tr>
<td>- Landscape planning takes into account climate factors (e.g. xeriscaping, etc.).</td>
<td>- Inform and reach out to general public and particularly vulnerable populations, through radio, TV, internet, etc., about the risks of excessive heat, summer time ozone and particulate matter levels and what they can do to avoid adverse health effects.</td>
</tr>
<tr>
<td>- Increase power surge capacity for the event of heatwaves.</td>
<td>- Put in place the regulatory and physical resources to a) warn sensitive populations to restrict their outdoor activities upon excessive levels of ozone, PM or other pollutant during a heatwave and b) restrict emissions of in-city stationary sources or trucks/general traffic if need be.</td>
</tr>
<tr>
<td>- Plan for arrangements of easily accessible back-up supplies of water in the event of a heatwave.</td>
<td>- Develop a tracking system of fire in the country or neighboring countries and satellite system of smoke travel.</td>
</tr>
<tr>
<td>- Coordinate weather forecast institutions and health institutions to create an early warning system.</td>
<td></td>
</tr>
</tbody>
</table>

### Adaptive strategies to avoid aggravating heat-sensitive illnesses and health effects related to air pollution and forest fires:

- Initiate and maintain dialogue with employers to facilitate selective condition-based absenteeism in the event of an officially declared heatwave.
- Inform and reach out to general public and particularly vulnerable populations, through radio, TV, internet, etc., about the risks of excessive heat, summer time ozone and particulate matter levels and what they can do to avoid adverse health effects.
- Put in place the regulatory and physical resources to a) warn sensitive populations to restrict their outdoor activities upon excessive levels of ozone, PM or other pollutant during a heatwave and b) restrict emissions of in-city stationary sources or trucks/general traffic if need be.
- Develop a tracking system of fire in the country or neighboring countries and satellite system of smoke travel.

<table>
<thead>
<tr>
<th>Responsive</th>
<th>Health Institutions/Professionals</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Develop a heatwave early warning system with help from weather forecasting institutions, allocating budgetary and human resources to its operation and maintenance.</td>
<td>- Provide continuous electricity for the city during heatwaves, with provisions for prioritization of healthcare facilities.</td>
</tr>
<tr>
<td>- Collaborate with government agencies and media in developing strategies for risk communication to the public.</td>
<td>- Keep health agencies and general public informed about government activities related to heatwaves, status of forest fires, and actions taken.</td>
</tr>
<tr>
<td>- Ensure a satisfactory number of staff to provide services if needed, including provisions for staff surges on short notice (retired doctors and other health practitioners in the area on call).</td>
<td>- Induce action from policy and decision-makers on the design and implementation of heatwave plans and provisions, including early warning systems.</td>
</tr>
<tr>
<td>- Provide a heatwave hotline and web-based service systems to answer heat-related inquiries.</td>
<td>- Stay alert about weather conditions forecast in the hot season.</td>
</tr>
<tr>
<td>- Develop outreach programs (including health practitioners and volunteers) targeted towards vulnerable populations</td>
<td>- Get educated and stay informed about the health risks of excessive heat, and how to protect self and family.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Public</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Get informed about how temperature can affect your medical condition.</td>
<td>- Agree in advance on possible leaves for medical reasons with employer.</td>
</tr>
<tr>
<td>- Induce action from policy and decision-makers on the design and implementation of heatwave plans and provisions, including early warning systems.</td>
<td></td>
</tr>
<tr>
<td><strong>Responsive</strong></td>
<td><strong>Health Institutions/Professionals</strong></td>
</tr>
<tr>
<td>----------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Monitor health status of patients within healthcare facilities, nursing homes, outpatient settings, the chronically ill, and the elderly at home.</td>
</tr>
<tr>
<td></td>
<td>Work with media to develop useful messages and inform the public on ways to stay healthy during heatwaves; health officials can deliver agreed message if deemed appropriate.</td>
</tr>
<tr>
<td></td>
<td>Work with media to inform the public on ways smoke and smog can affect health and ways to reduce exposure.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Public</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoid strenuous activities.</td>
</tr>
<tr>
<td>Stay indoors/under shade during peak heat hours of the day.</td>
</tr>
<tr>
<td>Use a fan or air conditioning to keep cool.</td>
</tr>
<tr>
<td>Stay hydrated by drinking lots of fluids and avoiding alcohol and caffeinated drinks</td>
</tr>
<tr>
<td>Cool down with extra showers.</td>
</tr>
<tr>
<td>Avoid sunburns as they affect the skin's ability to cool itself.</td>
</tr>
<tr>
<td>Reach out to vulnerable individuals (elderly, isolated, chronically ill, homeless, etc.).</td>
</tr>
<tr>
<td>Reduce vehicle use to the extent possible.</td>
</tr>
<tr>
<td>Use public transport or carpooling to reduce exhaust.</td>
</tr>
<tr>
<td>Refuel cars at night to reduce the input of gas vapor in photochemical smog.</td>
</tr>
<tr>
<td>Minimize the risk of forest fires (e.g. camp fire safety, throwing cigarettes when in forest areas).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Droughts</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government</strong></td>
</tr>
<tr>
<td>Formulate a multi-stakeholder preparedness plan, including an information dissemination strategy for preparedness and response measures.</td>
</tr>
<tr>
<td>Educate the public about the importance of water and energy conservation.</td>
</tr>
<tr>
<td>Mainstream climate change considerations into current national hydrologic planning.</td>
</tr>
</tbody>
</table>

