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Advisory Services on a National Climate Change Adaptation Strategy and Action Plan

Appendix 5: Assessment of the Human Health Sector

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DISCLAIMERS

This report was produced by the World Bank team to provide advisory support to the Ministry of Environment and Water (MoEW) in Bulgaria. The findings, interpretations and conclusions expressed in this report do not necessarily reflect the views of the Executive Directors of the World Bank or of the Government of Bulgaria or its MoEW.

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Abbreviations and Acronyms

AD	Alzheimer's Disease
AR5	Assessment Report 5
BAS	Bulgarian Academy of Sciences
BFSA	Bulgarian Food Safety Agency
CAP	Climate-Altering Pollutant
CC	Climate Change
CCA	Climate Change Adaptation
CCEm-s	Climate Change Emergencies
CCSP	Climate Change Science Program
CEHAPIS	Climate, Environment, and Health Action Plan Information System
CFC	Chlorofluorocarbon
CoM	Council of Ministers
COP21	Conference of the Parties
DALYs	Disability-Adjusted Life Years
DG CAA	Directorate General "Civil Aviation Administration"
DPA	Disaster Protection Act
DRM	Disaster Risk Management
EC	European Commission
ECDC	European Centre for Disease Prevention and Control
EEA	European Environmental Agency
EFSA	European Food Safety Authority
EHIS	European Health Interview Survey
EMEPA	Enterprise for Management of Environment Protection Activities
EPCC	Emerging Phenomena of Climate Change
ESS	European Statistical System
EU ETS	European Union Emissions Trading System
EU	European Union
EWRS	Early Warning and Response System
ExAAA	Executive Agency Automobile Administration
ExAEMDR	Executive Agency for Exploration and Maintenance of the Danube River
ExAMA	Executive Agency Maritime Administration
ExARA	Executive Agency Railway Administration
ExEA	Executive Environment Agency
ExFA	Executive Forest Agency

FPRD	Framework Programme for Research and Development
FRMP	Flood Risk Management Plan
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
HCsp	High Committee for Public Health
HIA	Health Impact Assessment
HSC	Health Security Committee
HWMId	Heat Wave Magnitude Index
IPCC	Intergovernmental Panel on Climate Change
IWGCCH	Interagency Working Group on Climate Change and Health
MAFF	Ministry of Agriculture, Food and Forestry
MC	Ministry of Culture
MCA	Multicriteria Analysis
MEc	Ministry of Economy
MEn	Ministry of Energy
MEx	Ministry of Exterior
MF	Ministry of Finance
MH	Ministry of Health
MI	Ministry of Interior
MoEW	Ministry of Environment and Waters
MRDPW	Ministry of Regional Development and Public Works
MTITC	Ministry of Transport, Information Technology and Communications
NAP	National Action Plan
NAS	National Adaptation Strategy
NDC	Nationally Determined Contribution
ND-GAIN	Notre Dame Global Adaptation Index
NECCC	National Expert Council on Climate Change
NFC	National Framework Contract
NGO	Non-Governmental Organization
NHIF	National Health Insurance Fund
NHS	National Health Strategy
NIMH	National Institute for Meteorology and Hydrology
NSI	National Statistical Institute
NTEF	National Trust EcoFund

ODS	Ozone Depleting Substances
OECD	Organisation for Economic Co-operation and Development
OOP	Out-of-Pocket
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PD	Parkinson's Disease
PESETA	Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis
PM	Particulate Matter
PTSD	Post-Traumatic Stress Disorder
RASFF	Rapid Alert System for Food and Feed
RCP	Representative Concentration Pathway
RTD	Directorate General Research and Innovation
SDR	Standardized Death Rate
SHI	Social Health Insurance
SWOT	Strengths, Weakenesses, Opportunities, and Threats
TFEU	Treaty on the Functioning of the European Union
UKCIP	United Kingdom Climate Impacts Programme
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework on Climate Change
UV	Ultraviolet
VBZD	Vector-Borne and Zoonotic Diseases
VHI	Voluntary Health Insurance
VHICs	Voluntary Health Insurance Companies
WBMP	Water Basins Management Plan
WGII	Working Group II
WHA	World Health Assembly
WHO	World Health Organization

Glossary[1]

Climate change refers to a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.
Global warming refers to the gradual increase, observed or projected, in global surface temperature, as one of the consequences of radiative forcing caused by anthropogenic emissions.
Adaptation is the process of adjustment to actual or expected adverse effects of climate change and taking appropriate action to prevent or minimize the damage they can cause. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.
Mitigation (of climate change) is a human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs).
Vulnerability to climate change is the degree to which any system is susceptible to, and unable to cope with, the negative impacts that climate change imposes upon it. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.
Resilience is the opposite of vulnerability and is defined as the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.
Risk is the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability or likelihood of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur.

[1] Definitions are based on WGII AR5 (IPCC 2014)

Executive Summary

1. Human health has always been influenced by climate and weather. Changes in climate and weather extremes affect the environment that provides us with clean air, food, water, shelter, and security. Climate change (CC), together with other natural and human-made health stressors, threatens human health and well-being in numerous ways. The most affecting climatic factors are an increasingly warmer climate, periods with extreme maximum and minimum temperatures, lasting and intensive precipitation, disasterous weather phenomena (windstorms, cyclones, floods), droughts, poor air quality, stratospheric ozone depletion, and corresponding changes in ultraviolet (UV)-radiation. Climate-related health effects could include the following conditions:

- Heat-related morbidity and mortality
- Extreme weather-related morbidity and mortality
- Cardiovascular diseases, including strokes
- Asthma, respiratory allergies and airway disease
- Cancer
- Vector-borne and zoonotic diseases
- Foodborne diseases and nutrition factors
- Waterborne diseases
- Mental health and stress-related disorders
- Neurological diseases and disorders

2. Health risk severity will depend on the capacity of the public health sector to address these conditions and prepare for them, as well as on factors such as individuals' behavior, age, gender, socioeconomic status, and so on. Impacts vary based on where people live, how sensitive they are to health threats, how exposed they are to CC impacts, and how well they and their community can adapt to change.

3. In Bulgaria, the provision of high-quality and sustainable health and long-term care is an important element of social protection policy. The stakeholder system in the field of climate change adaptation (CCA) provides an effective policy integration structure: (a) a strong leading institution; (b) complementary adaptation units and agents in leading and sector departments; (c) interdepartmental committees; and (d) low-level links ensuring information exchange and bottom-up input of local administrations, nongovernmental organizations (NGOs), stakeholders, and scientists.

4. However, Bulgarian health care services have so far been unable to take advantage of continuous developments in medical technology with regard to meeting the challenges of an aging population and people's increasing demands for quality of life, including quality healthcare. In the European Union (EU), Bulgaria continues to be among the countries with the highest mortality rates and lowest population growth. The working population's health status is characterized by higher levels of risk conditions (injuries, illnesses, poor workplace safety, stress) as compared to EU averages. Also, significant problems exist in the system and structure of healthcare expenditure. All the above heighten the level of health vulnerability to CC.

5. The majority of adverse climate change health impacts can be avoided by implementing suitable adaptation policies. Planned adaptation to health impacts of climate change comprises a broad range of public health interventions. This report proposes two categories of adaptation options for Bulgaria's human health sector:

1) Building adaptive capacity – activities aimed to improve and increase:

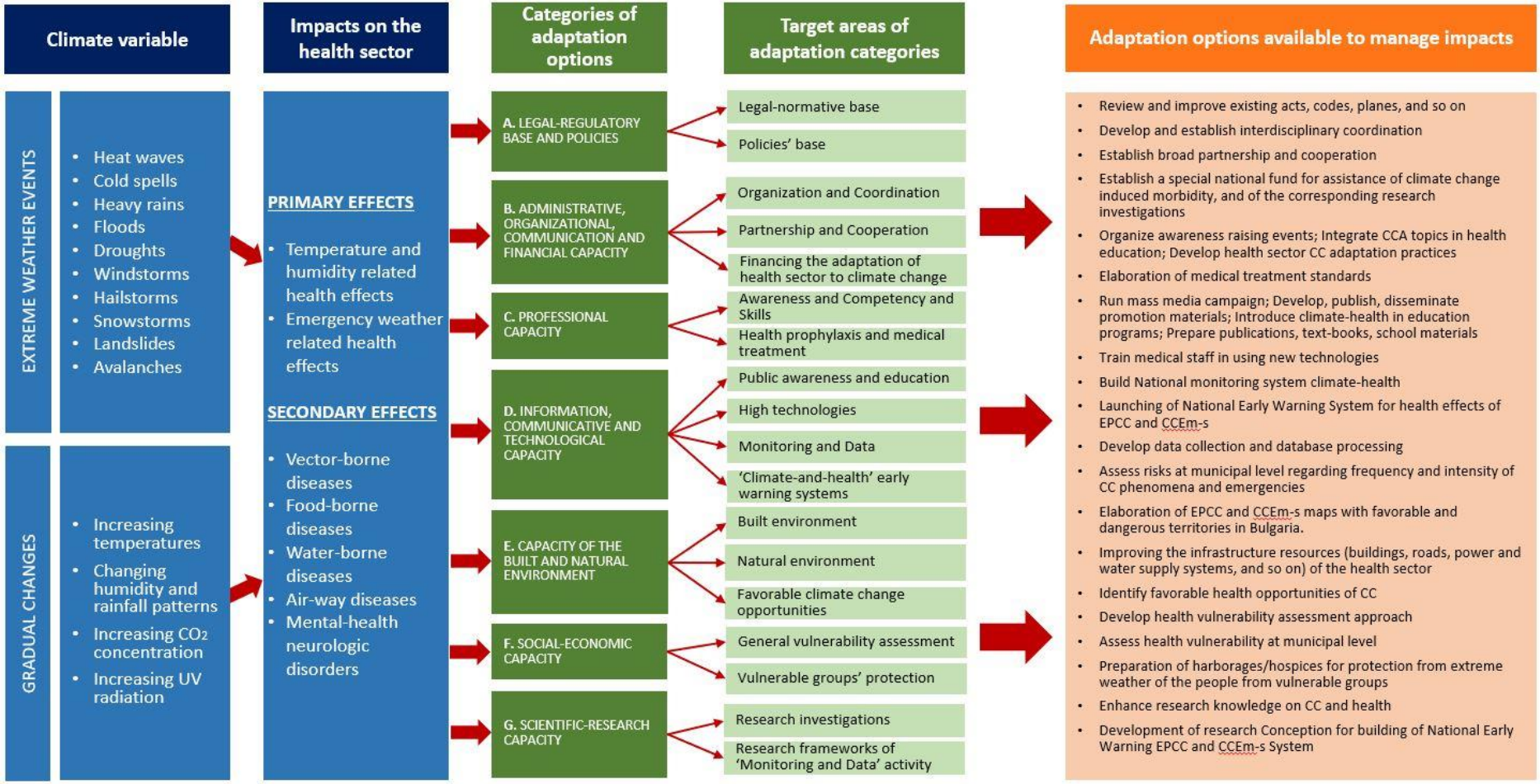
- Sectoral capacity (amending/developing legislation, regulations, standards, codes, plans, policy or programs as needed; improving the overall institutional framework; raising awareness, competency, and skills of human resources; improving health sector infrastructure; introducing high technology and innovations; working in partnership and cooperation (intra- and inter-sectoral; local, national, and international); and
- Socioeconomic capacity (protecting vulnerable groups, that is, children and the elderly, the poor and the sick, marginalized groups, other special needs groups, and so on)

2) Implementing adaptation actions – measures that help reduce climate risk vulnerability, but also take advantage of arising opportunities, that is:

- Prevention (recognize impacts, bear losses, exploit opportunities; health prophylaxis and health status checks; expand research/knowledge-base; monitoring and data collection; vulnerability assessment; public education and awareness outreach);
- Reducing exposure (adjustment of built environment, adaptation of natural environment, development of early warning systems); and
- Response/treatment (launching relevant medical treatment, establishing well-prepared and managed emergency response).

6. In practice, adaptation will often require a mix of response strategies, such as building climatic resilience (for example, enhanced design specifications), 'living with the risk' (for example, increased preparedness and contingency planning), and accepting the loss (for example, accepting occasional losses or worse quality). The exact combination will be case-specific, as it depends on factors such as risk aversion and the values and capacity of the affected and responding community/organization. An optimum mix may also include adopting measures that also exploit opportunities (for example, changing location of existing activities deemed no longer viable at their current location and introducing new replacement activities at the original location).

Figure 1. Simplified illustration of impacts of climate change and identified adaptation options



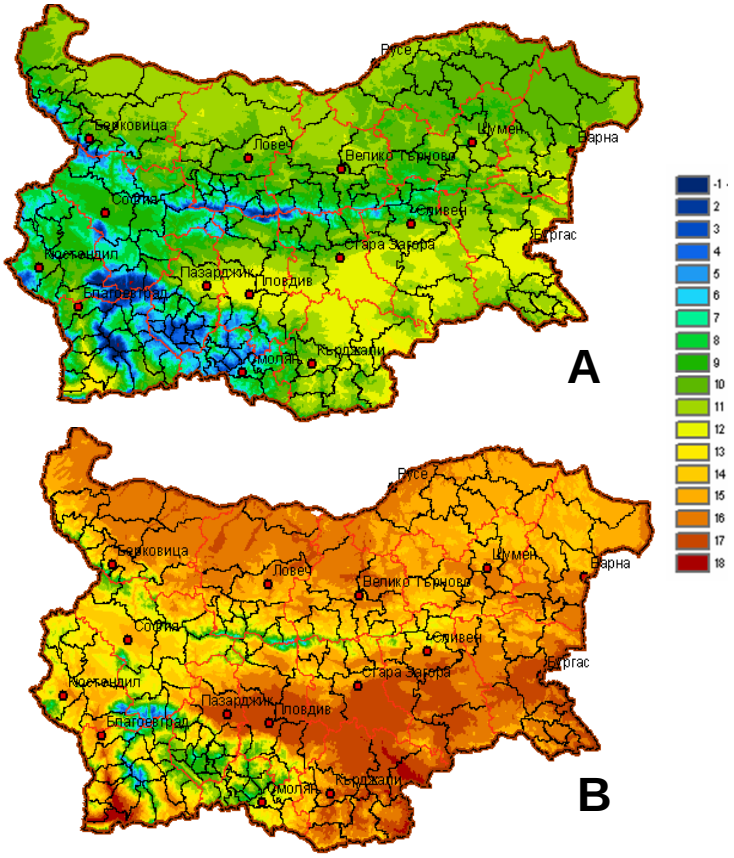
Source: World Bank design.

Introduction

7. Bulgaria is located in one of the regions of the world that are particularly vulnerable to climate change and related extreme weather events. Such events can lead to the loss of human lives or cause significant damage to economic growth and prosperity at national and cross-border levels.

8. Consensus exists in the scientific community that climate change is likely to increase the frequency and magnitude of extreme weather events. Over the past decades, in Bulgaria this frequency has increased significantly. The most common hydro-meteorological and natural hazards are extreme precipitation and temperatures, storms, floods, wildfires, landslides, and droughts. The number of deaths and victims due to natural hazards is considerable, indicating weather and climate vulnerability. The vulnerability of Bulgaria's population and businesses to the impacts of climate change is accelerated by a relatively high degree of poverty in the most affected areas, the continuing concentration of the country's population in several industrial and urban regions, and various consequences of the transition from a state-controlled economy to a free-market economy. A growing body of evidence suggests that economic losses from climate- and weather-related disasters have also been rising.

Figure 2. Average year temperature for 1961–1990 (A); Pessimistic climate scenario for average year temperature for 2080 (B)



Source: NIMH-BAS.

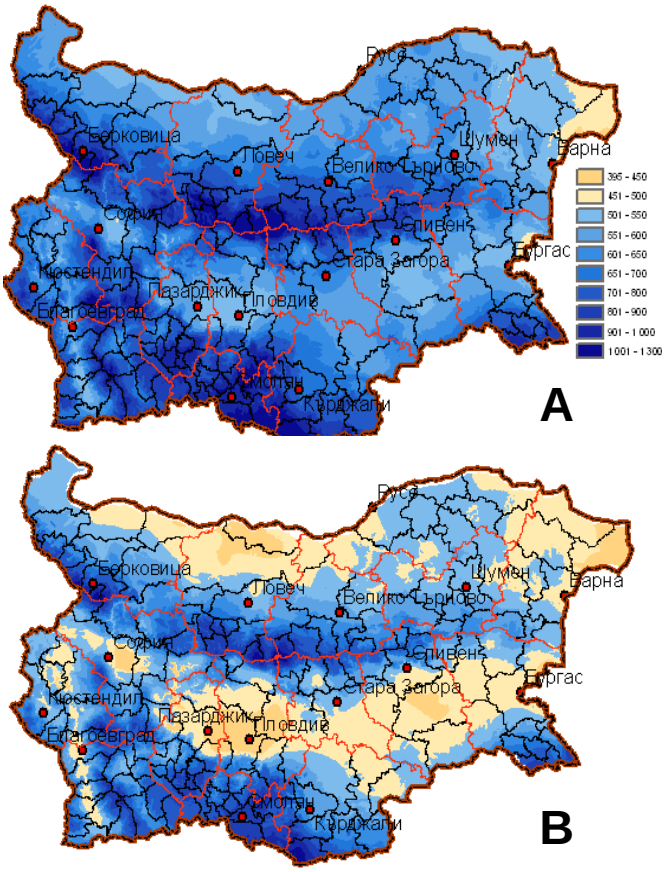
9. Scientific projections indicate that global temperature will rise between 1.8°C and 4°C by 2100, with the temperature increase in Europe expected to be even higher than the estimated global average.

10. Research conducted by the Department of Meteorology, National Institute of Meteorology and Hydrology at the Bulgarian Academy of Sciences (NIMH-BAS), projects an increase in annual air temperature in Bulgaria of between 0.7°C and 1.8°C by 2020. Even warmer temperatures are expected by 2050 and 2080, with projected increases of between 1.6°C and 3.1°C and between 2.9°C and 4.1°C, respectively. Generally, the temperature increase is expected to be more significant during the summer season (from July to September).

11. In terms of the expected changes in rainfall patterns, a reduction in precipitation is likely, leading to a significant reduction of the total water reserves in the country. In this regard, projections suggest a decrease in precipitation by approximately 10 percent by 2020, 15 percent by 2050, and up to 30–40 percent by 2080. In most climate change scenarios, rainfall during the winter months is likely to increase by the end of the century, but significant decrease in rainfall during the summer months is expected to offset this increase.

12. According to the available climate change scenarios for Bulgaria, there is a trend toward increased frequency of extreme events and disasters, as demonstrated by frequent occurrences of heavy rainfalls, heat and cold waves, floods and droughts, hurricane winds, forest fires, and landslides.

Figure 3. Precipitation per year for 1961–1990 (A); Precipitation per year for 2080, according to the pessimistic scenario (B)



Source: NIMH-BAS.

13. Biodiversity, land and aquatic ecosystems, as well as water resources, agriculture, and forestry sectors are expected to be affected by the anticipated changes. These changes would furthermore affect society and its citizens as well as the economy.

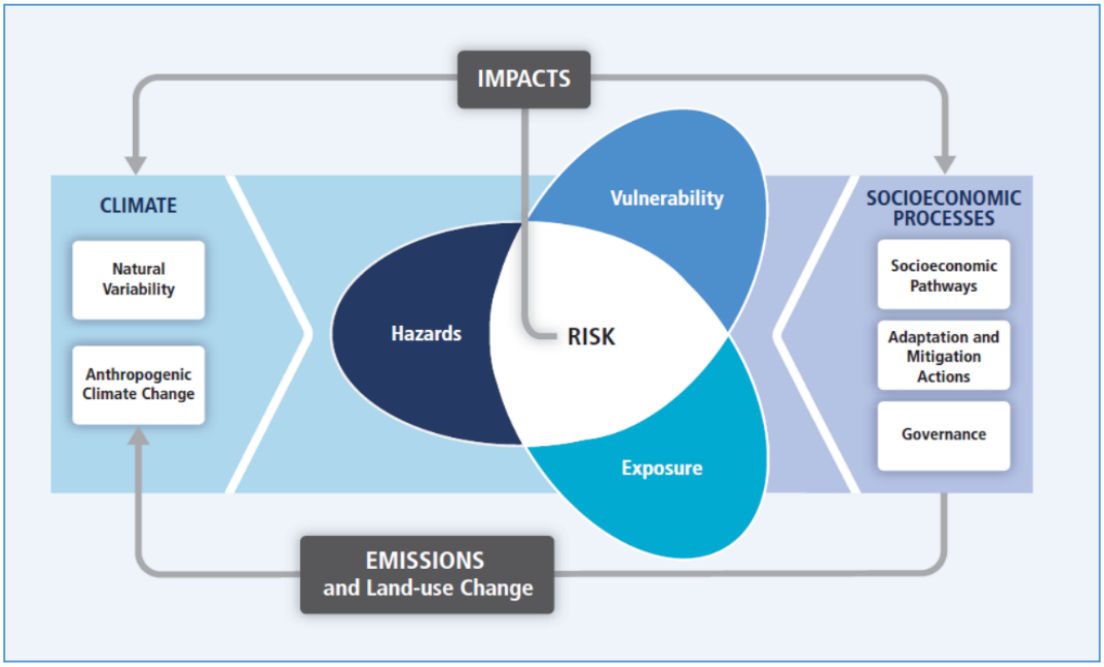
14. Climate change impacts do not affect all people and territories equally due to different levels of exposure, existing vulnerabilities, and adaptive capacities to cope. The risk is greater for the segments of the society and businesses that are less prepared and more vulnerable.

15. This report aims to inform on vulnerabilities to the Bulgarian health sector and at identification of adequate climate change adaptation options. The report is part of a set of nine sectoral assessment reports considered under the climate adaptation support program for Bulgaria, which will form the baseline for the National Climate Change Adaptation Strategy and Action Plan. The report follows the general logic and structure as proposed for all sectors and is divided into three parts: (1) part one of the report (Chapter 1) focuses on the climate change risks and vulnerabilities' assessment; (2) part two comprises a gap analysis of the policy, legal and institutional context (Chapter 2); and (3) part three focuses on the identification and prioritization of adaptation options (Chapter 3). This sector assessment was carried out during March – November 2017, as a combination of quantitative and above all, qualitative analysis. Several workshops have been organized as part of an ongoing consultation

process, inviting a broad audience of stakeholders.

16. The report uses the terms and definitions of risk, vulnerability and adaptation options as introduced by WGII AR5 (IPCC 2014). Risk of climate-related impacts results from the interaction of climate-related hazards with the vulnerability and exposure. Changes in both the climate system (left side in ***Figure 4***) and socioeconomic processes including adaptation and mitigation (right side of the ***Figure 4***) are drivers of hazards, exposure, and vulnerability. This understanding reveals the importance of the adaptation options. When they are properly identified and timely implemented, vulnerability, hazard and/or exposure will be reduced, thus the risk will be mitigated.

Figure 4. General concept of WGII AR5 (IPCC 2014)



Chapter 1. Risk and Vulnerability Assessment and Analysis

17. Human health has always been influenced by climate and weather. Changes in climate and climate variability, particularly changes in weather extremes, affect the environment that provides us with clean air, food, water, shelter, and security. Climate change, together with other natural and human-made health stressors, threatens human health and well-being in numerous ways. The warming temperatures, changes in precipitation, increases in the frequency or intensity of some extreme weather events threaten our health by affecting the food we eat, the water we drink, the air we breathe, and the weather we experience. The severity of these health risks will depend on the ability of public health and safety systems to address and prepare for these changing threats, as well as on factors such as an individual's behavior, age, gender, and economic status. Impacts will vary based on where a person lives, how sensitive they are to health threats how much they are exposed to climate change impacts, and how well they and their community are able to adapt to change. Connecting our understanding of how climate is changing with an understanding of how those changes may affect human health can inform decisions about adapting to current and future climate change and suggest priorities for protecting public health and help in identifying the corresponding knowledge-base gaps, uncertainties, challenges, and opportunities.

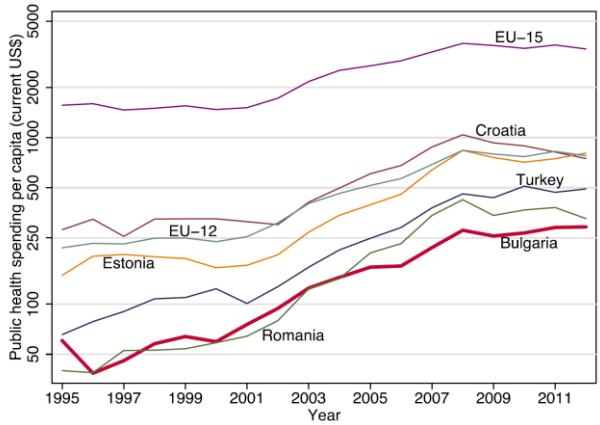
18. This chapter is designed to address the sector characteristics and trends, weather and climate-sensitive diseases and corresponding response actions in the sector, and sector-related climate change risks and vulnerabilities.

1.1. Sector Characteristics and Trends

19. The provision of high-quality and sustainable health and long-term care is an important element of the policy in the field of social protection in Bulgaria. The country has achieved significant improvements in health outcomes over time but is still falling behind most European Union (EU) countries on key health indicators. Public health spending per capita in Bulgaria has increased from US$ 60 in 1995 to US$291 in 2012 but is still significantly lower than the EU-12 average of US$777 and EU-15 average of US$3,404 (***Figure 5***). As a share of of gross domestic product (GDP), public health spending increased from 3.9 percent in 1995 to 4.1 percent in 2012, while private health spending increased from 1.4 percent to 3.9 percent during the same period, (***Figure 6***). The composition of health spending has changed during the same time. In 2012, the public share of total health spending represented 51.4 percent compared to almost 74 percent in 1995. As a result, private health spending increased from 26 percent in 1995 to 48.6 percent in 2012, with the out-of-pocket (OOP) share rising from 26 percent to 47.5 percent, respectively.[2]

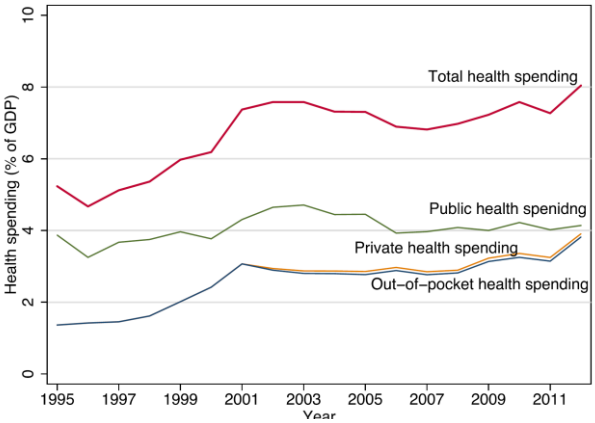
[2] Background paper: "International Comparisons of Bulgaria's Health System Performance." 2015, Advisory services agreement between ministry of health of the Republic of Bulgaria and the IBRD.

Figure 5. Public health spending per capita (current US$): country comparison 1995–2012



Source: World Development Indicators and WHO NHA, 2014[2]

Figure 6. Health spending as a share of GDP, Bulgaria, 1995–2012



Source: World Development Indicators and WHO NHA, 2014[2]

20. In the last 20 years, demographic development has been characterized by population decline, a low crude birth rate, a low fertility rate, a high mortality rate and an aging population. A stabilizing political situation since the early 2000s and an economic upsurge since the mid-2000s were important factors in the slight increase of birth and fertility rates and the slight decrease in mortality. Life expectancy at birth reached 74.6 years in 2016. In general, Bulgaria lags behind EU averages in most mortality and morbidity indicators. Although infant mortality has been decreasing by 5 percent to 6 percent a year in the last decade (the absolute numbers in Bulgaria totals 720 in 2006 and 423 in 2016), this indicator is still behind the EU averages (8.5/1,000 for Bulgaria against 3.6/1,000 for the EU in 2016) and the extent of progress varies considerably for mortality sub-types. One of the most important risk factors overall is smoking. Unsurprisingly, the average standardized death rate (SDR) for smoking-related causes in 2008 was twice as high as the EU15 average.

21. The health system in Bulgaria is facing serious challenges. Similar to the health systems in other EU countries, it is characterized by limited statism. The system has evolved under market conditions but with a substantial role for the state, the authorities of which have the responsibility for health care (Popov 2007). Both public and private ownership forms of physical resources and funds exist. Regional, sub-regional, and municipal authorities influence the management of health resources and organizations at the local level. Health providers and professional associations are autonomous players. The health system is financed from various sources, namely health insurance funds, state and local budgets, and OOP payments. Market mechanisms apply regardless of the forms of property. The population and their health needs are covered by compulsory health insurance.

22. According to a comprehensive study for the World Health Organization (WHO)/European Observatory on Health Systems and Policies (Dimova et al. 2012), the health system in Bulgaria is economically unstable. Health care establishments, most notably hospitals, are suffering from underfunding. A transparent regulatory framework for pricing is absent. Price formation is not based on real costs, but rather on available funding in the National Health Insurance Fund (NHIF) budget. Due to the monopolistic status of the NHIF, market

mechanisms play no role in public insurance, although this was an objective of the overall health care system. Today, a great number of individuals are not covered by statutory health insurance, while the voluntary health insurance (VHI) market is underdeveloped.

23. Health care reform since 1989 passed through three stages. The first stage (1989–1996) was characterized by the abolishment of the state monopoly in the health system, building a decentralized health care administration, and the emerging idea for the introduction of a health insurance system. During the second stage (1997–2001), the new health insurance system was introduced through the landmark laws on health insurance, health care establishments, and professional organizations of physicians and dentists. In the third stage (2002–present), the legislative foundation of the health care reform was completed with the adoption of new laws and amendments and additions of the existing regulatory acts. Efforts during the third stage aimed to decrease the number of individuals without social health insurance (SHI) coverage and to secure the financial stability of the system (mainly by raising the health insurance contribution from 6 percent to 8 percent). Yet the efforts did not lead to the desired results and the two main objectives set out in the beginning of the reform process in 1990 – improving population health and establishing a health system that would correspond to population health needs while being based on democratic and market principles have still not come to fruition.

24. On these grounds, the need for further reform seems even greater than in the early 1990s. The major challenge is improving population health. This entails not only substantially improving health indicators but also reducing health and access inequalities. The National Health Strategy (NHS) for 2008–2013, as well as the one for 2014–2020, outlined the implementation of several nationally targeted programs focusing on treatment and prevention of socially important diseases, raising public awareness on healthy lifestyles, and improving the public health network. However, the biggest challenge in this field is systematic monitoring and registration of population health status to restrict preventable mortality.

25. Currently, the healthcare system is driven by three main priorities and related policies regarding overcoming increasing challenges for Bulgarian citizens' health namely to create necessary healthy living conditions for everyone throughout their lives; develop and manage a fair, sustainable, and efficient healthcare system focused on quality and results; and strengthen public health capacity. Health protection and health improvement policies focus on generating long-term economic growth at the national and regional levels, but also on ensuring an effective performance of public sector defense mechanisms with regard to social inclusion and fighting poverty. The NHS 2020 is based on the understanding of cross-sector cooperation, that is realizing existing possibilities to unite the efforts of people working in the different spheres of socioeconomic life, but also of regional communities, to achieve expected results in terms of preserving and improving the nation's health (HIT profile of Bulgaria[3]).

26. To make a sustainable reform effort, health care policy should be approved by most of the political parties represented in the National Assembly and not be exclusively based on governmental concepts that are usually omitted by the next government. The national significance of health reform requires that these decisions be agreed upon and widely supported

[3] http://www.hspm.org/countries/bulgaria22042013/livinghit.aspx?Section=6.1%20Analysis%20of%20recent%20reforms&Type=Section

by a large constituent base, including civil organizations, trade unions, municipalities, and the scientific community (National Development Program: Bulgaria 2020).

27. All difficulties which the Bulgarian health system faces complicate the process of adaptation to climate change and require additional efforts for resolving of adaptation tasks.

Non-climatic drivers of health vulnerability to climate change

28. Some socioeconomic drivers of human health such as income, housing, employment, education, gender, and lifestyle can lead to uneven distribution of climate change health effects, becoming additional burdens for certain vulnerable groups (lower income groups, children, those working outdoors, the elderly, women, the homeless, people with a pre-existing illness and/or disability, and so on).

29. At this stage, Bulgarian healthcare services are unable to meet the challenges of an aging population, the continuous development of medical technology, and the increasing demands of the population for quality of life, and hence, for quality healthcare. Bulgaria continues to be one of the countries with the **highest mortality** rates in the EU and the **lowest population growth**. As a whole, the demographic processes in Bulgaria are characterized by a persistent downward trend in population and ageing. An **unfavorable trend in the labor force** is also reported – the absolute number of people within working age is declining in a situation of significant increase in the relative proportion of elderly workers. Data from a representative survey of mental health among the population showed that 22 percent had a psychiatric disorder in their lifetime and in about 25 to 30 percent of the cases, contact with the health system included **mental maladies**. The healthcare provided for children does not yet correspond to the EU average. Despite the positive downward trend, the **infant mortality** indicator counting 9.4 promille in 2010 is still above the values of that indicator in other EU countries (according to the National Statistical Institute's 2015 paper 'Zdrave'). This situation was still the case in 2016 with a figure of 8.5 promille. The **health status of the working population** is characterized by higher levels of risk conditions (injuries, illnesses, low safety at work, and stress) than those in the EU. Although the total number of accidents and lost calendar days has significantly declined, the increase in accidents with fatalities is alarming. Significant problems exist in the system and structure of costs spent to **finance health care**. In 2010, public spending on healthcare in the country accounted for only 4.3 percent of GDP. With respect to this indicator, Bulgaria still occupies one of the last places among the 27 Member States of the EU. According to a report by the World Bank, Bulgaria has the highest proportion of own resources payments as a percentage of total health expenditure. That fact, as well as the **extremely low incomes of the population**, pose serious problems for the citizens' access to health services. One of the main problems in Bulgaria's healthcare system over the past few years has been linked to **illegal payments**, which not only violate fundamental principles and values of contemporary Bulgarian society but also increase the social burden on the population[4].

30. The outlined picture of the unfavorable level of public health is due not only to the described socioeconomic determinants (low income, poverty, social exclusion), but also to the

[4] National Development Program: Bulgaria 2020

fact that the Bulgarian population is 'burdened' with multiple health risk factors. The results of a number of studies provide grounds to consider that, in the country there are approximately 30 percent **smokers** (according to data from the European Health Interview Survey (EHIS) 2014, conducted by the National Statistical Institute [NSI]);); on average about 40 percent men and women ages 15 and older are overweight; about 10 percent people with daily **drinking of alcohol**; about 345,000 to 360,000 Bulgarian citizens from 15 to 60 years have at least one **drug use** in their life; two-thirds of the population have **low physical activity**; and about 30 percent are hypertensive patients. A serious problem represents smoking at a young age. A survey conducted in 2008 among students age 13 to 15 years found that smokers were 28.2 percent. In 21.2 percent of the cases children have lit their first cigarette before reaching the age of 10 years[4].

31. According to the EU 'health consumer index' Bulgaria occupies the last position amongst 35 countries (Member States of the EU and candidate countries).[5]

Recommendations related to sub-chapter 1.1: There is an acute need for complex convalescence of the Bulgarian health system to decrease its sensitivity to climate change manifestations and reach maximum adaptive capacity. It is necessary to conduct a specialized study to parametrize the non-climatic factors of health vulnerability and health system vulnerability to climate change in Bulgaria at the national and sub-national levels.

1.2. Climate Change Health Consequences

32. Human health can be influenced by a great number of weather manifestations expressing climate changeability during the last decades. The most affecting climatic events are warmer climate, periods with extreme maximum and minimum temperatures, durable and intensive precipitation, emergency weather phenomena (windstorms, cyclones, and floods), droughts, air quality, stratospheric ozone depletion, and change in intensity of ultraviolet (UV)-radiation. The health effects from climate change concern the following diseases:

- Heat related morbidity and mortality
- Emergency weather-related morbidity and mortality
- Cardiovascular diseases and strokes
- Asthma, respiratory allergies and airway diseases
- Cancer
- Vector-borne and zoonotic diseases
- Foodborne diseases and nutritional deficiencies
- Waterborne diseases
- Mental health and stress-related disorders
- Neurological diseases and disorders

[5] Euro Health Consumer Index 2016. 2017, Arne Björnberg, Health Consumer Powerhouse.

1.2.1. Heat-related morbidity and mortality[6]

33. Based on the daily values of the Heat Wave Magnitude Index (HWMId), it is observed that Europe experienced intense and prolonged heat waves between 1950 and 2015, most of which occurred after 2000 (in 2003, 2006, 2007, 2010, 2014, and 2015) (Russo et al. 2015). Indices for extreme temperatures, including the annual maximum value of daily maximum temperature (Txx), have shown significant upward trends across Europe since the 1950s (Donat et al. 2013). The number of unusually warm days (Tx90p) has increased by up to 10 days per decade since 1960. Bulgaria shows a considerable rate, of 7 to 8 days per decade (***Figure 13 within Annex 4***).

34. Temperature, particularly temperature extremes, is associated with a wide range of health impacts. The health outcomes of prolonged heat exposure include heat exhaustion, heat cramps, heat stroke, and death (Ellis 1976, Kilbourne et al. 1982). Extreme heat events cause more deaths annually than all other extreme weather events combined (Lubeer et al. 2008). Prolonged exposure to heat may also result in additional illness and death by exacerbating preexisting chronic conditions such as various respiratory, cerebral, and cardiovascular diseases (Kovats et al. 2008), as well as increasing risk for patients taking psychotropic drug treatment for mental disorders (Davido et al. 2006), due to the body's impaired ability to regulate temperature. Figures for these illnesses and deaths may be dramatically underestimated as disparities in health care make morbidity measurements difficult and heat is rarely identified as an official cause of death. Public health response organizations should develop early warning systems for anticipated heat wave events and extended warm periods.

35. Both **increased average temperatures** and increasingly frequent and severe **extreme heat events** produce increased risks of heat-related illness, and death that can be significant: the European heat wave of 2003 caused more than 35,000 excess deaths (Vandentorren et al. 2006). Human susceptibility to heat-related illness depends on several factors, from physiologic adaptation to the local environment to socioeconomic status.

36. Varying age groups have shown to be sensitive to all-cause mortality under excessive heat stress, including adults over 65, children, and infants under 1 year of age (Bytomski et al. 2003). For type-specific mortality, sensitivity to death from respiratory disease has been demonstrated in the general population and in the elderly (Vandentorren et al. 2004). In general, risk of respiratory death due to heat stress is greater than that of cardiovascular effects. More commonly, sensitivity to cardiovascular disease-related mortality associated with heat has been seen in the whole population, as well as among the elderly. However, heat-related risks are not regionally or locally uniform; demographics in Bulgaria will produce concentrations of larger populations with higher mean age, and thereby, heightened vulnerability to excessive heat (Donat et al. 2003). Socioeconomic factors also determine vulnerability-economically disadvantaged and socially isolated people face higher burdens of death from heat (Gosling et al. 2009).

37. Cities and climate are coevolving in a manner that will certainly amplify both the health effects of heat and the vulnerability of urban populations to heat-related deaths by magnifying

[6] A Human Health Perspectiven on Climate Change, 2009. A Report Outlining the Research Needs on the Human Health Effects of Climate Change. The Interagency Working Group on Climate Change and Health1 (IWGCCH).

the increased temperatures caused by climate change as compared to adjacent rural and suburban locales (Brazel et al. 2005, Patz et al. 2005). The urban built environment can both exacerbate and alleviate the effects of heat. For example, high concentrations of buildings in urban areas cause, what is known as the heat island effect: generating as well as absorbing and releasing heat, resulting in urban centers that are several degrees warmer than surrounding areas. Expanding parks and green spaces and increasing the density of trees in and around cities can help to reduce this effect (Bolund et al. 1999, McPherson et al. 1997).

38. Despite an increase of mean global temperature, not only an increase of extremely hot weather phenomena has been observed but also of **extremely cold** ones. Cold-season deaths are largely associated with increases in respiratory infections such as influenza (Kiney et al. 2015). In cold weather, the body can lose heat faster than it is produced, which uses up stored energy and can lead to hypothermia, defined as a core temperature below 35°C. Low temperatures cause veins and arteries to narrow and blood to become more viscous, increasing cardiac workload and leading to many of the same cardiovascular stresses such as heat. In true hypothermia, this extra cardiac workload is coupled with a host of other concerns, including increased cardiac muscle sensitivity that can lead to dysrhythmias. In addition to straining the heart and other organs, impaired blood flow and decreased metabolic activity due to low temperatures can affect the brain, making the victim unable to think clearly or move well (Seltenrich 2015).

39. Hypothermia is most likely at extremely low temperatures, but it is also possible well-above freezing if a person becomes chilled from rain, sweat, or immersion in cool water. Many hypothermia diagnoses occur in tandem with other illnesses and environmental exposures; some patients, for example, have systemic infections that disrupt thermoregulation and allow sepsis-related hypothermia to occur even in the summer. For cold-related deaths, the most frequently cited underlying cause of death was exposure to excessive cold, followed by unintentional injuries and heart disease.

40. People most at risk of illness or death from exposure to high or low temperatures include those less able to regulate their body temperature due to age, those with pre-existing conditions or chronic diseases, and (especially heavy) users of alcohol or drugs (Benmarhnia et al. 2015, Berko et al. 2014). Individual vulnerability to heat and cold has also been found to vary with sex and race.

1.2.2. Emergency weather-related morbidity and mortality

41. Nowadays, the world experiences a variety of extreme weather events including windstorms, cyclones, heavy precipitation, floods, blizzards, and so on. Among those with the most expressive effect are precipitation and floods. Europe has exhibited an increasing trend in **heavy precipitation** over recent decades, particularly in winter. Heavy precipitation events have become more intense and more frequent in Europe on average, but there are important differences across regions, seasons, time periods, heavy precipitation indices and underlying datasets (EEA 2017). An index for the maximum annual precipitation over five consecutive days (Rx5d) shows smaller trends in central and south-eastern Europe. Bulgaria falls in the range from –1 to 1 mm per decade for the winter period and in 1 to 2 mm per decade for the summer (***Figure 14 within Annex 4***). The damage associated with heavy precipitation often

originates from sub-daily localized heavy precipitation events, which can lead to costly **flash floods**. The extreme sub-daily precipitation events have generally increased in Europe, even in regions with decreases in mean rainfall, but there is large variability across regions, seasons and event durations too. The local differences in Bulgaria expressed by annual average of affected GDP is shown in ***Figure 15 within Annex 4***.

42. Floods caused by these events can affect people immediately (for example, through drowning and injuries) and after the event (for example, through displacement, the destruction of homes, water shortages, disruption of essential services and financial loss, increasing risks of water- and vector-borne infectious diseases). The stress that flood victims are exposed to can also affect their mental health (traumatic stress disorder, serious mental illness and suicide), and it hits more younger children and females than males. The mental effects can persist a long time after the event. Two-thirds of flood-related deaths worldwide are from drowning and one-third are from physical trauma, heart attacks, electrocution, carbon monoxide poisoning, fire and infectious diseases. Health system infrastructure (e.g. hospitals) can also be affected by extreme weather events, in particular to flooding. Disruption of services, including health services, safe water, sanitation and transportation ways, plays a major role for the extent to which the extreme weather would affect the people.

43. The number of large inland floods in Europe has been increasing since the 1980s. Estimates for the WHO European Region indicate that coastal and inland floods killed more than 2,000 people and affected 8.7 million in the period 2000–2014. ***Figure 16 within Annex 4*** shows the number of deaths related to flooding in each EEA member and cooperating country for the 1991–2015 period, normalized by their population. The largest numbers are found in south-eastern Europe, incl. in Bulgaria. For example, at least 50 people were killed in massive floods in the Balkan countries in May 2014.

1.2.3. Cardiovascular disease and stroke

44. There is evidence of climate sensitivity for several cardiovascular diseases, with both **extreme cold** and **extreme heat** directly affecting the incidence of hospital admissions for chest pain, acute coronary syndrome, stroke, and variations in cardiac dysrhythmias though the reported magnitude of the exposure-outcome associations is variable (Bassil et al. 2009, Kilbourne 1999, McGeehin et al. 2001, Piver et al. 1999, Ye et al. 2001). Weather conditions such as extreme heat serve as stressors in individuals with pre-existing cardiovascular disease and can directly precipitate exacerbations (Fouillet et al. 2006, Wainwright et al. 1994). There is also evidence that heat amplifies the adverse impacts of ozone and particulates on cardiovascular disease. These pollutants are likely to be affected by climate change mitigation activities, and thus, likely reduce rates of cardiovascular morbidity and mortality. While the fraction of disease risk attributable to weather and associated environmental exposures is not known, given the prevalence of cardiovascular disease and the preventable nature of the exposures, further research into associations between weather, climate variability, long-term climate change, and cardiovascular disease is an immediate need.

45. Cardiovascular mortality associated with **heat** has been declining over time, presumably the result of increased air-conditioning use and mortality associated with extreme cold has remained constant (Barnett 2007). Cardiovascular hospital admissions increase with

heat. Dysrhythmias are primarily associated with extreme cold (Kysely et al. 2009), though associations with dysrhythmias and heat illness have been reported (Al-Harthi et al. 1992). Stroke incidence increases with increasing temperature as well (Ebi et al. 2004). For all direct associations between temperature and cardiovascular disease and stroke, elderly and isolated individuals are at greatest risk.

46. Indirect impacts of weather, weather variability, and climate changes on cardiovascular disease are many and varied. Associations between **air quality**, especially ozone and particulate burdens, and cardiovascular disease appear to be modified by weather and climate. Ozone, whose formation increases with temperature, increases cardiac effort and impairs pulmonary gas exchange (Martin-Latry et al. 2007). Ozone concentrations modify the association between temperature and cardiovascular mortality (Ren et al. 2008) and are also associated with acute myocardial infarction (Ruidavets et al. 2005). Particulate matter (PM) is associated with a variety of pathophysiological changes including systemic inflammation, deranged coagulation and thrombosis, blood vessel dysfunction and atherosclerotic disease, compromised heart function, deep venous thromboses (Baccarelli et al. 2008), and pulmonary embolism (Brook 2008). Increased burden of $PM_{2.5}$ is associated with increased hospital admissions and mortality from cardiovascular disease (Jerret et al. 2009), as well as ischemic heart disease (Pope et al. 2006).

47. **Extreme weather events** affect cardiovascular health through several pathways. Directly, the stress of the event and anxiety over event recurrence are associated with myocardial infarction (Suzuki et al. 1997), sudden cardiac death (Leor et al. 1996), and development of stress-related cardiomyopathy (Watanabe et al. 2005). Indirectly, displacement related to disasters is frequently associated with interruptions of medical care for chronic medical conditions (Krousel-Wood et al. 2008), putting populations with chronic cardiovascular conditions at risk for disease exacerbations.

48. Climate is also implicated as another indirect risk for cardiovascular disease: the incidence of certain vector-borne and zoonotic diseases (VBZD) with cardiovascular manifestations. One estimate holds that approximately 10 percent of strokes in the developing world are related to exposure to certain VBZD (Carod-Artal 2007), many of which are climate-sensitive.

1.2.4. Asthma, respiratory allergies and airway diseases

49. The inability of the immune system to adapt to the challenges of changing conditions causes deficiencies that in turn affect different organs and systems. It is no wonder that the increase in allergic and respiratory diseases is greatest in comparison with other diseases.

50. Climate change will affect air quality in several ways including production and allergenicity of aeroallergens such as pollen and mold spores and increases in regional ambient concentrations of ozone, fine particles, and dust. Some of these pollutants can directly cause respiratory disease or exacerbate respiratory disease in susceptible individuals.

51. Earlier flower blooming resulting from temperature increases and increased carbon dioxide (CO_2) concentrations affects timing of distribution of **aero-allergens** such as pollen through plant photosynthesis and metabolism (Stitt 1991). There is also a possibility that certain

aero-allergens may become more allergenic as temperatures and CO_2 concentrations increase (Uysal et al. 2003). Precipitation-affected aero-allergens such as mold spores also are of concern, as 5 percent of individuals are predicted to have some respiratory allergic airway symptoms from molds over their lifetime (Hardin et al. 2003).

52. In the presence of certain **air emissions**, the rate of ozone formation increases with higher temperatures and increased sunlight and can also be affected by changes in storm tracks, humidity, and stability of the boundary layer (lowest part of the atmosphere) (Houghton et al. 2001). Humidity and temperature also partly determine the formation of $PM_{2.5}$. Research studies associate fine particles with negative cardiovascular outcomes such as heart attacks, formation of deep vein blood clots, and increased mortality from several other causes (Bytomski et al. 2003, Vose et al. 2004, Baccarelli et al. 2008, Confalonieri et al. 2007, Parry et al. 2007, O'Neill et al. 2007, Peters et al. 2001, Samoli et al. 2008). These adverse health impacts intensify as temperatures rise (Qian et al. 2008). Studies also link elevated exposure to ground-level ozone, $PM_{2.5}$, coarse thoracic PM, and aero-allergens to decreased lung function, aggravation of asthma, rhinitis, exacerbations of chronic obstructive pulmonary disease, hospitalizations for respiratory and cardiovascular diseases, and premature mortality.

53. Air pollution overcomes the mucosal barrier in lungs by inducing airway inflammation, which results in allergen-induced respiratory responses (D'amato et al. 2008). In addition, air pollutants such as $PM_{2.5}$ and ozone may alter the allergenicity of aero-allergens like pollen, thereby, promoting further airway sensitization (D'amato et al 2001). The triggers for such adverse respiratory responses vary and include climatic factors (meteorological events, rainfall patterns, and temperature anomalies), high levels of vehicle emissions, land-use patterns, variables in the built environment, geography, and distance from roadways (Shea et al. 2008). Physiology also plays a significant role, as individuals with existing respiratory conditions are most vulnerable to disease exacerbations triggered by the environment (D'amato et al. 2008). The populations most vulnerable to the increased disease risks include children, pregnant women, persons of low socioeconomic status, persons situated near high-traffic zones within urban centers, and those with preexisting respiratory and cardiovascular diseases.

54. Other airborne exposures are also likely to worsen with climate variability and change. Changes in the hydrologic cycle with increasingly variable precipitation and more frequent drought may also lead to a global increase of **airborne dust**, which when coupled with anticipated stagnant air masses and increasingly strong inversion layers, will trap ozone and other airborne pollutants near the ground causing exacerbations of respiratory disease. Coarse thoracic PM (between 2.5 and 10 micrometers in diameter) is associated with increased risk of emergency department visits and hospitalizations for cardiovascular outcomes, especially among adults over 65 years of age (Ballester et al. 2006, Le Tertre et al. 2002, Zanobetti et al. 2003). Increased **incidence of wildfires** in some areas can also contribute to PM concentrations. In certain areas, airborne dust serves as a carrier of specific diseases, such as coccidioidomycosis, or 'valley fever' (Komatsu et al. 2003, Vugla et al. 2009). Prolonged drought will lead to more dust and particulate pollution while increased rainfall will cleanse the air but may create more mold and microbial pollution. In addition, drought, declining water quality, and increased temperatures contribute to the growth of harmful algal blooms that

produce toxins that can be aerosolized and exacerbate asthma and respiratory diseases (Abraham et al. 2005, Fleming 2007).

55. Despite strong evidence of associations between a wide range of environmental variables impacted by climate and respiratory disease, the direct impacts of climate change on asthma, respiratory allergies, and airway diseases need further study to evaluate the fraction of respiratory disease risk that can be attributed to climate change and potentially mitigated or avoided.

1.2.5. Cancer

56. Climate change will result in higher ambient temperatures that may increase the transfer of **volatile and semi-volatile compounds** from water and wastewater into the atmosphere and alter the distribution of contaminants to places more distant from the sources, changing subsequent human exposures (MacDonald et al. 2003). Climate change is also expected to increase heavy precipitation and flooding events, which may increase the chance of **toxic contamination** leaks from storage facilities or runoff into water from land containing toxic pollutants. Very little is known about how such transfers will affect people's exposure to these chemicals—some of which are known carcinogens—and its ultimate impact on incidence of cancer. More research is needed to determine the likelihood of this type of contamination, geographical areas and populations most likely to be impacted, and health outcomes that could result.

57. Marine animals, including mammals, also may suffer from the direct effects of cancer linked to sustained or chronic exposure to chemical contaminants in the marine environment, and thereby, serve as indicators of similar risks to humans (McAloose et al. 2009). Climate impact studies on such model cancer populations may provide added dimensions to our understanding of the human impacts.

58. Although the exact mechanisms of cancer in humans and animals are not completely understood for all cancers, factors in cancer development include pathogens, environmental contaminants, age, and genetics. Given the challenges of understanding the causes of cancer, the links between climate change and cancer are a mixture of fact and supposition, and research is needed to fill in the gaps in what we know.

59. Another direct effect of climate change, depletion of stratospheric ozone, will result in increased **UV radiation** exposure. UV radiation exposure increases the risk of skin cancers and cataracts (Tucker 2009). The incidence of typically nonlethal basal cell and squamous cell skin cancers is directly correlated to the amount of exposure to UV radiation. This effect is compounded by several other variables including temperature and exposure to other compounds that can amplify the carcinogenic potential of UV radiation (Burke et al. 2009). Rising temperatures (such as occur at night versus day and in summer versus winter) are associated with increases in UV exposure. If increases in average or peak temperatures occur as a result of climate change, an increase in the incidence of non-melanoma skin cancers may occur (Van der Leun et al. 2008). Previous studies have shown that increased UV radiation exposure combined with certain polycyclic aromatic hydrocarbons (PAHs) can enhance the **phototoxicity** of these compounds and damage DNA (Dong et al. 2009, Toyooka et al. 2006).

However, it is also possible that increased exposure to UV radiation could elevate levels of circulating Vitamin D, which has been associated with a decreased risk of certain cancers such as colorectal cancer (Garland et al. 2009). Increased UV radiation also could impact the **human immune system** and alter the body's ability to remove the earliest mutant cells that begin the cancer process, although it is unclear whether these changes would be beneficial or detrimental (Sleijffers et al. 2004).

1.2.6. Vector-borne and zoonotic diseases

60. VBZD are infectious diseases whose transmission cycles involve animal hosts or vectors. Vector-borne diseases are those in which organisms, typically blood-feeding arthropods (insects, ticks, or mites) carry the pathogen from one host to another, generally with amplification (increased virulence) in the vector (for example, malaria). Zoonoses are diseases that can be transmitted from animals to humans by either contact with animals or by vectors that can carry zoonotic pathogens from animals to humans (for example, avian flu). Both domestic animals and wildlife, including marine mammals, fish, sea turtles, and seabirds may play roles in VBZD transmission by serving as zoonotic reservoirs for human pathogens or as means of interspecies transmission of pathogens.

61. The epidemiology of VBZD has changed significantly over the past century, and many diseases that previously caused significant illness and death, including malaria (Faust 1949), dengue (Adlet et al. 2003), yellow fever (Petri et al. 2004), and murine typhus (White 1965) , are now rarely seen. This dramatic change is a result of intentional programs to control vectors, vaccinate against disease, and detect and treat cases, with additional benefits from improvements in sanitation, development, and environmental modification. Examples of vector-borne diseases currently prevalent include Lyme disease (Bacon et al. 2008) and ehrlichiosis, bacterial diseases that are transmitted primarily by ticks. Other important zoonoses, some of which are also vectorborne, include rabies (Blanton et al. 2008), Q fever (McQuiston et al. 2006), anthrax, pathogenic *E. coli*, tularemia, hantavirus pulmonary syndrome (Douglas et al. 2005), and plague. The most frequent of them are shown in ***Table 16*** within ***Annex 4***). Although VBZD currently are not a leading cause of morbidity or mortality, there is cause for some urgency on this issue. The population is directly susceptible to the VBZD that circulate in warmer climates and are vulnerable because of global trade and travel. Human ability to respond to such threats on both a national and international level is currently limited. In the long term, climate change's potential to cause social upheaval and population displacement may provide opportunities for resurgence of certain VBZD which has already seen some redistribution of vector species.

62. VBZD ecology is complex, and weather and climate are among several factors that influence transmission cycles and human disease incidence (Boxall et al. 2009). Changes in temperature and precipitation patterns affect VBZD directly through pathogen-host-vector interactions, and indirectly through ecosystem changes (humidity, soil moisture, water temperature, salinity, acidity) and species composition. Social and cultural behavior also affect disease transmission. Many VBZD exhibit some degree of climate sensitivity, and ecological shifts associated with climate variability and long-term climate change are expected to impact the distribution and incidence of many of these diseases (Gage et al. 2008). For instance, the

range of Lyme disease is expected to expand northward as the range of the deer tick that transmits it expands (Estrada-Peña 2002). In another example, the frequency of hantavirus pulmonary syndrome outbreaks, caused by human exposure to the virus in deer mice urine or feces, may change with increasingly variable rainfall, which affects the populations of deer mice and other rodents through changes in production of the pine nuts on which they feed (Douglass et al. 2005, Ebi et al. 2006).

63. Similarly, certain VBZD may decrease in specific regions as habitats become less suitable for host or vector populations and for sustained disease transmission. Coastal and marine ecosystems will be particularly affected by increasing temperatures, changes in precipitation patterns, sea-level rise, altered salinity, sea acidification, and more frequent and intense extreme weather events. These changes will directly and indirectly affect sea and coastal ecosystems by influencing community structure, biodiversity, and the growth, survival, persistence, distribution, transmission, and severity of disease-causing organisms, vectors, and reservoirs (Niemi et al. 2004). Also, of concern for both terrestrial and aquatic/marine ecosystems is the loss of biodiversity that further exacerbates the impacts of climate change on vectors or animal reservoir populations. Such alterations in ecosystem functions may alter the emergence of VBZD in populations. With the loss of predators, insect vectors may increase, making necessary either chemical or mechanical controls.

64. The extrinsic incubation period of pathogens in invertebrate vectors is highly dependent on ambient temperature. Because the lifespan of vector species is relatively constant, changes in the incubation period due to precipitation and temperature significantly alter the likelihood of transmission (Strickman et al. 2003). Also, large disruption and subsequent movement of human populations create conditions for wider distribution of pathogens and greater exposure to vector species (Scoville 1948). And, climate change is already affecting the biodiversity of marine and terrestrial ecosystems, which in turn will alter the dynamics of predator–prey relationships, as well as vector and reservoir pathogen populations. This may alter the types and quality of subsistence animal foods, and present dependent communities with new pathogen risks. The time scale of this threat will be continuous unless adapting measures are taken.

1.2.7. Water-borne diseases

65. Waterborne diseases are caused by a wide variety of pathogenic microorganisms, biotoxins, and toxic contaminants found in the water we drink, clean with, play in, and are exposed to through other less direct pathways such as cooling systems. Waterborne microorganisms include protozoa that cause cryptosporidiosis, parasites that cause schistosomiasis, bacteria that cause cholera and legionellosis, viruses that cause viral gastroenteritis, amoebas that cause amoebic meningoencephalitis, and algae that cause neurotoxicity (Batterman et al. 2009). Most of waterborne diseases are gastrointestinal, though waterborne pathogens affect most human organ systems and the epidemiology is dynamic. A recent shift has been seen in waterborne disease outbreaks from gastrointestinal toward respiratory infections such as that caused by *Legionella*, which lives in cooling ponds and is transmitted through air conditioning systems (Yoder et al. 2008). In addition to diarrheal disease, waterborne pathogens are implicated in other illnesses with immunologic, neurologic,

hematologic, metabolic, pulmonary, ocular, renal and nutritional complications (Meinhardt 2006). WHO estimates that 4.8 percent of the global burden of disease (as measured in disability-adjusted life years [DALYs]) and 3.7 percent of all mortality attributable to the environment is due to diarrheal disease (Mathers et al. 2008). Most of these diseases produce more serious symptoms and greater risk of death in children and pregnant women.

66. For most waterborne pathogens, surveillance is spotty, diagnoses are not uniform, and our understanding of the impact of normal weather and climate variation on disease incidence, as well as illness and death burdens, is not firmly established. Impacts of any intensifying of climate events at the local, regional, national, and global levels are a growing concern. Experts estimate that there is a high incidence of mild symptoms from waterborne pathogens and a relatively small, but not negligible mortality burden (Craun et al. 2006).

67. Climate change directly affects the incidence of waterborne diseases through effects on water temperature and precipitation frequency and intensity. These effects are pathogen- and -pollutant specific, and risks for human disease are markedly affected by local conditions, including regional water and sewage treatment capacities and practices. Domestic water treatment plants may be susceptible to climate change leading to human health risks. For example, droughts may cause problems with increased concentrations of effluent pathogens and overwhelm water treatment plants; aging water treatment plants are particularly at risk (Kistermann et al. 2002, Patz et al. 2008, Senhorst et al. 2005, Wilkby et al. 2005). Urbanization of coastal regions may lead to additional nutrient, chemical, and pathogen loading in runoff (Dwight et al. 2004 and 2002, Semenza et al. 2009). ***Table 12*** within ***Annex 1***) shows the links between some climatic variables and selected pathogens.

68. Our understanding of weather and climate impacts on specific pathogens is incomplete. Climate also indirectly impacts waterborne diseases through changes in ocean and coastal ecosystems including changes in pH, nutrient and contaminant runoff, salinity, and water security. These indirect impacts are likely to result in degradation of fresh water available for drinking, washing food, cooking, and irrigation. Even in countries that treat water, climate-induced changes in the frequency and intensity of extreme weather events could lead to damage or flooding of water and sewage treatment facilities, increasing the risk of waterborne diseases.

69. Climate change may also affect the distribution and concentrations of chemical contaminants in coastal and marine waters, for example through release of chemical contaminants previously bound up in polar ice sheets or sediments, through changes in volume and composition of runoff from coastal and watershed development, or through changes in coastal and ocean goods and services. Both naturally occurring, and pollution-related ocean health threats will likely be exacerbated by climate change (Sandifer et al. 2007). Other climate-related environmental changes may impact marine food webs as well, such as pesticide runoff; leaching of arsenic, fluoride, and nitrates from fertilizers; and lead contamination of drinking and recreational waters through excess rainfall and flooding.

1.2.8. Food-borne diseases and nutrition

70. Along with clean air, water, and shelter, nutritious food is a basic necessity of life. Extreme weather events and changes in temperature and precipitation patterns can directly

damage or destroy crops and other food supplies, as well as interrupt transport and distribution of food. This may happen seasonally but is anticipated to become a more chronic problem under changing climate conditions. Indirectly, there is potential for harm from damage to agricultural crops and related: trade, economic, and social instability; diversion of staple crops for use in biofuels (corn for ethanol or other biofuels); changes in agricultural practices including those intended to mitigate or adapt to climate change; impaired ability to grow crops due to changing environmental conditions and water availability; and reduced availability and nutritional quality of protein from fisheries, aquaculture, and other marine-based foods.

71. In addition to being a source of essential nutrients, food can be a source of exposure for foodborne illness. Such illness results from ingesting food that is spoiled or contaminated with microbes, chemical residues such as pesticides, biotoxins, or other toxic substances. Seafood contaminated with metals, biotoxins, toxicants, or pathogens; crops burdened with chemical pesticide residues or microbes; and extreme shortages of staple foods, are among the possible effects of climate change on the production, quality, and availability of food[7]. The potential effects of climate change on foodborne illness, nutrition, and security are for the most part indirect and, may be moderate and unlikely, except in the event of disruption of government regulatory programs.

72. Drought has been shown to encourage crop pests such as aphids, locusts, and whiteflies, as well as the spread of the mold *Aspergillus flavus* that produces aflatoxin, a substance that may contribute to the development of liver cancer in people who eat contaminated corn and nuts. Agronomists are also concerned that climate change-based increases in a variety of blasts, rusts, blights, and rots will further devastate already stressed crops, and thereby exacerbate malnutrition, poverty, and the need for human migration. The spread of agricultural pests and weeds may lead to the need for greater use of some toxic chemical herbicides, fungicides, and insecticides (Gregory et al. 2009), resulting in potential immediate hazards to farm workers and their families (Lynch et al. 2009, Park et al. 2009, Rusiecki et al. 2009) as well as longer-term hazards to consumers, particularly children (Eskenazi et al. 2008, Rosas et al. 2008).

73. The safety of agricultural crops and fisheries may also be threatened through contamination with metals, chemicals, and other toxicants that may be released into the environment as a result of extreme weather events, particularly flooding, drought, and wildfires, due to climate change (Ebi et al. 2008). Global changes in ocean currents and water mass distribution, along with changes in Arctic ice cover, length of melt season, hydrology, and precipitation patterns, will alter contaminant and pathogen pathways. Contaminants include a wide range of chemicals and metals such as polychlorinated biphenyls (PCBs), PAHs, mercury, and cadmium; pharmaceuticals such as synthetic hormones, statins, and antibiotics; widely used industrial chemicals such as fire retardants, stain repellants, and non-stick coatings; and pesticides and herbicides for agricultural use and vector control for public health protection. The health effects of human exposure to these environmental agents via complex land and marine food webs are not well documented or understood, but evidence from animal studies show that such compounds accumulate in foods at concentrations that may affect fetal development, immune function, and other biological processes. These agents often occur

[7] intergovernmental Panel on climate change. Working Group ii. 2007, Cambridge: Cambridge University Press. ix, 976 p.

together and may act synergistically, producing potentially greater harm than a single agent.

74. Recent findings demonstrate that pathogens that can pose disease risks to humans occur widely in marine organisms and may be affected by climate change (Moore et al 2008). In one specific example, the Climate Change Science Program (CCSP) of the United States noted the strong association between sea surface temperature and proliferation of many *vibrio* bacteria species that occur naturally in the environment (including those that cause cholera) and suggested that rising temperatures would likely lead to increased occurrence of illness associated with *vibrio* bacteria, especially seafood-borne disease associated with *V. vulnificus* and *V. parahaemolyticus* (Sandifer et al. 2007).

75. Rising temperatures and impacts on other environmental parameters such as ocean acidification may also lead to more virulent strains of existing pathogens and changes in their distribution, or the emergence of new pathogens (Smolinkski et al. 2003). Increased acidity of water associated with climate change may alter environmental conditions leading to greater proliferation of microbes of a public health concern. This is a significant concern in molluscan shellfish, because ocean acidification may affect formation of their carbonate shells and immune responses, making them more vulnerable to microbial infection. The combined impact of potential contaminant-induced immune suppression and expanding ranges of disease-causing pathogens and bio-toxins on food supply could be significant.

1.2.9. Mental health and stress-related disorders

76. Psychological impacts of climate change, ranging from mild stress responses to chronic stress or other mental health disorders, are generally indirect and have only recently been considered among the collection of health impacts of climate change (Fritze et al. 2008). Mental health concerns are among some of the most potentially devastating effects in terms of human suffering, and among the most difficult to quantify and address. A variety of psychological impacts can be associated with extreme weather and other climate related events. There has been significant research conducted depicting ways in which extreme weather events can lead to mental health disorders associated with loss, social disruption, and displacement, as well as cumulative effects from repeated exposure to natural disasters. The effects of climate change affect the social, economic, and environmental determinants of mental health, with the most severe consequences being felt by communities who were already disadvantaged before to the event. Extreme weather events such as storms, wildfires, and flooding, can create increased anxiety and emotional stress about the future, as well as create added stress to vulnerable communities already experiencing social, economic, and environmental disruption. Individuals already vulnerable to mental health disease and stress-related disorders are likely to be at increased risk of exacerbated effects following extreme weather or other climate change events. Prolonged heat and cold events can create chronic stress situations that may initiate or exacerbate health problems in populations already suffering from mental disease and stress-related disorders. In addition, psychotropic drugs interfere with the body's ability to regulate temperature; individuals being treated with these drugs could be at increased risk of heat-related illness during extreme heat events (Martin-Latry et al. 2007).

77. The severity of mental health impacts following an extreme climate event will depend on the degree to which there is sufficient coping and support capacity, both during and

following the event (Tapsell et al. 2002). During the recovery period following an extreme event, mental health problems and stress-related disorders can arise from geographic displacement, damage or loss of property, death or injury of loved ones, and the stress involved with recovery efforts (Sandifer et al. 2007). The most common mental health conditions associated with extreme events range from acute traumatic stress to more chronic stress-related conditions such as post-traumatic stress disorder (PTSD), complicated grief, depression, anxiety disorders, somatic complaints, poor concentration, sleep difficulties, sexual dysfunction, social avoidance, irritability, and drug or alcohol abuse (Silove et al. 2006. Weisler et al. 2006). The chronic stress-related conditions and disorders resulting from severe weather or other climate change-related events may lead to additional negative health effects. Studies have shown a negative relationship between stress and blood glucose levels, including influence on glycemic control among patients with type 2 diabetes (Surwit et al. 2002). Evidence has also shown that human response to repeated episodes of acute psychological stress or chronic psychological stress may result in cardiovascular disease (Black et al. 2002).

78. Climate change has the potential to create sustained natural and humanitarian disasters beyond the scale of those we are experiencing today, which may exceed the capacity of our public health systems to cope with societal demands[8]. Globally, climate change will continue to act as a threat to natural resources and ecosystem services that are already stressed, which may force the migration of large communities and create conditions leading to hostile political environments and conflicts (Kessler et al. 2005; Gamble et al. 2008). The resources required to meet the psychological needs of those affected by extreme weather events, environmental conflicts, or other effects of climate change may be limited immediately following such an event (Ebi et al. 2008), or as people migrate in search of more stable natural environments.

79. Research on mental health service delivery following disaster events has only recently become a higher profile topic of scientific interest. Though some mental health diseases and stress-related disorders have been incorporated into the collection of health impacts of extreme weather and temperature events, numerous research gaps remain.

1.2.10. Neurological diseases and disorders

80. Factors affected by climate with particular implications for neurological functioning include malnutrition (Kar et al. 2008), exposure to hazardous chemicals, biotoxins, and metals in air, food, and water (Kozma 2005, Papanikolaou et al. 2005) and changes in pest management (Handal et al. 2007). Understanding the role of climate in the incidence and progression of neurological conditions and how to prevent them is a critical need for public health and health care.

81. Numerous recent reports have described observed and anticipated detrimental effects of climate change on ocean health, resulting in increased risks to neurological health from ingestion of or exposure to neurotoxins in seafood and fresh and marine waters (Sandifer et al. 2007).[9] Neurotoxins produced by harmful algal blooms and other marine microorganisms can cause serious illness and death in humans. Under the correct conditions, harmful algal blooms

[8] The Center for Naval Analysis (CNA) Corporation 2007, p. 68

[9] National research council (US). committee on ecological impacts of climate change. 2008, Washington, D.C.: National academies Press. xii, 57 p.

produce potent neurotoxins that are often taken up and bioaccumulated in filter-feeding molluscan shellfish including oysters, clams, and mussels, as well as by certain marine and freshwater fish (Wang 2008). The most frequent human exposures are through consumption of seafood containing algal toxins, although some toxins may be present in freshwater sources of drinking water and others may be aerosolized by surf breaking on beaches and then, transported by winds to where they can cause respiratory distress in susceptible individuals who breathe them (Kirkpatrick et al. 2008). Because cooking or other means of food preparation do not kill seafood biotoxins, it is essential to identify contaminated seafood before it reaches consumers. Health effects including amnesia, diarrhea, numbness, liver damage, skin and eye irritation, respiratory paralysis, and Parkinson's Disease (PD) - and Alzheimer's Disease (AD) - like symptoms may be severe, chronic, and even lead to death (Wang 2008). It has recently been reported that even a single low-level exposure to algal toxins can result in physiological changes indicative of neurodegeneration (Lefebre, Ka et al. 2009). Work done on biotoxin-related neurologic disease in marine mammals indicates that domoic acid exposure can cause acute neurologic symptoms by crossing the placenta and accumulating in the amniotic fluid where it can impact neural development in the fetus, alter postnatal development, and lead to chronic illnesses such as epilepsy (Ramsdell et al. 2008, Brodie et al. 2006, Maucher et al. 2007) . Climate change may alter the geographic range in which harmful algal bloom toxins appear, the frequency of toxin production, and the actual delivery of toxins (both increasing and decreasing in some cases) due to extreme weather (Moore et al. 2008, Sandifer et al. 2007). Harmful algal blooms are increasing in frequency, intensity, and duration globally, partially because of climate change, although this link is poorly understood (Moore et al. 2008). Nonetheless, changes in precipitation and ocean temperatures, coupled with increased nutrient loading, may lead to earlier seasonal occurrence, as well as longer lasting and possibly more toxic harmful algal blooms (Pearl et al. 2008).

82. Emerging research suggests that exposure to certain agents whose environmental presence may increase with climate change may have effects on neurological development and functioning. For example, exposure to pesticides and herbicides during specific developmental windows, in combination with other exposures later in life, could increase the risk of PD and other neurological diseases (Costello et al. 2009). Exposure to heavy metals is known to exacerbate neurological deficits and learning disabilities in children (Kozma 2005) and is suspected of being associated with both onset and exacerbation of AD (Kotermanski et al. 2009, Lovell 2009, Mendes et al. 2009, Quinn et al. 2009) and PD. Evidence suggests that early-life occurrence of inflammation in the brain, because of either brain injury or exposure to infectious agents, also may play a role in the pathogenesis of PD (Miller et al. 2008). In addition to conditions such as PD and AD, PTSD is likely to have profound effects on the neurological functioning of populations exposed to the stress of extreme weather events, and the resulting dislocation and deprivation that may result from climate change (Naeem et al. 2005).

83. Some of the human health aspects affected by climate change are shown in ***Annex 1***.

Recommendations related to section 1.2:

1) There is a need to deepen the research about the mechanisms of climate change influence on human health.
2) Epidemiological research is needed to determine the climate change-related health consequences at the national and sub-national levels in Bulgaria.
3) Studies of the working environment micro-climate due to climate change and assessment of emerging occupational health risks are needed.

1.3. Sector-related Climate Change Risks and Vulnerabilities

1.3.1. Future projections of some climate change-related health consequences

Health consequences of the expected temperature changes

84. An increase in heat extremes will lead to a marked increase in heat-attributable deaths under future warming, unless adaptation measures are taken. Highly urbanized areas are projected to be at an increased risk of heat stress compared with surrounding areas. Projections of future heat effects on human health need to consider that the European population, including Bulgarians, is projected to age, because elderly populations are especially vulnerable (Lung et al. 2013, Watts et al. 2015). Several studies have estimated future heat-related mortality using similar methods and have arrived at largely comparable results, namely PESETA (Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis), Climate Cost and PESETA II (Ciscar 2011, Kovats et al. 2011, Watkiss and Hunt 2012, Paci 2014). The PESETA study estimates that, without adaptation and physiological acclimatization, heat-related mortality in Europe would increase by between 60,000 and 165,000 deaths per year by the 2080s compared with the present baseline, with the highest impacts in southern parts of the continent, damaging Bulgaria too. The results vary across climate models and emissions scenarios, with high emissions scenarios leading to much higher heat-related mortality than low emissions scenarios. Heat-related mortality would be significantly lower under full acclimatization if, for example, currently cool regions were able to achieve the temperature–mortality relationship of currently warm regions[10]. Another study estimates that climate change will lead to an increase in hospital admissions owing to heat-related respiratory diseases from 11,000 admissions (0.18 percent) in the period 1981–2010 to 26,000 (0.4 percent) in 2021–2050. The total number of hospital admissions and the increase because of climate change are the largest in southern Europe, with the proportion of heat-related admissions for respiratory conditions expected to approximately triple in this region over this time period (Aström et al. 2012). In low resolution, these studies cover also the territory of Bulgaria but there is a need to extend the investigations to a larger scale and districts level of the country.

85. The PESETA study estimated that cold-related mortality would decrease by between 60,000 and 250,000 deaths per year by the 2080s, which is about the same magnitude as the projected increase in heat-related mortality (Kotermanski and Johnson 2009, Lovell 2009,

[10] WHO, Comparable estimates for the WHO European Region, incl. Bulgaria

Mendes et al. 2009, Quinn et al. 2009). The PESETA II study no longer considers a potential reduction in cold-related mortality in its climate impact estimates (Lung et al. 2013). The choice not to include cold spells reflects recent evidence that does not suggest a significant shift in the balance of deaths between winters and summers because of lower cold-related mortality (Watts et al. 2015). However, the risk from (moderate) cold is expected to continue to account for most of the temperature-related risk throughout this century.

86. It is difficult to make valid projections of heat-related illness and death under varying climate change scenarios. A review of past changes in heat-related deaths found few significant relationships for any decade or demographic group, and suggested that improved medical care, air conditioning use, and other adaptation efforts were the causes of reduced death, stating that despite increasing stressful weather events, heat-related deaths are preventable, as evidenced by the decline of all-cause mortality during heat events over the past 35 years (Davis 2002). Overall, research suggests that under a climate change scenario using current anthropogenic emissions trends, there will be a small increase in the overall heat-related death rate by the end of the 21st century. Climate change is projected to increase the average number of summertime heat-related deaths, with the greatest increases occurring in mid-latitude major cities where summer climate variability is greatest. It is estimated that 60 percent of the global population will live in cities by 2030, greatly increasing the total human population exposed to extreme heat (UN DESA 2006). In Bulgaria, the number of individuals age 65 years and older (who are more susceptible to heat effects) is expected to increase from 12.4 percent in 2000 to 20 percent in 2060.

87. A standardized definition and methodology for identifying heat-related health outcomes is needed for surveillance and to evaluate temperature-related illness and death.

88. Based on numerous studies from all over the world, the general conclusions about the expected health consequences of projected temperature changes are the following (Mihaylova 2014):

- A 40 to 60 percent increase in the number of deaths from cardiovascular diseases and strokes in the big cities in summer due to heatwaves and the urban heat island effect;
- A 10 to 30 percent rise in vector-borne morbidity, owing to the vectors' longer vegetation cycle, and particularly that of the *I. Ricinus ticks*, which transmit the *Borrelia burgdorferi*;
- A 50 to 100 percent increase in the incidence of salmonella infections due to the longer growing period and more favorable conditions;
- A 10 to 100 percent surge in campylobacteriosis infections due to the longer growing period and more favorable conditions. The campylobacteriosis morbidity risk grows further when compounded with higher temperatures and humidity;
- A 10 to 30 percent increase and exacerbation of respiratory diseases due to the higher concentration of carbon dioxide (CO_2), dust, and PM in the air; and
- A 10 to 30 percent rise in the number of allergic diseases due to earlier flowering and increased concentration of pollen, spores, and other allergens in the air.

Table 1. Probability of health outcome from expected temperature changes

Probability of Outcome		Outcome	Probability (%)
Almost certain		• Rise in number of allergic diseases	99-100
Quite likely		• Increased VBD morbidity • Surge in Campylobacteriosis	90-100
Likely		• Increased CVD mortality • Increase and exacerbation of respiratory diseases	60-90
More likely than not		• Increase in incidence of Salmonella infections	33-60
Little likely		-	0-33
Very unlikely		-	0-10
Extremely unlikely		-	0-1
Additional / alternative	**Extremely likely**	• Increased VBD morbidity • Surge in Campylobacteriosis • Rise in number of allergic diseases	95-100
	More likely than not	• Increased CVD mortality • Increased VBD morbidity • Increase and exacerbation of respiratory diseases	50-100
	Extremely unlikely	-	0-5

Source: Modification based on Watkiss and Hunt, 2012.

Health consequences of the expected changes of some weather emergencies

89. European territory, including Bulgaria, is damaged by weather emergencies that are different by their nature, intensity and frequency, weather emergencies. For a medium emissions scenario (SRES A1B) and in the absence of adaptation, river flooding is estimated to affect about 300,000 people per year by the 2050s and 390,000 people by the 2080s; the latter figure corresponds to more than a doubling with respect to the baseline period (1961–1990). If no additional adaptation measures are taken, the number of people affected by coastal flooding at the end of the 21st century would range from 775,000 to 5.5 million people annually, depending on the emissions scenario. The number of deaths due to coastal flooding in the 2080s would increase by 3,000, assuming an 88cm sea-level rise. Flooding is also associated with mental health impacts. Coastal flooding could potentially cause 5 million additional cases of mild depression annually by the end of the 21st century under a high sea level rise scenario in the absence of adaptation (Watkiss and Huntt 2012, Bosello et al. 2011). In Bulgaria, the changes in expected annual damages for the 2020s, 2050s, and 2080s, compared to the control period (1961–1990), are shown on ***Figure 17 within Annex 4***.

90. Based on numerous studies from all over the world, the general conclusions about the expected health consequences of some other projected weather emergencies, are (Mihaylova 2014):

- A 10 percent increase in mortality due to extreme weather events and fires, with that increase being even higher among vulnerable groups – up to 30 prcent;
- A 10 to 30 percent rise in waterborne and foodborne morbidity due to damaged infrastructure; and
- A 10 percent increase in cases of PTSD.

Table 2. Probability of health outcome from the expected changes of some weather emergencies

Probability of outcome		Outcome	Probability (%)
Almost certain		• Increase in mortality due to extreme weather events and fires	99-100
Quite likely		• Increase in cases of PTSD	90-100
Likely		• Rise in water- and food-borne morbidity	60-90
More likely than not		-	33-60
Little likely		-	0-33
Very unlikely		-	0-10
Extremely unlikely		-	0-1
Additional / alternative	**Extremely likely**	• Increase in mortality due to extreme weather events and fires • Rise in water- and foodborne morbidity	95-100
	More likely than not	• Increase in cases of PTSD	50-100
	Extremely unlikely	-	0-5

Source: Modification based on Watkiss and Hunt 2012.

Health consequences of the expected changes of precipitations

91. Global warming is projected to lead to a higher intensity of precipitation and longer dry periods. Projections show an increase in heavy daily precipitation in large parts of Europe in winter, by up to 35 percent during the 21st century. Heavy precipitation in winter is projected to increase over most part of Europe, with increases of up to 30 percent. This is true for Bulgaria, in its north-western and north-eastern parts (***Figure 18 within Annex 4***). In the rest part of the country territory the heavy precipitations will increase up to 5 to 15 percent or 15 to 25 percent. In summer, an increase is also projected up to 15 percent in some northern and mountain parts of Bulgaria, but decreases are projected for other parts of Bulgarian territory too (***Figure 18 within Annex 4***). Evidence from high-resolution climate models suggests that the intensity of sub-daily extreme rainfall is likely to increase in the future, whereby a theoretically estimated increase of approximately 7 percent per 1°C appears most likely in many regions.

92. The expected health consequences include (Aström et al. 2013; Kovats et al. 2003):

- About 10 percent rise in the incidence of cryptosporidiosis in north-western Bulgaria due to more frequent and more abundant precipitation.
- A 10 to 100 percent surge in the cases of Campylobacteriosis in north-western Bulgaria due to a combination of more frequent precipitation and higher annual average temperatures; and
- Increased incidence of diarrheal infections caused by non-cholera vibrio due to more abundant precipitation and higher levels of humidity in north-western Bulgaria and the Black Sea region.

Table 3. Probability of health outcome from the expected changes of precipitations

Probability of Outcome		Outcome	Probability (%)
Almost certain		-	99-100
Quite likely		• Surge in the cases of Campylobacteriosis	90-100
Likely		-	60-90
More likely than not		• Increased incidence of diarrheal infections caused by non-cholera vibrio	33-60
Little likely		-	0-33
Very unlikely		• Rise in the incidence of cryptosporidiosis	0-10
Extremely unlikely		-	0-1
Additional / alternative	**Extremely likely**	• Surge in the cases of Campylobacteriosis	95-100
	More likely than not	• Increased incidence of diarrheal infections caused by non-cholera vibrio	50-100
	Extremely unlikely	• Rise in the incidence of cryptosporidiosis	0-5

Source: Modification based on Watkiss and Hunt 2012

1.3.2. Uncertainties

93. Assessing health outcomes in relation to climate change is a complex task that must accommodate the multiple types of uncertainty that compound across the antecedent environmental and social changes. Many different types of uncertainty relate to the health effects of climate change. A major source of uncertainty relates to the degree to which future emissions of greenhouse gases (GHG) will change radiative forcing over the coming century. GHG emissions are driven by complex factors such as population growth, economic growth and energy policy. Addressing this level of uncertainty is limited to the emissions scenarios that are available. ***Table 4*** below shows some main aspects of uncertainty in assessing the health sector.

Table 4. Sources of uncertainty

Sources of uncertainty	Examples
Problems with data	• Missing components or errors in data • 'Noise' in data associated with bias or imcomplete observations • Random sampling error and biases (non-representatviesness) in a sample
Problems with models (relationships between climate and health)	• Known process but unknown functional relatioships or errors in structure of model • Known structure but unknown or erroneous values of some important parameters • Known historical data and model structure but reasons to believe that the parameters or model or the relationship between climate and health will change over time • Uncertainty regarding the predictability of the system or effect

Sources of uncertainty	Examples
	• Uncertainty introduced by approximating or simplifying relationships within the model
Other sources of uncertainty	• Ambiguously defined concepts or terms • Inappropriate spatial or temporal units (such as in data on exposure to climate or weather) • Inappropriateness of or lack of confidence in underlying assumptions • Uncertainty resulting from projections of human behavior (such as future disease patterns or technological change) in contrast to uncertainty resulting from 'natural' sources (such as climate sensitivity)

Source: Kovats et al. 2003.

94. Some climate change risks and opportunities for human health are shown in ***Table 5*** below.

Table 5. Climate change risks and opportunities for human health

Human Health	Risks	Opportunities
Extreme high temperature (incl. heat spells and heat waves)	• Heat stress • Cardio-vascular diseases • Morbidity overburden • More availability of some vector borne pathogens • Better conditions for unfavourable chemical reactions between air pollutants at warmer environment • Lower food safety • Decreasing of mental condition; nervous & psychiatric diseases	• Less respiratory diseases • Climatic therapy of some diseases • Morbidity disburdens • Less availability of some other vector borne pathogens • Less temperature inversions – better air ventilation • Decreasing of food mould
Extreme low temperatures (incl. cold spells and cold waves)	• Cold stress • Blood pressure, pulmonary and respiratory diseases • Morbidity overburden • More temperature inversions – worse air ventilation – more air pollution • Decreasing of mental l condition	• Climatic therapy (cryo-therapy) of some diseases • Less availability of some vector borne pathogens • Worse conditions for some unfavourable chemical reactions between air pollutants • Better food safety
Increased precipitation and humidity	• Better conditions for air pollution chemical reactions at higher humidity • Increasing of transfer of air pollutants to surface grounds and waters • Worse conditions for climate therapy in the open air • Decreasing of human mental condition • Asthma diseases • Mould and fungus diseases • Vector borne diseases • More water pathogens	• Air cleaning • Less pollens

Human Health	Risks	Opportunities
Droughts	• Food and water shortage	• Less pathogens in air and waters • Better conditions for climate therapy in the open air • Less asthmatic, pulmonary, respiratory and allergic diseases • Less mould and fungus diseases
More hours of sun	• UVB radiation related diseases • Solar strikes	• Better conditions for climate therapy in the open air • Less osseous diseases • Increasing of mental condition
Winds & storms	• Thunder and lightning strikes • Physical hurts at stormy wind conditions • Worse conditions for climate therapy in the open air	• Better air quality • Less pollens
Floods	• Drown incidences • Water-borne diseases • Water pollution • Worsening of life conditions	
Stratospheric ozone depletion	• More UVB radiation effects	

1.3.3. Health related climate change vulnerability and risk

95. The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as the degree to which individuals and systems are susceptible to or unable to cope with the adverse effects of climate change, including climate variability and extremes. The vulnerability of human health to climate change is a function of exposure (E), sensitivity (S), and adaptive capacity (A) components (Kovats et al. 2003). E represents weather- or climate-related hazard, including the character, magnitude, and rate of climate variation. S and A represent the social sustainability to environmental impacts, which determines the differences in vulnerability by region and group depending on the interaction of these three components in space and time. In this sense, health vulnerability is materially and socially dependent. The material aspects include the built-up surroundings, buildings, infrastructure, transport, urbanization, and so on, while the social ones include the social institutions and existing concepts of disease and health.

96. Populations, subgroups, and systems that cannot or will not adapt are more vulnerable, as are those that are more susceptible to weather and climate changes. Understanding a population's capacity to adapt to new climate conditions is crucial to realistically assessing the potential health and other effects of climate change. In general, the vulnerability of a population to a health risk depends on the local environment, the level of material resources, effectiveness of governance and civil institutions, quality of the public health infrastructure, and access to relevant local information on extreme weather threats (Woodward et al. 1998). These factors are not uniform across a region or country or across time and differ based on geography,

demography and socioeconomic factors. Effectively targeting prevention or adaptation strategies requires understanding which demographic or geographical subpopulations may be most at risk and when that risk is likely to increase. Thus, individual, community and geographical factors determine vulnerability.

97. According to the Notre Dame Global Adapation Index (ND-GAIN), the health sector is represented by six indicators that represent the three cross-cutting components: the **exposure** to climate-related or climate-exacerbated hazards; the **sensitivity** of the sector to the impacts of the hazard, and the **adaptive capacity** of the sector to cope or adapt to these impacts. The six vulnerability indicators of ND-GAIN index are shown correspondingly in ***Table 6.***

Table 6. ND-GAIN Vulnerability Indicators for the health sector

Exposure Indicators	Sensitivity Indicators	Adaptive Capacity Indicators
Projected change of deaths from climate change induced diseases	Slum population	Medical staff (physicians, nurses and midwives)
Projected change of length of transmission season of vector-borne diseases	Dependency on external resource for health services	Access to improved sanitation facilities

Source: Bosello et al. 2011, Watkiss and Hunt 2012.

98. Additionally, ND-GAIN also assesses the health sector **readiness** to leverage private and public-sector investment for adaptive actions (Chen et al. 2015). The readiness indicators of the health sector used by ND-GAIN index are shown in ***Table 7***.

Table 7. ND-GAIN Readiness Indicators for the health sector

Readiness component	Indicators			
Economic Readiness	Doing Business Indicators			
Governance Readiness	Political stability and non-violence	Control of corruption	Rule of law	Regulatory quality
Social Readiness	Social inequality	ICT infrastructure	Education	Innovation

Note: ICT = Information and Communication Technology. The Doing Business indicators are composed of 10 sub-indicators.

Source: Bosello et al. 2011, Watkiss and Hunt 2012.

99. The climate change vulnerability score of the health sector in Bulgaria for 2015 is 0.128 (0÷1, higher is better), ranking the country at 51st position among 192 countries. It shows a considerable decrease since 1995 (***Figure 7*** below). The historic courses of these indicators' scores are shown in ***Figures 19 to 25 within Annex 4***, respectively.

100. The climate change readiness score of Bulgaria for 2015 is 0.560 (0÷1, lower is better), ranking the country at the 54th position among 185 countries. The readiness score includes the economic readiness score (0.646), governance readiness score (0.507), and social readiness score (0.528). It shows a considerable increase since 1995 (***Figure 8***). The historic courses of readiness' scores are shown in ***Figures 26, 27, and 28 within Annex 4***, respectively.