| **Health Institutions/Professionals** |
| Stock means for water purification. |
| Stock oral re-hydration solutions for treatment of dehydration. |
| Ensure storage of clean water reserves for healthcare facilities. |

| **Public** |
| Create community organizations to raise awareness about the importance of water and energy conservation. |
| Induce action from policy and decision-makers on assurance of water supplies and climate-appropriate water policies. |

| **Government** |
| Provide clean water sources and food supplies; enforce hydrologic regulations. |
| Restrict non-essential water uses. |
| Promote interagency coordination to prioritize uses and allocate water supplies. |

<p>| <strong>Health Institutions/Professionals</strong> |
| Provide mental health care and counseling services. |
| Provide malnutrition and diarrheal treatment centers. |
| Remind the public of the importance of consuming only safe water. |
| Provide emergency response treatments for fire induced burns. |
| Provide means for water purification. |
| Provide oral re-hydration solutions (ORS) for treatment of dehydration. |</p>
<table>
<thead>
<tr>
<th>Responsive Public</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>o Stock nonperishables, crops, food, and water in clean containers.</td>
<td></td>
</tr>
<tr>
<td>o Give community support to people who are struggling with impacts on their livelihood.</td>
<td></td>
</tr>
<tr>
<td>o Run community campaigns to raise awareness of safe drinking water sources.</td>
<td></td>
</tr>
<tr>
<td>o Self-restrict non-essential uses of water supplies.</td>
<td></td>
</tr>
</tbody>
</table>

**Matrix xx: Adaptive Strategies for Extreme Weather Events**

### 3.3 Adaptive Strategies for Changing Averages

**Table 11**

<table>
<thead>
<tr>
<th>Anticipatory</th>
<th>Government</th>
<th>Health Institutions/ Professionals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adaptive strategies for water-borne and food-borne diseases:</strong></td>
<td>o Create strict water run-off regulation measures and protect drinking water sources from pollution.</td>
<td><strong>Adaptive strategies for vector-borne and air-borne diseases:</strong></td>
</tr>
<tr>
<td></td>
<td>o Provide adequate sanitation and supplies of clean drinking water to the population.</td>
<td>o Expect diseases in areas previously not recorded and for longer seasons during the year.</td>
</tr>
<tr>
<td></td>
<td>o Continuously survey related diseases accompanied with meteorological data in order to better link any associations and make appropriate policies as well as increase public awareness.</td>
<td>o Use GIS and remote sensing to make predictive maps of high risk zones in order to advise the public on outdoor activities and preventive measures.</td>
</tr>
<tr>
<td></td>
<td>o Use technology such as remote sensing to predict outbreaks of disease.</td>
<td>o Health practitioners should be more aware of the symptoms of all possible diseases, so that in the case of an outbreak patients are treated more efficiently, and cases are reported early for an alarm system.</td>
</tr>
<tr>
<td></td>
<td>o Update, issue, and enforce regulations in food handling, hygiene in restaurants, caterers, street food stands, etc.</td>
<td>o Where applicable, offer vaccinations to the public (e.g. polio).</td>
</tr>
<tr>
<td></td>
<td>o Continuously survey related diseases accompanied with meteorological data in order to better link any associations and make appropriate policies as well as increase public awareness.</td>
<td>o Prepare increased diagnostic tools and treatment supplies during “high” seasons.</td>
</tr>
<tr>
<td></td>
<td>o Use technology such as remote sensing to predict outbreaks of disease.</td>
<td><strong>Adaptive strategies for vector-borne and air-borne diseases:</strong></td>
</tr>
<tr>
<td></td>
<td>o Update, issue, and enforce regulations in food handling, hygiene in restaurants, caterers, street food stands, etc.</td>
<td>o Expect diseases in areas previously not recorded and for longer seasons during the year.</td>
</tr>
<tr>
<td></td>
<td>o Continuously survey related diseases accompanied with meteorological data in order to better link any associations and make appropriate policies as well as increase public awareness.</td>
<td>o Use GIS and remote sensing to make predictive maps of high risk zones in order to advise the public on outdoor activities and preventive measures.</td>
</tr>
<tr>
<td></td>
<td>o Use technology such as remote sensing to predict outbreaks of disease.</td>
<td>o Health practitioners should be more aware of the symptoms of all possible diseases, so that in the case of an outbreak patients are treated more efficiently, and cases are reported early for an alarm system.</td>
</tr>
</tbody>
</table>
### Anticipatory Public

**Adaptive strategies for water-borne and food-borne diseases:**
- Sanitary activities at the household level include filtering or boiling drinking water.
- Stay informed and practice proper food handling, cooking, and food storage practices.