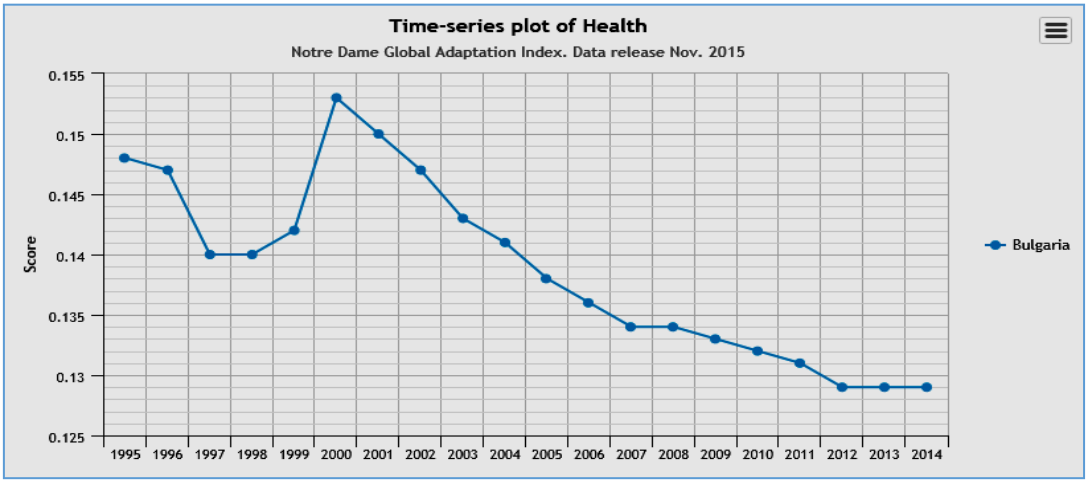
101. **Recommendations related to section 1.3:**

A. Conduction of a study on health projections of the climate change for the territory of Bulgaria.

B. Research of uncertainties in Bulgaria for health adaptation to climate change.

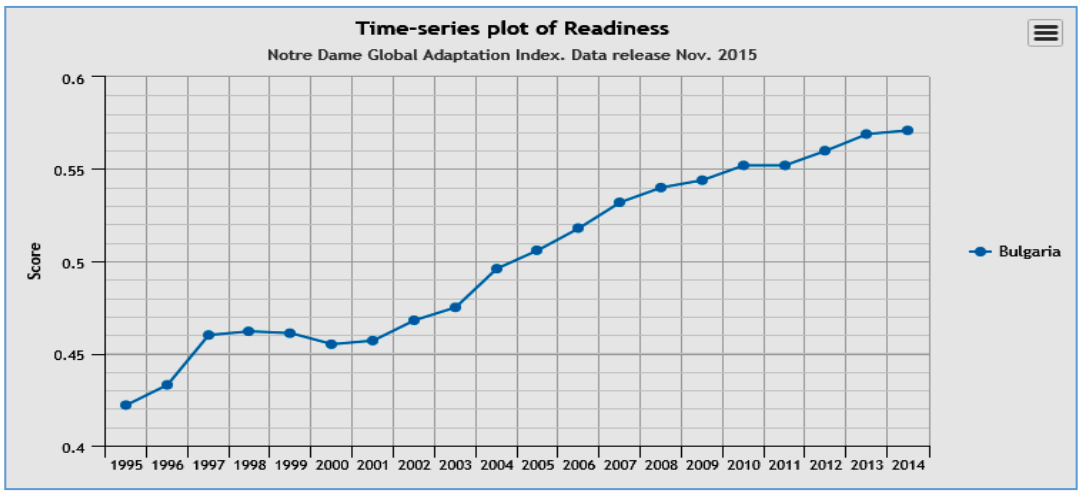
C. Determination of health sector vulnerability at the sub-national level in Bulgaria.

Figure 7. Vulnerability score of health sector in Bulgaria



Source: Chen et al. 2015.

Figure 8. Readiness score of Bulgaria



Source: Chen et al. 2015.

1.4. Conclusions

102. Climate change in Bulgaria is manifested by an increase in the average annual air and water temperatures, an increase in over-warming and over-cold rushes, a change in the annual rainfall, an increase in heavy rainfalls, an increase in dry periods, wind, thunder, and snow storms, contrast shifts of weather, river floods, as well as droughts, and UV radiation.These changes affect the bio-status of man and his health in a complex and individual way, depending on various climatic, socioeconomic, health, personal, and other factors.

103. The numerous, health-influencing factors of the changing climate in Bulgaria can generally be attributed to two broad groups: sudden (such as storms, floods, fires) and gradual, emerging (as changes in heat-humidity, precipitation, and solar conditions).

104. The health effects of these climate change phenomena can be extremely varied, and in general they can be differentiated as primary and secondary. Primary effects directly affect human health such as, for example, heat waves and cold spells, ultraviolet radiation, and floods. Secondary effects indirectly affect human health through other climatic-influenced factors such as pollen, vector-borne diseases, fires, contaminated food, water and air, and compromised crops. The primary and secondary health effects of climate change can be differentiated into the following groups: heat-related morbidity and mortality, extreme weather-related morbidity and mortality, cardiovascular diseases, including Strokes, asthma, respiratory allergies and airway diseases, cancer, vector-borne and zoonotic diseases, foodborne diseases and nutrition factors, waterborne diseases, mental health and stress-related disorders, and neurological diseases and disorders.

105. Climate-related health mostly effects affect the more vulnerable groups of the population - children and adults, people with chronic illnesses, people with a low socioeconomic status, those living in poverty or those with harmful personal habits (use of alcohol, drugs, tobacco). In Bulgaria, over the last decades, aging and impoverishment trends have been observed, and for most vulnerability indicators, the country is in a less favorable position than many of the countries in the European Union.

106. The health vulnerability of the country to climate change is also rising because of some features of the health sector. It is necessary to optimize the health infrastructure and structure, increase understanding and competencies of health personnel on the impact of climate change on human health, introduce the topic in training programs of universities and colleges in medical schools in the country.

107. Furthermore, it is necessary to deepen the knowledge and assessment of the manifestations of climate change in Bulgaria, the mechanisms of their impact on human health and socioeconomic and demographic parameters of vulnerability, through a large-scale plan.

Chapter 2. Baseline – Policy Context

108. Protecting human health is an issue that crosses institutional, scientific, and political boundaries. No single institution at the local, regional, or national level can fully protect public health without cooperation from other institutions. In addition, no single scientific field can accomplish all aspects of the research needed to understand the human health consequences of global climate change; such an endeavor will require a broad-based, trans-disciplinary research portfolio. And in our global society, the highly integrated activities of individuals around the world mean that no one country can be solely responsible for addressing the health impacts of global climate change. Through the process of developing this paper, it rapidly became clear that identifying research needs; mobilizing and creating the expertise, resources, tools, and technologies to address them; and translating these efforts into solutions that will enable human adaptation to the changing environment while protecting public health will require collaborations on an unprecedented scale. Such collaborations should build on the strengths and capacities of individual organizations in ways that maximize the efforts of the group toward these shared goals.[11]

2.1. State of Awareness, Understanding of Future Consequences of Climate Change, Knowledge Gaps in the Sector

2.1.1. State of awareness

109. In the early 1990s, there was little awareness of the health risks posed by global climate change. This reflected a general lack of understanding of how the disruption of biophysical and ecological systems might affect the longer-term wellbeing and health of populations. There was little awareness that changes in particular nature objects – climatic conditions, biodiversity stocks, ecosystem productivity, and so on – were of potential importance to human health. This was reflected in the meagre reference to health risks in the corresponding research, policy, legislative, and other publications and documents. The first major report of the United Nations (UN) IPCC, published in 1991 did not concern the health topic, in general. Subsequently, the situation has changed. The IPCC Second Assessment Report (1996) devoted a full chapter to the potential risks to health, and the subsequent reports deepen the knowledge over the climate change impacts on the human health.

110. Nowadays when people understand that climate change threatens human health there is still the need to determine how to effectively educate and organize the public to respond to climate change. This is complicated additionally by the fact that various audiences within the public respond to the issue of climate change each in their own distinct way (Maibach et al. 2009). Research is needed that will aid climate change communicators and educators in adapting their messages and approaches to most appropriately and effectively reach and be assimilated by each audience.

111. In addition to the public, all the three main stakeholder forces in the health sector – public, private, and civil actors - also require effective communication on issues of climate change. Stakeholders should be engaged throughout an assessment process. A communication

[11] A human health perspective on climate change. www.niehs.nih.gov/climatereport

strategy must ensure access to information, presentation of information in a usable form, and guidance on how to use the information. Risk communication is a complex, multidisciplinary, and evolving process. Often information has to be tailored to the specific needs of risk managers in specific geographic areas and demographic groups. This requires close interaction between information providers and those who need the information to make decisions. Further professional training would be the way of responding to this need, but so far very little training has been offered.

112. Now, the Bulgarian health sector forces (public, private and civil stakeholders) claim the presence of awareness of climate change and the related human health problems, although this is not visible in the sector's policies. The latest National Action Plan (NAP) for Climate Change mentions nothing about health. Despite numerous elucidating actions, there is an obvious need for further work to strengthen the awareness about climate change's threat to human health and its respective adaptation.

2.1.2. Knowledge gaps

Gaps in the research of climate change related diseases

113. *Asthma, Respiratory Allergies, and Airway Diseases*. Research should address the relationship between climate change and the composition of air pollutant mixtures (for example, how altered pollen counts, and other effects of climate change affect the severity of asthma) to produce models to identify populations at risk. Such tools support the use of science in understanding disease risks and as such are an integral component of developing effective risk communication and targeting the messages to vulnerable populations.

114. *Cancer.* The potential impact of changes in climate on exposure pathways for chemicals and toxins requires further study. Science should investigate the effects of mitigation and adaptation measures on cancer incidence so that the best strategies can be developed and implemented; for example, research to inform understanding of the benefits of alternative fuels, new battery and voltaic cells, and other technologies, as well as any potential adverse risks from exposure to their components and wastes. Better understanding of climate change impacts on the capacity of ocean and coastal systems to provide cancer curative agents and other health-enhancing products is also needed.

115. *Cardiovascular Disease and Stroke.* Science that addresses the cardiovascular effects of higher temperatures, heat waves, extreme weather, and changes in air quality on health is needed, and this new information should be applied to development of health risk assessment models, early warning systems, health communication strategies targeting vulnerable populations, land-use decisions, and strategies to meet air quality goals related to climate change.

116. *Foodborne Diseases and Nutrition.* Scientific research needs in this area include better understanding of how changes in agriculture and fisheries may affect food availability and nutrition, better monitoring for disease-causing agents, and identification and mapping of complex food webs and sentinel species that may be vulnerable to climate change. This research could be used to prepare the public health and health care sectors for new illnesses, changing surveillance needs, and increased incidence of disease, as well as development of

more effective outreach to affected communities.

117. *Heat-related morbidity and mortality.* Additional science should be focused on developing and expanding tools, such as heat wave response plans and health alert warning systems, in different geographic regions, specifically by defining environmental risk factors, identifying vulnerable populations, and developing effective risk communication and prevention strategies.

118. *Human developmental effects.* Research should examine the relationship between human development and adaptations to climate change, such as agriculture and fisheries changes that may affect food availability, increased pesticide use to control for expanding disease vector ranges, and prevention of leaching from toxic waste sites into floodwaters during extreme weather events, so that developmental consequences can be prevented.

119. *Mental Health and Stress-Related Disorders.* By causing or contributing to extreme weather events, climate change may result in geographic displacement of populations, damage to property, loss of loved ones, and chronic stress, all of which can negatively affect mental health. Research needs include identifying key mental health effects and vulnerable populations and developing migration monitoring networks to help ensure the availability of appropriate health care support.

120. *Neurological Diseases and Disorders.* Research in this area should focus on identifying vulnerable populations and understanding the mechanisms and effects of human exposure to neurological hazards such as bio-toxins (from harmful algal blooms), metals (found in new battery technologies and compact fluorescent lights), and pesticides (used in response to changes in agriculture), as well as the potentially exacerbating effects of malnutrition and stress.

121. *Vector-borne and Zoonotic Diseases*. Research should enhance the existing pathogen/vector control infrastructure including vector and host identification; integrate human with terrestrial and aquatic animal health surveillance systems; incorporate ecological studies to provide better predictive models; and improve risk communication and prevention strategies.

122. *Waterborne Diseases.* Research should focus on understanding where changes in water flow will occur, how water will interact with sewage in surface and underground water supplies as well as drinking water distribution systems, what food sources may become contaminated, and how to better predict and prevent human exposure to waterborne and ocean-related pathogens and bio-toxins.

123. *Weather-Related Morbidity and Mortality*. Research aimed at improving the capabilities of healthcare and emergency services to address disaster planning and management is needed to ensure that risks are understood and that optimal strategies are identified, communicated, and implemented.

Crosscutting and trans-disciplinary aspects

124. In addition to the research needs identified in the individual research categories, there are crosscutting issues relevant to preventing or avoiding many of the potential health impacts of climate change including identifying susceptible, vulnerable, and displaced populations;

enhancing public health and health care infrastructure; developing capacities and skills in modeling and prediction; and improving risk communication and public health education. Such research will lead to more effective early warning systems and greater public awareness of an individual's or community's health risk from climate change, which should translate into more successful mitigation and adaptation strategies. For example, health communications research is needed to properly implement health alert warning systems for extreme heat events and air pollution that especially affects people with existing conditions such as cardiovascular disease. Such a risk communication pilot project might demonstrate communication practices that are effective in multiple areas and contribute to a comprehensive strategy for addressing multiple health risks simultaneously.

125. Other tools are needed and should be applied across multiple categories to close the knowledge gaps, including predictive models to improve forecasting and prevention, evaluations of the vulnerability of health care and public health systems and infrastructure, and health impact assessments (HIAs). Trans-disciplinary development would help to ensure tools such as improved baseline monitoring that will be more widely applicable, and thus more efficient and cost effective than those currently available. In fact, many of the identified science needs will require trans-disciplinary responses. For example, to study how heat waves alter ambient air pollution and the resulting combined impact of heat and pollution on human illness and death, will require expertise in atmospheric chemistry, climate patterns, environmental health, epidemiology, medicine, and other science fields.

2.2. Experience with CCA in the Health Sector in Other (EU) Countries

126. Human bio-comfort and health have always been influenced by the weather conditions and for that reason, there is much cognition achieved on this issue. Nowadays when this influence gains a considerable significance in relation to climate change, the society pays more and more attention to the question and strives to deepen and enhance the knowledge on it. However, not all is known about the mechanisms of weather impacts over human health, geographical distribution of climate-related diseases, possible prevention responses to the weather influence, and so on.

127. Most of the existing National Adaptation Strategies (NASs) consider the question about the weather influence on human health sector and many of them give it the highest priority among the climate influences on the other economic sectors. Each NAS examines the health sector's dependence on the specific climate conditions of the country and which conditions appear with more or less heat, cold, precipitations, storms, floods, air pollution, and UV radiation. Some NASs consider mostly the heat stress and corresponding cardiovascular, or vector-, food-, air-borne diseases, and other diseases -the cold stress and respiratory, or water-borne, diseases and trace the respective measures.

128. The geographical location and morphographic characteristics of Bulgaria determine its very varied climate, both along its territory, and in a seasonal and temporal aspect. Some places in the country can experience extremely high temperature conditions, like the ones in more southern countries, and other places can be exposed to an extreme cold, similar to the cold of more northern countries. This situation is strengthened by changes in the weather dynamics

recently and appears as nearly all the weather phenomena related to climate change - heat waves, cold attacks, intensive precipitations, droughts, floods, and wind storms. This has been reflected in nearly all the spectrum of human physiological reactions and the related diseases. On this basis, Bulgaria can draw rich experience from all existing CCA NASs from countries with cool or warm manifestations of climate change, countries with wet or dry ones, and from emerging climate phenomena to emergencies. As the health vulnerability and responses to climate change depend also on the social economic circumstances, some NASs' health aspects of European countries with different natural and socioeconomic conditions are synthesized/extracted in ***Boxes 1 to 7***.

Box 1. UNITED KINGDOM: The National Adaptation Programme: Making the country resilient to a changing climate, 2013

The health sector sees climate change as one of the biggest global public health threats this century. The Climate Change Risk Assessment identified the health risks from increased summer temperatures and overheating in buildings as the most significant, along with the health impacts from floods. Extreme weather events such as droughts, wildfires and the continued occurrence of sudden cold weather snaps can also pose a risk to people's health. So, can the increased exposure to ground-level ozone and other air pollutants, including the aspects below. Actions to address these issues are included in the Register of Actions:

- Aeroallergens such as pollen, marine and freshwater pathogens
- Food and vector-borne diseases
- Chemical and biological contamination in the indoor environment (such as mold)
- Food quality and security

Responsibility for addressing many of the health risks rests with the local health and social care system and there are significant opportunities to ensure that a joined-up approach is taken for the short and long-term by a wide range of local partners. Many of the solutions, particularly for the long-term, will require action beyond the health sector. Actions to adapt to and mitigate climate change can often deliver wider benefits for health and wellbeing and cut costs. However, it is important to note that some interventions may have inadvertent negative health impacts. These should be considered when taking action. Examples include flood risk management creating habitats for vector diseases and increasingly air-tight buildings causing mold growth and the accumulation of harmful gases.

Source: https://www.gov.uk/government/uploads/system/uploads/attachment data/file/209866/pb13942-nap-20130701.pdf.

Box 2. FRANCE: National Climate Change Adaptation Strategy, 2006

The French NAS clearly indicates the health sector as the top priority in relation to CCA. The NAP presents five main adaptation actions unified under the following key measure of the health sector:

Create a 'Health-Climate' monitoring group within the High Committee for Public Health (HCsp). A permanent multidisciplinary team comprising experts in climate change science and health and expert social economists, teachers, and researchers – notably in the biodiversity and ecotoxicology fields – will be set up within the HCsp. This 'Health-Climate' group, for example, will carry out periodic reviews of climate change literature, assess data, alert the authorities, and produce various management recommendations such as research or studies, training, monitoring measures, or in-depth risk analysis by health agencies.

The five actions are:

- Action number 1: Consolidate 'Health-Climate' research;
- Action number 2: Introduce or increase monitoring of risk factors likely to be influenced by climate hazards (extreme events);
- Action number 3: Evaluate the risks to human health associated with extreme events and assess the health impacts of adaptation measures, notably by creating a 'Health-Climate' monitoring group;
- Action number 4: Develop preventive health actions considering the consequences of extreme events and adapt vigilance and alert mechanisms; and
- Action number 5: Raise awareness among all stakeholders and provide education through targeted training, information and communications initiatives.

Source: http://climate-adapt.eea.europa.eu/metadata/publications/national-adaptation-strategy-france)

Box 3. AUSTRIA: Strategy for Adaptation to Climate Change, 2012

Recommendations for action in the health action area:

- Public relations and specific work on preparing for extreme events or outbreaks of infectious diseases
- Dealing with heat and drought
- Dealing with floods, mudslides, landslides, avalanches, and rockfalls
- Advancement of knowledge and preparation for handling pathogens/infectious diseases
- Risk management regarding the spread of allergenic and toxic species
- Dealing with pollutants and UV radiation
- Establishment of monitoring and early-warning systems
- Training and further education of doctors and personnel in medical, therapeutic, and diagnostic health professions in consideration of climate-relevant topics

Good practices:

1. **Protection from natural hazards**
   - HORA 2.0 – Online Platform for Natural Hazard Detection
   - Severe Weather Warnings by Text Message/E-Mail
2. **Disaster management**
   - Team Austria: Rapid, Non-Bureaucratic Disaster Relief
3. **Health**
   - Ozone Warnings on Smart Phone
   - Heat Protection Plan:
     - Early warning stage: For times outside the observation period of May through September and periods in which the temperature limits have not been exceeded.
     - Warning stage: For periods in which the limits are expected to be exceeded for at least three days.
4. **Invasive Species Project**

Source: http://climate-adapt.eea.europa.eu/countries-regions/countries/austria)

Box 4. GERMANY: Strategy for Adaptation to Climate Change, 2008

The Federal Government takes the view that the adaptation strategy must be designed as a step-by-step medium-term process which, in consultation with relevant stakeholders, takes a transparent and structured approach to stating the needs for action, defining appropriate objectives, identifying and resolving conflicts of objectives, and developing and implementing potential adaptation measures. Cross-sectoral prioritisation of possible adaptation measures is a central task for further implementation of the adaptation strategy.

The human health sector is considered in fourpoints:

- Infectious diseases
- Non-infectious diseases and health consequences
- Information and health care
- Linking health care with other areas

Each point is accompanied by numerous recommendations for adaptation to climate change. A part of these recommendations are: epidemiological studies of vector migration, introduction of tropical diseases, and impacts on native pathogens; fundamental research into means of biological control of vectors; Development of new therapeutic products, vaccines and vaccination methods; analysis of changes and trends in food-transmitted infections; addressing the information and public relations work to the specialist target group, and also to the general public and its particularly vulnerable groups; networking between the DWD, the informed agencies at the federal state and district levels, and health and disaster control facilities and institutions such as schools and kindergartens, so that both preventive and response measures can be taken locally.

Source: http://www.bmub.bund.de/fileadmin/bmu-import/files/english/pdf/application/pdf/das_gesamt_en_bf.pdf

Box 5. DENMARK: Mapping Climate Change – Barriers and Opportunities for Action, 2012

Opportunities for future CCA in the health sector include the continuation of initiatives already launched, for example, information and consulting services to the public, the authorities and health-care staff about CCA and health. More precisely, these services involve e.g. information to the public about infectious diseases, pollen, and mold spore counts; advice to regional and local governments about the incorporation of extreme weather in public health emergency response plans; and guidance to the public about precautionary measures during heatwaves or when cleaning up after flooding with sewage water. Finally, there may be opportunity for using HIAs more extensively to assess potential alternative CCA measures within different sectors and industries. This would provide a better foundation for choosing the best solutions for public health in terms of CCA.

Source: http://en.klimatilpasning.dk/media/600858/130206_mapping_climate_change_final.pdf

Box 6. FINLAND: National Acaptation Strategy, 2005

In the Finnish health and social service sectors the need for adaptation has been recognised only in small circles and there has been little research on the health impacts of climate change. Instead, the health impacts of air quality and, through this, the health risks relating to the mitigation measures, such as smallparticle emissions caused by biofuels, are better known. The action guide on environmental health prepares for extreme weather events especially by ensuring the functioning of health care.

Sector-specific adaptation measures: Health sector

- Continuation and development of the careful monitoring of infectious diseases to be able to develop fl exible strategies for their prevention, where necessary
- Prevention of environmental health damages by ensuring the maintenance of technical infrastructure
- Securing the availability of electricity in all conditions and especially in special climate situations (heat waves, floods, storms, cold) to ensure the maintenance of the cold chain and supply of heat, energy, air-conditioning, and clean drinking water.

Source: http://mmm.fi/documents/1410837/1721050/MMMjulkaisu2005_1a.pdf/63f5d78d-8492-4621-b019-fe38d7aeb709

Box 7. BELGIUM: National Climate Change Adaptation Strategy, 2010

As a first step, the federal government has set up a 'heat waves and ozone plan' in the framework of the Belgian National Environment and Health Action Plan. This plan involves a series of phased-in measures and communication initiatives in addition to actions targeting the reduction of ozone formation. The first phase takes place every summer and focuses mainly on preparatory actions and dissemination of public information and calls for the support of people at risk. The pre-alert phase begins when the mean minimum and maximum temperatures, over a period of two consecutive days, exceed a threshold corresponding to the 95th percentile of summer temperatures. The alert phase is declared when the Royal Institute of Meteorology forecasts a heat wave of three days or more, or when the Interregional Environment Unit forecasts ozone concentrations above the EU information threshold. Warnings are then sent to emergency rooms and geriatric departments of hospitals, rest homes, and so on. A survey on the application of concrete measures in these organizations is being conducted. This monitoring is one of the elements taken into account by the authorities when deciding whether it is necessary to move into the crisis phase, which implies the creation of a crisis unit and additional measures. Since 2007, the working group has widened its scope to include air pollution episodes affecting human health.

Source: http://www.climat.be/files/6913/8262/2075/NASpublicatiedruk.pdf Source: http://www.climat.be/files/6913/8262/2075/NASpublicatiedruk.pdf

129. The EU Health Adaptation Strategy unifies, to a certain extent, the partial characteristics of its member states NASs. It summarizes that climate change is a significant threat to health in Europe. While the short- to medium-term impacts of climate change on health are mainly exacerbations of existing effects, projections for future impacts include an increase of heat-related mortality and illness as well as a higher burden from vector-borne, water-borne, and food-borne diseases. Changes in weather/precipitation pattern and increases in extreme events are projected; therefore, more intense and frequent events are expected. Already in the past 20 years, 953 disasters killed nearly 88,671 people in Europe, affected more than 29 million others and caused approximately €250 billion in economic losses. Floods alone resulted in more than 2,500 fatalities and affected more than 5.5 million people.

130. Despite the raising awareness of climate change impacts and the mobilization of health authorities and stakeholders, a certain number of knowledge gaps still need to be bridged. For instance, consistent and comparable epidemiological studies and analysis including urban effects of heat-related phenomena and heat waves are still lacking. Further analysis is also needed on possible interactions between climate change and air pollution on ozone, food-borne diseases, salmonella, prevalence of mycotoxins in feed and food, and the necessity to envisage financial support in areas where existing financial capacities might not be adequate to address

health risks correctly.

131. The serious climate change threats to health requires preparedness of early warning and surveillance, risk assessment, and risk management existing structures for different and serious cross-border menaces to health, including climate change.

132. As the effects of climate change and their impacts are transboundary by nature, and neither the spread of infectious diseases nor extreme weather events are hindered by political frontiers (Climate, Environment, and Health Action Plan Information System [CEHAPIS][12]), it is necessary for the EU to exert the coordinating role it has been granted by the Treaty on the Functioning of the European Union (TFEU or the Treaty of Lisbon), with minimal interference in the competences of the Member States.

More from the foreign experience with CCA in the health sector can be seen in Appendix 2.

2.3. EU CCA Legal Framework and Policies in the Sector[13]

2.3.1. Legal base

The Treaty of Lisbon (TFEU)[14]

133. This document mentions health for the first time, acknowledging that climate change is a common concern of humankind. The treaty addresses human health protection through different prescriptions (articles 6, 9, 56 and 191); it empowers the EU to support, coordinate, or supplement the action of the Member States in protection and improvement of human health and stipulates that 'Community actions shall complement national policies, shall be directed towards improving public health, preventing human illness and diseases, and obviating sources of danger to human health''.

134. According to the TFEU, two of the three strategic objectives of EU health policy are:

- Fostering good health — to prevent diseases and promote healthy lifestyles by addressing the issues of nutrition, physical activity, alcohol, tobacco and drug consumption, environmental risks and injuries. With an aging population, the specific health needs of older people also require more attention; and
- Protecting citizens from health threats — to improve surveillance and preparedness for epidemics and bioterrorism and increase capacity to respond to new health challenges such as climate change.

The Paris Agreement

135. The Paris Conference (Conference of the Parties [COP21], December 2015) of the United Nations Framework on Climate Change (UNFCCC) parties negotiated the Paris Agreement a global agreement on the reduction of climate change, the text of which represented a consensus of the representatives of the 196 parties attending it. The Paris

[12] Climate, Environment and Health Action Plan Information System
[13] 'Adaptation to climate change impacts on human, animal and plant health', Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels, 2013.
[14] Consolidated Reader-Friendly Edition of the Treaty on European Union (TEU) and the Treaty on the Functioning of the European Union (TFEU) as amended by the Treaty of Lisbon (2007)

Agreement is 'a historic win for human health', according to the words of Dr. Maria Neira (WHO Director, Department of Public Health, Environmental, and Social Determinants of Health)[15]. She said that the world now has a climate treaty that will become a public health treaty as countries act. As stated in the Agreement, 'the right to health', will be central to the actions countries take. While the world has been late in taking action against climate change, we now have the basic foundation to safeguard the environmental and social conditions on which health depends, including clean air, energy and water.

World Health Assembly Agreement

136. In 2015, World Health Assembly (WHA) countries agreed to a resolution to address the health impacts of air pollution. In line with this agreement, the WHO secretariat is scaling up its capacity to help countries implement WHO's outdoor and indoor air quality guidelines. In 2016, it also launched an urban health initiative in four cities to test strategies for reducing short-lived climate pollutants, such as black carbon and methane. This is just the start of a comprehensive approach to urban health that will link WHO with UN agencies in a comprehensive initiative to combat climate change and promote sustainable development, in cities around the world.

EU law on climate change and protection of the ozone layer

137. The EU has a strong commitment to protect the ozone layer and has put in place legislation that is among the strictest and most advanced in the world. Europe has not only implemented what has been agreed under the Montreal Protocol on protecting the ozone layer but also has often phased out dangerous substances faster than required.

138. Already by 2010, the EU had significantly reduced its consumption of the main ozone-depleting substances, 10 years ahead of its obligation under the Montreal Protocol. Furthermore, the EU has put in place controls on the use of ozone-depleting substances (ODS) that are not considered as consumption substances under the Montreal Protocol, such as the use of ODS as a feedstock in the chemical industry. The EU has also gone beyond the requirements of the protocol in banning the use of the toxic chemical methyl bromide for any kind of fumigation.

139. EU legislation has not only been very effective in controlling ozone-depleting substances but has also acted as a driver for the development of innovative technologies. These include alternatives to methyl bromide, new blowing agents for insulation foam, chlorofluorocarbon (CFC)-free metered dose inhalers for the treatment of asthma, and the creation of innovative non-halon fire-fighting systems, for example, on ships and airplanes.

2.3.2. The International Health Regulation

140. The European Commission (EC) is closely co-operating with international organizations such as WHO and Food and Agriculture Organization of the UN (FAO).

141. All the EU member states have adopted and are implementing the International Health Regulations of WHO.[16] This is a multilateral agreement to manage collective defenses to detect

[15] New climate change agreement a historic win for human health http://www.who.int/mediacentre/commentaries/climate-change-agreement/en/

[16] http://www.who.int/topics/international_health_regulations/en/

disease events and to respond to public health risks and emergencies, including those resulting from climate change events. This would include some events resulting from extreme weather conditions, if considered of international concern, and would also play an important role in the early detection of disease distribution as a result of climate change.

2.3.3. Political context

142. In its Conclusions on Environment and Health[17] the EU Council urged the EC and the member states to develop tools for anticipating, preventing and responding to potential threats from climate change.[18]

143. With the resolution of September 24, 2008 on the midterm review of the **Environment and Health Action Plan** 2004–2010, the European Parliament called for enhanced multi-agency cooperation 'to boost the early warning system and thus to curb the harmful effects which climate change has on health'[19]. It also called on member states and the EC to respond adequately to the new threats posed by climate change, such as the increased presence of emerging viruses and undetected pathogens, and therefore to implement new existing pathogen reduction technologies that reduce known and undetected viruses and other pathogens transmitted by blood.[20]

144. Furthermore, the Joint Decision of the European Parliament and the Council established the **Second Programme of Community Action in the Field of Health** (2008–2013)[21],addressing specifically that 'Environmental pollution is a serious risk to health and a major source of concern for European citizens. Special action should focus on children and other groups which are particularly vulnerable to hazardous environmental conditions.

145. **The EU health strategy "Together for Health"** supports the overall Europe 2020 Strategy, and the EU Climate Change Adaptation (CCA) strategy. The last one is adopted in 2013 and it has the objective to make Europe more climate resilient and enhance its preparedness and capacity to respond to the impacts of climate change. The adaptation strategy is accompanied by documents that explore relevant sector-specific climate-related risks and propose measures and tools that can be applied to adapt to these challenges. Such documents cover health too. The Europe 2020 Strategy aims to turn the EU into a smart, sustainable and inclusive economy promoting growth for all – one prerequisite of which is a population in good health. Under this strategy, the new Third Health Programme[22] (2014–2020) was adopted in March 2014. The program has four overarching objectives. It seeks to:

- Promote health, prevent diseases, and foster supportive environments for healthy lifestyles taking into account the 'health in all policies' principle;

[17] http://www.consilium.europa.eu/uedocs/cms_Data/docs/pressdata/en/envir/97852.pdf :20.12.2007.
[18] Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee. "The European Environment & Health Action Plan 2004–2010". Volume I. Brussels, 9.6.2004.
[19] Paragraph 24 of European Parliament Resolution of 4 September 2008 on the mid-term review of the European and Health Action Plan 2004-2010 (2007/2252(INI)).
[20] Paragraph 26 of European Parliament Resolution of 4 September 2008 on the mid-term review of the European and Health Action Plan 2004-2010 (2007/2252(INI)).
[21] Decision N° 1350/2007/EC of the European Parliament and of the Council of 23 October 2007, establishing a second programme of Community action in the field of health (2008-13).
[22] Regulation (EU) No 282/2014 of the European Parliament and of the Council of 11 March 2014 on the establishment of a third Programme for the Union's action in the field of health (2014-2020).

- Protect EU citizens from serious cross-border health threats;
- Contribute to innovative, efficient and sustainable health systems; and
- Facilitate access to better and safer healthcare for EU citizens.

146. **The third EU health programme** is the main instrument the EC uses to implement the EU health strategy. It is implemented by means of annual work plans which set out priority areas and the criteria for funding actions under the program. The total budget for the program is €449.4 million. The EC's Public Health Programme funds projects and other initiatives addressing climate change. The EC provides funding for national action on surveillance and information measures (on urban pollution, allergen emission and seasonality, exposure to ultraviolet rays, and so on). The European Centre for Disease Prevention and Control (ECDC) has several projects relating to climate change, notably the E3 Network, which models and maps the various types of risks of infectious diseases. EU-funded research into emerging diseases is also ongoing under the Seventh Framework Programme.

147. **The EU Statistical Programme:** The EHIS - of which the first wave was implemented during 2006–2009 in the European Statistical System (ESS) - monitored health including environment-related variables as part of Eurostat's data collection on health status and health determinants. The second wave was implemented in 2013–2015. The implementation of Regulation 1338/2008[23] 'establishing a framework for community statistics on public health and on health and safety at work' is key for a sustainable health monitoring system, which among others, includes data on human health in relation to climate change. The eighth consecutive medium-term program came into force in 2013, covering 2013–2017.

2.3.4. Other foreign policy tools addressing CCA and health

148. The health policy tools listed in the following paragraphs are not necessarily related to climate change but under the conditions of more and more changing climate they often touch and overlap the CCA issue and contribute to its progress.

Network for epidemiological surveillance and control of communicable diseases

149. The Decision 2119/98/EC[24] 'setting up a network for the epidemiological surveillance and control of communicable diseases in the community' is the preamble of the EU's effort to set up a Pan-European collaboration on infectious diseases. The network is responsible for the surveillance of communicable diseases and has established an early warning and response system (EWRS) for the prevention and control of these diseases.

The Health Security Committee

150. The Health Security Committee (HSC) was set up by the EU health ministers in the aftermath of the September 11, 2001, terrorist attacks in the United States as an informal committee to address preparedness for and responses to major health threats, such as chemical, biological, radiological, and nuclear (CBRN) events or pandemic influenza. Its mandate was limited to tackling bioterrorism, but it has subsequently been extended to cover all types of health-related crisis. Based on the work of the HSC, the EC adopted a Communication (COM

[23] The Regulation 349/2011 further defines the implementation of Regulation 1338/2008.
[24] Two Commission Decisions, 2003/534/EC and 2007/875/EC were introduced in order to amend Decision 2119/98/EC.

2005/605 final of 28.11.2005) on strengthening coordination of generic preparedness planning for public health emergencies at the EU level.

The European Centre for Disease Prevention and Control

151. One of the areas of competence of the ECDC,[25] concerns emerging health threats. The ECDC's mandate covers surveillance and risk assessment of threats to human health from communicable diseases and illnesses of unknown origin. The ECDC has taken over the epidemiological surveillance of communicable diseases and the operation of the EWRS from the network for epidemiological surveillance and control of communicable diseases referred to point under Network for epidemiological surveillance and control of communicable diseases earlier in this section. Within its terms of reference, the ECDC has thoroughly investigated the topic of impacts on health caused by climate change.

Food safety response mechanisms

152. The EU legislative framework and policies, which aim at ensuring a high level of food safety for European consumers and citizens, are constantly challenged in their capacity to respond to future threats to global food safety. This notably includes challenges related to climate change and the subsequent impacts on human, animal, and plant health as well as production resource scarcity and resource competition.

153. The EC manages the Rapid Alert System for Food and Feed (RASFF),[26] established by regulation 851/2004/EC which is an effective tool for exchanging information between competent authorities of the member states and EEA countries on consignments of food and feed in cases where a risk to human health has been identified and measures have been taken. The EC works on a further harmonization of data collection for food-borne infections and zoonosis in food and animals to allow a better comparison of data between the member States. The member states are obliged to monitor the most important zoonosis and zoonotic agents at the most relevant stages of the food chain in accordance with Directive 2003/99/EC (Salmonella, Listeria, Campylobacter, parasites).

European Food Safety Authority – zoonosis and other foodborne risks

154. Besides the prominent task of carrying out risk assessments, the European Food Safety Authority (EFSA)[27] coordinates the EU-wide data collection on zoonosis, zoonotic agents and antimicrobial resistance in food and animals as well as on food-borne and water-borne outbreaks. The monitoring of temporal trends in the prevalence of agents (including food-borne pathogens and vector-borne zoonosis) and the number of outbreaks in the member states are continuously developed further and harmonized.[28]

The EU Framework Programmes for Research in relation to human health

155. The Sixth and Seventh Framework Programmes for Research and Development (FPRD) focus on the health impact of climate change. The Sixth FPRD mainly concentrated on the development of an integrated impact assessment methodology, relationship between

[25] http://www.ecdc.europa.eu/en/Pages/home.aspx.
[26] http://ec.europa.eu/food/food/rapidalert/index_en.htm
[27] http://www.efsa.europa.eu/
[28] http://www.efsa.europa.eu/en/supporting/pub/234e.htm.

temperatures and air pollution and health impact of floods. The Seventh FPRD includes on-going projects with a focus on human health impact of climate change.

2.4. Bulgarian CCA Legal Framework and Policies in the Sector

2.4.1. Legal base

156. The Republic of Bulgaria is party to various international conventions and acts in the environmental field, such as the UNFCCC, Kyoto Protocol; Vienna Convention for the protection of the ozone layer and its various protocols; Convention on trans-border air pollution, and many others. In 2016, Bulgaria joined the **Paris Agreement**. It required parties to put forward their best efforts for reduction of climate change through 'nationally determined contributions' (NDCs). The NDCs represent targets and actions for the post–2020 period. The EU's NDC, submitted by Latvia and the EC on behalf of the Member States (including Bulgaria), includes a collective target to reduce GHG emissions by at least 40 percent by 2030 compared to 1990 levels. By the Paris Agreement, through monitoring and revision of national commitments every five years, the world will begin to see improvements not only in the environment, but also in health, including reductions in the more than 7 million deaths worldwide attributed to air pollution every year.

157. **The Climate Change Mitigation** Act (last amended on October 24, 2017) represents the key climate change mitigation legislation in Bulgaria. It lays down the principles of the state policy in the climate sector, procedures for issuing GHG emissions permits, responsibilities for organizing national inventories, rules for operation of the emissions trading mechanism and procedures for financing green projects. So, the Climate Change Mitigation Act largely addresses mitigation and GHG emission reductions as a major tool to combat climate change. This will exercise a considerable direct effect on human health through enhancing of air purity and the quality of air surroundings. Besides, the Act contains few adaptation aspects, which also discuss the health issue, as follows:

- Among others, the act aims to guarantee the long-term planning of measures to CCA (including those measures related to the health).
- A National Council of Experts is established under the act to consult the minister of the Ministry of Environment and Waters (MoEW) and includes representatives of the ministries, the executive agencies, the Bulgarian Academy of Science, the National Association of Municipalities, and non-profit organizations with an interest in climate change, including representatives of the Bulgarian health institutions and organizations.
- The above-mentioned ministries are responsible for mainstreaming climate policies in the respective sectors, including the health one. They should also develop and implement, in coordination with the MoEW, adaptation measures to climate change. At the same time, the MoEW should consult the National Council of Experts (including health experts) in the development of these measures.

158. The basic legal document of the health sector in Bulgaria is the **Health Act** (last amended on October 24, 2017). This act aims at providing a healthy living environment, protection from harmful impacts, including climatic ones, and taking measures for their reduction. The act does not explicitly represent any CCA issues. The recent conditions of

enhancement of the climate change-related health effects require careful reexamination of those parts of the act that concern climate influence on health and the revision and enrichment of them from a CCA perspective. Examples of such parts in the act are Articles 32, 33, 63a, 114, 116, and others.

159. The piece of legislation governing public relations in terms of safeguarding the population's life and health and protecting their property and the environment in case of disasters is the Disaster Protection Act (DPA) (Published in 2006, last modified on February 7, 2017). Under the DPA executive bodies, legal entities and sole proprietors are assigned respective functions with regard to the overall organization of disaster protection. Their actions are coordinated within a Unified Rescue System. According to the law, disaster protection is carried out at the national, regional, and municipal levels. This is put into effect by preventive action; undertaking disaster preparedness and response activities; support and recovery; resource provisioning and providing and receiving aid. In that context, preventive action is undertaken to reduce disaster risk and includes: disaster risk analysis and assessment; disaster risk mapping; disaster risk reduction planning; developing and implementing disaster risk reduction programs and projects; categorizing settlements in terms of the number of potentially affected human population; identifying critical infrastructure and their facilities and assessing the risk they face; critical infrastructure protection measures; disaster protection planning; setting spatial planning, design, construction and building maintenance standards related to disaster risk reduction; developing and maintaining monitoring, early warning and information dissemination systems; providing temporary accommodation sites and conditions for disaster victims (affected people); ensuring collective and individual remedies; schooling and practical training for central and territorial executive bodies, rapid response forces, voluntary organizations, as well as citizens. The Disaster Protection Act is directly related to health risks caused by extreme phenomena resulting from climate change.

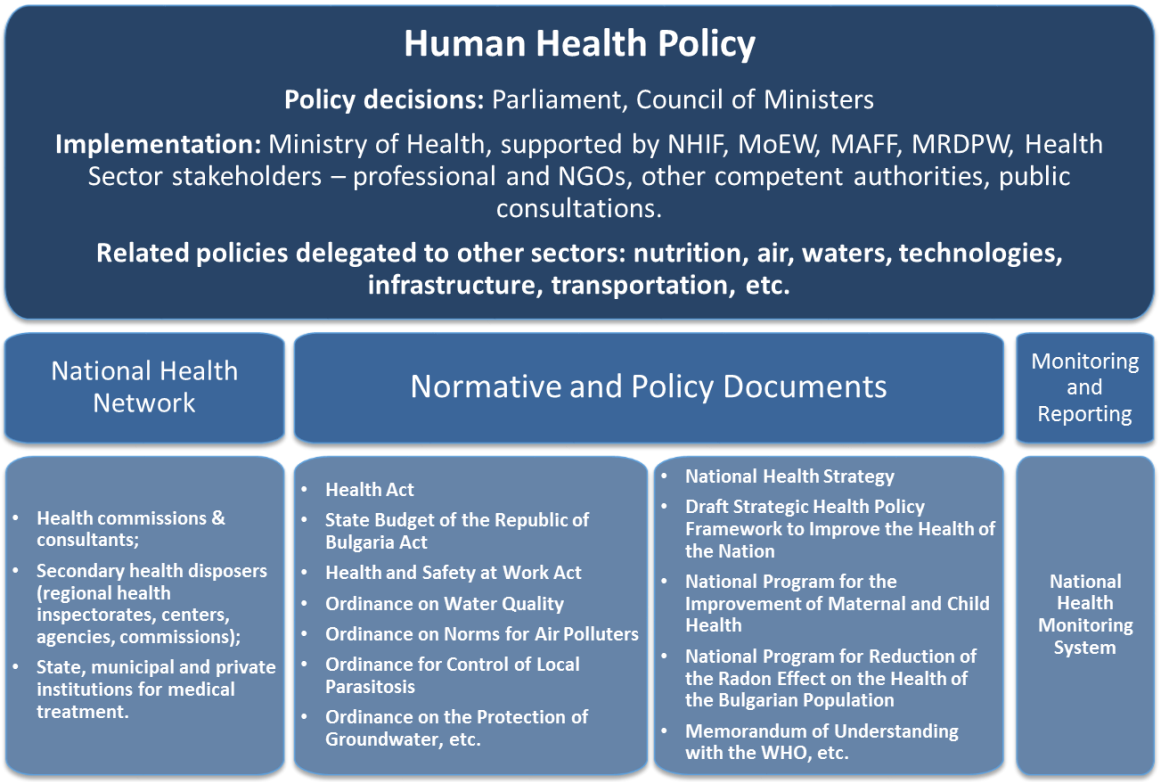
160. Other legal acts are **the Medical Institutions** Act (Promulgated in 1999, last amended on October 24, 2017), the **Foods Act** (Promulgated in 1999, last amended on August 4, 2017), the **Healthy and Safe Labor Conditions** Act (Promulgated in 1997, last amended on November 1, 2015), the **Health Insurance Act** (Promulgated in 1998, last amended on October 24, 2017), the **Bulgarian Red Cross Act** (Promulgated in 1995, last amended on October 14, 2011), etc. All these normative acts regard in one way or another the environment conditions, including climatic, as a factor of the health, but none of them is directly related to the CCA, including adaptation of the human health. Therefore, most of the legislation related to climate change mitigation and adaptation in Bulgaria does not go beyond implementation of EU specific CCA legislation.

2.4.2. Policy context

National Adaptation Strategy to Climate Change

161. As a party of the Kyoto Protocol and of the Paris Agreement, Bulgaria is committed to develop a NAS, which as a major action plan against the climate change impacts has the objective to meet the existing and growing vulnerability of the country to the consequences of climate change. The commitment to draw up a NAS also arises from the Bulgarian Climate Change Mitigation Act.

Figure 9. Structure and main actors in implementing the Bulgarian health policy



Source: World Bank design.

162. To reduce the country's vulnerability to the effects of climate change and improve the capacity to adapt the natural, social, and economic systems, including the health sector, to the inevitable negative impacts of climate change, the MoEW initiated a process towards development of a NAS. The NAS will be a package of strategic documents, a set of a risk and vulnerability assessments, and a number of other documents with sectoral measures and economic analysis. The MoEW, as a body coordinating the development of the NAS, is guided by the EU adaptation strategy.

163. Considering that developing of such a strategic document is subject to substantial expertise and significant data collection, a stepwise approach was adopted. As a first step, a framework document "National Climate Change Risk and Vulnerability Assessment for the Sectors of the Bulgarian Economy" was prepared, the health sector is examined in detail and can serve as a basis for the further development of a NAS. However, it is necessary to undertake an additional examination of socioeconomic parameters of health vulnerability, such as demography, poverty, morbidity, and so on, for preparation of a more reliable vulnerable assessment. Nevertheless, the collected and evaluated information gave some grounds for the development of specific measures which should present the overall appearance of the strategic actions that reduce the health vulnerability of the country to the effects of climate change.

164. Another very important part to be integrated in the NAS is insurance. The MoEW already developed an analytical document ‘Financial Disaster Risk Management and Insurance Options for Climate Change Adaptation in Bulgaria’. The document was prepared with the financial and technical support of the World Bank and its purpose is to analyze the role and importance of the insurance business for the prevention of risks that occur because of climate

change and for the development of adaptation measures. It presents a number of ideas to be included into the health package of measures for adaptation to climate change.

Third National Action Plan on Climate Change (2013–2020)

165. The Third National Action Plan on Climate Change (2013–2020) analyses GHG emissions in Bulgaria and plans measures for the reduction of the use of gas by economic sectors. It does not specify concrete CCA actions, and also the health sector is not regarded in the plan. However, it notes that the Multiannual Financial Framework 2014–2020 envisions significant possibilities for cofunding of CCA activities, earmarking 20 percent of the total budget for climate change-related activities. The action plan also outlines different mechanisms which could be utilized, such as the Cohesion Fund, Connecting Europe Facility, the Common Agricultural Policy, the program for research and innovations, Horizon 2020, and the EU's funding instrument for the environment and climate action, LIFE.

National disaster risk management (DRM) policies

- National Strategy for Disaster Risk Reduction 2014–2018

166. Within the Disaster Risk Reduction Strategy, the following strategic goal has been formulated: "Prevention and/or reduction of the negative consequences for human health, socioeconomic activity, the environment and the Bulgarian cultural heritage as a result of natural or anthropogenic disasters". To achieve this strategic goal, the following priorities for action were identified:

I. Development of sustainable national policy and provision of a stable legal and institutional framework for disaster risk reduction.

II. Identification, assessment and monitoring of disaster risks. Enhancing and maintaining effective national systems for prediction, monitoring, early warning, and disaster alerts.

III. Establishing a disaster protection culture at all governance levels and within the wider society by utilizing available experience, training, scientific research, and innovations.

IV. Reducing the key risk factors and increasing the readiness for effective disaster response at all management levels.

167. The strategy is closely related to health risk from extreme weather phenomena which mainly appear as climate change manifestations. Thus, the DRM has a first-rate importance in health adaptation to climate change.

Other health related strategies and programs

168. The documents listed in the following paragraphs are not explicitly devoted to the health adaptation to climate change, but they concern different topics, such as poverty reduction, socioeconomic, demographic, health and health-care, environmental, life-style, ethnical improvement, and so on, and this way they contribute - directly and/or indirectly - for human health promotion and should be taken into consideration in the process of CCA-related to health.

- National Development Programme Bulgaria 2020

169. This is a major strategic program document defining Bulgaria's policy objectives by 2020. Climate change policies have been defined among the key challenges. The program states that 'national policies in the sphere of climate change should address adaptation of the most vulnerable sectors', and the health one is undoubtedly in a priority position among them.

- National Health Strategy (2014–2020)

170. The document identifies the priorities and strategic goals for development of the country's healthcare system until 2020. The strategy aims at making better the health, safety and welfare of the population to the average level of the EU by increasing the number of Bulgarians who are healthy at every stage of life. The main goals of the strategy are improving access to health care and tackling health inequalities. Another priority in the framework document is strengthening the capabilities of public health care.

- National Strategy for Demographic Development in the Republic of Bulgaria (2012-2030)

171. This strategy is a key document which formulates guidelines and priority tasks in the demographic policy field, aimed at slowing the rate of population reduction and stabilizing it in the long-term, as well as ensuring high quality human capital, including healthy people with high qualifications, skills, and abilities.

- National Strategy for Poverty Reduction and Social Inclusion Promotion 2020

172. This strategy aims at developing and implementing a unified, coherent and sustainable policy of social inclusion based on an integrated approach and inter-sectoral collaboration at the national, regional, district, and municipal level. The strategy identifies the priority areas and actions for policy development in the field of poverty and social exclusion in Bulgaria until 2020. The document was adopted in 2013.

- National Environment Strategy and Action Plan (2009–2018)

173. The strategy notes that the impacts of climate change are being tangibly felt in Bulgaria. Therefore, adequate adaptation policy and measures are required in all sectors of economy and social life, including in the health sector. Among the indices for implementation of adaptation policies, the strategy highlights the following: early warning systems at place, awareness and information of climate change, and forming of new behavioral models of society aiming reduction and limitation of climate change impacts. The strategy also notes future risk of spread of infectious diseases as a result of climate change which would directly affect human health.

- National Strategy on Roma Integration (2012–2020)

174. This strategy is a political framework document which identifies the guidelines for the implementation of social integration policy for the Roma community. The document was adopted in 2012.

- National Plan for Promotion of Active Aging among Elderly in Bulgaria (2012–2030)

175. The Plan is related to the development of appropriate conditions and ensuring equal living opportunities for people ages 50 years and older, with the trend to change the scope to the range of ages from 60 to 70 years. The document was adopted in 2012.

- National Program for Prophylactic and Control of Vector-Borne Transmission Infections at People in Bulgaria (2014–2018)

176. The strategic goal of the program is decreasing of morbidity and mortality from vector-borne diseases to a single case in Bulgaria.

- Better Health-Care Concept

177. The objectives of the concept are:

- Suspending the rising negative trends and disintegration of healthcare;
- Public health promotion; and
- Achieving a higher degree of national health safety.

178. Others include the National Programme for Disaster Protection 2014–2018, as well as National, Regional, and Municipal Disaster Protection Plans; National Forest Strategy 2013–2020; Common Strategy for Management and Development of Hydro-melioration (Irrigation and Drainage) and Protection Against Harmful Effects of Water; Strategy on Adaptation to Climate Change for Sofia Municipality; Operational Programme 'Environment 2014–2020' with its separate priority axis 4 – 'Prevention and Flood Risk Management', aimed at providing resistance to disasters, prevention of risk to human health and the environment; Priority axis 3 'Natura 2000 and biodiversity', Strategy of Bulgarian Red Cross, and so on.

2.5. Institutional Framework and Stakeholder Community in Bulgaria

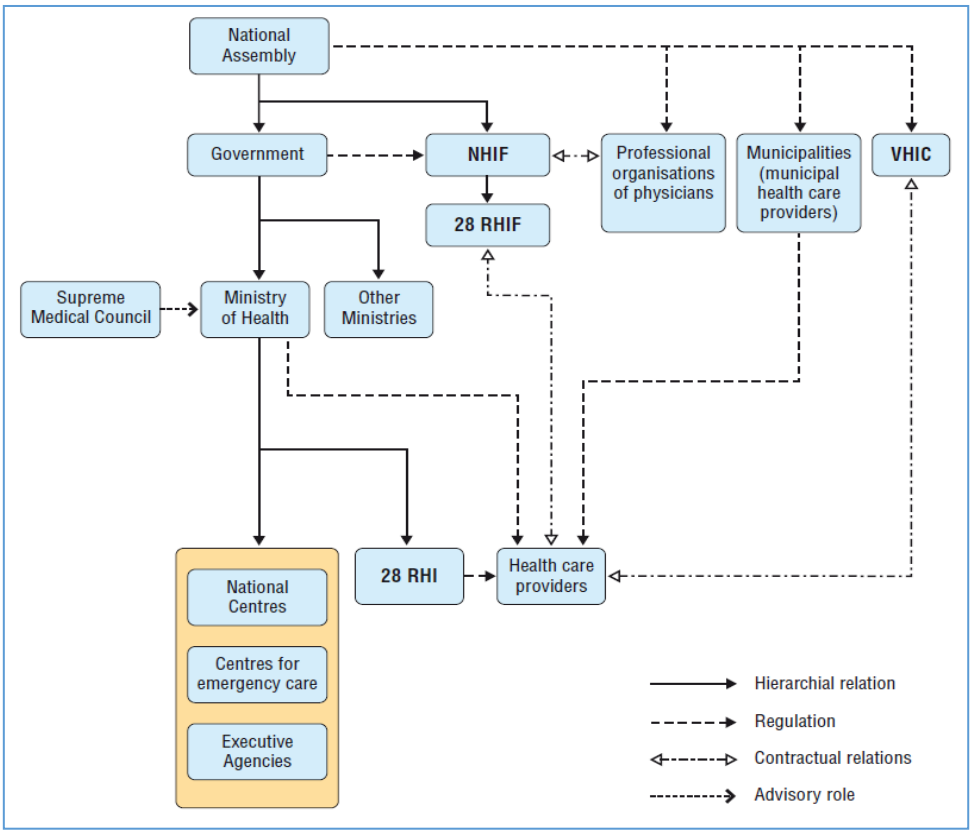
2.5.1. Governmental institutions

179. The decision-making mechanisms for the development and implementation of health promotion and primary prevention-related policies in Bulgaria are initialized, developed and approved by the **Ministry of Health.**[29] It is responsible for the national health policy and the overall organization and functioning of the health system and coordinates with all ministries with relevance to public health. The Health Insurance Act of 1998 (last amended on October 4, 2017) reformed the Bulgarian health system into a health insurance system with compulsory health insurance and VHI. The key players in the insurance system are the insured individuals, health care providers, and third-party payers, comprising the **NHIF**, the single payer in the SHI system, and voluntary health insurance companies (VHICs). While the insurance system covers health-related information dissemination, prophylaxis, diagnostic, treatment and rehabilitation services as well as medications for insured individuals, the Ministry of Health is responsible for providing and funding public health services, emergency care, transplantations, transfusion haematology, tuberculosis treatment and inpatient mental health care. The ministry is also responsible for planning and ensuring human resources for the health system, the development of medical science, and collecting and maintaining data on the health status of the population and the national health accounts. The quality and reliability of the collected

[29] http://www.mh.government.bg/

information deteriorated after the introduction of the health insurance system. Health care providers are autonomous self-governing organizations. The private sector encompasses all primary medical, dental and pharmaceutical care, most of the specialized outpatient care and some hospitals. The realisation of national policies is part of the tasks at the local level. Implementation is a local-level responsibility, which is also part of the local level action plans. Therefore, the obligation of local-level governments is to fulfil the objectives of the national health policies. Institutions at the regional and local levels are **Regional Health Inspectorates**, and **regional and municipal bodies responsible for healthcare, disease prevention, and social protection** (***Figure 10*** below).

Figure 10. Organization of the health system in Bulgaria, 2011



Source: Dimova et al. 2012.

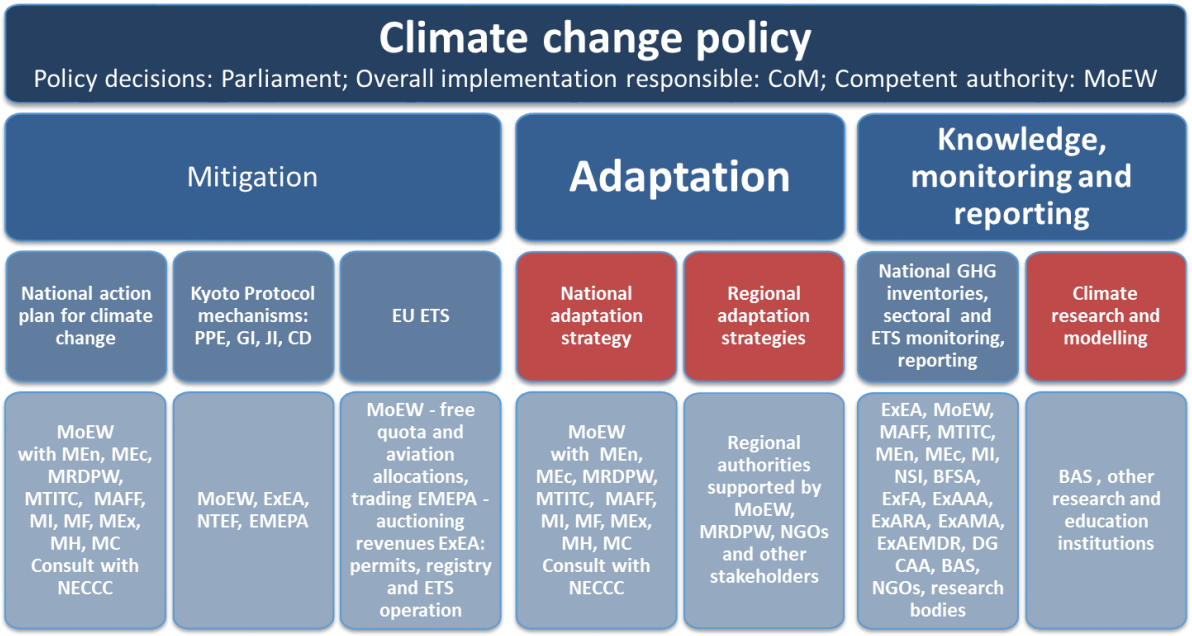
180. The central body coordinating the adaptation policy making process in Bulgaria, including in non-environment areas, is the **MoEW.**[30] The MoEW, with its **Climate Change Policy Directorate**, is responsible for the design and implementation of the Climate Change Policy, and the **EEA**[31]—for the coordination of the National GHG Inventory. The Climate Change Policy Directorate, among other functions, takes part in the development of national strategies, plans, and projects in the area of climate change and reports on their implementation, develops regulations in the area of climate change, and carries out and coordinates the work of **other ministries and institutions** and of interdepartmental working groups in respect of the

[30] http://www5.moew.government.bg/
[31] http://www.eea.government.bg/

national policy on climate change.[32] Within the governance system, horizontal coordination mechanisms exist, with a division of responsibilities. **The Interministerial Committee on Climate Change** (set up in 2000) and the **Interministerial Working Group** for Development of the National Allocation Plan (set up in 2005) coordinate climate and climate change measures in key sectoral policies, including in the health sector. The Climate Change Mitigation Act (last amended on October 24, 2017) clarifies the responsibilities of different institutions with regard to climate change.

181. Horizontal coordination is currently focused on the preparation of the NAS to Climate Change. Institutions with responsibilities for integration of climate change (both mitigation and adaptation) include the Ministry of Agriculture, Food, and Forestry (MAFF) (with the Executive Forest Agency to the MAFF); Ministry of Transport, Informatipn Technology, and Communications; Ministry of Finance; Ministry of Interior (with the Fire Safety and Civil Protection Directorate General); Ministry of Foreign Affairs; Ministry of Health; Ministry of Education and Science; Ministry of Labour and Social Policy; and the EEA at the MoEW. Moreover, some adaptation measures have been taken at the national level by the Ministry of Economy, Ministry of Energy, and Ministry of Regional Development and Public Works. Relevant ministries are in charge of CCA in their respective sectors.

Figure 11. Structure and main actors in implementing the Bulgarian climate change policy



Note: All abbreviations used in this figure could be found within the Abbreviations and Acronyms section.

Source: World Bank design.

182. The structure of the Ministry of Health supposes it is engaged into the CCA actions by a number of its units. For now, there are no facts showing the presence of any health related CCA activity, but its structure can presume such possibilities in principle. For this purpose, a close relationship should be established between health and healthcare and environmentally oriented units of the ministry.

[32] All functions of the Climate Change Policy Directorate are available at the website of the MoEW at http://www.moew.government.bg/?show=top&cid=5

2.5.2. Non-governmental stakeholder community

183. The IPCC Fourth Assessment Report (IPCC 2007) established that stakeholder dialogue is essential to improve decisions about and awareness of climate change and that global knowledge on the climate system need to be integrated with local knowledge on observed climate impacts. Stakeholder interaction has become a key strategy in research and policy-making on climate. It has been acknowledged that successful adaptation not only depends on government authorities but also on the active and sustained engagement of stakeholders. For this purpose, platforms for exchange of adaptation knowledge and practices between national, regional, multilateral, and international organizations, the public and private sectors, civil society, and other relevant stakeholders should be launched in the health sector.

184. In Bulgaria, the issues related to CCA, including in the health sector, depend significantly on the contribution of state bodies, but also on the businesses, researchers, non-governmental organizations (NGOs), as well as on all citizens.

185. The following organizations support the CCA activities of the MoEW as the central body coordinating the adaptation policy making process: Sustainable Energy Development Agency, Joint Implementation Steering Committee, NSI, Bulgarian Academy of Sciences, and several lower level government offices. **There is no availability of a pure climate-and-health-related structure** involved in this process. It is, therefore, highly recommendeded that such a unit be established in Bulgaria.

186. Article 3, paragraph 4 of the Climate Change Mitigation Act governed the establishment of the **National Expert Council on Climate Change** as an advisory body to assist the minister of the MoEW in the elaboration of positions, statements, and taking initiatives to fully implement the state policy on mitigation and adaptation to climate change. It consists of representatives of the governmental sector, including the Ministry of Health, the Red Cross, National Association of Municipalities in the Republic of Bulgaria, regional governmental authorities, Bulgarian Academy of Sciences, environmental NGOs, and businesses. Thus far, nothing can be identified in the council's activities with regard to human health and adaptation to climate change, like for example, what adaptation measures should be taken.

187. **The Bulgarian Red Cross**, together with the **Youth Red Cross**, is a humanitarian volunteer organization, working according to its statutes and the principles of the International Red Cross Movement, committed to providing support to vulnerable people victims of crisis and disasters to improve their life and dignity and relieve their suffering. Some part of Red Cross activity is directed to extreme weather manifestations and their health outcomes which are closely related to the climate change recently. Special preparedness measures should be included in the Red Cross working program to present an adaptive response to the climate change challenge. The same also concerns the activity of the **Mountain Rescue Service** in Bulgaria, the **Water Life-Saving Service**, Fire Safety and Civil Protection Directorate General and other organizations acting at climatic disasters conditions.

188. There is a large number of other nongovernmental health-related organizations in Bulgaria. Not many of them deal explicitly with CCA of the health sector. However, many of these organizations could be able to develop some activity indirectly related to this area. Such

activities could include educational programs in medical universities and schools, research and publications of scientific medical societies, actions to promote health-related CCA, corresponding initiatives of the health professional organizations, and so on. There is no established database on such kind of activities in Bulgaria, which are highly recommendable to be included in the CCA measures of the health sector.

189. These organizations can be divided into the following groups:

- Professional organizations - Bulgarian Union of Medical Doctors, Bulgarian Association of Health Care Professionals, and alike;
- Medical universities and schools - Medical Universities in Sofia, Pleven, Varna, Plovdiv; faculty of Public Health Care at Ruse University; medical faculty at the Thracian University; Medical School in Sofia, and alike;
- Research institutes - Institute of Molecular Biology, Institute of Microbiology;
- Scientific societies - Bulgarian cardiological society, Bulgarian society of infectious diseases, Bulgarian society of medical geography, Union of Bulgarian medical specialists, Bulgarian society of urgent medicine, and alike;
- NGOs - national association of urgent medical support staff, health care community, 'The health—a right of everybody', Institute of ecology of thinking, and alike;

***

190. The stakeholder system for adaptation to climate change in Bulgaria presents an effective policy integration structure: (a) a strong leading institution - MoEW; (b) potentially complementing adaptation units and agents in leading and sector departments – Climate Change Policy Directorate at the MoEW, Health Control Directorate and International Projects Directorate at the MH, and a number of others, including secondary disposers at the MH such as the Center for Infectious and Parasitic Diseases, NCHPAs, and others; (c) interdepartmental committees – Council of Scientists at the MoEW, National Expert Council on Climate Change, Interinstitutional Working Group for Adaptation to Climate Change MoEW, and so on; (d) bottom links providing information exchange and bottom-up input of local administrations, NGOs, stakeholders, and scientists. However, the health sector in particular should be harmonized by much better coordination among these structures and by appropriate distribution of CCA responsibilities and actions.

191. It would be appropriate if a specialized inter-institutional, multi-level and multi-disciplinary group would be established under the control of the Council of Ministers (CoM) to initiate, organize, and coordinate future activity in the field of human health adaptation to climate change.

2.6. Financial and Human Resources in Bulgaria

192. Development of CCA plans and their implementation have their financial cost and correspondent dependency by it. Respective financial and workforce resources should be available to provide realization of CCA actions in a response to the increased and associated challenges of the climate.

2.6.1. Financial resources

Internal financial mechanisms

193. Bulgaria has a mixed public-private health care financing system. Health care is financed from compulsory health insurance contributions, taxes, OOP payments, VHI premiums, corporate payments, donations, and external funding. Total health expenditure, as a share of the GDP, increased from 5.3 percent in 1995 to 7.3 percent in 2008. The structure of the total health expenditure has changed over time, with private expenditure increasing at the expense of public financing. In 2008, the total health expenditure consisted for 36.5 percent of OOP payments, 34.8 percent from the SHI, 13.6 percent from the MH, 9.4 percent municipal expenditure, and 0.3 percent from the VHI. Overall, public sources still prevail over private sources. In 2008, public expenditure on health, as a share of total health expenditure, was 57.8 percent, while private expenditure accounted for 42.2 percent (Dimova 2012).

194. The main purchaser of health services is the National Health Insurance Fund (NHIF). Social health insurance (SHI) contributions are calculated at 8 percent of monthly income, paid by the insured individuals, their employers, or the state. Relations between the NHIF and health care providers are based on the contract model. The fund and the professional associations of physicians and dentists sign the National Framework Contract (NFC), which regulates the format and operational procedures of the compulsory health insurance system. Based on the NFC, providers sign individual contracts with the regional branches of the Fund and the NHIF makes payments for the provided medical activities. Public health services and services provided by the national centers for emergency care, state psychiatric hospitals, and health and social care children's homes are funded by the Ministry of Health.

195. Private expenditure on health in Bulgaria includes OOP payments, VHI payments, and payments by non-profit institutions, and commercial organizations. The share of formal OOP payments (user fees and direct payments) accounted for more than 86 percent of all private health expenditures in 2008. User fees exist for visits to physicians, dentists, laboratories, and hospitals and apply to all patients with a few exceptions. Informal payments in the health sector represent a substantial part of the total OOP payments (47.1 percent in 2006). VHI is provided by for-profit, joint-stock companies intended for VHI only. Beyond the package covered by the NHIF, all citizens are free to purchase different insurance packages. The VHICs can also cover the cost of services included in the basic benefit package guaranteed by the NHIF budget. Relations between purchasers and providers in the field of VHI are based on integrated and reimbursement models. In 2010, less than 3 percent of the population purchased some form of VHI.

196. Some policies (identified in section 2.4.2.: Better Healthcare Concept, National Program for Prevention of Chronic Non-Communicable Diseases, National Strategy for Demographic Development in the Republic of Bulgaria, National Strategy for Poverty Reduction and Social Inclusion Promotion, National Strategy of the Republic of Bulgaria on Roma Integration, National Strategy for Long-Term Care, and National Plan to Promote Active Aging among Elderly in Bulgaria), which concern indirectly the adaptation of human health sector to climate change, are directly funded by the state budget.

Financial mechanism of the European Economic Area

197. Since the mid-1990s, the Bulgarian health system has received substantial foreign assistance, including governmental loans, international projects, and grants from various governments, institutions and organizations. The external financing was the highest during the first period of the health care reform process (1992–2001) but has decreased since then.

198. Some mechanisms which could be utilized, such as the Cohesion Fund; Connecting Europe Facility; Common Agricultural Policy; the program for research and innovations Horizon 2020; and the environmental financial tool LIFE, have been outlined by the National Climate Change Action Plan.

199. A Memorandum of Understanding on the implementation of the financial mechanism of the European Economic Area was signed between Bulgaria and Iceland, Liechtenstein, and Norway. Some of the priority axes of the financial mechanism of the European Economic Area which are indirectly related to the human health and CCA, are:

- Environmental management and protection
- Climate change and renewable energy sources
- Civil society
- Human and social development, and
- Academic research covering one or more priority sectors

200. The financial mechanisms of these axes have provided a budget for development of lot of projects with favorable effect on the human health and the adaptation to extreme phenomena of climate change. Among several such projects are the following:

- The Flood Risk Management Plans, (FRMP), which are developed for each basin of water management in Bulgaria for the period 2016–2021. The FRMP examines all aspects of the flood risk management, focusing on prevention, protection, preparedness, including flood forecasts, early warning systems, and so on. Special packages of measures are developed for human health and life protection.
- The Water Basins Management Plans (WBMPs) 2016–2021 which are developed for each water basin in Bulgaria. All plans represent special packages of measures oriented to human health protection from harmful environment processes, including those related to climate change.
- The Integrated Urban Transport Project of Sofia and of Bourgas Municipality, which is planning to have significant environmental, social and health benefits, such as the improvement of air quality by reducing emissions and energy consumption, Improvement of operational speed and travel conditions, and so on.[33, 34]

2.6.2. Human resources

201. In 2009, health workers in Bulgaria accounted for nearly 5 percent of the total workforce. Compared to other countries, the relative number of physicians and dentists is particularly high, but the relative number of nurses remains well below the EU15, EU12 and

[33] http://www.itransport.bg/
[34] http://www.transportburgas.bg/en/index

EU27 averages. Bulgaria is faced with increased professional mobility. The migration of medical specialists has become a serious challenge for the country.

202. Medical education is imparted in several universities. The CoM determines the requirements for obtaining both higher education degrees and specializations. Professional specialties in health provision are determined by the Ministry of Health and require a state examination by the State Examination Commission in Sofia. Continuous medical education is organized and credited by the professional associations in accordance with the Health Act. However, emphasis should be put on the quality of training provided, in view of the specifics of the medical professions directly related to the life and health of people.

203. Many of the existing skills used in public health and health care are well established and applicable to dealing with the health effects of climate change, but new skills will also be needed. Skills used in certain types of disease surveillance are well established. Less well established are the skills and methods needed to integrate current and future surveillance activities and retrospective datasets with weather and climate information. Understanding of how to conceptualize and conduct epidemiological analysis using weather and climate as exposures is also preliminary. Methods and skill in combining spatial epidemiology with ecological approaches are also lacking. There is a strong need for the ability to translate vulnerability mapping and HIAs into behavioral changes and effective public health actions.

204. A greater emphasis must be placed on developing and maintaining interdisciplinary and inter-institutional collaborations, as well as on ensuring that established resources and expertise of all the relevant disciplines, including climatology, modeling, environmental science, risk assessment, public health, and communications and education, are applied to these pressing problems. Many additional disciplines including ecology, social science, economics, geography, behavioral psychology, and others will need to play a vital role in climate change and health decision making. At present, continuing medical education needs considerable improvements in terms of organization and the teaching approaches. Adaptation of health sector to the climate changes require an additional knowledge to be included to the medical educational programs explicitly oriented to climate change and adaptation.

205. In Bulgaria, there is no collected information about any specific 'Health-CCA' staff. It would be valuable if a specialized investigation could be conducted on the staff of some specialized institutions and organizations, such as the Red Cross, the Fire Safety and Civil Protection Directorate General, the structures acting at hazards and disasters, units of the Ministry of Internal affairs, and so on, about their expertise on the new climate change challenges.

2.7. Sector Participation in CCA-Specific International Cooperation or Information Exchange

206. Effects of climate change and their impacts on the health are transboundary by nature, as neither the spread of infectious diseases nor extreme weather events are hindered by political frontiers (CEHAPIS).[35] This requires international cooperation for increasing the possibilities of solving the common climate change challenges directed towards human health.

[35] Climate, Environment and Health Action Plan Information System.

207. All the EU member states endorsed the first (Frankfurt in 1989), third (London in 1999) and fourth (Budapest in 2004) WHO Ministerial Conferences on Environment and Health declarations highlighting the need for action on climate change and health. In 1999, it was recommended: to establish a Europe-wide interagency network for monitoring, researching and reviewing the early human health effects of climate change, support the development of indicators and monitoring activities and national HIAs, and to review mitigation and adaptation options and strategies (WHO 1999). In 2004, further action was recommended to reduce the current burden of disease resulting from extreme weather and climate events through a proactive and multidisciplinary approach, as well as to promote healthy energy efficient approaches in other sectors. At the Fifth Ministerial Conference on Environment and Health in Parma, Italy, in 2010, all WHO European member states adopted the declaration endorsing a "Commitment to act" which welcomes the European Regional Framework for Action[36] titled *Protecting Health in an Environment Challenged by Climate Change*. The Commission endorsed its conclusions,[37] including:

- Integration of health in all climate change mitigation and adaptation measures, policies, and strategies at all levels and in all sectors.
- Strengthening of health, social welfare, and environmental systems and services to improve their response to the impacts of climate change.
- Development and strengthening of early warning surveillance and preparedness systems for extreme weather events and disease outbreaks.
- Development and implementation of educational and public awareness programs on climate change and health.
- Collaboration on increasing the health sector's contribution to reducing GHG emissions and management of energy and resources in a more efficient manner.
- Encouraging research and development.

208. The health sector in Bulgaria does not present data on international cooperation or information exchange in the field of CCA. Although some health sector activities may be based on different climate change threats to health, no information is gathered on this theme. It is recommended that a specific database is developed to show the gaps and the respective measures to be taken.

2.8. Bulgarian Sector Specific Ongoing and Foreseen CCA (-related) Actions

209. There is no data available about any specific CCA actions of the health sector as a whole. However, individually, the sector representatives take part in numbers of activities at the local, national, and international level, which can touch one or other aspects of climatic threat to the health, and the respective possibilities for adaptation, as follows:

[36] Protecting health in an environment challenged by climate change: European Regional Framework for Action. Copenhagen, World Health Organization Regional Office for Europe, 2010. http://www.euro.who.int/__data/assets/pdf_file/0005/95882/Parma_EH_Conf_edoc06rev1.pdf.
[37] Declaration of the European Commission. Fifth Ministerial Conference on Environment and Health. Parma 10-12 March 2010. Available online: http://ec.europa.eu/health/healthy_environments/docs/parma_declaration_en.pdf

- Participation into the work of different national, international and local bodies – societies, committees, associations, professional organizations, etc., which touch in certain extent the CCA topic in its wider and/or closer context.
- Participation in the process of policy making by giving formal or unformal consultations, taking part in discussions, presenting expert opinions, recommendations, development of policy documents, etc.
- Education activity – reading lectures, giving consultations and explanations, leading of classes, etc., which concern CCA and health topics, participation in thematic specializations and training courses, etc.
- Research activity – research investigations on different climate change phenomena which can present some threat to the human health, on mechanisms of climatic influence over the health, on territorial and temporal distribution of the climate change related diseases, epidemiological studies, etc.
- Information provision – providing information about arising and spreading of some climate related health effects.
- Participation in the public communication at all levels - providing information to authorities and public.

210. It is recommendable undertaking of actions for identifying the existent individual activity of the health sector representatives and making steps for involving of this activity into official sector framework.

2.9. Recommendations, Questions, Gaps, Barriers Hindering Adequate CCA Action; Interface with Climate Change Mitigation

211. Progress in formulating and implementing effective adaptation policies is often hampered by a wide variety of barriers that are well documented in CCA literature (Clar et al. 2013). They can be brought to some specific needs-related topics such as those discussed below.

Science-policy nexus

212. Over the last decades, interdisciplinary climate change research has increasingly complemented disciplinary efforts. This happened still predominantly in a closed community, from which only a small group participated in policy-oriented assessments and communication with policymakers. For effective adaptation research, the scientific community must open further to society. This is necessarily a slow learning process. How to accelerate this process and make it more effective raises a number of questions which should find their solution.

Methodological approaches

213. The two fundamental methodological approaches to adaptation assessment are the hazards-driven approach and the vulnerability-driven approach. The importance of these two approaches in a specific assessment is largely defined by the expected magnitude of (additional) risks attributable to climate change compared to baseline risks during the time horizon of relevant adaptation decisions. The relative magnitude of these risks varies largely across health effects and regions, with important implications for adaptation assessment and

planning. None of the health-specific frameworks discusses this issue comprehensively UNDP 2003).

Implications of uncertainty

214. Uncertainty about future changes in health risks varies significantly across climate-sensitive health issues and regions, depending on the complexity of the causal web linking climate and disease, availability of projections for relevant climatic and non-climatic risk factors, availability of relevant epidemiological data on the cause-effect relationship, and availability of resources for the assessment.

215. Especially important practical impediment to the application of quantitative risk assessment approaches in CCA assessments are large uncertainties about future exposure scenarios. In general, uncertainties in future climate scenarios are larger for precipitation and wind speed than for temperature, for extreme events than for mean values, and for local characteristics than for average values referring to large geographical regions. Of course, the level of uncertainties also depends on the data, expertise and resources available in a specific region for developing state-of-the-art regional climate change scenarios. All these variations have important implications for the choice of quantitative or qualitative assessment methods, and for the design of adaptation strategies. None of the health-specific frameworks considers this issue comprehensively.[38]

Data collection

216. Strict procedures and requirements for the data collection of the health status of the population in terms of climate change related morbidity are needed; as are mechanisms to detect diseases through data on socioeconomic determinants of health.

Urgency of adaptation

217. Because of resource constraints, health managers typically need to prioritize adaptation measures based on their urgency. The National Development Programme Bulgaria 2020 points that the most vulnerable sectors, including health, need to be addressed with priority to limit any economic losses in the long run. [39] None of the guidelines addresses this topic comprehensively enough.

Inventory approach

218. There is need for development of inventories of adaptation measures/strategies to provide examples for different contrasting types of adaptation (sometimes mentioned explicitly in NASs), including anticipatory versus reactive adaptation, spontaneous versus planned adaptation, adaptation decisions based on 'monetary and nonmonetary valuation approaches', 'no/low regrets' and 'win-win' adaptation, and integrated approaches to adaptation and mitigation.

Policy integration and coherence

219. Integrating, or mainstreaming, climate change concerns into other sectoral policies, including health sector, is one of the main ways of developing adaptation action. Dependent on

[38] UKCIP Framework

[39] Council of Ministers (2012). National Development Programme: Bulgaria 2020. Available at: http://www.strategy.bg/StrategicDocuments/View.aspx?lang=bg-BG&Id=765

the status of those policies (existing, under development), different strategies are possible. Only a few examples exist where NASs incorporates concrete proposals on how adaptation can effectively be addressed in sector policies. Lack of knowledge is one of the obstacles for adaptation policy integration.

220. The following catalysts have been identified by the OECD (2002) within an administrative system which may promote effective policy integration: (a) a strong leading institution, (b) complementing adaptation units and agents in leading and sector departments, (c) interdepartmental committees, and (d) bottom links providing information exchange and bottom-up input of local administrations, NGOs, stakeholders and scientists.

Institutional capacity and multilevel governance

221. Issues related to the different responsibilities for CCA at the different spatial levels and the coordination between the levels emerged as one of the major problems for effective development and implementation of adaptation action in several countries (Swart et al. 2009). There is a need for increasing the capacity and changing the status of the structures which are responsible for the implementation of human health CCA programs.

Stakeholders involvement

222. There is a lack of dedicated stakeholder engagement process (Bassil et al.). The Climate Change Mitigation Act of Bulgaria does not mention any stakeholder engagement mechanism with respect to CCA. For the purposes of conducting the national climate change mitigation policy, a National Expert Council on Climate Change was established in 2014 with an order of the Minister of MoEW. It is a consultative body that supports the Minister of MoEW in conducting the respective state policy.

Cooperation, integration, partnership, networking and human capacity

223. Cooperation and integration, in healthcare and with other sectors that are directly related to the climate change should be enhanced. Continuous climate change training of health professionals is needed, as well as more opportunities for their professional growth.

Communication, awareness, understanding, willingness

224. Most adaptation strategies in the EU member states include plans for communication of information about climate change, impacts, and response options to societal stakeholders. Generally, the role of the government in adapting to climate change is limited in the sense that adaptation action is taking place at the local scale by municipalities, companies, and communities, and individual citizens. This means that communication and awareness raising are important, and that information should be targeted to the needs of the vulnerable groups, in contrast to mitigation for which most of the options are similar for different groups.

225. A survey conducted by the UN Global Compact and United Nations Environment Programme (UNEP) concludes that ‘businesses have become increasingly aware of the critical role they play in enabling effective, timely, and appropriate adaptation. Businesses have also begun to recognize opportunities to expand operations and increase their market share through developing climate-resilient products and services to help people, other businesses, and governments adapt’.

226. Given this, great differences between in views between Bulgarian private stakeholders, as to their role in adaptation in comparison with the expected contribution of businesses and individuals could be established. There seems to be a wide lack of understanding among private sector stakeholders, particularly businesses and individuals, as to how they are affected and can affect CCA policy. This could be explained by the lack of understanding what CCA is, which is seen as a major barrier by stakeholders. Therefore, efforts are required to promote greater awareness and understanding of climate change and adaptation, particularly among stakeholders and the public.

Implementation, review, cost-effective evaluation

227. For some European countries, the NASs are not yet available and sometimes being planned, while some existing strategies are of a rather general nature, aiming at putting climate change on the agenda rather than including concrete policy plans. Therefore, little thought has been given to the implementation and review of adaptation policies when they are put in place. This early stage of policy development implies that there is still room for research to analyze which tools and mechanisms could be used for this purpose, learning from experiences in other areas but considering the specific characteristics of CCA.

228. It is recommended that an independent, qualified, and systematic evaluation of ongoing adaptation procedures be conducted in a way that the results are used for effective improvements. Also recommended are cost-effective evaluation criteria and strengths, weakenesses, opportunities, and threats (SWOT) analysis. The involvement of academic staff and research institutes in the examination of programmes and interventions related to health promotion and disease prevention is desirable too. Applying the obtained data and results for planning strategies and policies (Krousel-Wood et al. 2008).

2.10. Conclusions

229. Although awareness of the impact of climate change on human health has increased over recent decades, there is still a need for multi-directional and varied actions to improve it. At the same time, it is necessary to expand and deepen the knowledge on the mechanisms of impact of the changing climate on human health. This requires expanding cooperation and exchange of good practices in the healthcare system as well as with other sectors in the country and beyond. Financial and regulatory provisions in the sector are needed for this purpose.

230. Bulgarian health legislation is closely linked to international health regulations and coordinated with international institutions such as the World Health Organization (WHO), United Nations (UN), and others. As a member of the European Union, Bulgaria accepts and applies the provisions of the EC to address the risks of a health nature, including those related to climate change. The regulatory framework and policies of the Bulgarian health sector set foot on the Lisbon Treaty (2007), the Paris Agreement (2015), the Agreement with the WHO (2015) and a number of other international instruments, such as EU legislation on climate change and the protection of the ozone layer, as well as the Environment and Health Action Plan, the Community Programme in the Field of Health, the EU Health Strategy, and many others. The legal basis of the Bulgarian healthcare system is formed by the Health Act, the Climate Change Restriction Act, the Law on Healthcare Institutions, the Health Insurance Act,

the Bulgarian Red Cross Act, and the Health and Safety at Work Act. These acts need to be amended to specifically address the impacts of climate change on human health and the measures to address them. Along with these basic normative documents, various aspects of climate-related problems of health and the health care sector in Bulgaria are addressed in other documents that directly or indirectly relate to the health sector, such as the National Health Strategy, the National Strategy for Disaster Risk Reduction, the Food Law, the National Development Programme of Bulgaria, the National Strategy for Demographic Development, the National Strategy for Poverty Reduction and the Promotion of Social Inclusion, the National Programme for Prevention and Control of Vector Transmitted Infections in Human Beings, and several others.

231. Despite this rich database of documents, directly or indirectly related to health and healthcare, none of them specifically addresses the health consequences of climate change and how to mitigate these. This raises the need to update the health and climate change legal and regulatory documentation base in Bulgaria or developing a new one. Institutionally, the decision-making mechanisms for activities related to the adaptation of the health and health sector to climate change are managed by the Ministry of Health. However, the central body coordinating the process of establishing a climate adaptation policy is the MoEW. In the system of initiating and managing the adaptation process, horizontal and vertical coordination mechanisms exist, covering several other ministries, institutions, and organizations. In general, the system of parties involved in adapting to climate change represents an imposing structure of political integration. There is a strong leading institution, complementary units and sectoral departments, interdepartmental committees, links at the local level to ensure exchange and submission of information 'bottom-up', NGOs, interest groups, individuals, and scientists. Howeveer, the health sector should be 'climatically harmonized' through better coordination between these entities and by appropriate allocation of adaptation responsibilities and climate change- related actions. For this purpose, it is necessary to create a specialized interdepartmental, cross-sectoral, multi-hierarchical, multi-disciplinary group under the control of the Council of Ministers, to initiate, organize, and coordinate future activities to improve sectoral parameters: structure, finance, cooperation, professionalism, staff, application of technology, information gathering and exchange, and monitoring provisions, with a view to optimally adapting the human health sector to climate change.

Chapter 3. Adaptation options

Introduction

232. Although the climate change is projected to affect the distribution and urgency of health risks around the world, most of the adverse health impacts of climate change can be avoided by implementing suitable adaptation policies. Planned adaptation to the health impacts of climate change comprises a broad range of public health interventions. Successful planned adaptation depends on an awareness of and information about the problem, on the existence of effective response strategies, and on the availability of the resources, information, and incentives to implement them. The main challenges in developing adaptation strategies for human health are to account for the diversity of health impairments, regional conditions and adaptation actors, and for the large uncertainty about future changes in most climate-sensitive health risks. The review of the diverse set of conceptual frameworks enables to identify those criteria that determine the most suitable adaptation options to the health effects of climate change in different decision situations and to evaluate the potential for their implementation in the frames of the planned adaptation.

3.1. Identified Adaptation Options

3.1.1. General considerations

233. Health adaptation options to climate change should provide possibilities for implementation of actions to avoiding, preparing for or responding to the detrimental impacts of observed or anticipated climate change. The identification and choice of the options for planned health adaptation to climate change depends on various factors and should reflect issues such as the magnitude of current risks and of potential future risk changes, so that to reduce adverse health effects of climate change and variability, by a wide range of preventive public health measures for improving behavioral styles, medical interventions, infrastructure, or the use of technologies, education, institutional structure, policy, rule, etc.

234. The options need to account also the most important challenges at adaptation of health sector, namely: diversity of health impairments, diversity of regions, diversity of actors, uncertainty about future changes in risk levels.

235. The options/measures/actions which provide for a good adaptation should consider the following principals of the health adaptation to climate change:[40]

- The National adaptation planning is a country-driven process owned by the countries.
- Ensuring that health adaptation planning is based on the best available evidence. Any adaptation plan should aim at strengthening the development and availability of evidence, building the data and reducing knowledge gaps, and inform relevant policies.
- Building on existing national efforts towards health adaptation to climate change, including assessments, and development and implementation of policies and programs at local to national levels.

[40] WHO Guidance to protect health from climate change through health adaptation planning, ISBN 978 92 4 150800 1

- Integrating health adaptation to climate change into national health planning strategies, processes, and monitoring systems.
- Providing for a flexible and context-specific approach to health adaptation to climate change. National circumstances and available information and experience on health and climate change will determine the scope, institutional arrangements, and resources required to proper implement the health component of the NAP.
- Maximizing synergies across sectors, mainly across those that determine health, such as the food, water, energy and housing sectors. This calls for developing relevant health indicators within the adaptation monitoring systems in these sectors, ensuring that health considerations are integrated into their adaptation planning to avoid maladaptation.
- Ensuring that the health adaption plan feeds into and coordinates with the overall NAP.
- Piloting approaches that promote an iterative process for health adaptation to climate change, producing time-bound plans.
- Promoting inter-country collaboration and harmonizing adaptation approaches at sub-regional levels.

3.1.2. Adaptation options

236. As there are generally many valid perspectives on a complex phenomenon such as climate sensitive health risks, a multitude of conceptual frameworks of adaptation options may exist, each of which serving a distinct purpose. The selection of the most suitable types of options for adaptation planning should consider the following questions (Letho and Ritsatakis 1999):

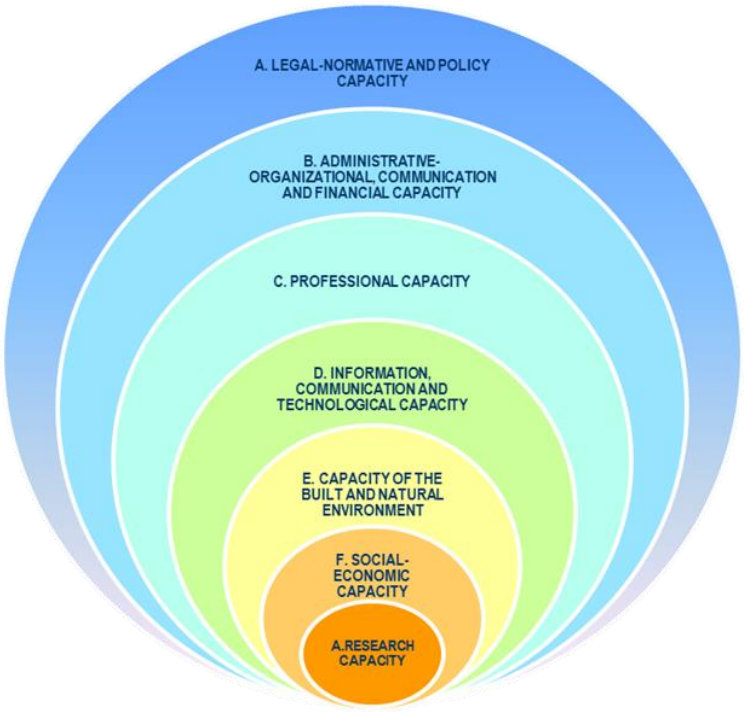
- How to balance near-term and long-term effects;
- How to weight the different potential effects in different population groups;
- How to balance the more certain, quantifiable potential effects with those that are less certain and not quantifiable, as well as the qualitative effects; and
- How to balance the interests of the various stakeholder groups: experts, people potentially affected and decision-makers.