**Adaptive strategies for vector-borne and air-borne diseases:**
- Travelers to endemic areas should be more aware of risk factors for acquiring diseases and ways of prevention.
- Increase knowledge on ways to decrease vector exposure, and for some diseases, take preventative measures such as vaccinations.

### Responsive Government

- Ensure adequate funding, staffing, and timely implementation of vector control programs.
- Choose environmental management over pesticide application where feasible.
- Increase resources for sanitary inspection and public health surveillance efforts during high-risk seasons.

### Responsive Health Institutions/Professionals

- Collaborate with government and the media in preparing and delivering messages on food and water safety, as well as vector-borne diseases and how to avoid the health effects from these hazards.
- Implement continuing education programs and emerging diseases awareness campaigns.
- Ensure the functionality of mandatory reporting systems and surveillance programs.

### Responsive Public

**Get educated and stay informed on:**
- Food and water safety, and the role of enforcing agencies.
- Behavioral and other risk factors related to vector-borne diseases.

### 3.4 Adaptive Strategies for Migration-Related Health Effects

**Table 12**

<table>
<thead>
<tr>
<th>Anticipatory</th>
<th>Government</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>o Establish systematic screening policies for immigrants from countries with high tuberculosis incidences.</td>
</tr>
<tr>
<td></td>
<td>o Develop information campaigns about health care possibilities for migrants.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Anticipatory</th>
<th>Health Institutions/Professionals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>o Develop sensitivity trainings and cultural awareness campaigns for health care providers to eliminate social and cultural barriers for migrants.</td>
</tr>
<tr>
<td></td>
<td>o Modify training programs for health providers to focus on diseases from migrant source countries.</td>
</tr>
<tr>
<td></td>
<td>o Increase in-country migration of health professionals from migrant source regions.</td>
</tr>
<tr>
<td></td>
<td>o Provide services and facilities for exotic or uncommon diseases.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Responsive</th>
<th>Government</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>o Inform arriving migrants about local health care possibilities.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Responsive</th>
<th>Health Institutions/Professionals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>o If there is acute migrant flow, locate more health professionals in needed capacities.</td>
</tr>
<tr>
<td></td>
<td>o Screen migrants for tuberculosis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Responsive</th>
<th>Public</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>o Provide outreach community services for migrants.</td>
</tr>
</tbody>
</table>
3.5 Adaptive Strategies for Eutrophication Health Effects

Table 13

<table>
<thead>
<tr>
<th>Anticipatory</th>
<th>Government</th>
<th>Health Institutions/Professionals</th>
<th>Responsive</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Perfect a forecasting system to predict algal bloom events. This should be based on monitoring</td>
<td>Further disseminate knowledge about the possible increase in cases of exposure to toxic algae.</td>
<td></td>
<td>Develop an integrated coastal management plan covering different watersheds and specifically</td>
</tr>
<tr>
<td></td>
<td>of environmental parameters that could favor specifically toxic algae, and on knowledge of</td>
<td>Educate both practitioners and the public about the possible effects of climate change on toxic</td>
<td></td>
<td>aimed at reducing the input of nutrients into the Baltic basin.</td>
</tr>
<tr>
<td></td>
<td>the geographic and temporal distribution of nutrients.</td>
<td>algae blooms.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Establish a warning system based on threshold levels to alert both practitioners and the public</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>in case of major algal blooms.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Annex 1: Summary Table for Flood-Related Health Outcomes