Identified adaptation options according to the adaptation activities

237. According to the UKCIP, adaptation responses and decisions can be attached either to *building adaptive capacity* or to *delivering adaptation actions*. These two categories reflect the range of adaptation measures and strategies from which a good adaptation response can be developed.

238. Accepting this comprehension, we formulated the following 7 main adaptation categories (each of which has its respective thematic target areas) for planning the climate change adaption activities in the Human Health sector ***(Figure 12):***

Figure 12. Main categories of health adaptation options



- A. Legal-normative and policy capacity

239. A solid legal and regulatory framework is one of the most important conditions for the implementation of activities aimed at adapting the health sector to climate change. At present, none of the legal, strategic and policy documents governing the status and activities of Bulgaria's health sector directly address the impact of climate change on human health. The issue is mainly addressed at an individual level through separate studies and publications. It is necessary to undertake targeted action reviewing all existing regulatory and normative documents in the field with the aim to identify the presence of relevant texts and their potential improvement, updating, or the development of new ones.

240. The 'Legal-normative and policy capacity' category is directed to two main target areas: 'Legal-normative base' and 'Policies' base' (see ***Annex 2***).

- B. Administrative, organizational, communicational and financial capacity

241. To address climate change challenges, the health sector should develop relevant administrative, organizational, communication, and financial capacities. It is necessary to create an administrative unit for the initiation, organization, and coordination of overarching sectoral actions regarding climate change. Making good use of existing best practices should be ensured by creating useful partnerships, cooperating at local, national, and international level, and building a dedicated network of contacts for joint action. To a large extent, the success of these actions depends on budget availability. To this end, there is a need to carefully consider all local, national, and external funding options, including the creation of a targeted national fund.

242. The 'Administrative, Organizational, Communication, and Financial Capacity' category is directed to three main target areas: 'Organization and Coordination', 'Partnership and Cooperation', and 'Financing' (see ***Annex 2***).

- C. Professional capacity

243. Climate change and its health consequences is not covered by general and specialized courses in higher and semi-high medical schools in Bulgaria. Medical education staff have not undergone specialized thematic training. They currently rely on self-interest and self-development regarding this issue of increasing relevance. Successful treatment of climatic dependent morbidity requires doctors to know the mechanisms of climatic influence (direct or indirect) on the human body and the corresponding health effects involved. To this end, it is necessary to further qualify medical staff, by participation in specific lectures, seminars, workshops, and other. Additionally, it is necessary to include the subject in master's and doctoral programs of the medical schools. Climate change and health as a topic is currently missing in medical standards for prevention and treatment. In this respect, it is necessary to develop specialized treatment standards as well as programs for adequate control and prophylaxis of the population's health status.

244. The 'Professional Capacity' category is directed to two main target areas: 'Awareness, Competency and Skills' and 'Health prophylaxis and medical treatment' (see ***Annex 2***).

- D. Informational, communicational and technological capacity

245. Successful implementation of policies and actions to adapt the health sector to climate change depends not only on the sector's readiness but also on people's attitude. Personal understanding and attitude to the process of adaptation is of great importance. Increasing awareness of the problem by society can be achieved through a broad educational campaign, various media, and publicity events. Particularly useful would be the creation of a National Early Warning System and Code of Conduct, as well as a National System for Monitoring and Generating Databases on the Health Effects of Climate Change. Finally, high quality technological solutions are important in this target area. Providing the health sector with specific high-tech solutions will be an important action in the light of relevant response to the health impacts of climate change.

246. The 'Information, Communicative and Technological Capacity' category is directed to four main target areas: 'Public awareness and education', 'High technologies', 'Monitoring and data', and 'Climate and health early warning systems' (see ***Annex 2***).

- E. Capacity of the built and natural environment

247. The characteristics of the external environment of habitation are important when enhancing or reducing the impact of climate change. The built-up urban environment is generally prerequisite for the emergence of the so-called heat island effect, which can be avoided by adapting the architecture to climatic parameters, using construction materials with appropriate heat-insulating and reflective properties, climate-friendly positioning of areas for labor, living and recreation, and so on. Particularly important is the construction of high quality infrastructure for the health sector, adapted to the manifestations of climate change, allowing it to absorb the work load, including an increased flow of patients under unfavourable climatic circumstances. Health impacts from climate change also depend on the physical geographic parameters of the natural environment, where different economic activities are carried out, such as agricultural, construction, recreational and touristic, and others. For better spatial and time allocation of these activities, it is necessary to assess the risk of dangerous climatic phenomena

and arrange their large-scale mapping accordingly. Not without significance is the identifcation of certain beneficial health effects from climate change with a view to using them as a resource to strengthen health.

248. The 'Capacity of the Built and Natural Environment' category is directed to three main target areas: 'Built environment'; 'Natural environment'; and 'Favorable climate change opportunities' (see ***Annex 2***).

- F. Socio-economic capacity

249. Socioeconomic capacity is important for adapting to climate change through parameters that determine the degree of vulnerability of the population to this change. More severely exposed to risk are people living in poverty; suffer from a disadvantaged socioeconomic status or poor living conditions; have harmful personal habits, such as smoking, alcohol and drug addiction; are children or adults with chronic diseases. Improving the socioeconomic potential of society would be a factor in reducing the vulnerability of the health sector to climate change.

250. The category of 'Socioeconomic Capacity' is directed to two main target areas: 'General vulnerability assessment' and 'Vulnerable groups' protection' (see ***Annex 2***).

- G. Scientific research capacity

251. Scientific knowledge of the impact of climate change on human health is still suffers from a number of 'white spots'. These mainly relate to uncertainties about mechanisms of occurrence of climatic-determined diseases, the spatial and temporal distribution of these diseases, the prognosis for their future development, the influence of other determinant factors (personal, social, economic, environmental, and other), the monitoring, generation and processing of databases, and the concepts of adapting health and the health sector to climate change. Finding answers to these uncertainties is a major challenge to scientific research in this knowledge area, requiring its inclusion in the list of national research priorities.

252. The category of 'Scientific Research Capacit' is directed to two main target areas: 'Research investigations' and 'Research frameworks of 'Monitoring and Data' activity' (see ***Annex 2***).

253. In practice, adaptation will often involve a mixture of response strategies: some building climatic resilience (for example, enhanced design specifications), some 'living with risks' (for example, increased preparedness and contingency planning), and some acceptance of loss (e.g. accepting occasional losses or reductions in quality). The specific mixture will be case specific as it will depend on such things as risk aversion, as well as the values and capacity of the affected and responding community/organization. An optimum mixture may also include adopting measures that also allow for the exploitation of opportunities (for example, changing location of existing activities deemed no longer viable at their current location and introducing new replacement activities at that original location).

254. Considering the nature of projected changes in climate (potentially rapid change, continuing change over the long-term, and the degree of uncertainties), an effective approach to adaptation should consist of enhancing the flexibility or resilience of hard-to-reverse investments, particularly those expected to have a long design and enhancing information and its accessibility and utility (Frankhauser et al. 1999). In the case of infrastructure and systems,

an effective approach would be to time introduction of adaptation measures to coincide with planned maintenance and/or upgrading or to take advantage of opportunities that arise with unscheduled interruptions or breakdowns. This timing could reduce the overall costs of the adaptation measure, particularly when considering associated capital and labor costs.

Identified adaptation options according to the health effects of climate change

255. Climate change in Bulgaria can affect human health by numerous mechanisms whose health effects appear in the following diseases:

- Heat related morbidity and mortality
- Emergency weather-related morbidity and mortality
- Cardiovascular diseases and stroke
- Asthma, respiratory allergies and airway diseases
- Cancer
- Vector-borne and zoonotic diseases
- Foodborne diseases and nutrition
- Waterborne diseases
- Mental health and stress-related disorders, and
- Neurological diseases and disorders

256. Each of these diseases differs by the way of treatment and prevention, and specific adaptation approaches should be applied to each of them. Nevertheless, some diseases present common or similar climate change adaptation responses that allow their relating to the following two general groups of health impacting climate change phenomena:

I. Emerging phenomena of climate change (EPCC) – heat waves, cold spells, increase of temperature averages, changes in annual amounts of precipitations, droughts, increase of contrast shifts of weather, increase of UV radiation, and so on;

II. Climate change emergencies (CCEm-s) – storms, floods, strong winds, and so on.

Each of these groups involves separate or common adaptation measures, related to the corresponding adaptation categories and target areas.

257. Based on this, we propose a 'Climate and health' adaptation table which includes the 7 main adaptation categories (A, B, C, D, E, F and G), 18 target areas of adaptation and 49 adaptation options that were identified in relation to the above two groups (EPCC and CCEm-s) (see ***Annex 2***).

3.2. Experience with Selecting Adaptation Options in the Sector in Other (EU) Countries

258. An EEA study[41] reports that of 30 countries, 14 have undertaken an analysis of suitable adaptation options. Most of these countries have presented their adaptation activities either in the framework of a NAP (that is, in Austria, Denmark, France — presenting only some adaptation options, Germany, Malta, the Netherlands, Norway, Spain, Switzerland and the

[41] EEA Report: National adaptation policy processes in European countries, 2014

United Kingdom), in overall climate change policies (that is, in in Belgium [subnational Climate Plans] and Lithuania), or in the format of adaptation plans for selected sectors at various administrative levels (that is, in Portugal and Sweden).

259. In addition, five other countries report to be in the process of identifying and assessing adaptation options to be presented in a NAP or related climate change policies (that is, in Cyprus, Czech Republic, Hungary, Italy and Slovakia). Of 30 countries, seven have not yet identified their adaptation options but will do so soon (including Bulgaria, Estonia, Latvia, Romania, and Slovenia).

260. Regarding administrative levels, 6 of 15 countries state that they have identified or will assess adaptation options for the national level only (that is, Czech Republic, Denmark, Hungary, Malta, Norway, and Slovakia). Two countries mention that options have been or will be identified for the national and subnational level (that is, Belgium and Sweden) and two countries mention that they work on measures for the national, subnational and sectoral levels (that is, Poland and Spain). Portugal reported have identified and assessed adaptation options at the national and sectoral level. Austria and the United Kingdom have developed measures for the national, subnational, sectoral, and cross-sectoral levels. Lithuania mentioned it had identified and assessed options to be implemented at the national, transnational and sectoral levels. Cyprus reported it had options available for the national level as well as the sectoral and cross-sectoral levels.

261. The EEA report identifies four types of adaptation options: soft, grey, green, and combined.

- 'Soft' adaptation options are managerial, legal and policy approaches that aim at altering human behavior or styles of governance. Examples include early warning systems or financial infrastructure that can insure against damage from natural disasters.
- 'Grey' adaptation options are 'hard' options used to reduce vulnerability to climate change and enhance resilience. Examples include dyke building and beach restoration to prevent coastal erosion.
- 'Green' adaptation options make use of nature. Examples include introducing new crop and tree varieties, allowing room for rivers to naturally flood onto floodplains, and restoring wetlands.
- 'Combined' options make use of all of these three types. In fact, the best results are often achieved by combining actions. For example, flood risk in a particular area can be addressed by a combination of 'green' and 'grey' actions, or 'grey' and 'soft' actions.

262. Results from the self-assessment survey show that soft measures are the type of adaptation option most often identified: 20 of 26 countries European countries report that they have identified soft options such as awareness-raising initiatives, information policy approaches and early warning systems. Two countries report only soft options for adaptation (that is, Bulgaria and Estonia). Some 17 countries indicate they consider soft options in combination with 'green' and 'grey' options for adaptation. 'Combined' adaptation options together with other types of options are recognized by 12 countries. Six countries reported only 'combined' options (i.e. Cyprus, Hungary, Liechtenstein, Malta, Slovenia and Turkey).

263. According to the UKCIP,[42] when it comes to identifying appropriate adaptation measures, a prudent approach begins by recognizing that there are several viable options that result in effective adaptation, yet which minimize the risks associated with implementation (and are cost-effective) even in the face of associated uncertainties. These options are normally referred to as no-regrets, low-regrets, win-win and flexible/adaptive management.

264. *No-regrets adaptation options* – adaptive measures that are worthwhile (that is, they deliver net socioeconomic benefits) whatever the extent of future climate change. These types of measures include those justified (cost-effective) under current climate conditions (including those addressing its variability and extremes) and are further justified when their introduction is consistent with addressing risks associated with projected climate changes. The feasibility of implementing these types of options needs to be considered in the light of existing barriers and potential conflicts (as discussed earlier). In addition, focusing on no regrets options is particularly appropriate for the near term as they are more likely to be implemented (obvious and immediate benefits) and can provide experience on which to build further assessments of climate risks and adaptation measures.

265. *Low-regrets (or limited regrets) options* – adaptive measures for which the associated costs are relatively low and for which the benefits, although primarily realized under projected future climate change, may be relatively large.

266. *Win-win options* – adaptation measures that have the desired result in terms of minimizing the climate risks or exploiting potential opportunities but also have other social, environmental or economic benefits. Within the climate change context, win-win options are often associated with those measures or activities that address climate impacts, but that also contribute to mitigation or other social and environmental objectives. These types of measures include those that are introduced primarily for reasons other than addressing climate risks, but also deliver the desired adaptation benefits.

267. *Flexible or adaptive management options* – involve putting in place incremental adaptation options, rather than undertaking large-scale adaptation in one fell swoop. This approach reduces the risks associate with being wrong, because it allows for incremental adaptation. Measures are introduced through an assessment of what makes sense today, but are designed to allow for incremental change, including changing tack, as knowledge, experience and technology evolve.

268. 'Delaying' introducing a specific adaptation measure (or suite of measures) can be part of a flexible or adaptation management strategy as long as that decision is accompanied by a commitment to continue building the necessary adaptive capacity while continuing to monitor and evaluate the evolving risks. A decision to delay introducing a specific action is often taken when the climate risks are below defined thresholds or when the required adaptive capacity (for example, regulatory or institutional circumstances) is insufficient to allow effective action.

[42] UKCIP, Identifying adaptation options

3.3. Adaptation Options Assessed

269. The criteria set for assessment of adaptation options includes parameters such as time, budget, benefits, efforts, indicators for measurement, institutional arrangements, consequences of in-adaptation and maladaptation. These parameters of assessment for the health sector in Bulgaria are preliminary determined referring them to the list of health sector adaptation options.

3.3.1. Time

270. The timing of adaptation is a particularly difficult decision because it involves balancing two significant but highly uncertain risks. Delaying adaptation often allows to better target a measure (and thus to avoid the misallocation of scarce resources) as a result of improved knowledge about climate change and its impacts but it may involve adverse impacts that could have been avoided by earlier action. Various authors have investigated this decision problem and come up with criteria for the prioritization of adaptation measures (Smit and Lenhart 1996). There is general agreement that the following criteria indicate conditions that are favorable for anticipatory adaptation:

- Net benefits across the plausible range of climate scenarios ('no/low regrets');
- Addresses decisions with long-term effects or measures with a long lead time;
- Addresses irreversible or catastrophic impacts;
- Addresses systems that are sensitive to rapidly changing climate parameters (primarily extreme weather); and
- Reverses trends that reduce future adaptability.

271. The health adaptation to climate change should comply with the time programming and horizons of the NHS (2014–2020), the municipal development plans (2014–2020), and not the least – the working agenda of the EU and WHO health policies. As a part of the NAS and the NAP, it is not expected that CCA activities in the health sector will start before 2018. Sometimes tolerance is needed toward the health sector stakeholders and the population for organization and also, to become more familiar with the adaptation idea. This means that adaptation actions cannot be expected before 2018. Thus, it is suggested that the first health adaptation period covers the period of 2018–2022, when evaluation of the adaptation outcomes can be done, and further actions can be traced.

3.3.2. Budget

272. The value of adaptation is demonstrated by the health impacts of some disasters associated with extreme weather and climate events, although not necessarily attributed with confidence to climate change itself.

273. The World Bank[43] estimates average annual adaptation costs in the health sector for diarrhea and malaria prevention and treatment at around US$2 billion over the 40- year period 2010–2050. These estimates are lower than prior UNFCCC estimates (see in the following paragraphs). The estimated adaptation costs in 2010 lie between US$3 billion and US$5 billion and decline over time in absolute terms to less than half that amount by 2050.

[43] Costs of Adapting to Climate Change for Human Health in Developing Countries. Kiran Pandey, World Bank, 2010.

274. UNFCCC (2007) has estimated costs of US$4 billion to US$12 billion per year in 2030 for adaptation in the health sector in developing countries. These costs represent the costs of preventing additional cases of malnutrition, malaria, and diarrheal disease due to climate change by 2030 (low- and middle-income countries only, developed country costs were not estimated).

275. The early evidence from global, national and local studies suggests that the costs of treating additional cases of illness resulting from climate change may be substantial, and considerably higher than the current budgets allocated for these diseases in most developing countries (Ebi 2008). However, studies of the health economics of climate change are in their infancy. There are very few estimates of adaptation costs, and these are difficult to compare with other health cost studies because of the use of different metrics and analytical assumptions. The nature of climate change and the diverse and often indirect ways in which it poses health risks, presents challenges. These include the challenge of joint cost (interventions paid for by one sector may have implications across a range of other sectors), as well as the difficulty in distinguishing between 'costs of inaction' (that is, the costs and physical impacts associated with climate change in the absence of planned adaptation or mitigation) and 'costs of adaptation' (the costs of taking measures to reduce or to cope with additional health impacts arising as a result of climate change).

276. In addition, there has been relatively little work on estimating the economic value of the potential health co-benefits that may be gained through climate change mitigation. Considering only the implications of GHG mitigation on air quality, the most recent assessment report of the IPCC concluded that there is 'much evidence', and 'high agreement', that 'the monetized health benefits may offset a substantial fraction of the mitigation costs' (Barker et al. 2007). However, these assessments have not yet considered many potential health benefits, and costs, for example valuing lives saved through improvements in insulation and energy efficiency in houses, or from facilitating safe public and active transport (Younger et al.).

277. According to Sambo (2011) health 'adaptation costs' include the following:

- Costs of improving or modifying health protection systems, for example, expanding health or vector surveillance systems – this includes the costs associated with building new infrastructure, increasing laboratory and other capacities, and training new health care workers; disaster preparedness including training and keeping a roster of emergency health professionals; and community-based first aid training, for example, to deal both with new risks (such as heat strokes) or post- disaster health needs;
- Costs of introducing novel health interventions (for example, heat-wave or other broader early warning systems);
- Additional costs for meeting environmental and health regulatory standards (for example, air quality standards, and water quality standards);
- Costs of improving or modifying health systems infrastructure, for example, adapting hospitals to hotter summers; and 'disaster proofing' existing and new infrastructure;
- Occupational health costs, for example, measures to prevent the adverse impacts of increased heat load on the health and productivity of workers;

- Costs of health research on reducing the impact of climate change, for example, evaluation studies; and
- Costs of preventing the additional cases of disease due to climate change as estimated by scenario-driven impact models.

278. Financing of adaptation broadly refers to resources that are deployed to support climate-resilient development (World Bank 2011). Funding for adaptation can be mobilized through a range of international and domestic, public and private financing mechanisms, and can take various forms (for example, loans and grants). Public financing sources are typically used to support projects in the infrastructure sectors, where returns on investments are usually less attractive to private investors.

279. Sources of public financing for adaptation include contributions from national budgets, multilateral and bilateral development funds, and UNFCCC operational funds — the Adaptation Fund, the Least Developed Countries Fund, and the Special Climate Change Fund (Christiansen et al. 2012). A potentially key source of future public financing for adaptation is the Green Climate Fund that was officially designated at the 17th Conference of the Parties to the UNFCCC in Durban.

280. Private adaptation financing remains limited owing to market, institutional, and policy barriers that depress return on investments on these activities (Korvats et al. 2008). However, public-private partnerships that use public financing to leverage private investment are currently used to fund projects in several climate-sensitive sectors, such as infrastructure in the energy, transport, and water and sewage sectors (World Bank 2011b). These partnerships are not necessarily focused on climate adaptation but can serve as models for future adaptation projects.

281. A preliminary cost estimation of the health adaptation options is shown in ***Table 8***.

Table 8. Health Adaptation options in Bulgaria assessed by various criteria

Target areas of Adaptation	*Criteria*						
	Time	*Budget*	*Benefits*	*Efforts*	*Measurement Indicators (outputs)*	*Institutions Involved*	*Consequences no Adaptation/ Maladaptation*
1. Legal-normative base	1-2 years	L	H	Tr	NAS & NAP approved	National Assembly; MH; MoEW; MF; MJ	H
2. Policies' base	1-2 years	L	H	Tr	NAS & NAP approved	National Assembly; MH; MoEW; MF; MJ	H
3. Organization & Coordination	1 year	L	M	Tr	Establishment of a 'Climate change and Health Adaptation' working group	MH; MF	H
4. Parthership & Cooperation	2-3 years	L	M	Ir	Number of intra-sectoral and inter-sectoral cooperations; Number of local, regional and international collaborations	MH; Reserch groups; business organizations; NGOs; international organizations	H
5. Financing	2-3 years	H	H	Tf	Officially established target fund for CCHH	MF, MH, MoEW; business organizations	H
6. Awareness, competency, skills	2-3 years	M	H	Ir	Number of educational courses, seminars, forums; No of participants	MH; Research; and Education Institutions; Health care providers; Professional organisations; NGOs	H
7. Health prophylaxis and medical treatment	2-3 years	L	H	Ir	Number and quality of prophylaxis and controlling programs	MH; health providers	H
8. Public awareness and education	4-5 years	H	H	Ir	Number of education and communication campaigns; Number and diversity of participants	MH; Research; NGOs; Professional organizations	H
9. High technologies	5-6 years	H	H	Ir	Number of innovations; Number of high technologies	MH; Research Institutions; business organizations	H

Target areas of Adaptation	*Criteria*						
	Time	*Budget*	*Benefits*	*Efforts*	*Measurement Indicators (outputs)*	*Institutions Involved*	*Consequences no Adaptation/ Maladaptation*
10. Monitoring and data	2-3 years	M	H	Ir	Data-bases created	Research; MH	H
11. Climate-and-health early warning systems	2-3 years	H	H	Ir	EWS established at local and regional level	Research; Business, MH	H
12. Built environment	4-5 years	H	H	Ir	Cases of good practices	MH; MRD; Research	H
13. Natural environment	3-4 years	M	M	Ir	Cases of good practices	MH; MoEW; Research	M
14. Favorable climate change opportunities	5-6 years	M	H	Ir	Number of cases for good practices	Research organizations; MH	M
15. General assessment of health vulnerability	2-3 years	M	H	Tr	Health vulnerability assessed at the nantional, regional and local levels	Research; MH	H
16. Protection of vulnerable groups	2-3 years	M	H	Ir	Number of protection activities	MH; Academy; NGOs; Professional organizations; Municipalities	H
17. Research investigations	2-5 years	M	H	Ir	Number of research projects and publications	Research; Medical univercsties	H
18. Research frameworks of 'Monitoring and data'	2-3 years	M	H	Tf	Research base developed of: CCHH monitoring; database development; early warnings; etc).	BAS, MH, MoEW	H

Note: L = Low; M = Medium; H = High degree; Tr = Transitional Efforts; Tf = Transformational Efforts; Ir = Incremental Efforts; MH = Ministry of Health; MRD = Ministry of Regional Development; MJ = Ministry of Justice; MF = Ministry of Finance; MIA = Ministry of Internal Affairs.

3.3.3. Cost-benefit analysis

282. Health adaptation to the climate change may have a wide range of favorable consequences, some of which are (alphabetically) listed below (WHO):

- A healthier and more economically active population, resulting in fewer social payments to sick people;
- Creating awareness among communities, to increase resilience to climate change and variability;

- Development of practical tools to cope with climate variability and change;
- Enabling field practitioners to carry out required interventions as per requirement of Early Warning Reporting System Guidelines, the Psychosocial Intervention Guidelines;
- Enhanced coordination and cooperation among different governmental and NGOs concerned with CCA to protect human health;
- Enhanced knowledge among the general public on how to protect themselves against climate-sensitive diseases;
- Facilitating the harmonization of health issues with economic development;
- Harmonized management structures across all provisions provided by the Annual Operational Plans;
- Improved general health of the national population and consequent contribution to human development;
- Improved interactions between health officers and stakeholders and sharing of resources and reduction in duplication of tasks within a district;
- Increased awareness of the potential impacts of climatic change across various media;
- Increased awareness and strengthened institutional capacity to address other health risks from climate change;
- Increased capacity of health actors to climate sensitive diseases;
- Increased knowledge and skills to monitor variations in climate and make preventive steps to minimize possible detrimental effects on human health;
- Strengthening both inter disciplinary collaboration and communication within all levels the Ministry of Health;
- Strengthening health education and training on the impacts of climatic change on the environment and human health;
- Strengthening inter-sectoral collaboration at all levels;
- Strengthening partnerships.

283. *Ancillary benefits of adaptation.* Some adaptation options may offer ancillary benefits (*or co-benefits*) independent of their direct benefits with respect to reducing vulnerability to climate. The potential for co-benefits has two important implications for adaptation planning and implementation. First, their consideration may result in a more favorable assessment of the cost-effectiveness of a specific adaptation option (Hallegatte 2009). Second, consideration of the ancillary benefits of adaptation may help in efficiently integrating adaptation into existing management and decision-making processes (Ahmed and Fajber 2009, Dovers 2010). ***Table 9*** below shows some examples on co-benefits related to the public health policies.

Table 9. Examples of (post-AR4) research studies on co-benefits of climate change mitigation and public health policies

Co-benefit category	Benefits for health	Benefits for climate	References
Reduction of co-pollutants from household solid fuel combustion	Potentially reduce exposures that are associated with disease, chronic and acute respiratory illnesses, lung cancer, low birth weight and stillbirths, and possibly tuberculosis	Reduces CAP emissions associated with household solid fuel use including CO2, SO, black carbon, and CH4	Bell et al. (2008); Wilkinson et al. (2009); Lefohn et al. (2010; Venkataraman et al. (2010); World Health Organization Regional Office for Europe (2010); Po et al. (2011); Anenberg et al. (2012)
Reduction of greenhouse gases and associated co-pollutants from industrial sources, such as power plants and landfills, by more efficient generation or substitution of low carbon alternatives	Reductions in health-damaging co-pollutant emissions would decrease exposures to outdoor air pollution and could reduce risks of cardiovascular disease, chronic and acute respiratory illnesses, lung cancer, and preterm birth	Reductions in emissions of CO2, black carbon, CO, CH4, and other CAPs	Bell et al. (2008); Apsimon et al. (2009); Jacobson (2009); Puppim de Oliveira et al. (2009); Smith et al. (2009); Tollefsen et al. (2009); Dennekamp et al. (2010); Jacobson (2010); Nemet et al. (2010); Rive and Aunan (2010); Shonkoff et al. (2011); Shindell et al. (2012); West et al. (2012, 2013)
Energy efficiency. Actual energy reduction may sometimes be less than anticipated because part of the efficiency benefit is taken as more service	Reductions in fuel demand potentially can reduce emissions of CAPs associated with fuel combustion and subsequent exposures to pollutants that are known to be health damaging	Reductions in emission of CAPs due to decreases in fuel consumption	Markandya et al. (2009); Wilkinson et al. (2009)
Increases in active travel and reductions in pollution due to modifications to the built environment, including better access to public transport and higher density of urban settlements	Increased physical activity; reduced obesity; reduces non-communicable disease burden, health service costs averted; improved mental health; reduced exposure to air pollution; increased local access to essential services, including food stores; enhanced safety	Reductions of CAP emissions associated with vehicle transport; replacing existing vehicles with lower emission vehicles could reduce air pollution	Babey et al. (2007); Reed and Ainsworth (2007); Kaczynski and Henderson (2008); Casagrande et al. (2009); Jarrett et al. (2009); Rundle et al. (2009); Woodcock et al. (2009); Durand et al. (2011); Grabow et al. (2011; McCormak and Shiell (2011); Jensen et al. (2013); Woodcock et al. (2013

Co-benefit category	Benefits for health	Benefits for climate	References
Healthy low greenhouse gas emission diets, which can have beneficial effects on a range of health outcomes	Reduced dietary saturated fat in some populations (particularly from ruminants) and replacement by plan sources associated with decreased risk of (ischemic) heart disease, stroke, colorectal cancer (processed meat consumption). Increased fruit and vegetable consumption can reduce risk of chronic diseases, Reduced CH4 missions due to a decreased demand for ruminant meat products would reduce tropospheric ozone	Reductions in CO2 and CH4 emissions from energy-intensive livestock systems	McMichael et al. (2007); Friel et al (2009); Sinha et al. (2009); Smith and Balakrishnan (2009); Jakszyn et al. (2011); Hooper et al. (2012); Pan et al. (2012); Su et al. (20121)
Greater access to reproductive health services	Lower child and maternal mortality from increased birth intervals and shifts in maternal age	Potentially slower growth of energy consumption and related CAP emissions; less impact on land use change, etc.	Tsui et al. (2007); Gribble et al. (2009); Prata (2009); O'Neill et al. (2010); Diamong-Smith and Potts (2011); Potts and Henderson (20112); Kozuki et al. (2013)
Increases in urban green space	Reduced temperatures and heat island effects; reduced noise; enhanced safety; psychological benefits; better self-perceived health status	Reduces atmospheric CO2 via carbon sequestration in plant tissue and soil	Mitchell and Popham (2007); Babey et al. (2008); Maas et al. (2009); vanden Berg et al. (2010); van Dillen et al. (2011)
Carbon sequestration in forest plantations reducing emissions from deforestation and degradation, and carbon offset sales	Poverty alleviation and livelihood/ job generation through sale of clean Development Mechanism and voluntary market credits. Ameliorate declines in production or competitiveness in rural communities	Reduces emissions of CAPs and promotes carbon sequestration through reducing emissions from deforestation and degradation	Holmes (2010); Ezzine-de-Blas et al. (2011)

Note: CAP = climate-altering pollutant.

Source: IPCC 5th AR-11.

284. The CBA for the sector (explained in more detail in ***Annex 3***) focuses on the assessment of soft adaptation measures. The benefits gained as a result of their implementation are best exemplified through the quantification of a number of main performance indicators (current expenditure for hospitals; current out-patient health expenditure; current expenditure through the system of retail sale in pharmacies, optical and sanitary shops; current expenditure on curative and rehabilitative care). These are assumed to be positive. The net present value (NPV) in ***Table 10*** illustrates the monetary value of avoided losses as a result of implemented adaptation measures, while the cost effectiveness quantifies the benefits achieved in relation to the required investments/costs.[44]

Table 10. Benefits of adaptation measures in the Human health sector until 2050 (in €, million)

Climate scenarios	NPV (€, mln.)	Cost-effectiveness (Benefit/Cost ratio)
Realistic scenario +2°C	5.01	1.10
Optimistic scenario +2°C	9.04	1.18
Pessimistic scenario 2°C	0.984	1.02
Realistic scenario +4°C	107.27	3.21
Optimistic scenario +4°C	118.99	3.45
Pessimistic scenario +4°C	95.548	2.96

285. The projection shows that on average, under the +2°C realistic scenario, the total cash flow in NPV is €5.0 million and €107.2 million under the realistic scenario at +4°C. Under the optimistic scenario the projected cash flow in NPV is €9.0 million at +2°C average and €118.9 million at +4°C average. Even in the pessimistic scenario the future cash flow in NPV is projected at €984 thousands at +2°C and €95.5 million at +4°C.

286. In this analysis, the cost-effectiveness of the adaptation measures is used to quantify the effect of investments under each scenario.[45] Under the +2°C realistic scenario the benefit/cost ratio is €1.10 (that is, the benefit achieved per Euro spent), and €3.21 under the +4°C realistic scenario. The benefit is higher at +4°C temperature rise. In that case, the benefit is €3.45 per one Euro of investment under the optimistic scenario and €2.96 per one Euro of investment under the pessimistic scenario. A higher effect of investments is observed under the +4°C scenario because the average air temperature during 1991–2015 has already increased by +1.6°C. Thus, to date, the level of the +2°C scenario has already almost been reached.

287. The overall effects of the adaptation measures will be cost saving as a result of potentially decreased health damage from climate change. The NPV calculation shows that investments in adaptation measures are economically efficient. Moreover, adaptation measures

[44] The NPV of an adaptation option is given by the present value of the estimated benefits and costs. If NPV is more than zero, this indicates that the investment is efficient and incremental benefits of adaptation exceed the incremental resource costs. If NPV is <0 or B/C is <1, then the adaptation measures add no net benefit to the Human Health sector. If NPV is >0 or B/C is >1, then it adds positive benefits. The positive value of NPV confirms that investments for adaptation are efficient.
The benefit-cost ratio (B/C) is the ratio of the present value of benefits to the present value of costs. When the B/C ratio is more than one, the present value of the option's benefits is larger than the present value of its costs.

[45] The cost-effectiveness refers to all measures.

are important for effective health preparedness and response to climate change. Benefits calculation of adaptation measures to climate change provide overall estimates of the economic dimensions of the problem and illustrate the relative costs of climate change effects of human health.

3.3.4. Efforts

288. CCA in the health sector requires considerable multi-directional efforts targeting the different health adaptation areas: Changing or developing specific regulations, standards, codes, plans, policy or programs; Development of Institutional frameworks for the health sector; Raising of awareness, competency and skills of human resources in the health sector; Improvement of infrastructure resources in the health sector; Introducing high technologies and innovations; Working in partnership and Cooperation; Working with vulnerable groups; Health prophylaxis and controlling of health status; Research; Data collecting and monitoring; Public education and awareness outreach; Early warning systems; Relevant medical treatment; Well managing of emergency response; and so on.

289. The efforts referring the human health sector are qualitatively assessed in ***Table 8***.

3.3.5. Indicators for measurement

290. Indicators for measurement of health adaptation to climate change indicate two groups of adaptation actions: building adaptive capacity and delivering adaptation actions. The first group considers specific sectoral capacity actions, as well as actions directed to socioeconomic parameters of health vulnerability. The second group measures prevention activity, actions to reduce exposure and response treatment. A separation between actions directed to each of the two kinds of health impacting climate change phenomena – EPCC and CCEm-s – should be considered as well (***Table 8***).

3.3.6. Institutional arrangements

291. Institutions are composed of tangible formal procedures, laws and regulations and tacit informal values, norms, traditions, codes, and conducts that shape expectations and guide actions among actors and organizations, serving as manifestations of institutions (Ostrom 1990, Dovers and Hezri 2010). A key role that institutions play in facilitating adaptation is through legal and regulatory responsibilities and authorities. Adaptation can also be constrained owing to the complexities of governance networks that are often composed of multiple actors and institutions such as government agencies, market actors, NGOs, as well as informal community organizations and social networks (Rosenau 2005, Adger et al. 2009, Juhola and Westerhoff 2011, Carlsson-Kanyama et al. 2013, Sosa-Rodriguez 2013). Coordination among these different actors is important for facilitating adaptation decision making and implementation.

292. The main institutions in Bulgaria involved in the identified adaptation types and options will be all health stakeholders (***Figure 10*** from Chapter 2). The main role is to be played by the Ministry of Health (with its centers and executive agencies), together with the MoEW, Ministry of Justice, and Ministry of Finance, which will be responsible for the general climate change and health adaptation policies, strategies and regulatory documentation.

293. The second group of stakeholders is constituted by the national and regional offices of the Health Insurance Fund, professional organizations, municipalities and VHICs. They will

implement the CCA policy at the regional and local levels (except for the national NGOs). An effective and efficient network among all institutions should be created for the better coordination of all adaptation measures.

3.3.7. Consequences from no action/maladaptation

294. Maladaptation arises in many forms, but several broad causes can be identified. Actions that may benefit a specific group, or sector, at a specific time may prove to be maladaptive to those same groups or sectors in future climates or to other groups or sectors in existing climates. For example, some development policies and measures that deliver short-term benefits or economic gains but lead to greater vulnerability in the medium to long term, such as in cases where the construction of 'hard' infrastructure reduces the flexibility and the range of future adaptation options. Another cause of maladaptation is the failure to account for multiple interactions and feedbacks between systems and sectors leading to inadequate or inaccurate information for developing adaptive responses. Maladaptation may also occur if the true potential of an option or a technology is unduly over-emphasized, making it over-rated.

295. As examples of maladaptation, failure to take measures to reduce the impact of extreme temperatures or improper adaptation of the urban environment will bring about deterioration of human health and increase the risk of loss of life. This risk is greater for health in cities where urban sprawl has reached forest areas. The poor management of urban water supply systems will increase the risk for population and public health respectively from shortages of necessary quantities of good quality water. Delaying the supply of necessary equipment and capacity building of the natural disasters risk management units and disaster recovery centers will greatly hamper their work, lead to loss of staff, make emergency interventions inadequate and increase the number of victims and the scope of damages. In addition to specific measures, it is necessary to follow up to the consequences of non-implementation of regional and spatial development policies which are indirectly related to climate change and impacts on human health.

3.4. Cross-cutting Issues, Trade-Offs and Synergies of Adaptation Options

296. Some of the possible measures for adapting to climate change lie outside the direct control of the health sector. They are rooted in areas such as sanitation and water supply, education, agriculture, trade, tourism, transport, development and housing. Inter-sectoral and cross-sectoral adaptation strategies are needed to reduce the potential health impact of climate change. A policy analysis will determine the feasibility of and priorities among these options. In general, many of the policies and measures identified also promote sustainable development.

297. Other sectors—including ecosystems, water supply and sanitation, agriculture, infrastructure, energy and transportation, land use management, and others—play an important part in determining the risks of disease and injury resulting from climate change.

298. Within the context of the EuroHEAT project, a review of public health responses to extreme heat in Europe identified transport policies, building design, and urban land use as important elements of national and municipal heat wave and health action plans (WHO 2009). A study examining well-established interventions to reduce the urban heat island effect (replacing bitumen and concrete with more heat-reflective surfaces and introducing more green spaces to the city) estimated these would reduce heat-related emergency calls for medical

assistance by almost 50 percent (Silva et al. 2010). Urban green spaces lower ambient temperatures, improve air quality, provide shade, and may be good for mental health (Van den Berg et al. 2010). However, the extent to which changes in these factors reduce heat wave-related morbidity and mortality depend on location. A study in London, United Kingdom, found that the built form and other dwelling characteristics more strongly influenced indoor temperatures during heat waves than did the urban heat island effect (Oikonomou and Wilkinson 2012).

299. A review of food-aid programs indicates that a rapid response to the risk of child undernutrition, targeted to those in greatest need, with flexible financing and the capacity to rapidly scale up depending on need, may reduce damaging health consequences (Alderman 2010). Community-based programs designed for other purposes can facilitate adaptation, including DRM. In the Philippines, for example, interventions in low-income urban settings with the potential to reduce the harmful effects of climate extremes on health include savings schemes, small-scale loans, hygiene education, local control and maintenance of water supplies, and neighborhood level solid waste management strategies (Dodman et al. 2010). It is important to note that CCM in other sectors may influence health in a positive manner (for example, re-vegetation of watersheds to improve water quality), or on occasion, exacerbate health risks (for example, urban wetlands designed primarily for flood control may promote mosquito breeding) (Medlock and Vaux 2011).

300. Interdependencies between human health and other sectors is shown in ***Table 11.***

Table 11. Interdependencies between human health and other sectors

Affecting → HUMAN HEALTH		
CC effect in… ↑ *(see below)*	**Positively**	**Negatively**
Agriculture	More qualitative nourishment due to the: ○ Longer season of vegetation ○ New agriculture species	Threats to the food due to the: ○ more droughts; ○ heavy rains; ○ floods; ○ extremely high and/or low temperatures ○ shorter season with snow cover ○ late spring frosts ○ wind storms ○ hails
Biodiversity & Ecosystems	Improved parameters of natural environment because of: ○ increasing of some biodiversity richness; ○ new herb species ○ Healthy sport and recreation in natural environment; Regulation of micro-climate in built environment	○ Pollens; ○ Invasion of harmful phyto- species ○ Invasion of harmful zoo- species

Affecting → HUMAN HEALTH		
CC effect in… *(see below)* ↑	**Positively**	**Negatively**
Energy	Less air pollution due to the green energy by reason of: ○ more intensive solar radiation; ○ increased frequency of strong winds; ○ better climatic conditions for some "energy" plants	○ Threatening situations to human health due to sudden power outages due to extreme weather events
Forestry	○ New forest species and longer vegetation period oweing to: ○ More intensive solar radiation ○ Changes in temperature-and humidity conditions	○ Air pollution from forest fires ○ Disease or extinction of some forest species ○ Conditions for the development of some harmful species
Tourism	○ Opportunities for longer summer tourist season ○ Longer period for herb tourism	○ Damage of tourism infrastructure due to some emergency weather manifestations ○ Shorter winter tourist season
Transport	○ More regular winter transportations due to the longer periods with dry and warmer weather	○ Deteriorated air quality due to accelerating the reactions between the pollutants emitted by the transport under the changed thermal and humidity conditions
Urban Environment	○ More green space because of the longer warm season	○ Increasing the intensity of the heat islands ○ More air pollution at higher temperatures
Water	○ Longer period for water-sports and recreation in the open	○ Floods; ○ Insufficient water quantities; ○ Conditions for water pollution at intensive rains; ○ Invasion of harmful water species (phyto- and zoo-) at floods, draughts, higher water temperatures

3.5. Priority Setting Approach

301. Identification of CCA options is an important step in the process of establishing resilience to climate change. However, it is not realistic to expect that all identified adaptation options can be implemented simultaneously. Therefore, adaptation options are normally scored to establish a priority order for their implementation. In the framework of this report, following EU guidance, the adaptation options specifically identified for the human health sector have been prioritized.

302. In support of the priority setting a prioritization meeting was organised in Sofia in October 2017, inviting a variety of stakeholders from the sector. The meeting used a basic version of the multi-criteria analysis (MCA) approach. MCA is an approach as well as a set of techniques, that aims at providing an overall ordering of options, ranging from the most preferred to the least preferred. It represents a way of looking at complex problems that are characterised by a mix of monetary and non-monetary objectives. MCA breaks down options

into more manageable pieces by using a set of criteria. The two groups of criteria used for the analysis were those of 'Net Benefits', further broken down into economic, social, and environmental benefits, and 'Implementation Risks', further broken down into financial, social, institutional, technical, and technological risks. This approach allows data and judgements to focus on the separate pieces that are then reassembled to present a coherent overall picture.

303. In carrying out MCA (that is, 'scoring the different adaptation options'), the meeting benefited from the presence of stakeholders with professional knowledge and experience in the sector. Nevertheless, this priority setting effort must be considered as indicative and tentative, for three main reasons. First, the effort was carried out at an early stage in the process of developing a strategic view and planning of sector-specific CCA options. Second, not all those who were invited to the prioritization meeting used this invitation to attend. And third, a broader understanding of underlying information and notions at the side of the stakeholders would be beneficial to allow them to make more founded scores. Therefore, the current priority list only serves as a 'first feel' about the main direction of the actions to be taken first.

304. At a later stage further attention should be paid to the priority setting process, both for this sector as across all economic sectors that play a role in the planning of Bulgaria's CCA actions.

305. The five main priority adaptation options that were tentatively and indicatively identified for the human health sector are:

1) Amending/ developing legislation, regulations, standards, codes, plans, policies and/or programmes;
2) Monitoring and collecting of data;
3) Public education and awareness outreach;
4) Working in partnership and cooperation: intra- and inter-sectoral (local, national and international);
5) Carrying out research/raising knowledge-base.

3.6. Conclusions

306. Successful adaptation of health and the health sector to climate change depends on the degree of individual awareness and understanding of the problem, the availability of an effective response strategy, and the availability of resources, information and initiatives for their actual implementation. The main challenges in the development of adaptation strategies for the health sector in Bulgaria relate to a wide variety of climatically driven health effects, with large differences in climate and socioeconomic conditions across the country, and with great uncertainty regarding further changes of climate-sensitive health risks. In addition, the protection of human health against the negative effects of the changing climate has not yet resulted in a specific regulatory framework, with adequate knowledge of the problem in medical circles, with adequate understanding among the population, with adequate medical and urban infrastructure, with a specialized information base, with low socioeconomic vulnerability of the population, with targeted research and results, and so on. In this context, it is indicated that action to adapt the health and healthcare sector in Bulgaria to climate change should be geared toward improving the adaptation capacity in the following seven categories:

A. Legal Normative Capacity
B. Administrative, Organizational and Financial Capacity
C. Professional capacity
D. Information, Communication and Technological Capacity
E. Infrastructure (built and natural environment) Capacity
F. Socioeconomic Capacity
G. Research Capacity

307. On a temporal basis, health adaptation to climate change should be consistent with the National Health Strategy horizons, the plans for development of the territorial-administrative units in the country, the EU Health Policy Agenda, and the WHO agenda. It is expected that the first period of health adaptation in Bulgaria will cover 2019–2022, after which it will be possible to evaluate the results and to identify further actions.

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Annex 1. Potential Climate Change Impacts on the Human Health Sector in Bulgaria

Table 12. Potential climate change impacts on the human health sector in Bulgaria

Affected Human Health Sector aspects	High temp.		Low temp.		Prolonged rainfall		Drought		Water table rise		Sea level rise		Specific effects of CC relevant for human health						Extreme Weather Events											
													UV-radiation		Combinat-ion (*)		Fires		Electric storms		Fog		Floods		Ava-lanches		Landslides		Storms	
	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P
Heat related morbidity and mortality	M	H	-	-	-	-	M	M	-	-	-	-	-	-	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-	-
Cold related morbidity and mortality	-	-	M	M	M	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H	H	-	-	-	-	-	-	-	-
Emergency weather-related morbidity and mortality	M	H	M	M	M	H	-	-	M	M	L	L	-	-	M	H	M	H	M	H	M	M	M	H	M	H	M	M	M	H
Cardiovascular diseases and strokes	M	H	M	M	-	-	-	-	-	-	-	-	-	-	M	H	M	H	M	M	-	-	-	-	-	-	-	-	L	L
Asthma, respiratory allergies and airway diseases	M	H	M	M	M	H	M	H	-	-	-	-	-	-	H	H	M	H	-	-	M	H	-	-	-	-	-	-	-	-
Cancer	U	U	-	-	-	-	-	-	-	-	-	-	H	H	H	H	L	M	U	U	M	M	-	-	-	-	-	-	-	-
Vector-borne and zoonotic diseases	M	H	H	H-	M	H	M	H	M	H	M	H	-	-	-	-	M	M	-	-	-	-	M	H	-	-	-	-	-	-
Foodborne diseases and nutrition	M	H	L	L	M	H	M	H	M	H	L	L	-	-	-	-	M	M	-	-	-	-	M	H	-	-	-	-	-	-
Waterborne diseases	M	H	H	H	M	H	M	H	M	H	M	H	-	-	-	-	-	-	-	-	-	-	M	H	-	-	-	-	-	-
Mental health and stress-related disorders	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H
Neurological diseases and disorders	M	H	L	M	M	H	L	M	M	H	L	M	-	-	M	H	M	H	-	-	M	H	M	H	-	-	-	-	-	-
Displacement of communities	M	H	M	H	M	H	M	H	M	H	M	H	L	M	L	M	L	M	-	-	L	M	M	H	-	-	L	M	L	M

(*) Combination of air pollution, humidity, and temperature

Legend: *D = damage; P = probability of occurrence by 2050 at latest; U = unknown; H = high; M = medium; L = low*
red = negative impact; green = positive impact; blank = neutral impact

Annex 2. Climate Change Adaptation Options in Detail

Table 13. Adaptation options presented in detail

<table>
<tr><th colspan="6">CLIMATE CHANGE ADAPTATION OPTIONS</th></tr>
<tr><td colspan="6">A. Legal-normative and Policy Capacity</td></tr>
<tr><td colspan="6">A.I. Target area Legal-normative Base</td></tr>
<tr><td colspan="2" rowspan="2">Relevant to:</td><td colspan="2">Health effects from Emerging Phenomena of Climate Change (EPCC)</td><td colspan="2">Health effects from Climate Change Emergencies (CCEm-s)</td></tr>
<tr><td colspan="2">X</td><td colspan="2">X</td></tr>
<tr><td colspan="2">Description</td><td colspan="4" rowspan="3">1. Review of all existing regulatory and normative documents in the field; identification of presence/lapses of relevant texts (with regard to EPCC and CCEm-s); development of prescriptions and recommendations.
2. Improvement of the existing texts/development of new texts (acts, standards, codes, rules, plans, etc.) (in relation to EPCC and CCEm-s).</td></tr>
<tr><td colspan="2">Option's relevance</td></tr>
<tr><td>Economic</td><td>Ecologic</td><td>Social</td></tr>
<tr><td>+++</td><td>+++</td><td>+++</td><td colspan="4"></td></tr>
<tr><td colspan="2">Opportunities that arise</td><td colspan="4">When the legislation is oriented toward preventive climate change risk management, this saves financial resources for post-event recovery.</td></tr>
<tr><td colspan="2">Cross-cutting relevance</td><td>YES</td><td colspan="3">Some legislative documents are cross-sectoral.</td></tr>
<tr><td colspan="2">Risks addressed</td><td colspan="4">All health risks induced by climate change</td></tr>
<tr><td colspan="6">A.II. Target area Policies' Base</td></tr>
<tr><td colspan="2" rowspan="2">Relevant to:</td><td colspan="2">Health effects from Emerging Phenomena of Climate Change (EPCC)</td><td colspan="2">Health effects from Climate Change Emergencies (CCEm-s)</td></tr>
<tr><td colspan="2">X</td><td colspan="2">X</td></tr>
<tr><td colspan="2">Description</td><td colspan="4" rowspan="3">1. Review of all existing policies in the field; development of prescriptions and recommendations for their improvement and/or actualization, or development of new policies.</td></tr>
<tr><td colspan="2">Option's relevance</td></tr>
<tr><td>Economic</td><td>Ecologic</td><td>Social</td></tr>
<tr><td>++</td><td>++</td><td>++</td><td colspan="4"></td></tr>
<tr><td colspan="2">Opportunities that arise</td><td colspan="4">Good policies are a base for further legislative improvements.</td></tr>
<tr><td colspan="2">Cross-cutting relevance</td><td>YES</td><td colspan="3">The different policies may be of relevance to one, a few, or all other sectors.</td></tr>
<tr><td colspan="2">Risks addressed</td><td colspan="4">All health risks induced by climate change</td></tr>
<tr><td colspan="6">B. Administrative, Organizational, Communicational and Financial Capacity</td></tr>
<tr><td colspan="6">B.I. Target area Organization and Coordination</td></tr>
<tr><td colspan="2" rowspan="2">Relevant to:</td><td colspan="2">Health effects from Emerging Phenomena of Climate Change (EPCC)</td><td colspan="2">Health effects from Climate Change Emergencies (CCEm-s)</td></tr>
<tr><td colspan="2">X</td><td colspan="2">X</td></tr>
<tr><td colspan="2">Description</td><td colspan="4" rowspan="3">1. Establishment of inter-disciplinary coordination Working Group on 'Climate Change and Health' at the MoH (concerning EPCC and CCEm-s).
2. Development of Conception for coordination of actions on 'Climate Change and Health' with other sectors, and amongst the Health sector structures (concerning EPCC and CCEm-s).</td></tr>
<tr><td colspan="2">Option's relevance</td></tr>
<tr><td>Economic</td><td>Ecologic</td><td>Social</td></tr>
<tr><td>++</td><td>+</td><td>+++</td><td colspan="4"></td></tr>
<tr><td colspan="2">Opportunities that arise</td><td colspan="4">Chances for better intra- and inter-sectoral coordination.</td></tr>
<tr><td colspan="2">Cross-cutting relevance</td><td>YES</td><td colspan="3">All vertical and horizontal levels within the health sector, and between health sector and other sectors.</td></tr>
<tr><td colspan="2">Risks addressed</td><td colspan="4">All health risks induced by climate change</td></tr>
</table>

B.II. Target Area Partnership and Cooperation			
Relevant to:		Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)
		X	X
Description		1. Development and periodic updating of catalogue with good health sector adaptation practices (local, national and international aspects). 2. Establishment of partnerships and cooperation at local, national and international level with institutions and organizations presenting good practices.	
Option's relevance			
Economic	Ecologic	Social	
++	++	++	
Opportunities that arise		Faster exchange of useful ideas and their practical implementation.	
Cross-cutting relevance		YES	Health related aspects of all other sectors.
Risks addressed		All health risks induced by climate change	

B.III. Target Area Financing the adaptation of health sector to climate change			
Relevant to:		Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)
		X	X
Description		1. Preparation of a catalogue of all ways and approaches for financing the adaptation activities in the health sector, and - a conception for implementation of these approaches in the practice. 2. Establish a special national fund for assistance in case of climate change induced morbidity/mortality. 3. Establish a special national fund for assistance of research on climate change-and-health.	
Option's relevance			
Economic	Ecologic	Social	
++	+	+++	
Opportunities that arise		Better chance to find financial opportunities.	
Cross-cutting relevance		YES	In some cases, the financing is common for several sectors.
Risks addressed		All health risks induced by climate change	

C. Professional Capacity			
C.I. Target Area Awareness, Competency, and Skills			
Relevant to:		Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)
		X	X
Description		1. Elaboration and publication of series of thematic information materials – booklets, placards, brochures and others (concerning EPCC & CCEm-s), and their distribution amongst healthcare professionals. 2. Conducting of series of thematic workshops, lectures and trainings on the health effects of emerging and emergency climate change phenomena, embracing all the professionals, aiming at rising of the competency and skills of human resources in health sector (EPCC) and in civil protection, emergency, and fire services (CCEm-s). 3. Involving of the 'Emerging climate change phenomena and health' (EPCC) and the 'Climate change emergencies and health' (CCEm-s) topics into the education programs of master's and Ph.D. students from medical and other related to the topic universities and schools. 4. Organization of training courses for operation with the high technologic instruments.	
Option's relevance			
Economic	Ecologic	Social	
++	+	+++	

Opportunities that arise	The rise of awareness for health would rise the understanding for climate change effects on other sectors too. Better qualification could give better chance for career development, as well as for reduction of climate change related morbidity and mortality.	
Cross-cutting relevance	YES	All aspects and levels of climatic and medical sciences.
Risks addressed	All health risks induced by climate change	

C.II. Target Area Health prophylaxis and medical treatment

Relevant to:	Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)
	X	X
Description	1. Development of Program for prophylactic control of health status in relation to the diseases and disorders resulting from EPCC and CCEm-s. 2. Elaboration of medical treatment standards for health effects from each kind of EPCC and CCEm-s. 3. Conduction of specialized course for all staff of medical services on the elaborated standards. 4. Preparation of an organization to implement the developed standards and launch of the relevant medical treatment.	

Option's relevance		
Economic	Ecologic	Social
++		+++

Opportunities that arise	General strengthening of health, as well as earlier detection of other diseases, and their timely treatment. Opportunities for utilization during the prophilaxis of some favourable manifestation of climate change.	
Cross-cutting relevance	YES	Human well-being and life, tourism, climato-prophilaxis and climato-therapy, medical geography, and so on.
Risks addressed	All health risks induced by climate change	

D. Informational, Communicational and Technological Capacity

D.I. Target Area Public awareness and Education

Relevant to:	Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)
	X	X
Description	1. Development of a program for enhancement of public awareness and education on health effects of climate change in Bulgaria. 2. Introduction of the "Climate change and health" topic into education programs of primary and secondary schools. 3. Preparation and publication of textbooks and other materials for school education. 4. Conduction of a wide mass-media campaign on "Climate change and health" theme 5. Development, publication and dissemination of a range of promotion materials – brochures, placards, films, flyers, etc.	

Option's relevance		
Economic	Ecologic	Social
++	++	+++

Opportunities that arise	The rise of public awareness & education on the topic would contribute for rise of the general culture and understanding the climate change consequences related to other sectors too	
Cross-cutting relevance	YES	Education, Mass-media, Publiching activity.
Risks addressed	All health risks induced by climate change	

D.II. Target Area High technologies				
Relevant to:			Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)
			X	X
Description			1. Equipping the sector with high technologic and innovative installations for relevant reaction to the health effects of EPCC and CCEm-s.	
Option's relevance				
Economic	Ecologic	Social		
+	+	+++		
Opportunities that arise			Reduction of some old and, in some respects, harmful medical equipment	
Cross-cutting relevance			YES	IT sector, Internal designeing
Risks addressed			All health risks induced by climate change	

D.III. Target Area Monitoring and data				
Relevant to:			Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)
			X	X
Description			1. Launching of a National system for monitoring "Climate change and health". 2. Development of a National data-base "Climate change and health".	
Option's relevance				
Economic	Ecologic	Social		
+	++	+++		
Opportunities that arise			Monitoring and generateing a data-base could be of use not only for the health sector but for all others too	
Cross-cutting relevance			YES	Statistics, Monitoring technologies, All other sectors
Risks addressed			All health risks induced by climate change	

D.IV. Target Area 'Climate-and-health' early warning systems'				
Relevant to:			Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)
			X	X
Description			1. Establishment of National Early Warning System for health effects of EPCC and CCEm-s.	
Option's relevance				
Economic	Ecologic	Social		
++	+	+++		
Opportunities that arise			The early warning for climate change health hazards could be indicative for other sectors' hazards too.	
Cross-cutting relevance			YES	All sectors
Risks addressed			All health risks induced by climate change	

E. Capacity of the Built and Natural Environment

E.I. Target Area Built environment

Relevant to:	Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)
	X	X

Description	1. Improving the infrastructure resources (buildings, roads, power and water suply systems, etc.) of the health sector and adapting them to the manifestations of climate change, as well as to the corresponding increase in patients. 2. Development of conception for adjustment of built environment to EPCC and CCEm-s. 3. Economic stimulation for application of weather-proof constructions, materials and other protective tools. 4. Building of public places with protective architecture and landscape design against extreme manifestations of the changing climate - hot, cold, humid, dry, windy, stormy, etc. 5. Application of strict and rigorous control on air quality. 6. Preparation of harbourages/hospices for protection from extreme weather of the people from vulnerable groups.

Option's relevance		
Economic	Ecologic	Social
++	neutral	+++

Opportunities that arise	The improvements of built environment could be of use not only for health but for all sectorys (excluding agriculture) - transport, tourism, energy, waters, etc.

Cross-cutting relevance	YES	Most sectors, without agriculture and partially – ecology and biodiversity

Risks addressed	All health risks induced by climate change

E.II. Target Area Natural environment

Relevant to:	Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)
	X	X

Description	1. Risk assessment of the territory at municipal level according to the frequency and intensity of EPCC and CCEm-s - geographic (territorial and temporal) distribution and mapping. Development of corresponding knowledge-base catalogue. 2. Elaboration of EPCC and CCEm-s maps with favorable and dangerous territories in Bulgaria. 3. Development of measures for adequate treatment of harmful health sector waste

Option's relevance		
Economic	Ecologic	Social

Opportunities that arise	The differentiation of the country territory according to the health risks is could give useful information for governmental and local authorities, and for planning of the future development. Risk resource assessment will be of use for highlighting of favorable climatic resources too.

Cross-cutting relevance	YES	All sectors.

Risks addressed	All health risks induced by climate change

E.III. Target Area Favorable climate change opportunities			
Relevant to:	Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)	
	X	X	
Description	1. Identification, assessment and mapping the territorial distribution of favorable health opportunities from climate change (related to EPCC). 2. Elaboration of Program for exploitation of favorable climate change opportunities.		
Option's relevance			
Economic	Ecologic	Social	
++	++	++	
Opportunities that arise	Elicitation of favorable climatic resources for tourism, nutrition, clean and renewable energy, biodiversity, etc.		
Cross-cutting relevance	YES	All sectors.	
Risks addressed	no		

F. Socio-economic Capacity			
F.I. Target Area General vulnerability assessment			
Relevant to:	Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)	
	X	X	
Description	1. Development of methodologic approach for vulnerability assessment of health sector to climate change in Bulgaria. 2. Assessment and mapping of health sector vulnerability in Bulgaria at a municipal level. 3. Classification of the territory in Bulgaria according to the level of a health vulnerability to climate change.		
Option's relevance			
Economic	Ecologic	Social	
++	neutral	+++	
Opportunities that arise	Assessment of the exposure, sensitvity and adaptive capacity of health sector to the climate change		
Cross-cutting relevance	YES	All sectors.	
Risks addressed	All health risks induced by climate change		

F.II. Target Area Vulnerable groups' protection			
Relevant to:	Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)	
	X	X	
Description	1. Development of cadaster of groups in Bulgaria vulnerable to EPCC and CCEm-s at municipal level. 2. Development of Program for work with groups vulnerable to EPCC and CCEm-s. 3. Development of Program for work with climate change migration groups		
Option's relevance			
Economic	Ecologic	Social	
++	neutral	+++	
Opportunities that arise	Solving some other problems of vulnerable groups, not only related to health and climate change.		
Cross-cutting relevance	YES	Social development.	
Risks addressed	All health risks induced by climate change		

G. Research Capacity

G.I. Target Area Research investigations

Relevant to:	Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)
	X	X

Description	1. Development of methodological approaches for risk and vulnerability assessment of climate change impact on the human health. 2. Enhancement of knowledge-base about the mechanisms of influence of EPCC and CCEm-s in Bulgaria on human health. Development of corresponding knowledge-base catalogue. 3. Involving 'Climate and Health' topic into the list of National research priorities.

Option's relevance		
Economic	Ecologic	Social
++	++	+++

Opportunities that arise	Enhancement of knowledgebase of climatology and human bio-climatology.	
Cross-cutting relevance	YES	Climatology, medical geography, all sector
Risks addressed	All health risks induced by climate change	

G.II. Target Area Research frameworks of 'Monitoring and Data' activity

Relevant to:	Health effects from Emerging Phenomena of Climate Change (EPCC)	Health effects from Climate Change Emergencies (CCEm-s)
	X	X

Description	1. Development of a conception about "Climate change-and- health" monitoring, data collection and database generation. 2. Development of Conception for building of National Early Warning EPCC and CCEm-s System.

Option's relevance		
Economic	Ecologic	Social
++	++	++

Opportunities that arise	Improvement of approaches and techniques for monitoring and data-base processing, and translating the results into an appropriate for the public usage kind	
Cross-cutting relevance	YES	Monitoring technologies; statistics.
Risks addressed	All health risks induced by climate change	

Annex 3. Cost-benefit Analysis

1. General Description

Climate change is affecting human health and it entails a wide variety of public health risks. Climate change has already affected human health directly by changing weather patterns (temperature, precipitation and frequent extreme events) and indirectly by changing water, air and food quality and biodiversity systems. Investment in healthy environments and in health systems could reduce the burden of disease and improve the health of the population.

The conceptual framework of the cost-benefit-analysis (CBA) was developed based on climate change affecting the Human Health sector.

The purpose of this section is to:

- Estimate the parameters of a relationship between performance indicators and climate change indicators for the human health sector (temperature +2° C and +4°C, and precipitation changes). It is considered that climatic drivers associated with the impact assessment are average temperature and average precipitation.
- Develop a CBA model – appraising the costs and benefits of adaptation actions, thus measuring the efficiency of investments. It quantifies the anticipated costs and benefits of adaptation options with the aim of comparing them and determining whether the benefits outweigh the costs. Benefits are the advantages or positive effects of adaptation measures. Costs are the resources required to deliver adaptation measures. The effects are expressed as a decrease in costs because of adaptation measures taken.
- Evaluate and rank the adaptation measures in terms of economic efficiency.

1.1. Description of the methodology

Climate effects were evaluated in an integrated assessment model, which combines a regression (or sensitivity) analysis with CBA, that is, assesses the value of the costs and benefits of each adaptation action - giving a net present value (NPV) - and compares the costs (investment expenditure) and benefits (costs avoided). Costs and benefits are expressed in monetary terms and a discount rate is used to determine the NPV of the adaptation measures.

The regression analysis - as a technique to assess adaptation measures under uncertainty - identifies those factors that have most influence on main sectoral indicators. The effect can be positive or negative.

The estimation of the negative and positive effects of climatic changes was developed according to distinct scenarios at +2°C and +4°C temperature rise by 2050. These main scenarios are divided into sub–scenarios: optimistic, realistic, and pessimistic. The sub-scenarios are considered in the context of efficient and effective implementation of the proposed climate change adaptation measures.

The projected effects of adaptation measures are expressed as a logarithmic function, which is a tool to measure the effects of investments that would be gradually made until 2050.

An assessment was carried out of the NPV and the benefits until 2050, holding all other aspects constant. The monetary value of the effects was discounted by 4.5 percent for public funding and by 8 percent for private funding.[46]

The benefits are defined as the positive effect of the implementation of climate change adaptation measures in the health sector.

1.2. Data collection procedure

The primary data used for the CBA was obtained from the Action Plan that is part of a draft proposal for a National Climate Change Adaptation Strategy and Action Plan for Bulgaria, and from official statistical data, as far as available.

The correlation determined whether there is a relationship between the performance indicators and climate factors. The relationship indicates which indicators are significantly dependent on climate change. Estimation of the correlation coefficient (dependence between each sectoral indicator and climate change factors [temperature and precipitation]) is used to stand out and select the critical variables (variables, which are highly sensitive to climate factors).

1.3 Model specifications - assumptions and limitations

A number of assumptions were made when preparing and carrying out the CBA. These include:

- The projected trend value of each sector indicator based on historical data (2005–2015);
- To estimate health costs, the performance indicators are addressing health, health care and health service. The main performance indicators included in the analysis are: current expenditure for hospitals; current out-patient health expenditure; current expenditure through the system of retail sale in pharmacies, optical and sanitary shops; and current expenditure on curative and rehabilitative care. Public budgets and private costs which address new health threats as a result of climate change are taken into account. The impact of climate change factors on cash outlay, and on public budget allocations for curative and rehabilitative care was clarified.
- Climate projections (temperature and precipitation) were applied to historical variances experienced in Bulgaria (1991–2015). The input data for climate factors consist of annual temperatures (maximum, minimum, and average) and precipitation (maximum, minimum, and average).
- A baseline scenario is used to evaluate the development trend of the performance indicators under the +2°C and +4°C temperature rise scenarios. The baseline scenario reflects a continuation of current policies and plans, that is, a future in which no new measures are taken to address climate change.
- The benefits are defined as the positive effect of the implementation of climate change adaptation measures in the health sector.

[46] Discount rate: the rate at which future benefits and costs are discounted to make them comparable with benefits and costs at the present time.

2. Results of the Regression Analysis

The regression analysis between climate change factors and sectoral performance indicators could not be made because of a lack of available statistical data of diseases and mortality resulting from climate change (increased temperature, heat waves, and extreme weather events). Climate change has a wide range of implications for human health, including increased mortality and different illnesses caused by temperature changes. This insufficient information availability hinders the correct accounting of the relationship between performance indicators and climate change parameters.

A baseline scenario was used to evaluate the development trend of the performance indicators in the +2°C and +4°C temperature rise scenarios without taking into account climate change adaptation measures. This baseline scenario reflects a continuation of current policies and plans (that is, a future in which no new measures are taken to address climate change).

The assumption of the CBA is that climate change can negatively affect human health and thus, additional use of health care, lost human productivity, and partially avoidable loss of welfare are accounted as economic cost. The objective of the baseline analysis is, in the context of climate change, to show the losses of inaction and to highlight the value of health effects and the need to avert or reduce them.

Adaptation measures can reduce the health effects of climate change, protect the health of the population, and avoid damage costs.

The cumulative sector effects presented in ***Table 14*** illustrate the difference between the baseline scenario (that is, without implementing selece

ted adaptation measures), and the +2°C and +4°C temperature rise scenarios until 2050.

Table 14. Expected cumulative sector effects from climate change in the Human Health sector until 2050 without adaptation measures (baseline scenario in € mln.)

Performance indicators	2°C scenario	4°C scenario
Current expenditure for hospitals - total (€ mln.)	107.09	233.65
Current out-patient health expenditure - total (€ mln.)	57.18	124.76
Current expenditure through the system of retail sale in pharmacies, optical and sanitary shops (€ mln.)	130.69	285.14
Current expenditure on curative and rehabilitative care (€ mln.)	150.30	327.93

Overall, the effects of climate change on the performance indicators are negative.

Additional expenditure for hospitals to cover the damage to health in case no adaptation measures are taken for the period until 2050, will be around €107 million under the +2°C and €233 million under the +4°C scenario. Out-patient health expenditure are €57 million higher under the +2°C and €124.76 million higher under the +4°C scenario.

The economic consequences of climate change variability are substantial for the Bulgarian population; the indicator 'expenditure through the system of retail sale in pharmacies' will reach

an amount of €130 million under the +2°C and €285 million under the +4°C scenario. In addition, expenditure for curative and rehabilitative care will also increase to 2050.

3. Results of the Cost-Benefit Analysis

The CBA for the sector focuses on the assessment of soft adaptation measures. The benefits gained as a result of their implementation are best exemplified through the quantification of a number of main performance indicators (current expenditure for hospitals; current out-patient health expenditure; current expenditure through the system of retail sale in pharmacies, optical and sanitary shops; current expenditure on curative and rehabilitative care). These are assumed to be positive. The net present value (NPV) in ***Table 15*** illustrates the monetary value of avoided losses as a result of implemented adaptation measures, while the cost effectiveness quantifies the benefits achieved in relation to the required investments/costs.[47]

Table 15. Benefits of adaptation measures in the Human health sector until 2050 (in €, mln.)

Climate scenarios	NPV (€, mln.)	Cost-effectiveness (Benefit/Cost ratio)
Realistic scenario +2°C	5.01	1.10
Optimistic scenario +2°C	9.04	1.18
Pessimistic scenario 2°C	0.984	1.02
Realistic scenario +4°C	107.27	3.21
Optimistic scenario +4°C	118.99	3.45
Pessimistic scenario +4°C	95.548	2.96

The projection shows that on average, under the +2°C realistic scenario, the total cash flow in NPV is €5.0 million and €107.2 million under the realistic scenario at +4°C. Under the optimistic scenario the projected cash flow in NPV is €9.0 million at +2°C average and €118.9 million at +4°C average. Even in the pessimistic scenario the future cash flow in NPV is projected at €984 thousands at +2°C and €95.5 million at +4°C.

In this analysis, the cost-effectiveness of the adaptation measures is used to quantify the effect of investments under each scenario.[48] Under the +2°C realistic scenario the benefit/cost ratio is €1.10 (that is, the benefit achieved per Euro spent), and €3.21 under the +4°C realistic scenario. The benefit is higher at +4°C temperature rise. In that case, the benefit is €3.45 per one Euro of investment under the optimistic scenario and €2.96 per one Euro of investment under the pessimistic scenario. A higher effect of investments is observed under the +4°C scenario because the average air temperature during 1991–2015 has already increased by +1.6°C. Thus, to date, the level of the +2°C scenario has already almost been reached.

[47] The NPV of an adaptation option is given by the present value of the estimated benefits and costs. If NPV is more than zero, this indicates that the investment is efficient and incremental benefits of adaptation exceed the incremental resource costs. If NPV is <0 or B/C is <1, then the adaptation measures add no net benefit to the Human Health sector. If NPV is >0 or B/C is >1, then it adds positive benefits. The positive value of NPV confirms that investments for adaptation are efficient.
The benefit-cost ratio (B/C) is the ratio of the present value of benefits to the present value of costs. When the B/C ratio is more than one, the present value of the option's benefits is larger than the present value of its costs.

[48] The cost-effectiveness refers to all measures.

4. Conclusions

The economic savings and potential benefits of health relevant adaptation is measured against the costs of implementing adaptation measures.

The total sector effect of increased temperature is negative, and it leads to an increase of the costs for health care.

The overall effects of the adaptation measures will be cost saving as a result of potentially decreased health damage from climate change. The NPV calculation shows that investments in adaptation measures are economically efficient. Moreover, adaptation measures are important for effective health preparedness and response to climate change. Benefits calculation of adaptation measures to climate change provide overall estimates of the economic dimensions of the problem and illustrate the relative costs of climate change effects of human health.

Annex 4. Miscellaneous Human Health Sector Information

Table 16. Some of the most frequent climate change affected vector-borne diseases in Bulgaria

	Vectors		
	TICKS	MOSQUITOES	PHLEBOTOMES
Diseases	Lyme disease	West-Nile encephalitis	Leishmaniasis
	Q-fever	Malaria	
	Tick-bone encephalitis		

Source: Mihaylova 2014.

Table 17. Demonstrable links between climatic variables and selected pathogens

	Campylobacter	Salmonella	Listeria	Vibrio	Cryptosporidium	Norovirus
Temperature	↔	↔	?	↔	↔	↔
Extreme Temperature	↔	?	?	↔	↔	?
Temperature threshold	↔	↔	?	↔	↔	?
Precipitation	↔	↔	?	↔	↔	?
Precipitation pattern(a)	↔	?	?	?	↔	↔
Extreme precipitation	↔	?	?	↔	↔	↔
Humidity	↔	↔	↔	?	?	?
UV light	↔	↔	↔	↔	↔	?
Seasonality	↔	↔	?	↔	↔	↔
Salinity	O	O	O	↔	O	O
Floods	↔	↔	?	↔	↔	↔
Drought	↔	?	?	O	↔	?
Storms	?	?	?	↔	?	?
Irrigation(b)	?	↔	?	O	↔	?
Recreational activities	↔	↔	?	↔	↔	↔
Shellfish production	↔	↔	↔	↔	?	↔
Consumption habits	↔	↔	↔	↔	↔	↔

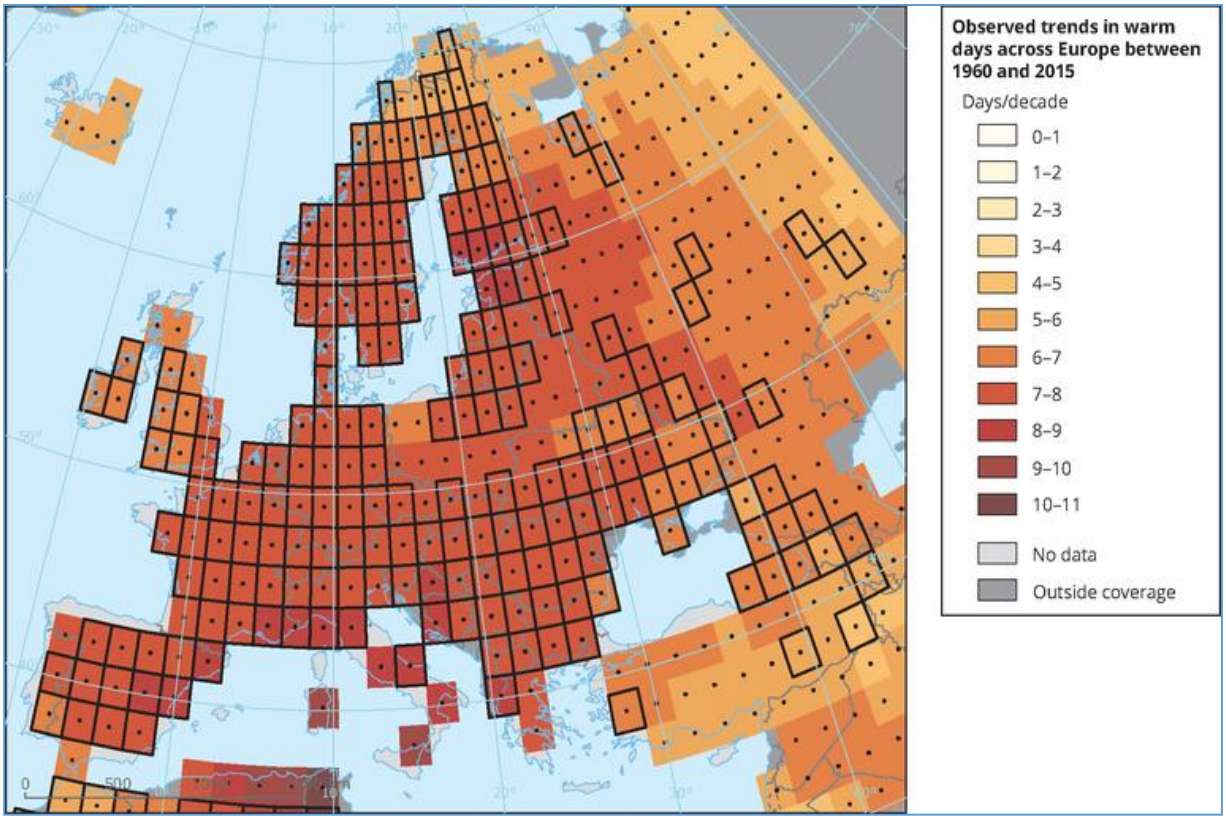
Note: [(a)] For example, seasonality of rain events

[(b)] Water

↔ = impact; O = no impact; ? = impact unknown

Source: Semenza et al. 2012.

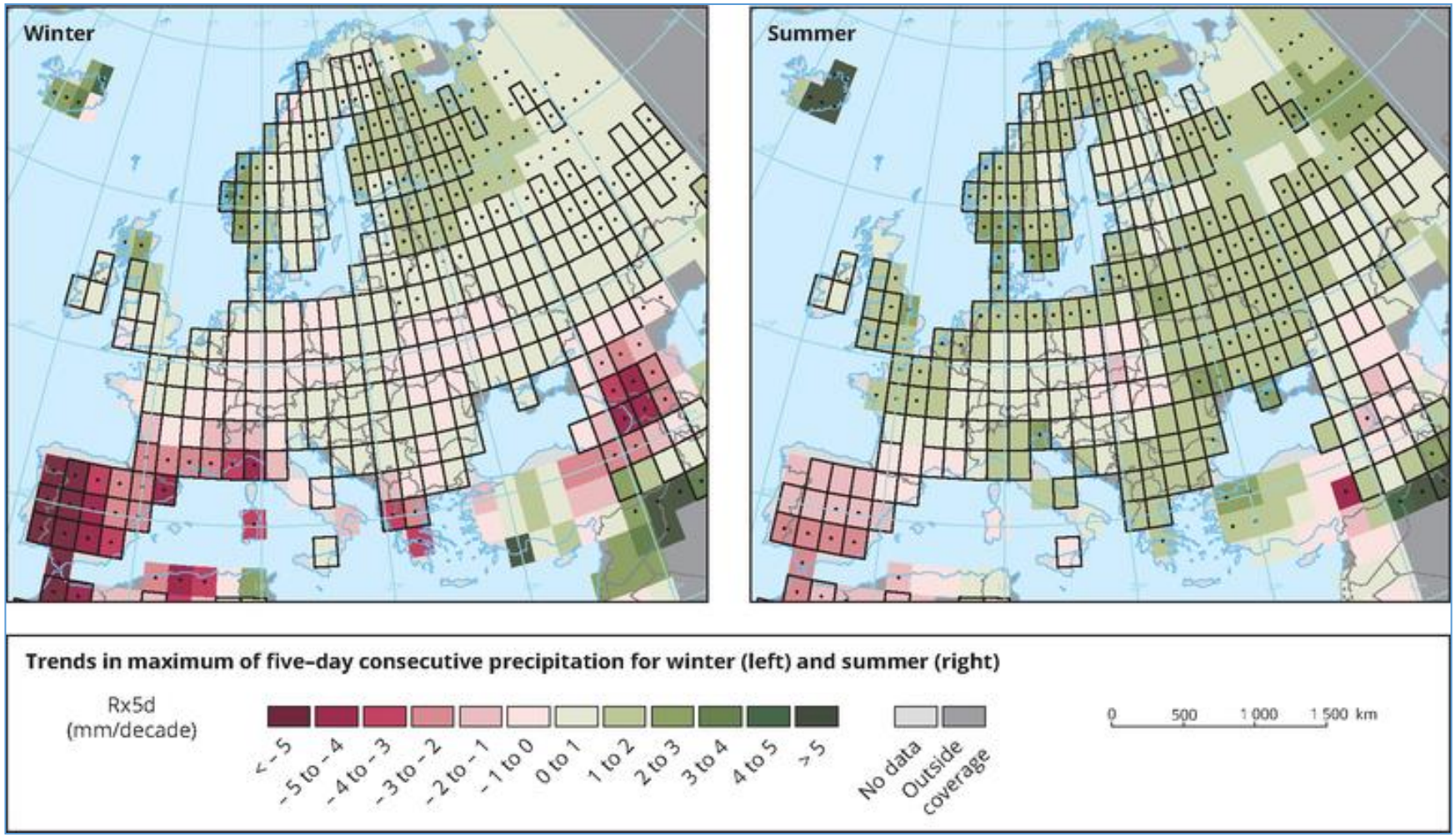
Figure 13. Observed trends in warm days between 1960 and 2015



Note: Warm days are defined as being above the 90th percentile of the daily maximum temperature centered on a five-day window for a reference period. Grid boxes outlined with solid black lines contain at least three stations and thus trends are more robust. High confidence in the long-term trend (at the 5 percent level) is shown by a black dot (which is the case for all grid boxes in this map). The reference period is 1971–2000.

Source: EEA and UK Met Office, based on HadEX2 (updated from Donat et al. 2013).

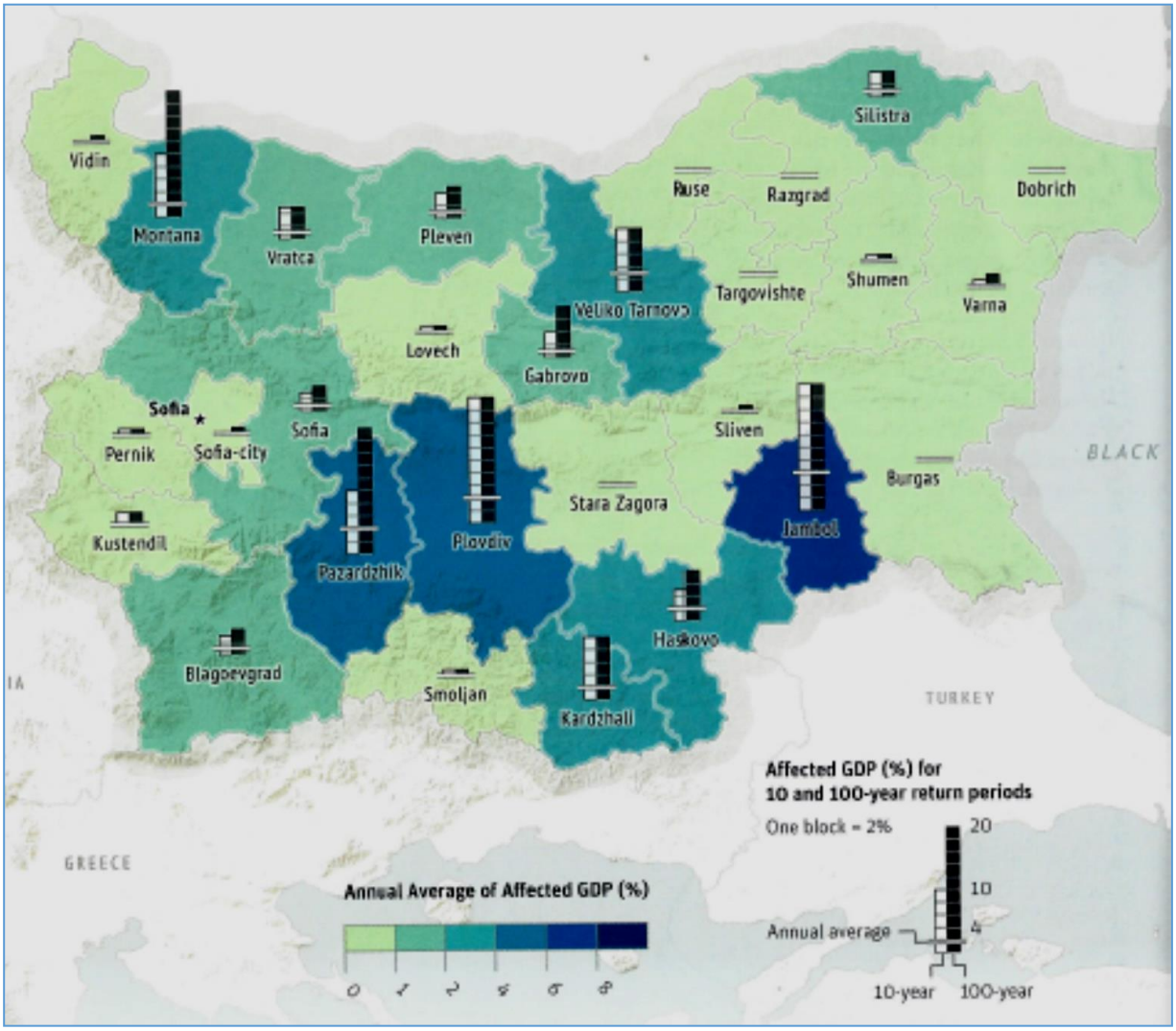
Figure 14. Observed trends in maximum annual five-day consecutive precipitation in winter and in summer between 1960 and 2015



Note: This map shows observed trends in maximum annual five-day consecutive precipitation across Europe in winter (left) and summer (right) between 1960 and 2015. Boxes with an outline contain at least three stations. Black dots show trends that are statistically significant (at the 5 percent level).

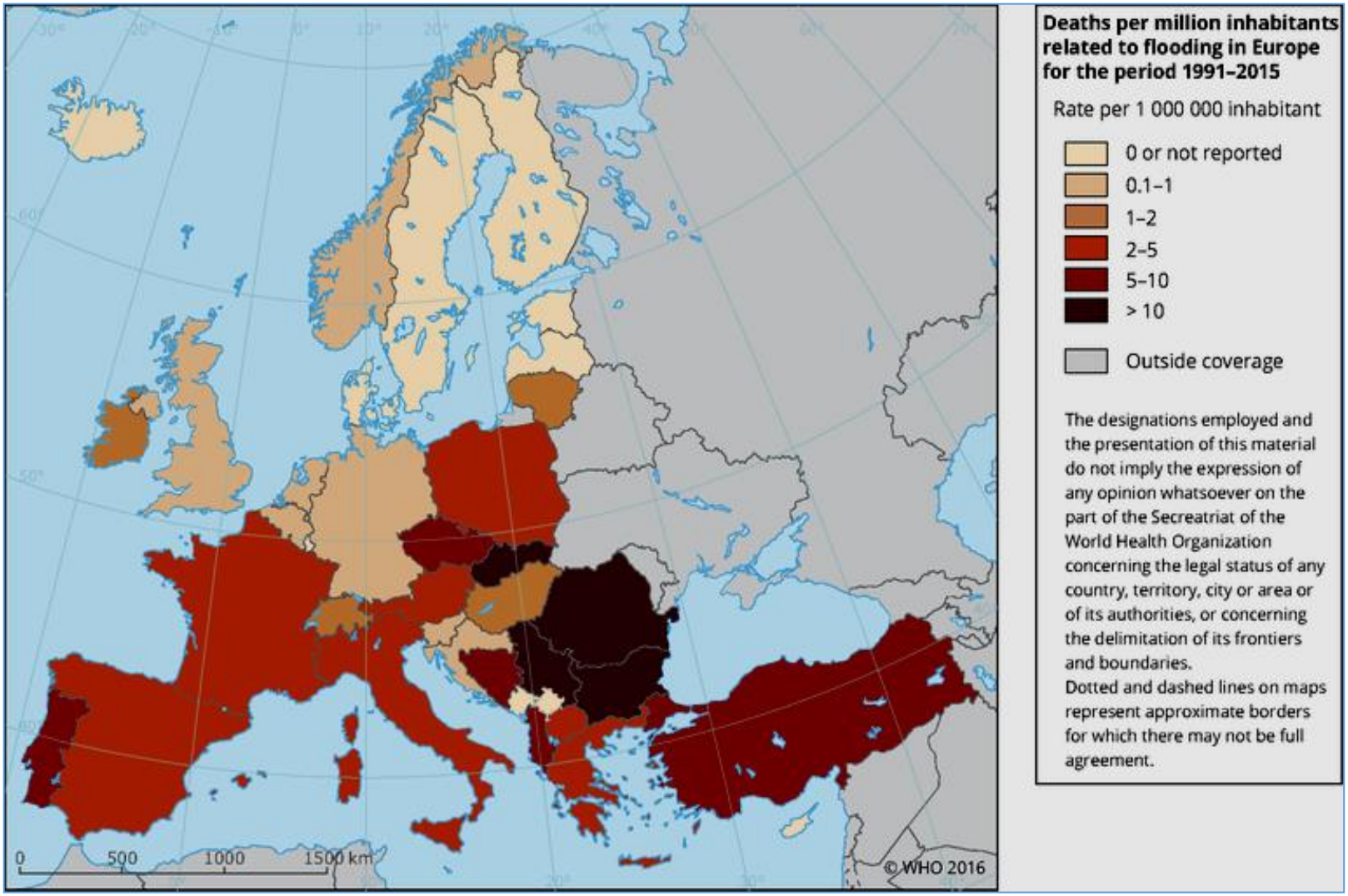
Source: EEA and UK Met Office, based on HadEX2 (updated from Donat et al. 2013).