<table>
<thead>
<tr>
<th>Reference</th>
<th>Location (Year)</th>
<th>Design</th>
<th>Population</th>
<th>Exposure</th>
<th>Disease/Outcome</th>
<th>Measure of Effect (+/-95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Han et al. 1999</td>
<td>Bucharest, Romania (1996)</td>
<td>Matched case control</td>
<td>24 asymptotically infected persons and 37 uninfected persons, all apartment residents</td>
<td>Flooded apartment building basements</td>
<td>West Nile virus infection (likely vector <em>Cx. pipiens</em>)</td>
<td>WNV was associated with having flooded apartments; OR = 3.94 (1.16-13.7).</td>
</tr>
<tr>
<td>Hubálek and Halouzka 1999</td>
<td>Southern Moravia, Czech Republic (1997)</td>
<td>Cohort</td>
<td>497 participants of all ages who lived in flooded areas (includes 437 who lived in a flood risk zone and 60 in a control zone).</td>
<td>Flooded areas with risk-zone ranking according to mosquito quantities</td>
<td>Tahyna virus (largely from vectors <em>Oc. sticticus</em>, <em>Oc. cantans</em>, <em>Ae. vexans</em>, and <em>Ae. cinereus</em>)</td>
<td>Infection with Tahyna was associated with living in a flood risk zone (RR = 3.61). Seroprevalence of neutralizing antibodies to Tahyna increased with increased risk-zone ranking and was significantly higher than in the control zone ($\chi^2 = 14.57; p = 0.002$). Within risk zones, seroprevalence also increased as residence distance to floodplain forests decreased ($\chi^2 = 8.51; p = 0.003$). Half the cases of leptospirosis were directly associated with floods. Pre-post analysis RR = 3. An increase in the number of patients with GUD during the flood years was observed. In 2001, the number of patients admitted to hospitals with late stages of the disease doubled. Psychosocial stress observed during the flood event was associated with pregnancy loss and perinatal complications. (55.3%)</td>
</tr>
<tr>
<td>Hubálek et al. 2005</td>
<td>Central Bohemia, Czech Republic (2002)</td>
<td>Cohort</td>
<td>7,156 subjects in 1997 of which 94 were diagnosed infected; 4,999 subjects in 2002 of which 92 were diagnosed infected</td>
<td>Flood (residual water, mud in cellars, etc.)</td>
<td>Leptospirosis</td>
<td>Half the cases of leptospirosis were directly associated with floods. Pre-post analysis RR = 3. An increase in the number of patients with GUD during the flood years was observed. In 2001, the number of patients admitted to hospitals with late stages of the disease doubled. Psychosocial stress observed during the flood event was associated with pregnancy loss and perinatal complications. (55.3%)</td>
</tr>
<tr>
<td>Zitek and Benes 2005 (in Czech)</td>
<td>Czech Republic (1997, 2002)</td>
<td>Cohort</td>
<td>7,156 subjects in 1997 of which 94 were diagnosed infected; 4,999 subjects in 2002 of which 92 were diagnosed infected</td>
<td>Flood (residual water, mud in cellars, etc.)</td>
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</tr>
<tr>
<td>Peresta et al. 2006 (in Ukrainian)</td>
<td>Zakarpatty, Ukraine (1998, 2001)</td>
<td>Cohort</td>
<td>7,156 subjects in 1997 of which 94 were diagnosed infected; 4,999 subjects in 2002 of which 92 were diagnosed infected</td>
<td>Flood (residual water, mud in cellars, etc.)</td>
<td>Leptospirosis</td>
<td>Half the cases of leptospirosis were directly associated with floods. Pre-post analysis RR = 3. An increase in the number of patients with GUD during the flood years was observed. In 2001, the number of patients admitted to hospitals with late stages of the disease doubled. Psychosocial stress observed during the flood event was associated with pregnancy loss and perinatal complications. (55.3%)</td>
</tr>
<tr>
<td>Neuberg et al. 1998 (in Polish)</td>
<td>Kotlin Klodzki, Poland (1997)</td>
<td>Cohort</td>
<td>47 pregnant women injured from the flood event and exhibiting psychosocial stress, and a random control group of 100 pregnant women</td>
<td>Flood</td>
<td>Pregnancy loss and disorders including premature delivery, missed abortion, birth asphyxia, premature rupture of membranes, intrauterine growth retardation</td>
<td>Pregnancy loss and disorders including premature delivery, missed abortion, birth asphyxia, premature rupture of membranes, intrauterine growth retardation</td>
</tr>
<tr>
<td>Neuberg et al. 1999 (in Polish)</td>
<td>Koldzko region, Poland (1997)</td>
<td>Cohort</td>
<td>17 female adolescents injured from the flood event</td>
<td>Flood</td>
<td>Hypogonadotropic hypogonadism amenorrhea</td>
<td>Hypogonadotropic hypogonadism amenorrhea</td>
</tr>
</tbody>
</table>


Norris et al. 2002 | Opole and neighboring villages, Poland | Cohort | 285 adults living in apartment buildings with signs of flood damage one month post-event | Trauma (injury or life threatening) during flood | Post-traumatic stress disorder (PTSD) was diagnosed in % of participants. Older Poles were more symptomatic than younger Poles. Trauma, an indicator of flood severity, was associated with PTSD symptoms (increasing in trauma).
## Annex 2: Summary Table for Heatwave-Related Health Outcomes