Figure 15. Country districts of Bulgaria presented by annual average of affected GDP (%)



Source: World Bank Group/Country risk profiles/Europe and Central Asia

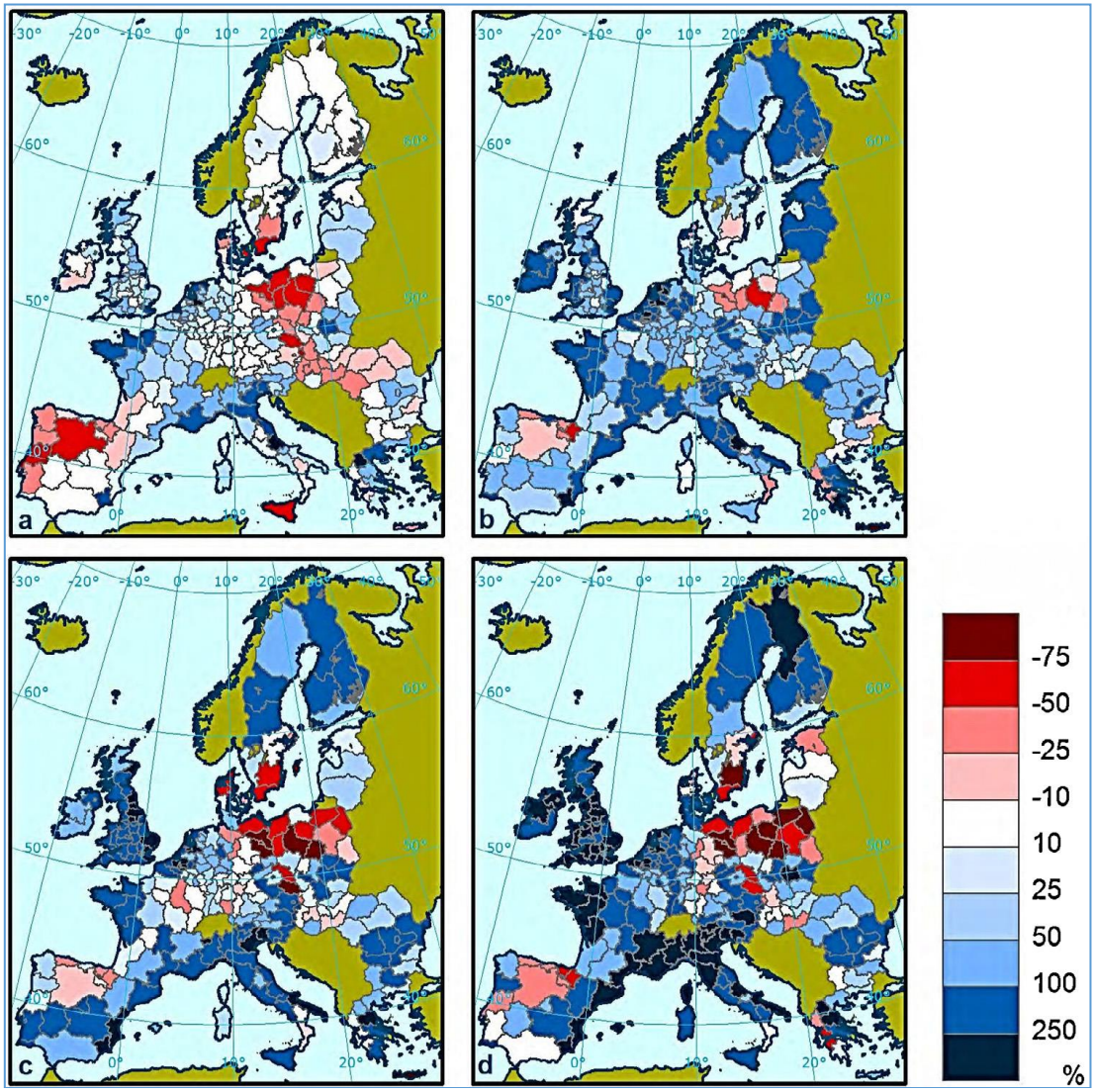
Figure 16. Deaths related to flooding in Europe for the period 1991–2015



Note: This map shows the number of deaths per million inhabitants related to flooding in Europe (cumulative over the period 1991–2015)

Source: EM-DAT, adapted from WHO and PHE, 2013. © 2016 WHO.

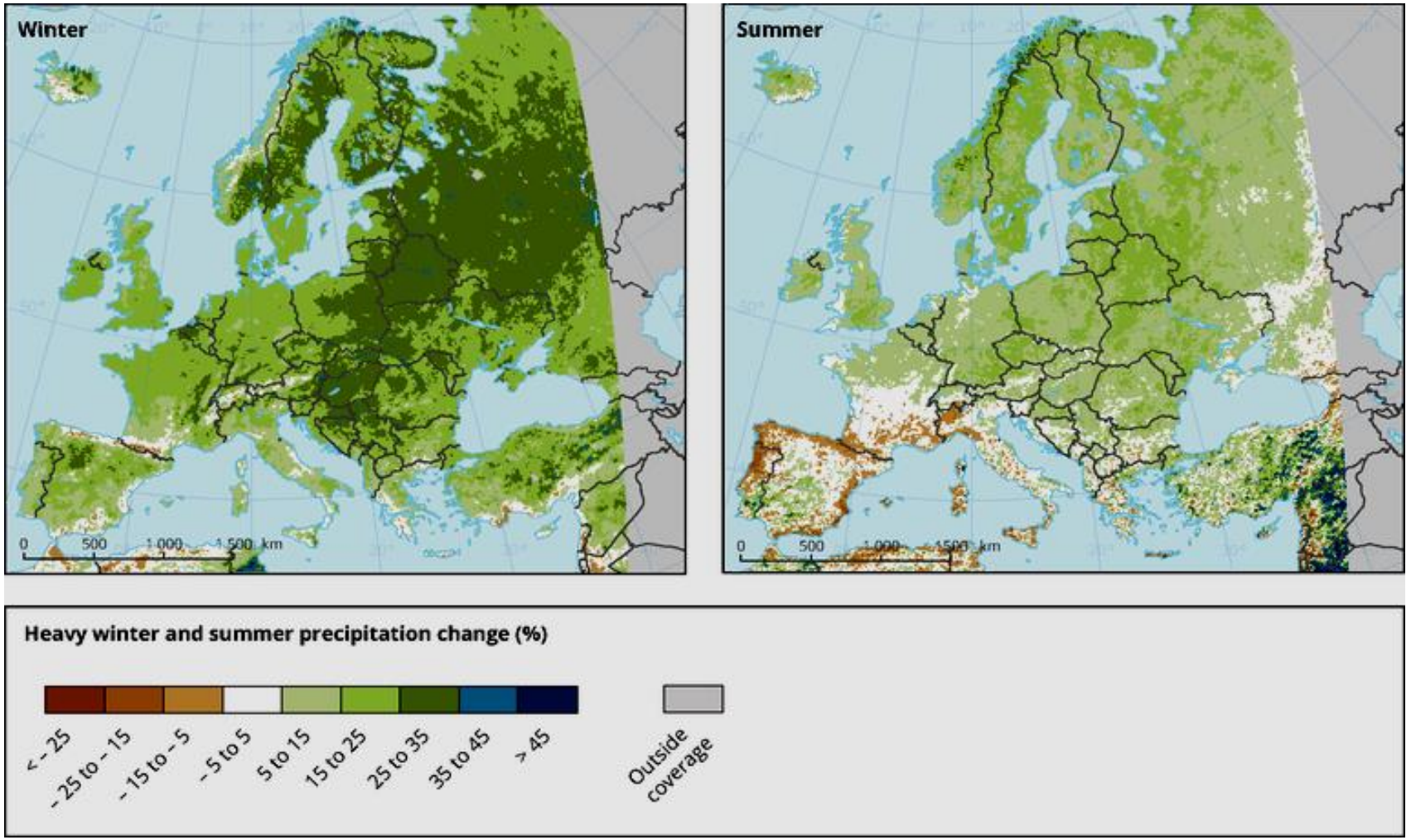
Figure 17. Changes in expected annual damages compared to the control period (1961–1990) for the (a) 2000s, (b) 2020s, (c) 2050s, and (d) 2080s.



Note: Scenario with only climate change, with flood protection up to the current 100-year flood event assumed constant in time. Ensemble-based average estimates based on 12-member climate ensemble for the A1B scenario. Values are aggregated at administrative level NUTS2 regions.

Source: Rojas, Feyen, and Watkiss 2013.

Figure 18. Projected changes in heavy precipitation in winter and summer

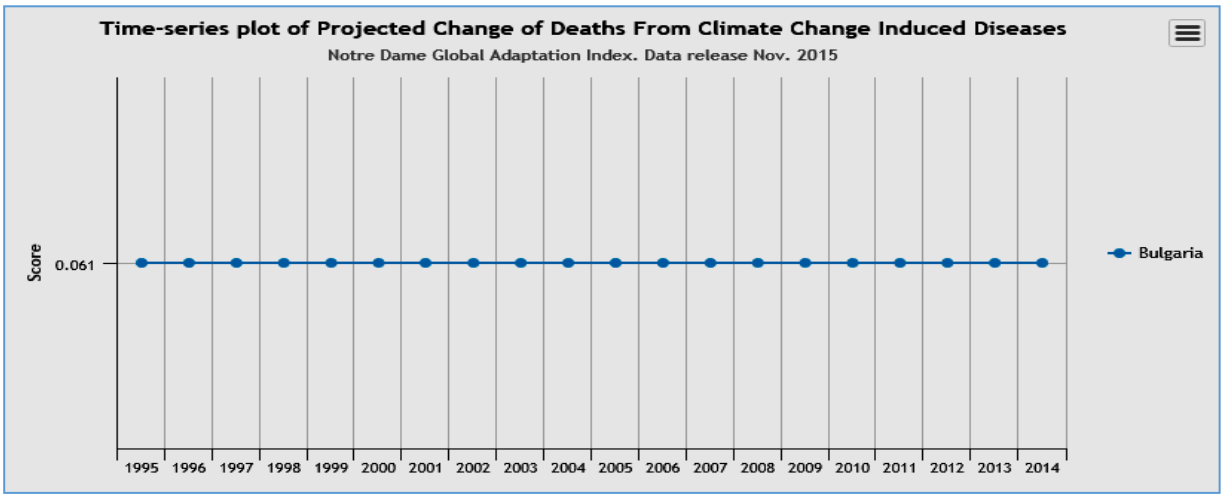


Note: *This map shows projected changes in heavy daily precipitation (percentage) in winter and summer for 2071–2100, compared with the baseline period 1971–2000, for the RCP8.5 scenario based on the ensemble mean of different RCMs nested in different GCMs.*

Source: *EURO-CORDEX (Jacob et al. 2014).*

Indicators' score of vulnerability of health sector in Bulgaria to climate change

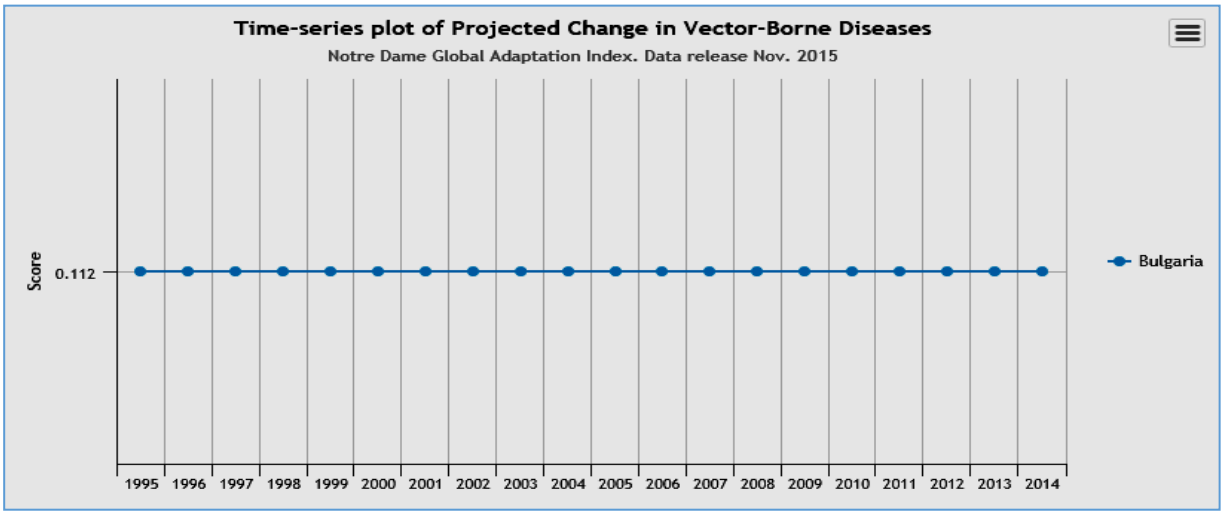
Figure 19. Score of Projected change of deaths from climate change induced diseases indicator



Source: Bosello et al.2011, Watkiss, and Hunt 2012.

Description: Projected impact of climate change on malnutrition and diarrheal diseases measured by DALYs. The projected change is the percent increase of DALYs from the historical baseline (2000) to the 2030 estimation using S550 emission scenario

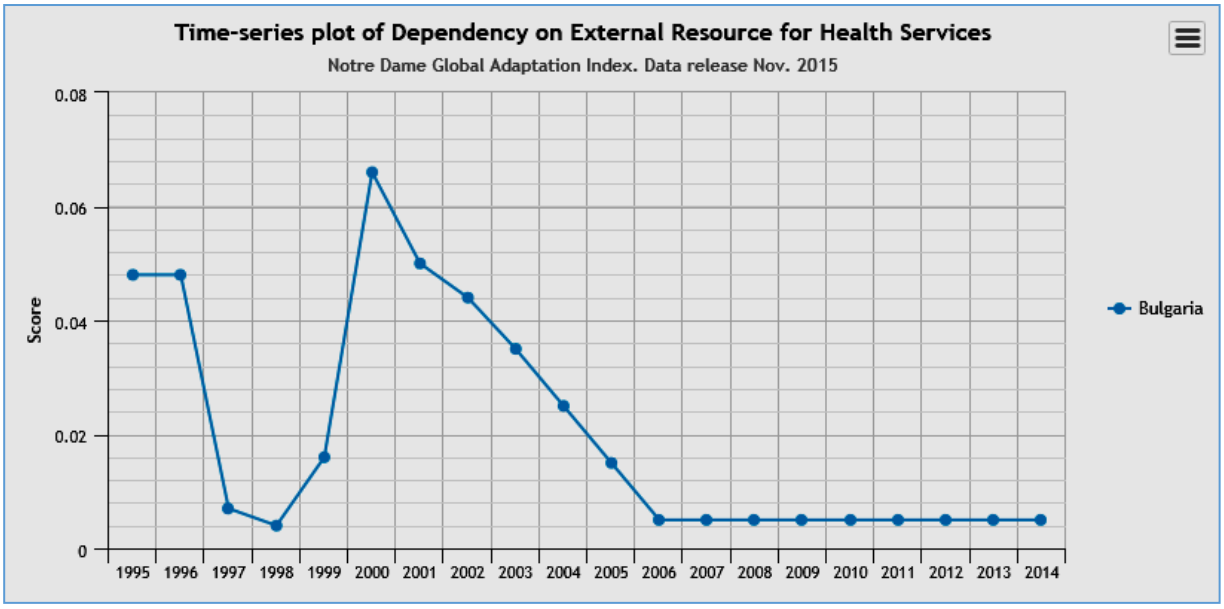
Figure 20. Score of Projected change in vector-borne diseases indicator



Source: Bosello et al. 2011, Watkiss and Hunt 2012.

Description: Projected change of the hazard of vector-borne diseases. This indicator takes malaria as the type of vector-borne disease measuring its Length of Transmission Season (LTS). The projected change is the percent increase of malaria length of transmission season from the baseline projection (1980–2010) to the future projection in 2050, using RCT4.5 emission scenario.

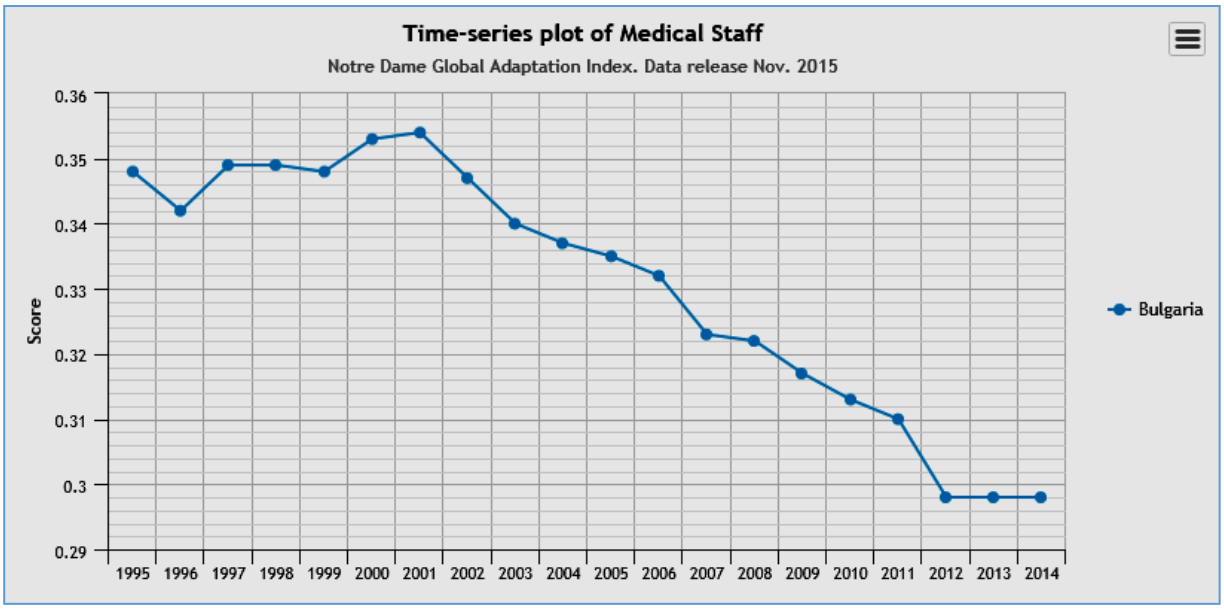
Figure 21. Indicator score of Dependency on external resource for health services



Source: Bosello et al. 2011, Watkiss and Hunt 2012.

Description: The proportion of total expenditures to health or related services that are provided by entities external to the country.

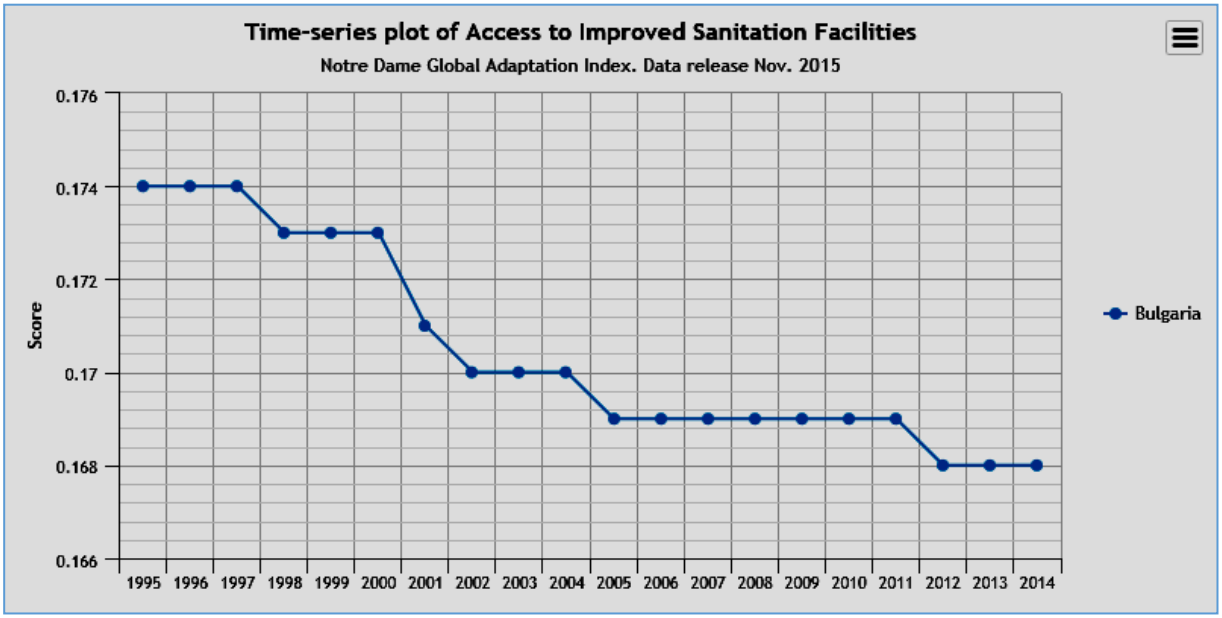
Figure 22. Score for Medical staff indicator



Source: Bosello et al. 2011, Watkiss and Hunt 2012.

Description: Number of medical staff per 1,000 people, including physicians, nurses and midwives.

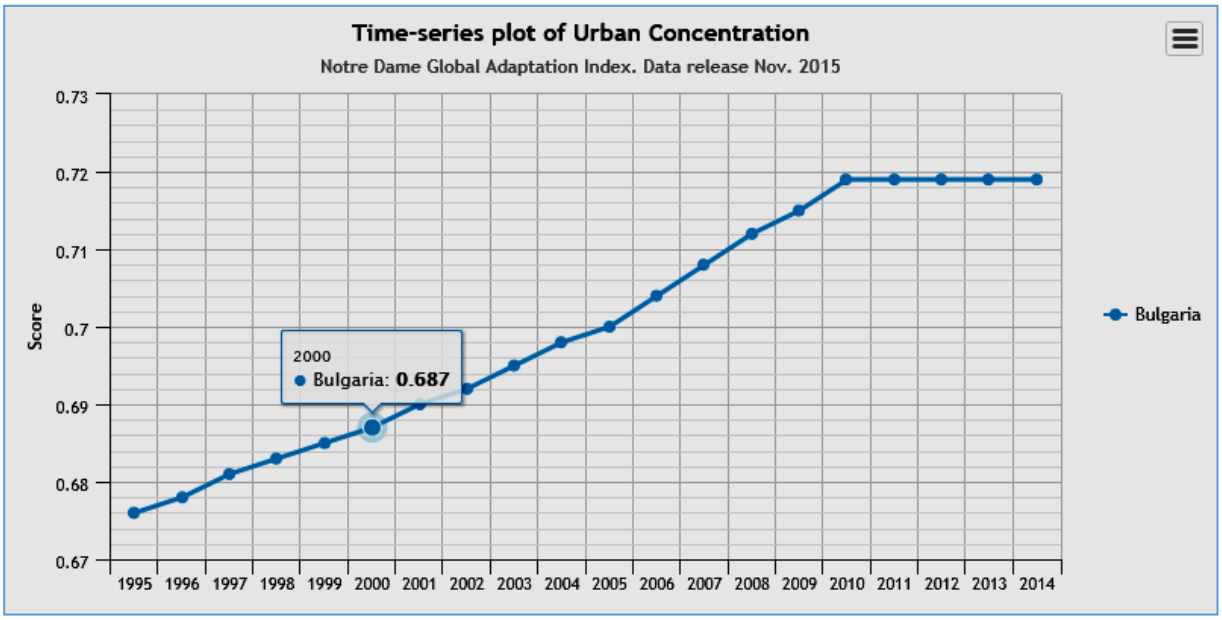
Figure 23. Score for Access to improved sanitation facilities indicator



Source: Bosello et al. 2011, Watkiss and Hunt 2012.

Description: The proportion of the population with access to excreta disposal facilities that can effectively prevent human, animal, and insect contact with excreta.

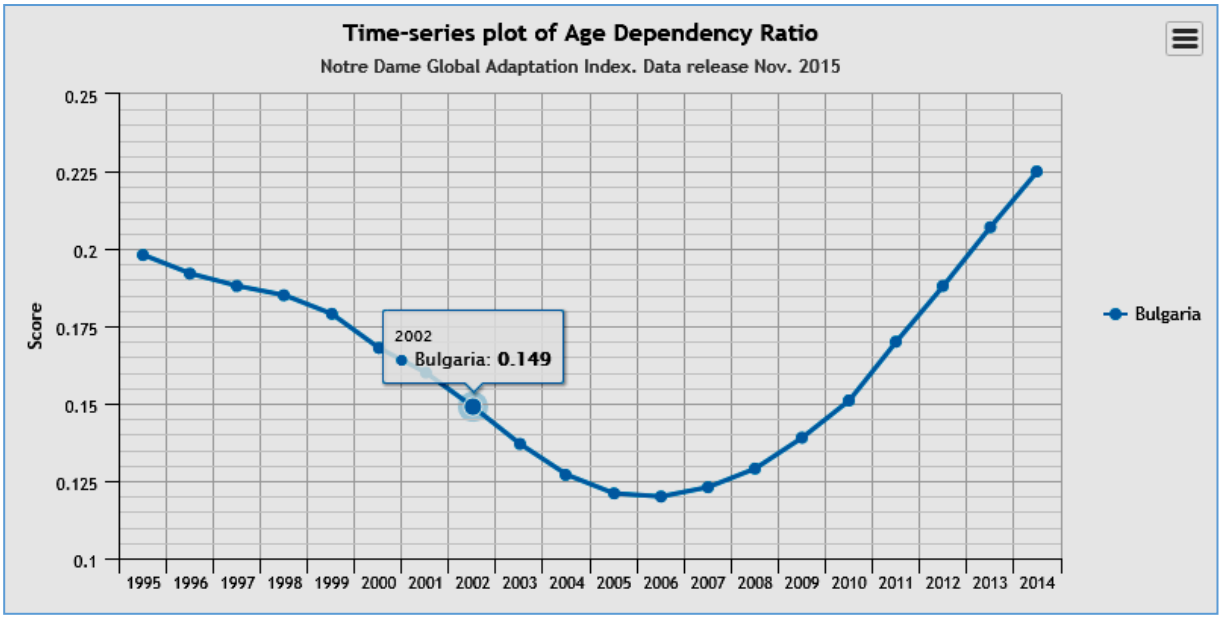
Figure 24. Score of Urban concentration indicator



Source: Bosello et al. 2011, Watkiss and Hunt 2012.

Description: The concentration of a country's population within a small number of large population centers. It is the concentration of the urban population residing in large cities (>750,000), weighted by the total urbanized population. Specifically, it is the summation of a concentration measure for each city within the country times the proportion of urban population over the total country population.

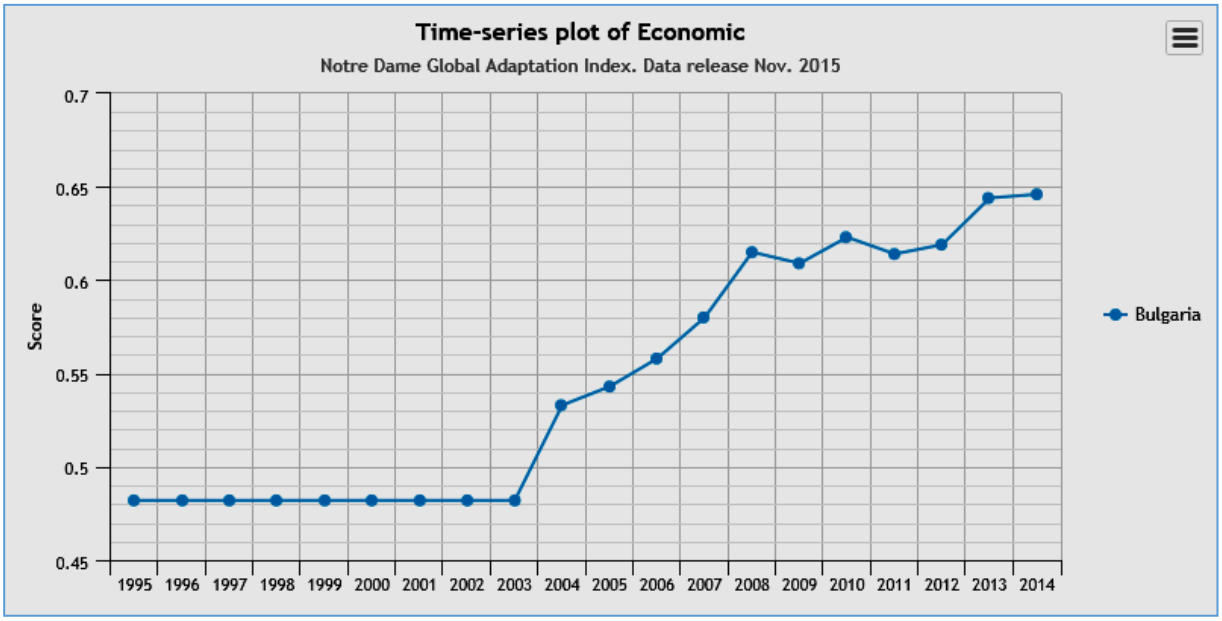
Figure 25. Score of Age dependency ratio indicator



Source: Bosello et al. 2011, Watkiss and Hunt 2012.

Description: The proportion of vulnerable populations, including the share of the population above age 65 and the population under 14.

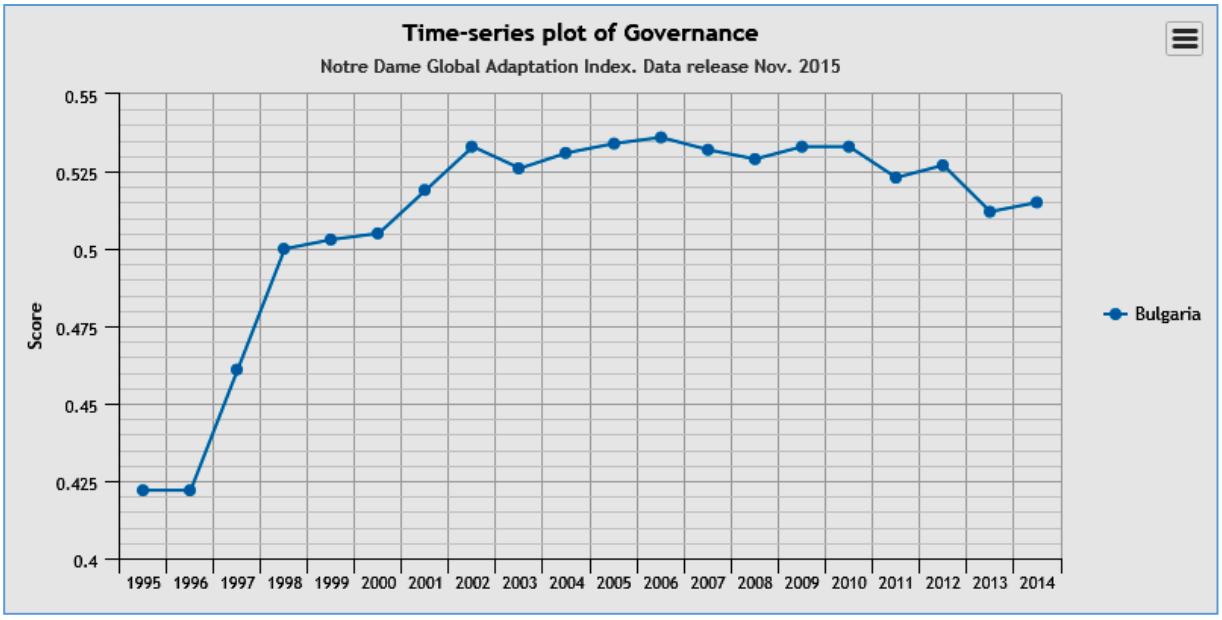
Figure 26. Score of Economic readiness indicator



Source: Bosello et al. 2011, Watkiss and Hunt 2012.

Description: The score of Economic readiness captures the readiness of a country's business environment to accept investment that could be applied to adaptation in the form of business formation and maintenance. A simple multi-factor index, Doing Business Index from the World Bank is the measure of economic readiness.

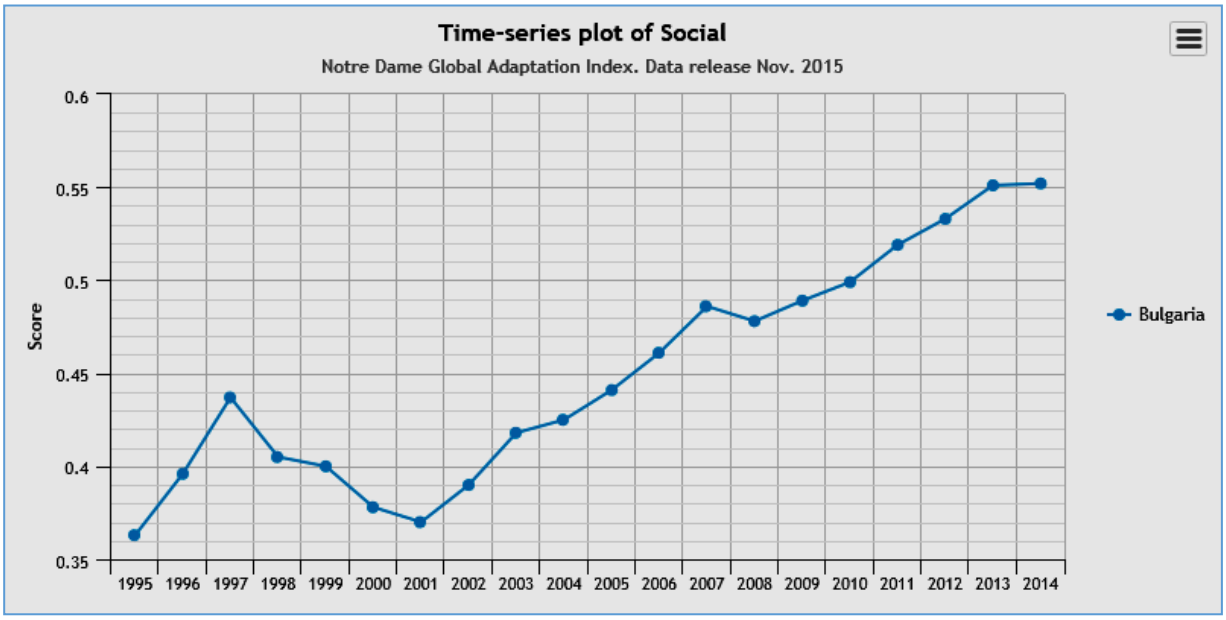
Figure 27. Score of Governance readiness indicator



Source: Bosello et al. 2011, Watkiss and Hunt 2012.

Description: The score of governance readiness captures the institutional factors that enhance application of investment for adaptation. Indicators include: political stability and non-violence, control of corruption, regulatory quality, and rule of law. All are from the World Governance Indicators.

Figure 28. Score of social readiness indicator



Source: Bosello et al. 2011, Watkiss and Hunt 2012.

Description: The score of social readiness captures the social factors that enhance the mobility of investment to be converted to adaptation actions. Indicators include: social inequality, ICT infrastructure, education and innovation.

Experience with CCA in the Human Health Sector in Other (EU) Countries

1. Lessons from the reviews of CCA in the health sector: questions and answers[49]

1.1. Typologies of climate change assessments (or: How can 'climate change-human health' assessments be categorized?)

Typologing of climate change assessments for human health would help to choose and follow the best example, for achieving the optimum results when investigate the climate change impact on human health.

'Climate Change-Human Health' adaptation assessments can be classified, among others, according to their analytical approach and policy purpose (***Table 18*** and ***Figure 29*** *and* ***Figure 30*** within ***Annex 4***), their methodological approach (***Table 19*** within ***Annex 4***), and their level and comprehensiveness.

Rothman and Robinson (1997) propose a conceptual framework within which individual integrated assessment studies, and the practice of integrated assessment of climate change as a whole, can be placed and evaluated. This framework comprises eight categories, whereby the first six refer to the level of integration, and the latter two to the policy usefulness of the assessment:

- Vertical integration (along the cause-effect chain)
- Horizontal integration (across sectoral and regional boundaries)
- Consideration of feedbacks and dynamics
- Consideration of autonomous and purposeful human adaptation
- Recognition of multiple baselines
- Integration of quantitative and qualitative knowledge
- Consideration of the policy context in which the analysis is used
- Involvement of stakeholders

Adaptation assessments are a specific type of integrated assessments of climate change. The eight categories proposed earlier can provide useful guidance for the design and the evaluation of adaptation assessments, including those intended to reduce climate-related health risks.

1.2. Guidelines for climate change assessments (or: Which steps are involved in assessing vulnerability to climate change and developing effective adaptation strategies, and how should these steps be implemented?)

The review of the major guidelines for health risk assessment and for climate change impact, vulnerability, and adaptation assessment shows that most guidelines employ one of two fundamental methodological approaches: the hazard-driven (also known as scenario-driven or top-down) approach, which starts from scenarios for climatic hazards, and the vulnerability-driven (also known as bottom-up) approach, which starts from current health risks.

[49] Sections 1 and 2 of Application 2.1. are grounded basically on the PIK 92 review report results, by Hans-Martin Füssel and Richard J. T. Klein, Conceptual Frameworks of Adaptation to Climate Change and their Applicability to Human Health.

The Health Impact and Adaptation Assessment Framework developed by the WHO and Health Canada[50] (***Figure 31 within Annex 4***) is amongst the most important guidance document for CCA assessment for human health. Based on the preliminary review, an important limitation of this framework seems to be the insufficient consideration of the dynamic aspects of climate change.

Environmental Health Risk Assessment is concerned with assessing the risks to population health associated with specific environmental risk factors. Adaptation policy assessment for human health can be regarded as a specific type of environmental health risk assessment, which itself is a subcategory of risk assessment. This model is most easily applicable for the direct health impacts of local exposure to specific climatic stimuli, such as the health effects of heat-waves. It is least applicable to the indirect health impacts of complex climatic stimuli that strongly interact with non-climatic factors, such as many vector-borne diseases. An important practical impediment to the application of quantitative risk assessment approaches in CCA assessments are large uncertainties about future exposure scenarios. Some frameworks which illustrated the environmental health risk assessment approach and terminology are shown on ***Figures 32, 33, and 34 within Annex 4***.

The IPCC Technical Guidelines (***Figure 35 within Annex 4***) are one the most important documents that describe the *hazards-driven approach to climate impact and adaptation assessment*. They have also served as the starting point for the development of the UNEP Handbook and the USCSP Guidebook. In the hazards-driven approach, adaptation needs are exclusively defined by the outcome of the climate impact assessment. However, the 'classical' climate impact assessment, which aims to determine the incremental impacts of anthropogenic climate change, is primarily designed according to the needs of mitigation policy rather than those of adaptation policy. Because hazards-driven approaches do not adequately consider the current level of climate risks, the interaction of climatic and non-climatic risk factors, and the uncertainties in climate impact projections at the scale relevant for adaptation decision-making, they need to be combined with vulnerability-driven approaches in order to produce useful recommendations for adaptation policy.

The UNDP-GEF Adaptation Policy Framework (***Figure 36 within Annex 4***) focusses on the current adaptation needs of developing countries. It proposes a flexible combination of hazards-driven and vulnerability-driven approaches yet with a strong focus on the latter. The most suitable mixture of these two approaches in an adaptation policy assessment for human health varies across health issues and regions. Key factors that determine their relative importance are the current level of climate-sensitive diseases; complexity of the causal web linking climatic risk factors with specific diseases; type and predictability of relevant climatic hazards; time horizon of adaptation decisions; expected importance of future risk changes (within that time horizon); the availability of resources for the assessment in terms of data, expertise, time, and money. Hazards-driven approaches are most valuable if adaptation decisions have a long lifetime and/or lead time, and if expected increases in risk levels are significant compared to current risks, if the reliability of future risk projections is high.

[50] Health Canada (2002). National health impact and adaptation assessment framework and tools. Health Canada, Ottawa, Canada.

The UKCIP Framework (***Figure 37 within Annex 4***) applies a risk management approach to adaptation decision-making. It is most useful when decisions that are potentially sensitive to global climate change have already been identified by the relevant decision-maker. Large-scale adaptation policy assessments for an impact domain as diverse as human population health would need to include an additional screening phase that identifies potential risks from anthropogenic climate change in the considered region and raises awareness of the issue among relevant stakeholders.

1.3. Conceptual frameworks for vulnerability and adaptation (or: Which system components and/or analytical concepts are important to assess adaptation, and how are they related?)

The review of variety of conceptual frameworks for vulnerability and adaptation to climate change show that many of them cannot provide substantial guidance for human health adaptation assessments due to a variety of reasons. Only few frameworks present a reliable approach which can be related to the human health. Some of them are:

The DPSEEA Framework[51] (***Figure 38, Figure 39 within Annex 4***). It is a hierarchical model for categorizing environmental health indicators, and for identifying suitable intervention points. It is based on the classical toxicological model for environmental health, which limits its application to non-local and complex environmental hazards such as anthropogenic climate change. The review concluded that applications of the DPSEEA framework to different climate-sensitive health issues would need to extend it flexibly, often including ecological indicators and non-climatic 'confounding' factors.

The 'Hierarchy of causes' (or causal web) model (***Figure 40 and Figure 41 within Annex 4***) is another hierarchical model for structuring the risk factors for specific diseases according to their spatial scale and 'proximity' to the health outcome. Similar to the DPSEEA framework, the 'hierarchy of causes' model would need to be extended flexibly to adequately represent the causal structure of different climate-sensitive health impairments.

Burden of Disease Assessments (***Figure 42 within Annex 4***). It strives to quantify the amount of ill-health caused by a particular risk factor, and the expected reduction in disease burden that could be achieved by reducing human exposure to this risk factor. Application of the burden of disease approach to the risk factor 'anthropogenic climate change' raises a variety of methodological and practical issues regarding the quantification of the risk factor, the choice of the time horizon, and the consideration of uncertainties. Once again, the difficulties are larger for indirect than for direct health effects of climate change.

1.4. Typologies of adaptation (or: How can adaptation measures and adaptive systems be categorized?)

Typologizing of CCA approaches for human health would help to choose and follow the best example for achieving the optimum adaptation of human health sector to the climate change.

There are various frameworks for categorizing adaptation measures, adaptive systems, and/or adaptation decision situations according to a wide range of criteria. Some of these typologies

[51] DPSEEA stands for: Driving-force – Pressure – State – Exposure – Effect – Action

are specific to human health whereas others have a more general scope. Three of the generic frameworks are considered as particularly relevant for designing adaptation strategies to the health impacts of climate change.

The 'anatomy of adaptation' (***Figure 43 within Annex 4***) formulates four questions about adaptation and uses them to discuss key concepts of adaptation in a broad range of decision contexts.

The 'portraits of adaptation' framework (***Table 20***) uses six characteristics of an adaptive system as the basis for the distinction of ten 'portraits of adaptation'. Each of these portraits is then discussed as to its implications for the development of adaptation strategies and for priority research needs. Adaptation to the health effects of climate change covers many of these portraits, depending on the particular disease and region considered. The consideration of the specific circumstances of an adaptation context, as facilitated by the 'portraits of adaptation' framework, is thus highly relevant for the development of effective adaptation strategies for human health.

A framework for analyzing the urgency of adaptation actions presents the most important criteria for balancing the risks associated with early action and late action, respectively. This framework, which synthesizes the results from several publications on the prioritization of adaptation actions, is highly relevant for human health.

1.5. Evaluation frameworks for adaptation strategies (or: How can the quality of adaptation be assessed?)

There are existing various frameworks for evaluating how 'good' a particular adaptation strategy is, and for identifying recommended strategies. All frameworks include criteria related to the expected outcome of a proposed measure (for example, the expected magnitude and distribution of health benefits and costs). Some of them also specify criteria referring to the process of adaptation (for example, on participation and decision-making procedures). The selection of a particular set of decision criteria is ultimately a normative decision that cannot to be made by scientists alone.

2. Implications: Deduction of Key questions about 'CCA-Human health'

The development of adaptation strategies for a particular health issue in a specific region should be guided by the following key questions:

- *How significant is the expected increase in the particular health risk due to global climate change, compared to current risk levels?*

The answer to this question largely determines the need for a detailed analysis of the particular health issue: the larger the potential increase in health risk, the more efforts should be put into the detailed analysis of the issue.

- *How familiar is the population with the particular health issue, and with its effective control?*

The answer to this question largely determines the need for *new* preventive measures: the less familiar a population is with a particular health risk, or the less effective it is controlled

currently, the more important are additional intervention measures to control the risk now and in the future.

- *How reliable are projections for future risk changes at the scale of potential adaptation measures?*

The answer to this question largely determines the specificity with which interventions can be designed to reduce a particular health risk: if knowledge about future changes in regional health risk is reliable, specific adaptation measures can be implemented already now. However, if regional increases in health risks are less certain, a generic adaptation strategy (focusing on improved monitoring, surveillance, research, and so on.) will generally be more appropriate.

- *How large are the risks (in terms of additional costs) of acting early compared to the risks (in terms of additional disease burden) of acting late?*

The answer to this question largely determines the need for acting now: The lower the expected reduction in adaptation costs due to additional information in the future and the higher the health risks in the near future, the more important it is to act now rather than later.

TABLES AND FIGURES to the text above

Table 18. Different purposes of adaptation assessment

	Adaptation as part of IMPACT ASSESSMENT	Adaptation as part of POLICY EVALUATION
Analytical function	Positive	Normative
Purpose	Predict, estimate likelihood	Evaluate, prescribe
Central Question	What adaptations are likely?	What adaptations are recommended?
UNFCCC Article	Art. 2: Are the impacts likely to be dangerous for ecosystems, food production and sustainable economic development?	Art. 4: Which measures should be formulated and implemented to facilitate adequate adaptation?

Source: Smit et al. 1999.

Table 19. The two approaches of an assessment

Method	Natural hazard	Vulnerability
Hazard characterization	Ranges of uncertainty described by climate scenarios and/or characterization of hazard under climate change well-calibrated	Ranges of uncertainty described by climate scenarios and/or characterization of hazard under climate change ***not*** well-calibrated
Drivers of change	Main drivers known and understood	Many drivers with multiple uncertainties
Structure	Change of consequences understood	Multiple pathways and feedbacks

Source: Jones and Mearns 2003.