<table>
<thead>
<tr>
<th>Reference</th>
<th>Location (Year)</th>
<th>Design</th>
<th>Population</th>
<th>Exposure</th>
<th>Disease/Outcome</th>
<th>Measure of Effect (+/-95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revich and Shaposhnikov 2007</td>
<td>Moscow, Russia (2000-2006)</td>
<td>Time-series covering 2,251 consecutive days from Jan 1, 2000 to Feb 27, 2006</td>
<td>All non-accidental death cases. - General population living in Moscow - Also separately considered elderly age 75+</td>
<td>- High temperatures defined as 18 &gt; T &gt; 25 °C in average daily ambient air temperature - Extreme air temperature defined as T &gt; 25 °C</td>
<td>Overall non-accidental mortality. - Also assessed cause-specific mortality related to respiratory disease, ischemic coronary heart disease, and cerebrovascular disease</td>
<td>Temperatures 18-25 °C were associated with increased average non-accidental mortality of 2.8 % (2-3.6) per °C (p&lt;0.001) and temperatures above 25 °C were associated with 11.2% increase per °C (p=0.001).</td>
</tr>
<tr>
<td>Pattenden et al. 2003</td>
<td>Sofia, Bulgaria (1996-1999)</td>
<td>Time-series covering the period of 1996-1999 for both mortality and temperature</td>
<td>All deaths in the general population living in Sofia.</td>
<td>- High temperatures defined as the 90th percentile of two day mean temperatures. Determined cut off point of 21.55 °C. - Separately examined the role of particulate matter (PM)</td>
<td>Increased all cause mortality</td>
<td>A 1 °C increase over 2 days above 21.55 °C, increases total mortality by 3.49 % (2.23-4.76). This is calculated adjusting for PM, humidity season, and other potential confounders. Not taking into account PM increases the result for the heat effect slightly. The estimated PM effect on mortality was significant: a 0.06% (0.03-0.10) increase in mortality per 1 g/m³ increase in TSP.</td>
</tr>
<tr>
<td>Study</td>
<td>Location</td>
<td>Methodology</td>
<td>Population</td>
<td>Air Pollution Exposure</td>
<td>Mortality</td>
<td>(\text{PM}_{10}) Effect</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Alebić-Juretić et al. 2007</td>
<td>Zagreb and Rijeka, Croatia (August 8-14, 2003)</td>
<td>Time-series</td>
<td>800,000 people of Zagreb and 150,000 people of Rijeka</td>
<td>Air pollution (PM and ozone) exposure during a heatwave</td>
<td>Increased all cause mortality</td>
<td>Air pollution during heatwave contributed to 50% of excess deaths. Taking threshold value of 100 g/m(^3) of ozone into account, the combined effects of PM(<em>{10}) and ozone, were associated with 14 excess deaths in Zagreb and 1.6 excess deaths in Rijeka during the heatwave period. The estimated PM effect on mortality in Zagreb: a 2% increase in average monthly mortality per 10 g/m(^3) increase in PM(</em>{10}).</td>
</tr>
</tbody>
</table>
| Páldy et al. 2005 | Budapest, Hungary (1993-2000) | Time-series (identified heatwaves and then quantified the excess mortality) | General population in Budapest | 6 heatwaves defined as 3 days or longer with mean temperature (lag 0-2 days) above 99\(^{th}\) percentile of daily mean temperature (26.6 °C) from 1990 to 2000 | Excess total mortality | - All 6 heatwaves showed an increase in excess mortality.  
- Exposure to heatwaves was associated with a 25% mean increase in total mortality (SD = 14.35). |
<p>| Páldy et al. 2005 | Budapest, Hungary (1993-2000) | Time-series | General population in Budapest | High temperature defined as &gt; 18 °C in average daily temperature | Excess total, cardiovascular, and respiratory disease mortality | - A 5 °C increase in daily mean temperature above 18 °C increases the risk of total mortality by 10.6% (96% CI 9.7-14.0), cardiovascular mortality by 18% (96% CI 11-29), and respiratory disease mortality by 8.8% (96% CI 5.4-23). |</p>
<table>
<thead>
<tr>
<th>Reference</th>
<th>Location</th>
<th>Study Design</th>
<th>Population Characteristics</th>
<th>Exposure</th>
<th>Outcome</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zunnunov 2000</td>
<td>Uzbekistan</td>
<td>General population</td>
<td>Summer heat</td>
<td>Ischemic heart disease</td>
<td>Heat was observed to aggravate cases of IHD. During the period of heat, there was an increased frequency in angina attacks, episodes of arrhythmia, and coronary failure; especially in elderly and the migrants.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Also separately examined the elderly (70+) and migrants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mićić D et al. 1993</td>
<td>Dalmatia, Croatia</td>
<td>1,306 AMI patients admitted to the two Split hospitals in 1981-1987</td>
<td>Air temperature</td>
<td>Acute myocardial infarction (AMI)</td>
<td>Increased incidence of AMI was associated with increased ambient temperatures (p&lt;0.05).</td>
<td></td>
</tr>
<tr>
<td>Kysely 2004</td>
<td>Czech Republic (1982-2000)</td>
<td>All inhabitants in the Czech Republic, approximately 10 million individuals</td>
<td>17 heatwaves defined as 3 consecutive days with daily maximum temperature at or above 30.0 °C</td>
<td>Excess total mortality and excess cardiovascular (CVD) mortality</td>
<td>After taking a one day lag into account, exposure to heatwaves was associated with a 12.9% (SD = 6.6) mean increase in total mortality and 13.6% (SD = 7.8) mean increase in CVD mortality. Total relative mortality increase and mean temperature during heatwaves display Pearson correlation coefficient = 0.55.</td>
<td></td>
</tr>
<tr>
<td>Kislitin et al. 2005</td>
<td>Moscow, Russia (2002)</td>
<td>Time-series Moscow residents</td>
<td>Selected air pollutants: carbon monoxide, ozone, nitrogen dioxide, PM&lt;sub&gt;2.5&lt;/sub&gt;, and PM&lt;sub&gt;10&lt;/sub&gt; during summer smog event</td>
<td>Total cardiovascular and respiratory mortality, acute myocardial infarctions, and hospitalizations with respiratory disease</td>
<td>PM&lt;sub&gt;2.5&lt;/sub&gt; and PM&lt;sub&gt;10&lt;/sub&gt; were probably the most hazardous exposures of the selected pollutants causing the greatest number of total, cardiovascular, and respiratory mortality cases. A few AMI cases were caused by exposure to CO and NO&lt;sub&gt;2&lt;/sub&gt;, and hospitalization with respiratory disease by NO&lt;sub&gt;2&lt;/sub&gt; and ozone.</td>
<td></td>
</tr>
</tbody>
</table>
## Annex 3: Summary Table for Drought-Related Health Outcomes

<table>
<thead>
<tr>
<th>General Category</th>
<th>Reference</th>
<th>Synopsis</th>
<th>Country, Location, Year(s)</th>
<th>Design/Report</th>
<th>Population</th>
<th>Exposure</th>
<th>Outcome</th>
<th>Measure of Effect (+ 95% CI)</th>
<th>Comment/link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immunity</td>
<td>UNICEF</td>
<td>“Their illnesses are largely due either to the decline in the quality of drinking water, which is a result of the worsening ecological situation, or to a general decline in living and nutritional standards due to the current drought.”</td>
<td>Uzbekistan, Khorezm, 20001</td>
<td>Survey</td>
<td>Children</td>
<td>Drought</td>
<td>3 out of 4 children reported sick</td>
<td><a href="http://www.unicef.org/infobycountry/uzbekistan_1296.html">http://www.unicef.org/infobycountry/uzbekistan_1296.html</a></td>
<td></td>
</tr>
<tr>
<td>Malnutrition</td>
<td>Small et al.</td>
<td>WHO &amp; MSF</td>
<td>Uzbekistan, Karakalpkan, 2001</td>
<td>Drought</td>
<td>Levels of acute malnutrition for children under 5 did not exceed 5% yet food accessibility was reduced, aggravating malnutrition among children.</td>
<td>13 million people were affected by the drought — 6 million of them were children under the age of 14 years.</td>
<td><a href="http://www.reliefweb.int/rw/rwb.nsf/db900sid/ACOS-64C9TY?OpenDocument">http://www.reliefweb.int/rw/rwb.nsf/db900sid/ACOS-64C9TY?OpenDocument</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malnutrition</td>
<td></td>
<td></td>
<td></td>
<td>the local market with naturally occurring iodine.</td>
<td></td>
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<td>-------------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td>Moldova (see Box 3 and Box 4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrheal diseases</td>
<td>WHO Europe 2001</td>
<td>Uzbekistan, Muynak, 2000</td>
<td>Report</td>
<td>General population</td>
<td>Drought</td>
<td>Increased cases of acute intestinal infections in 2000</td>
<td>Muynak was the exceptional district where cases increased. Overall, “According to the conclusions arrived at by experts, the decreased availability of water had no major impact on the communicable disease situation in Uzbekistan.” (p. 6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrheal disease and respiratory disease</td>
<td>WHO Europe 2001</td>
<td>UNCIEF provided a twelve month supply of essential drugs to 17 primary health care units (SVAs and FAPs) in Takhtakupyr for respiratory infection/diarrheal disease case management.</td>
<td>Uzbekistan</td>
<td>Report</td>
<td>General population</td>
<td>Drought</td>
<td>Acute lower respiratory tract infection risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dehydration</td>
<td>WHO Europe 2001</td>
<td>UNICEF donated one million ORS packs to the Ministry of Health</td>
<td>Uzbekistan</td>
<td>Report</td>
<td>General population</td>
<td>Drought</td>
<td>Dehydration risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
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<td>---------------------------------------------------------------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Water-borne diseases</td>
<td>WHO Europe 2001</td>
<td>UNICEF donated drugs for the treatment of cholera for emergency preparedness</td>
<td>Uzbekistan</td>
<td>Report</td>
<td>General population</td>
<td>Drought</td>
<td>Cholera risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental Health</td>
<td>Sharashidze et al. 2004</td>
<td>Listed as one of the environmental influences on mental health of the country.</td>
<td>Georgia, 2000</td>
<td>General population.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>MSF-Holland</td>
<td></td>
<td>Uzbekistan, Karakalpakstan Turkmenistan, Northern region</td>
<td>Report</td>
<td>General population</td>
<td>Drought</td>
<td>Migration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Annex 4: Qualitative Indicators

The following are examples of qualitative indicators that may be used to assess adaptive capacity in certain determinants within the Vulnerability Assessment Toolkit. These are only suggestions, and by no means a comprehensive, fully developed set of indicators. Such set would have to be fitted to the local context according to country-specific health priorities and institutional/economic constraints. The banding of all suggested indicators has been fitted to five categories for consistency. The questionnaire to assess these indicators would ideally be responded by one or more key informants at different levels of governance.

1- Infrastructure Qualitative indicators

a. Access

<table>
<thead>
<tr>
<th>Waiting time at Emergencies</th>
<th>Very Good</th>
<th>Good</th>
<th>Medium</th>
<th>Bad</th>
<th>Very Bad</th>
</tr>
</thead>
<tbody>
<tr>
<td>How much is the average waiting time at an emergency room?</td>
<td>&lt;30’</td>
<td>30’-60’</td>
<td>60’-90’</td>
<td>90’-120’</td>
<td>&gt; 120’</td>
</tr>
</tbody>
</table>

b. Quality

<table>
<thead>
<tr>
<th>Maintenance of health facilities</th>
<th>Very good</th>
<th>Good</th>
<th>Medium</th>
<th>Bad</th>
<th>Very Bad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do providers have adequate budget for capital investment?</td>
<td>Yes, all providers</td>
<td>Yes, the majority of providers</td>
<td>Yes, some providers</td>
<td>Yes, but only for very few providers</td>
<td>Not at all</td>
</tr>
<tr>
<td>Is there a plan for maintenance of health facilities(^{26})?</td>
<td>Yes: - Present at both central and provider levels - Both short and long term</td>
<td>Yes: - Present at both central and provider levels - ONLY short term</td>
<td>Yes: - Present, but not at both levels - Both short and long term</td>
<td>Yes: - Present, but not at both levels - ONLY short term</td>
<td>Not at all</td>
</tr>
</tbody>
</table>

\(^{26}\) Maintenance of both infrastructure and medical devices
2- **Human Capital Qualitative indicators**

a. **Health Professionals Preparedness for Extreme Weather Events Emergencies**

<table>
<thead>
<tr>
<th>Health Professionals Preparedness for Extreme Weather Events Emergencies</th>
<th>Very good</th>
<th>Good</th>
<th>Medium</th>
<th>Bad</th>
<th>Very Bad</th>
</tr>
</thead>
</table>
| Are health practitioners trained to deal with the expected health effects and challenges of extreme weather events? | - There is a relevant training plan  
- A curriculum for the plan has been developed  
- The plan has been implemented  
- All health professionals have access | | | | | |
| | - There is a relevant training plan  
- A curriculum for the plan has been developed  
- The plan has been implemented  
- Access is limited to some health professionals | | | | | |
| | - There is a relevant training plan  
- A curriculum for the plan has not been developed  
- The plan has not been implemented | | | | | |
| | - There is no relevant training plan | | | | | |

b. **Provider Accreditation**

<table>
<thead>
<tr>
<th>Provider Accreditation</th>
<th>Very good</th>
<th>Good</th>
<th>Medium</th>
<th>Bad</th>
<th>Very Bad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is provider accreditation implemented in your country?</td>
<td>Yes, <strong>fully</strong></td>
<td>Not yet, but it is a <strong>short</strong> term goal (within next 2 yrs)</td>
<td>Not yet, but it is a <strong>medium</strong> term goal (within next 5 yrs)</td>
<td>Not yet, but it is a <strong>long</strong> term goal (within next 10 yrs)</td>
<td>No, and currently there are <strong>no plans</strong> to implement</td>
</tr>
</tbody>
</table>
c. Health Professionals Preparedness for Emerging or Expanding Infectious Diseases

<table>
<thead>
<tr>
<th>Health Professionals Preparedness for Emerging or Expanding Infectious diseases</th>
<th>Very good</th>
<th>Good</th>
<th>Medium</th>
<th>Bad</th>
<th>Very Bad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are health practitioners trained to deal with the expected effects of climate change on infectious diseases?</td>
<td>- There is a relevant training plan</td>
<td>- There is a relevant training plan</td>
<td>- There is a relevant training plan</td>
<td>- There is a relevant training plan</td>
<td>- There is no relevant training plan</td>
</tr>
<tr>
<td>- A curriculum for the plan has been developed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The plan has been implemented</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- All health professionals have access</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- There is a relevant training plan</td>
<td>- A curriculum for the plan has been developed</td>
<td>- The plan has been implemented</td>
<td>- The plan has not been implemented</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- A curriculum for the plan has been developed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The plan has been implemented</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Access is limited to some health professionals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- There is a relevant training plan</td>
<td>- A curriculum for the plan has not been developed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- A curriculum for the plan has not been developed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3- Access to Risk-Spreading Mechanisms Qualitative indicators

a. Basic Benefits Package

<table>
<thead>
<tr>
<th>Basic Benefit Package (BBP)</th>
<th>Very good</th>
<th>Good</th>
<th>Medium</th>
<th>Bad</th>
<th>Very Bad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think the current BBP(^{27}) is adequate for a fair, accessible and sustainable healthcare system?</td>
<td>Yes: - Fully</td>
<td>Yes: - But needs minor reforms to ensure sustainability</td>
<td>Yes: - But more funds necessary to ensure sustainability</td>
<td>No: - Current BBP too generous for available funds (which should not be increased)</td>
<td>No: - BBP should be reduced and funds should be increased to attain sustainability</td>
</tr>
</tbody>
</table>

\(^{27}\) The BBP is the list of services of guaranteed entitlement. In some countries, it has a negative form (exceptions being family planning and plastic surgery, all the rest being covered) and in others, it has a positive form (an explicit list of interventions and services specifying the level of coverage by the public insurance). Countries with too generous a BBP typically face financial sustainability problems.
4- Access to and Ability to Manage Information Qualitative indicators

a. Functionality of Health Information System

<table>
<thead>
<tr>
<th>Functionality of HIS</th>
<th>Very good</th>
<th>Good</th>
<th>Medium</th>
<th>Bad</th>
<th>Very bad</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do you consider the quality of data flow among providers, MoH, Public Health Agency and Statistical Office?</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
</tbody>
</table>

b. Functionality of the Public Health Surveillance System

<table>
<thead>
<tr>
<th>Functionality of PH Surveillance System</th>
<th>Very good</th>
<th>Good</th>
<th>Medium</th>
<th>Bad</th>
<th>Very bad</th>
</tr>
</thead>
<tbody>
<tr>
<td>How is the public health surveillance system for communicable diseases?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

- Active
- Efficient data collection & reporting
- Timely response action

- Active
- Efficient data collection & reporting
- Response action relatively efficient

- Passive
- Inefficient data collection & reporting
- Response action relatively efficient

- Passive
- Inefficient data collection & reporting
- Response action slow & inadequate

28 Data are actively sought out by the agency.
29 Data are reported in such a way that the receiving agency waits for data reports to be sent in.

The team is developing 2 qualitative indicators to account for the presence and functionality of a health emergency communication system. The following are being considered:

- Presence of infrastructure for health emergency communication system (hardware)
This indicator will capture the physical infrastructure of the system, and its capacity to send/receive information, including the recursiveness of the system and resilience in the event of surges, emergencies, etc. (call centers and others)

- **Presence of coordination mechanisms for effective functionality of the health emergency communication system (software and facilitating factors)**
  This indicator will relate to the timeliness and accuracy of information delivered to decision-makers in the event of a health emergency or situation of concern, the channels through which it flows and how it spreads to other relevant players (including interagency coordination). Furthermore, it will account for the presence of proper delegation of authority, clear roles and responsibilities, assurance of transparency and accountability, etc. (possible use of governance indicators)

4- **Institutions Qualitative indicators**

a. **Availability and Use of Clinical Guidelines**

<table>
<thead>
<tr>
<th>Are clinical guidelines available AND USED in your country?</th>
<th>Very good</th>
<th>Good</th>
<th>Medium</th>
<th>Bad</th>
<th>Very bad</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes, for all specialties</td>
<td>Yes, for the majority of specialties</td>
<td>Yes, for some specialties</td>
<td>Yes, but only for very few specialties</td>
<td>Not at all</td>
</tr>
</tbody>
</table>

b. **Availability of Protocols to Monitor Clinical Quality**

<table>
<thead>
<tr>
<th>Do providers(^30) have clear protocols to monitor clinical quality of their healthcare professionals?</th>
<th>Very good</th>
<th>Good</th>
<th>Medium</th>
<th>Bad</th>
<th>Very bad</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes, all providers</td>
<td>Yes, the majority of providers</td>
<td>Yes, some providers</td>
<td>Yes, but only for very few providers</td>
<td>Not at all</td>
</tr>
</tbody>
</table>

\(^30\) This includes primary, specialist outpatient and inpatient providers.
### National Health Emergency Preparedness, Management, and Response Plan

<table>
<thead>
<tr>
<th></th>
<th>Very good</th>
<th>Good</th>
<th>Medium</th>
<th>Bad</th>
<th>Very bad</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Is there a functional National Health Emergency Preparedness, Management and Response Plan?</strong></td>
<td>There is a plan, it has been tested through a field exercise and revised in the last 3 years.</td>
<td>There is a plan and it has been tested through a field exercise.</td>
<td>There is a plan and it has been tested through a tabletop exercise.</td>
<td>A Plan is in place*.</td>
<td>There is no plan.</td>
</tr>
<tr>
<td>* Either a stand alone plan or a part of broader National Health Policies or provisions</td>
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### Presence and Functionality of a Vector Management Program

<table>
<thead>
<tr>
<th>Vector Management Program</th>
<th>Very good</th>
<th>Good</th>
<th>Medium</th>
<th>Bad</th>
<th>Very bad</th>
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</thead>
<tbody>
<tr>
<td><strong>Is there an adequate Vector Management Program?</strong></td>
<td>- There is an Integrated Vector Management Program*.</td>
<td>- There is an Integrated Vector Management Program*.</td>
<td>- There is a pesticide application only vector control program.</td>
<td>- There is a pesticide application only vector control program.</td>
<td>- There is no vector control program.</td>
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<td></td>
<td>- Vector control activities are conducted in all at-risk areas.</td>
<td>- Vector control activities are conducted in endemic/encephalitic disease areas only.</td>
<td>- Vector control is conducted by trained personnel.</td>
<td>- Vector control is conducted by trained personnel.</td>
<td>- Vector control is conducted by untrained personnel.</td>
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<td>- Vector control is conducted by trained personnel.</td>
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* As defined by WHO in *Global Strategic Framework for Integrated*
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