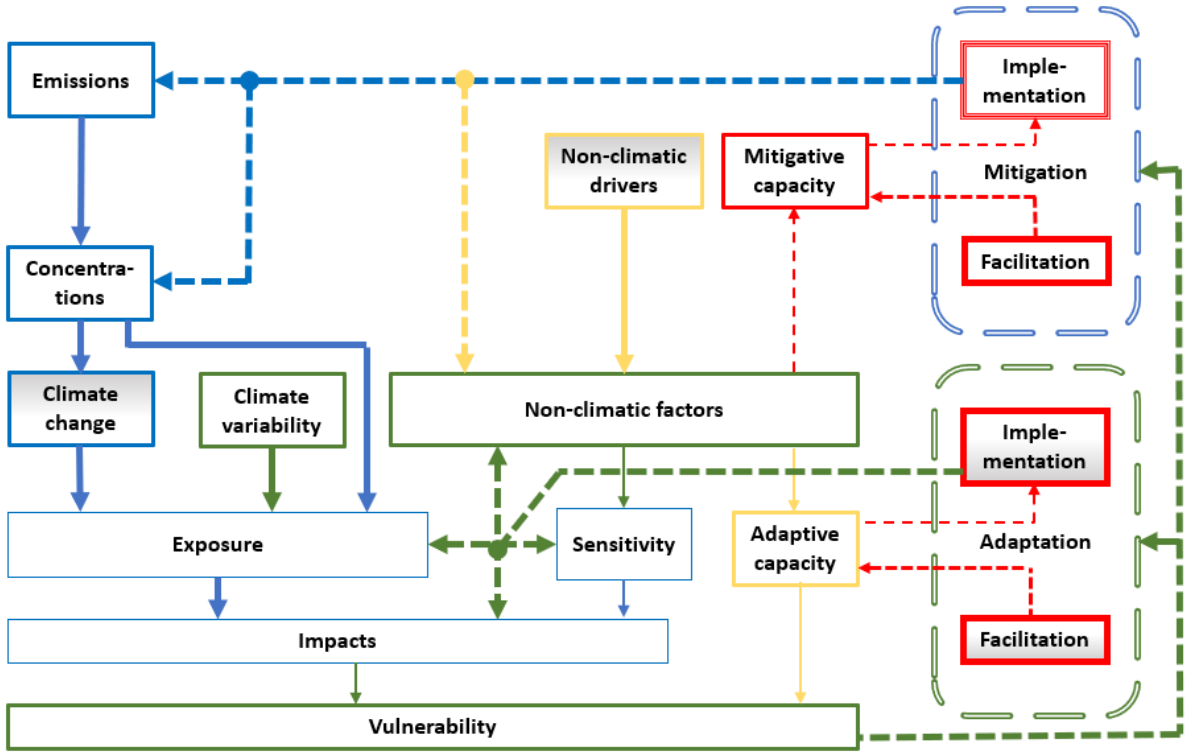
Table 20. Ten system response portraits of adaptation defined in terms of knowledge, flexibility, and time frame

Portrait	Short-run (SR), autonomous flexibility	Short-run, non-autonomous flexibility	Knowledge for SR flexibility	Long-run, autonomous flexibility	Long-run, non-autonomous flexibility	Knowledge for LR flexibility
I.1	Y	*	#	*	*	#
II.1	N	Y	Y	Y	*	#
II.2	N	Y	Y	N	*	#
III.1	N	Y	N	N	*	#
III.2	N	Y	N	Y	Y	Y
III.3	N	Y	N	N	Y	Y
IV.1	N	N	#	Y	*	*
IV.2	N	N	#	N	Y	Y
IV.3	N	N	#	N	Y	N
V.1	N	N	#	N	N	#

*Note: Y: present; N: not present; */#: additional outcomes excluded due to simplifying assumptions*

Source: Reilly and Schimmelpfennig 2000.

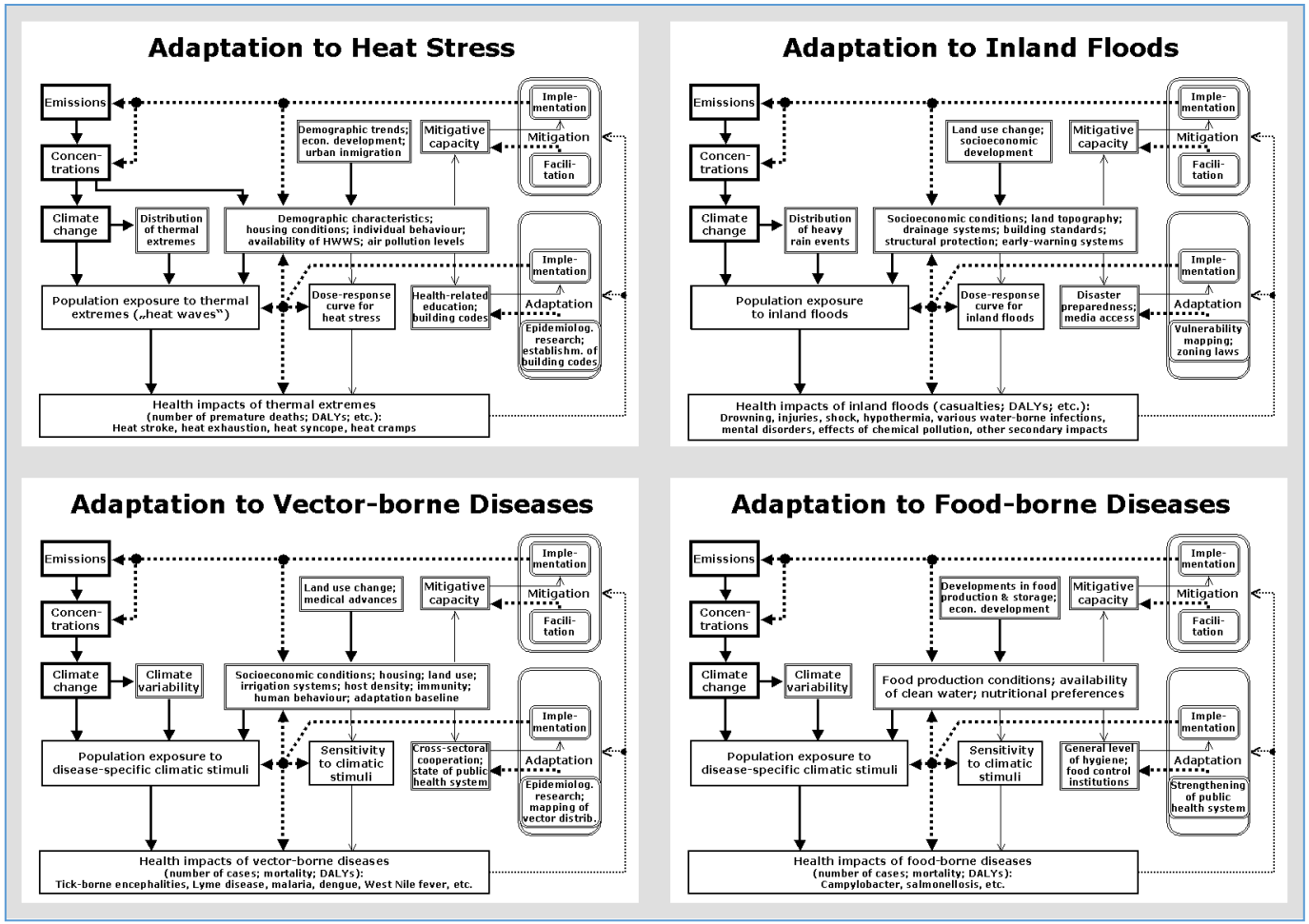
Figure 29. Conceptual framework for adaptation policy assessment



Note: The colors refer to different generations of vulnerability assessments: blue: impact assessment; green: first-generation vulnerability assessment; yellow: second-generation vulnerability assessment; red: adaptation policy assessment.

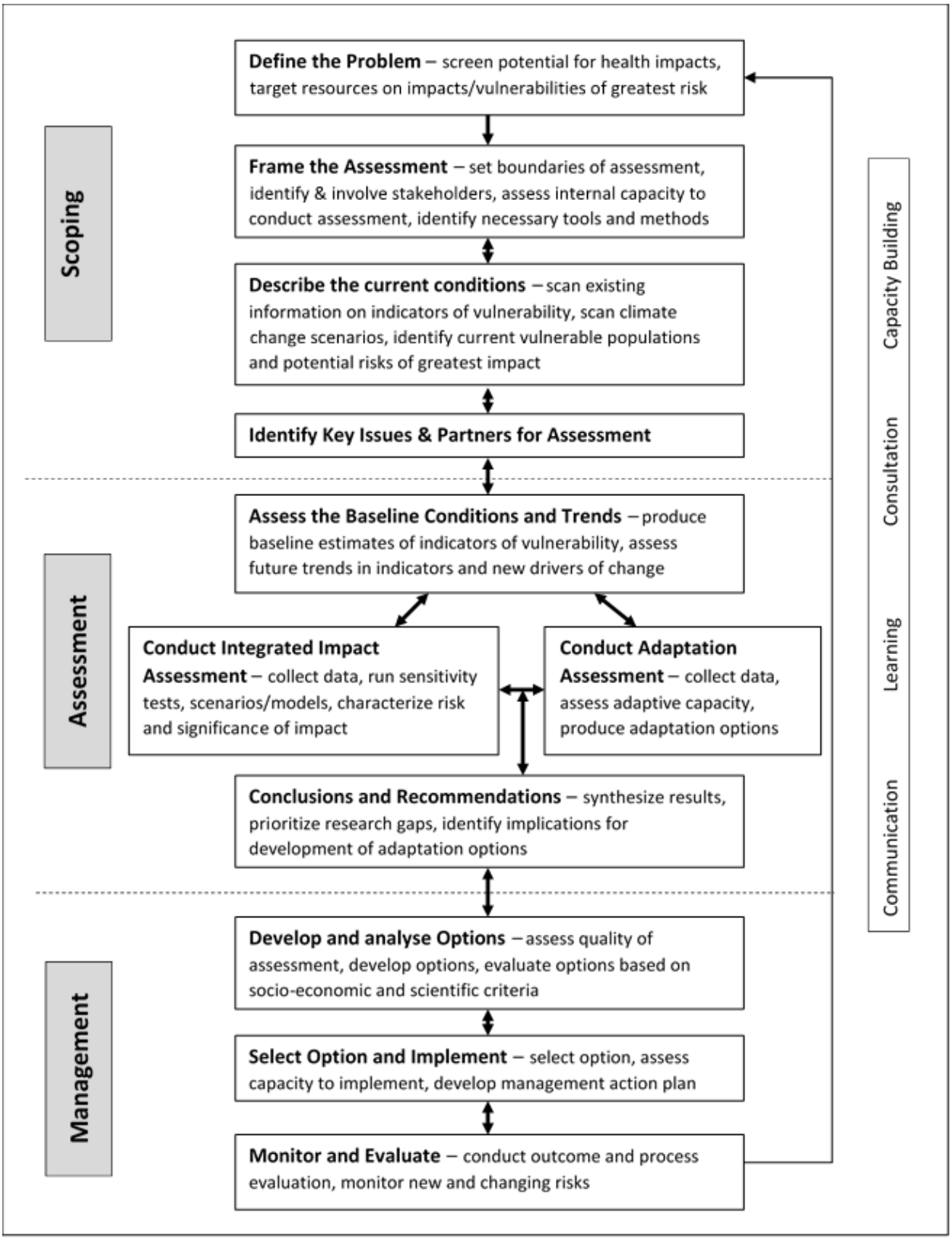
Source: Fuessel et al. 2004.

Figure 30. Conceptual frameworks for adaptation to the health effects of climate change. Application to the four different diseases addressed in cCASHh



Source: Fuessel et al. 2004.

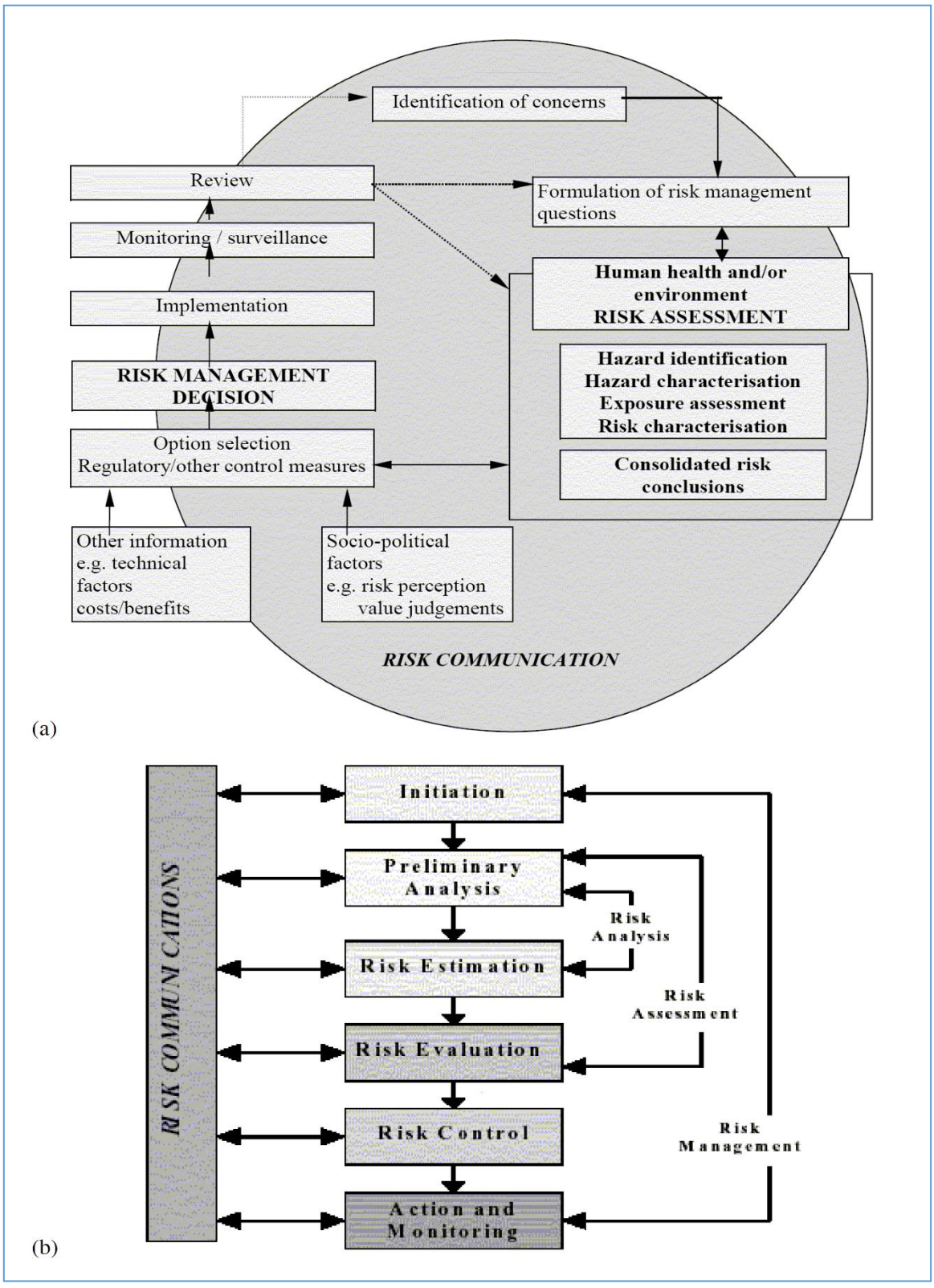
Figure 31. National Health Impact and Adaptation Assessment Framework



Source: Health Canada 2002.[52]

[52] Health Canada (2002). National health impact and adaptation assessment framework and tools. Health Canada, Ottawa, Canada.

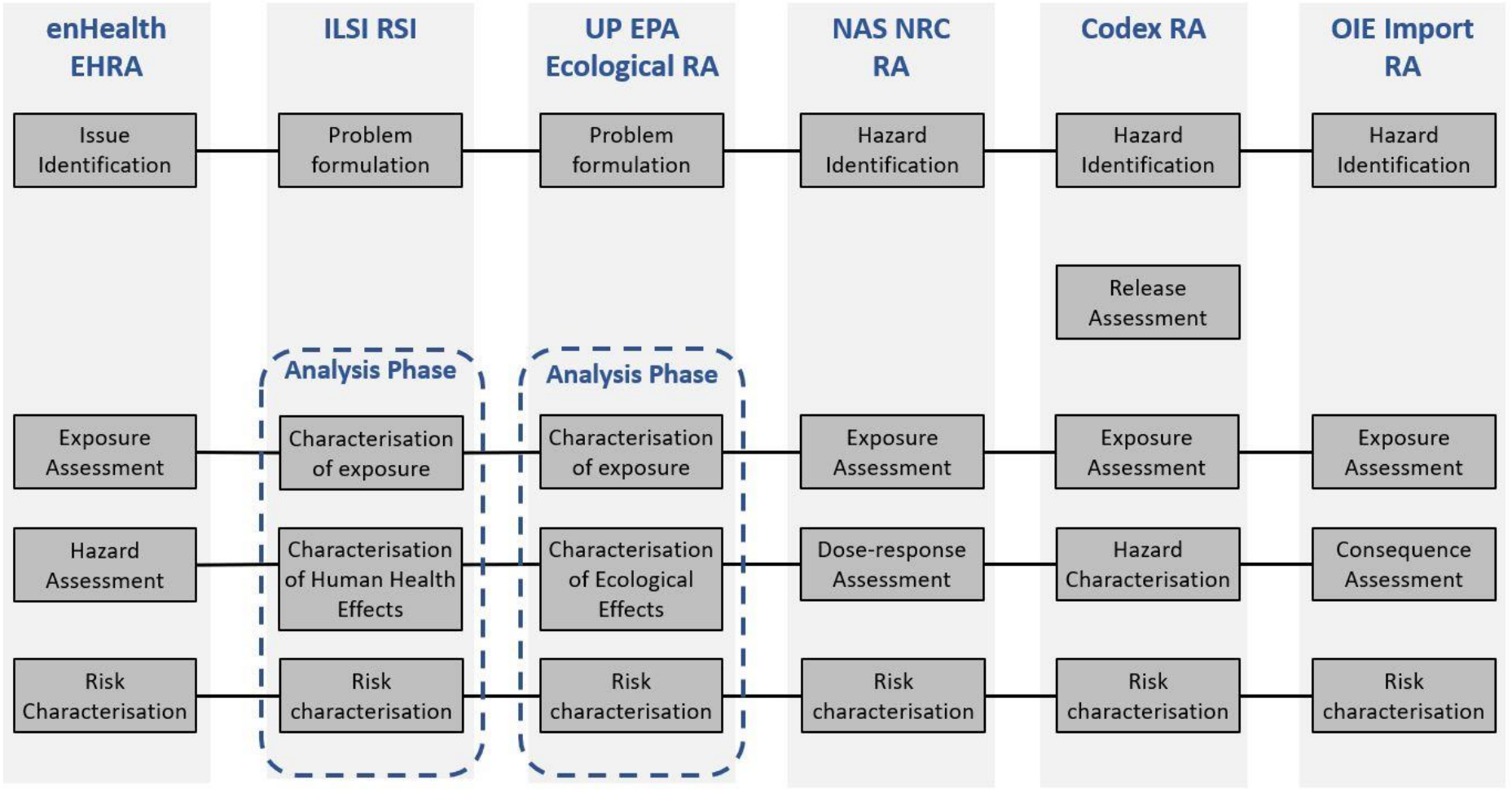
Figure 32. Two frameworks for structuring the process of risk governance



Sources: European Commission 2000[53], Canadian Standards Association 1997.

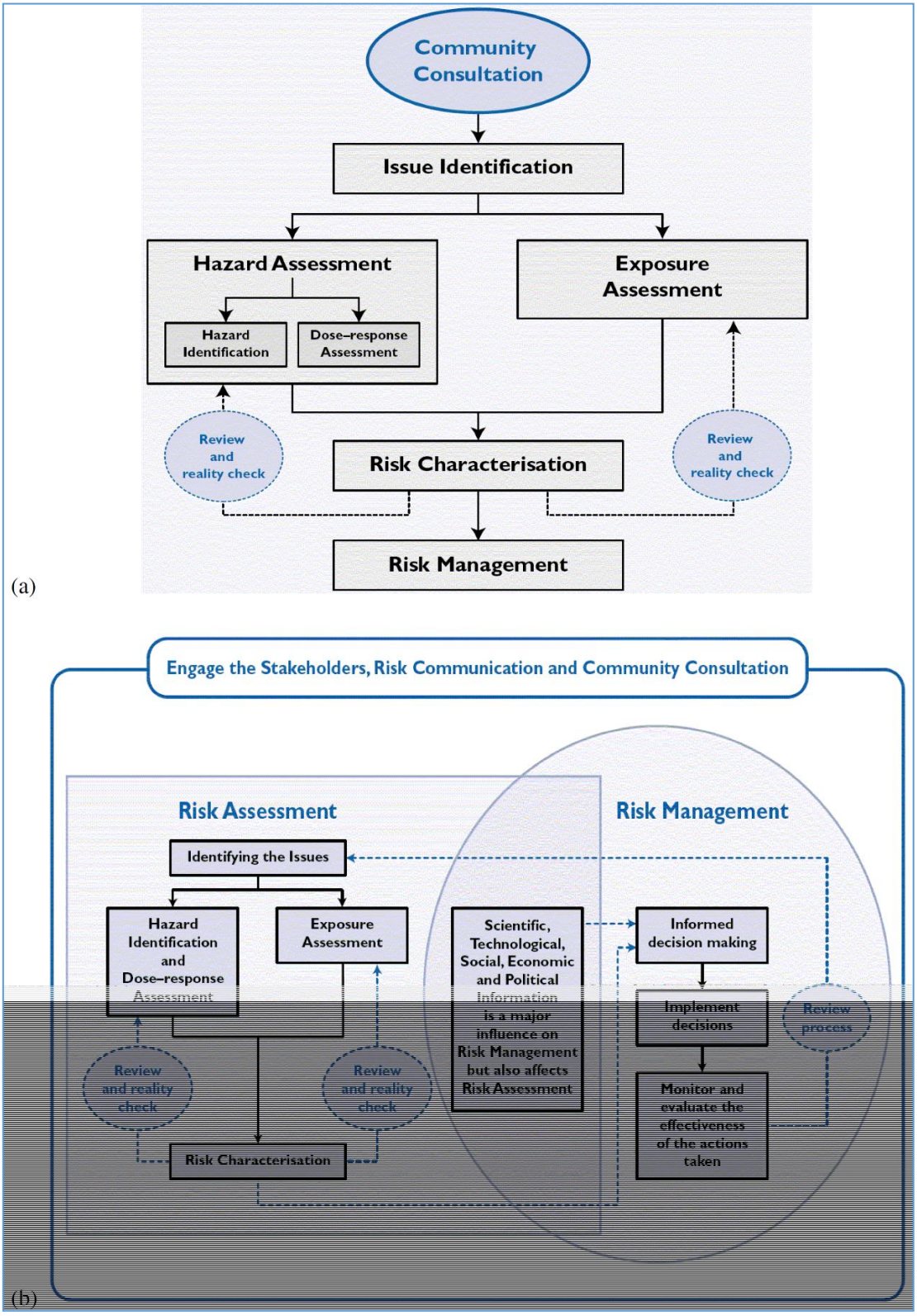
[53] European Commission (2000). First Report on the Harmonisation of Risk Assessment Procedures. Part 1: The Report of the Scientific Steering Committee's Working Group on Harmonisation of Risk Assessment Procedures in the Scientific Committees advising the European Commission in tarea of human and environmental health. Available at http://europa.eu.int/comm/food/fs/sc/ssc/out83 en.pdf

Figure 33. Different terminologies used in health risk assessment



Source: Department of Health and Ageing 2002.

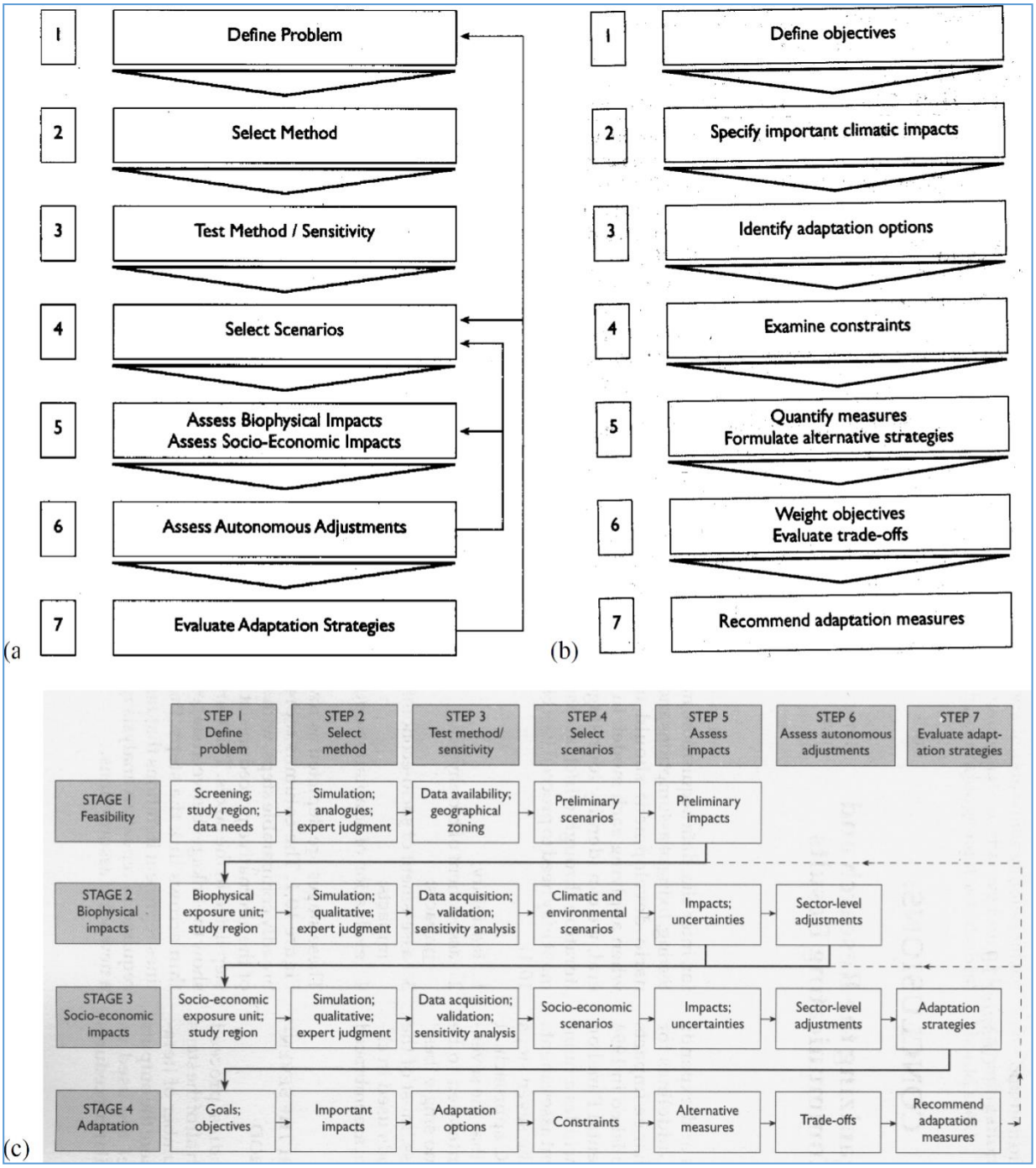
Figure 34. Australian framework for health risk assessment: (a) Steps in risk assessment; (b) Relationship of risk assessment and risk management



Source: Department of Health and Ageing 2002.

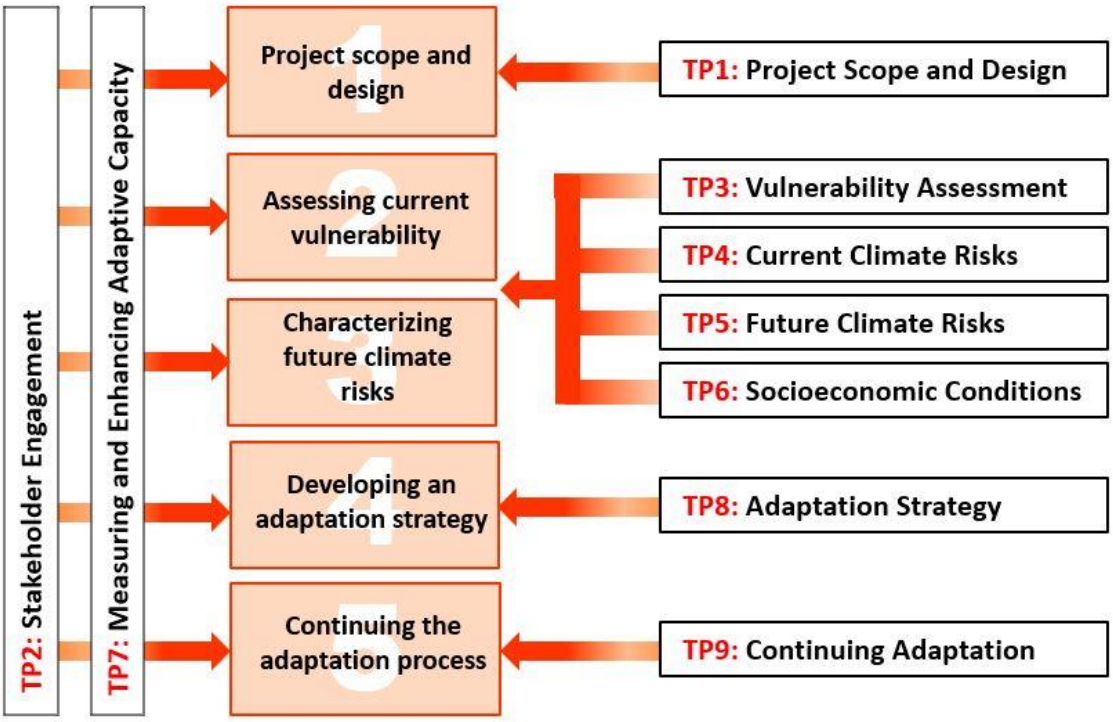
Figure 35. Assessment framework of the IPCC Technical Guidelines

(a) Seven steps of impact assessment; (b) Seven steps of adaptation assessment; (c) Four stage method for conducting impact and adaptation assessments.



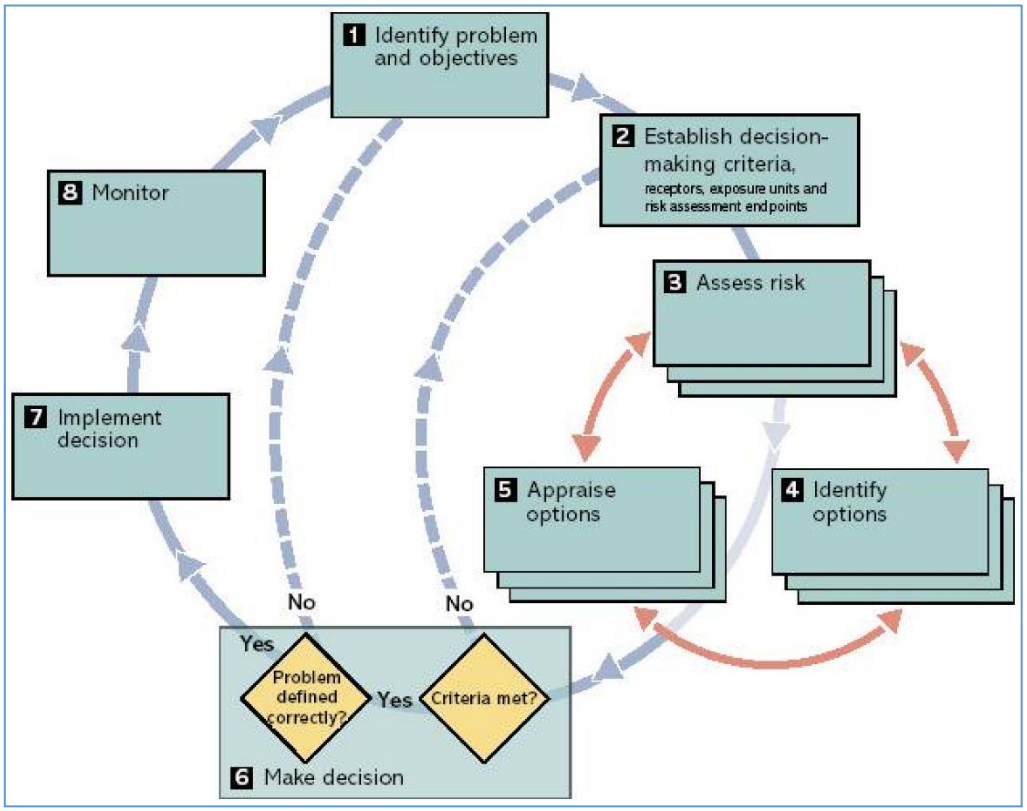
Sources: Carter et al. 1994, Parry and Carter 1998.

Figure 36. Outline of the Adaptation Policy Framework process



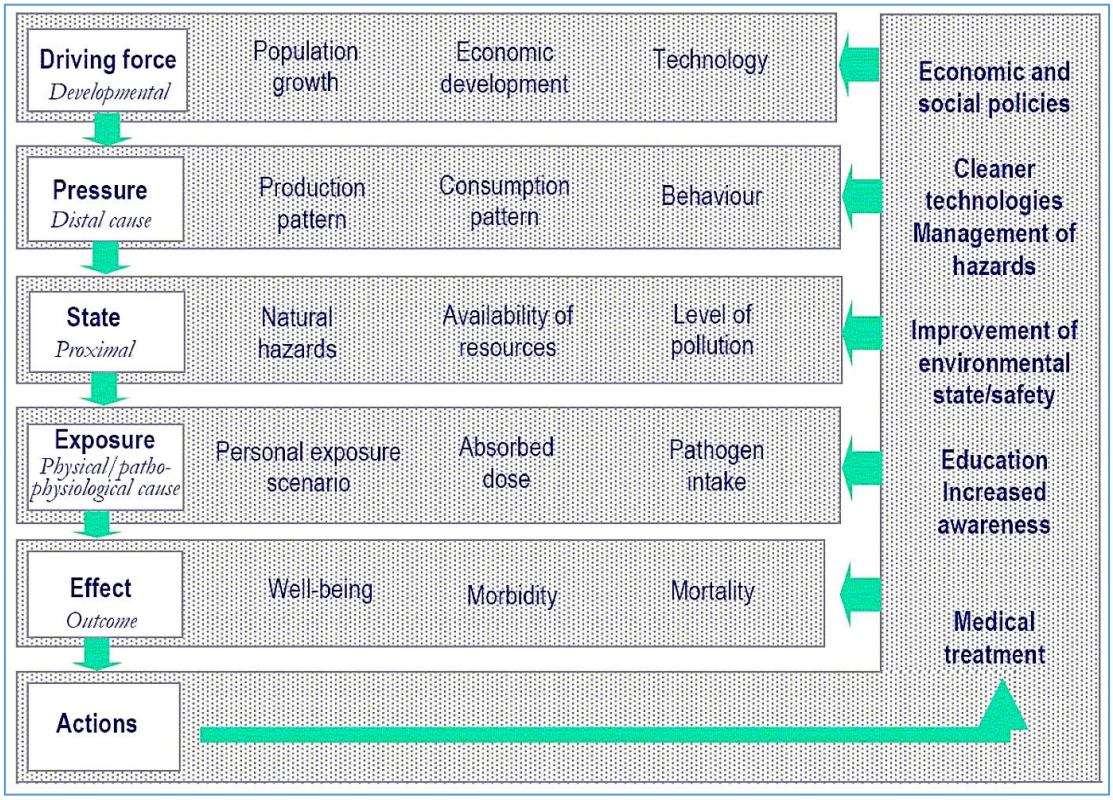
Source: UNDP 2003.

Figure 37. UKCIP framework to support decision-making in the face of climate change risk



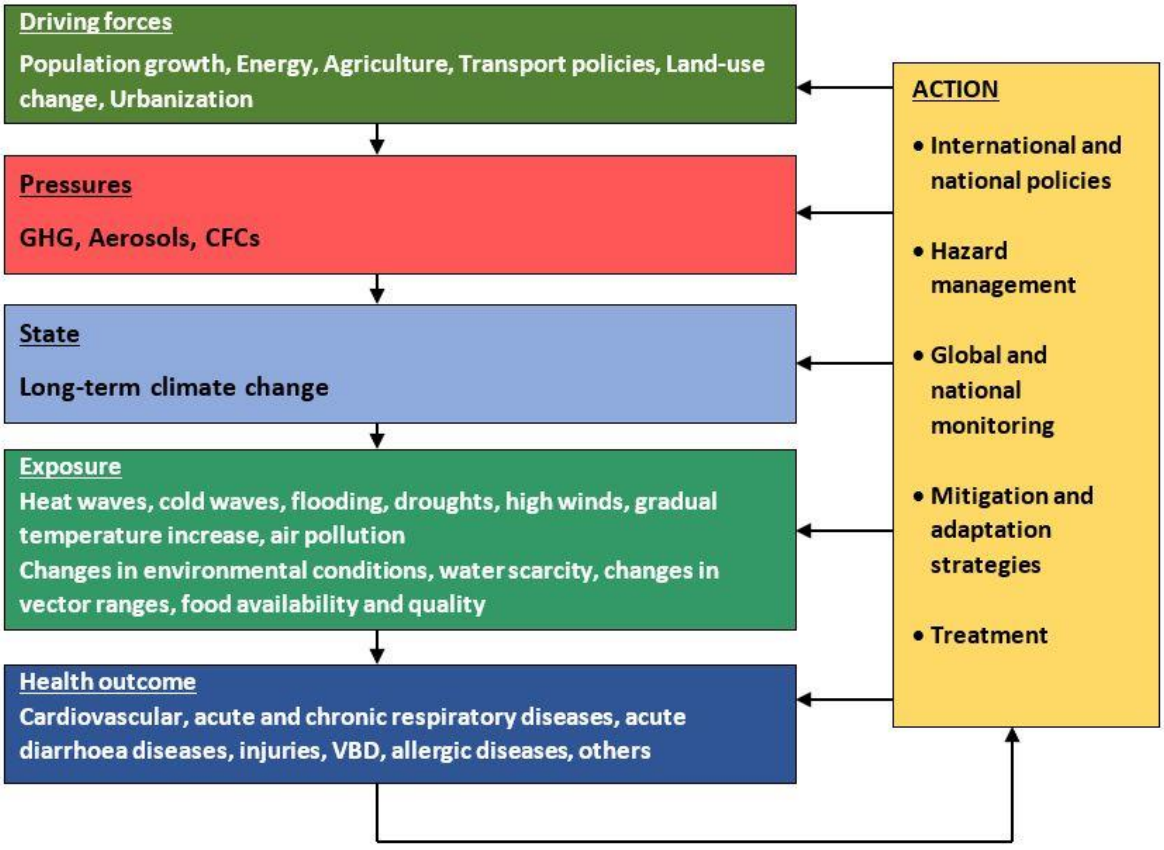
Source: Willows and Connell 2003.

Figure 38. DPSEEA framework for environmental health



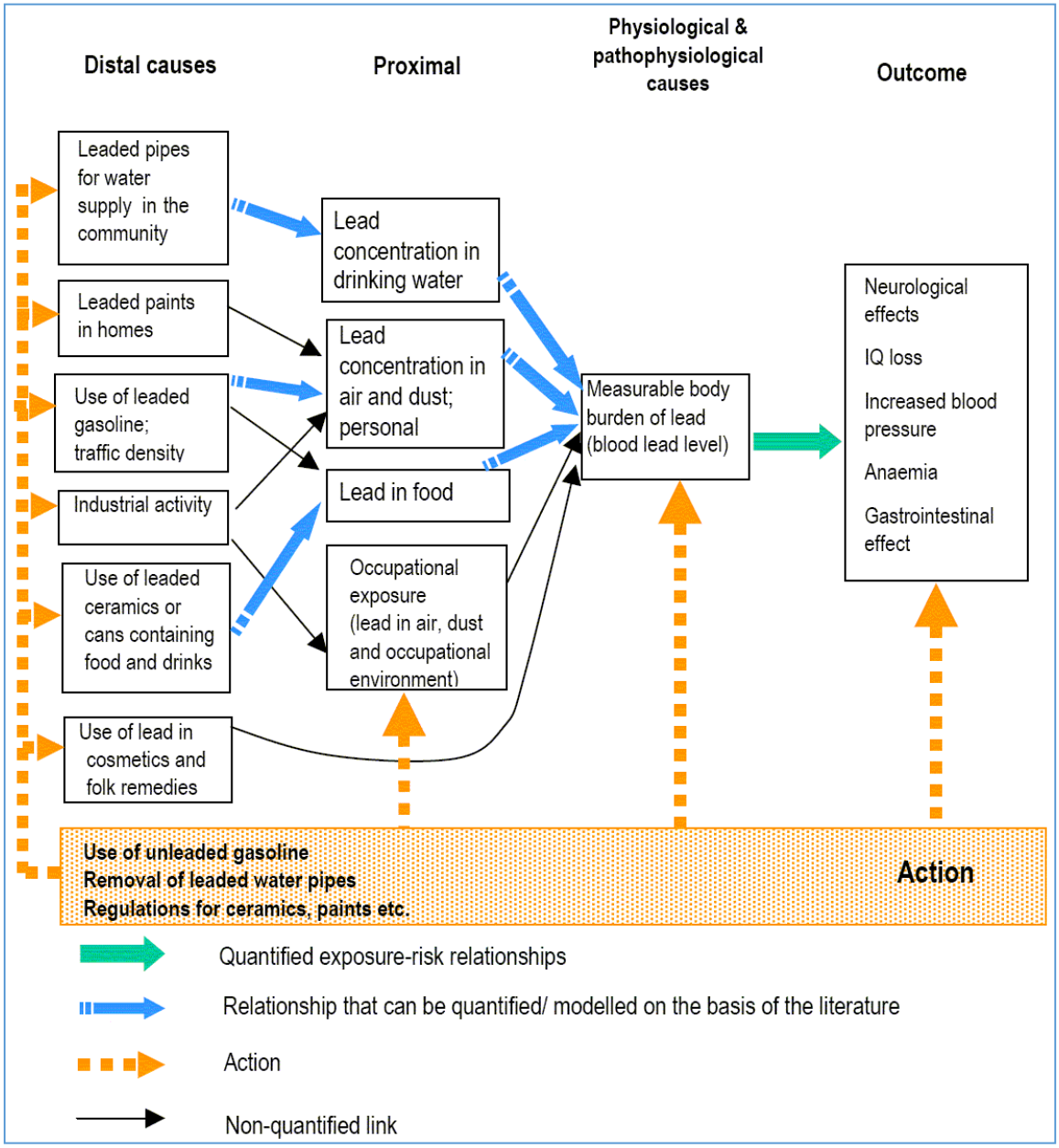
Source: WHO 1999b.

Figure 39. Adoption of the DPSEEA framework to climate change impacts on human health



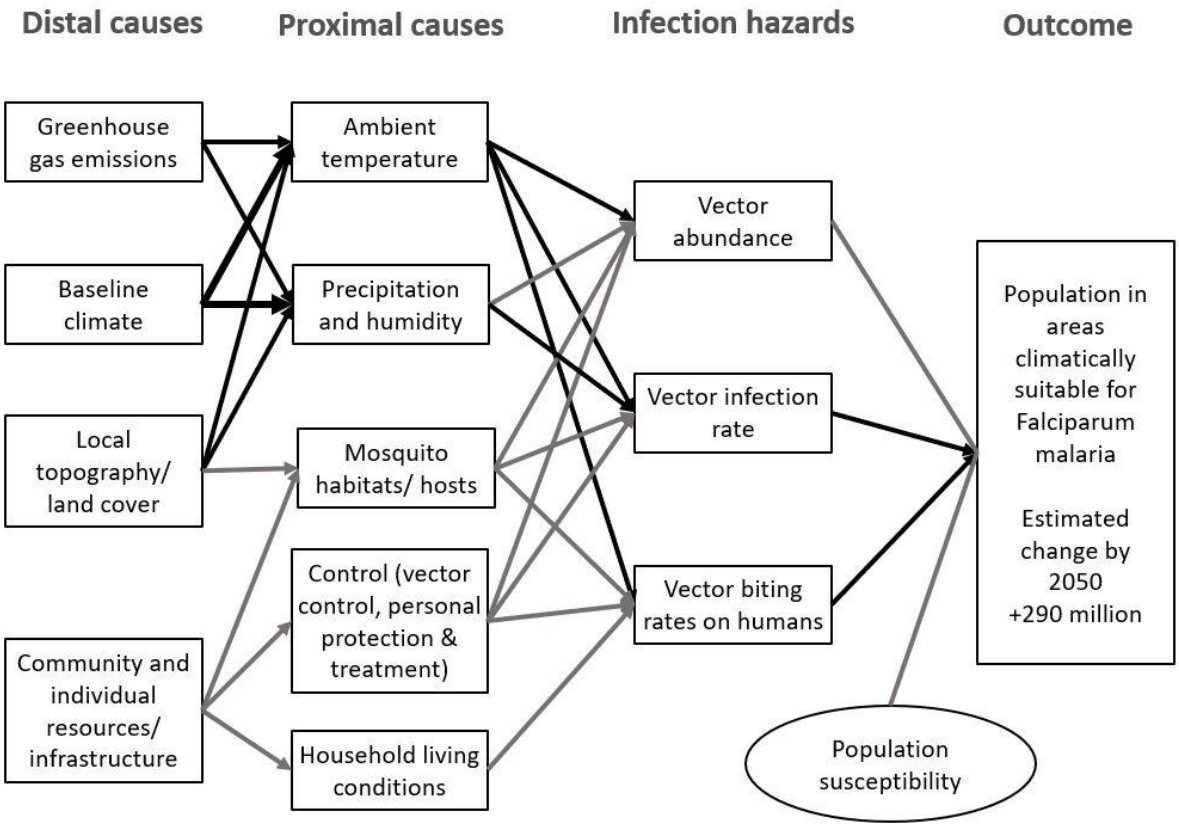
Source: WHO 2000.

Figure 40. Causal web for chronic exposure to lead



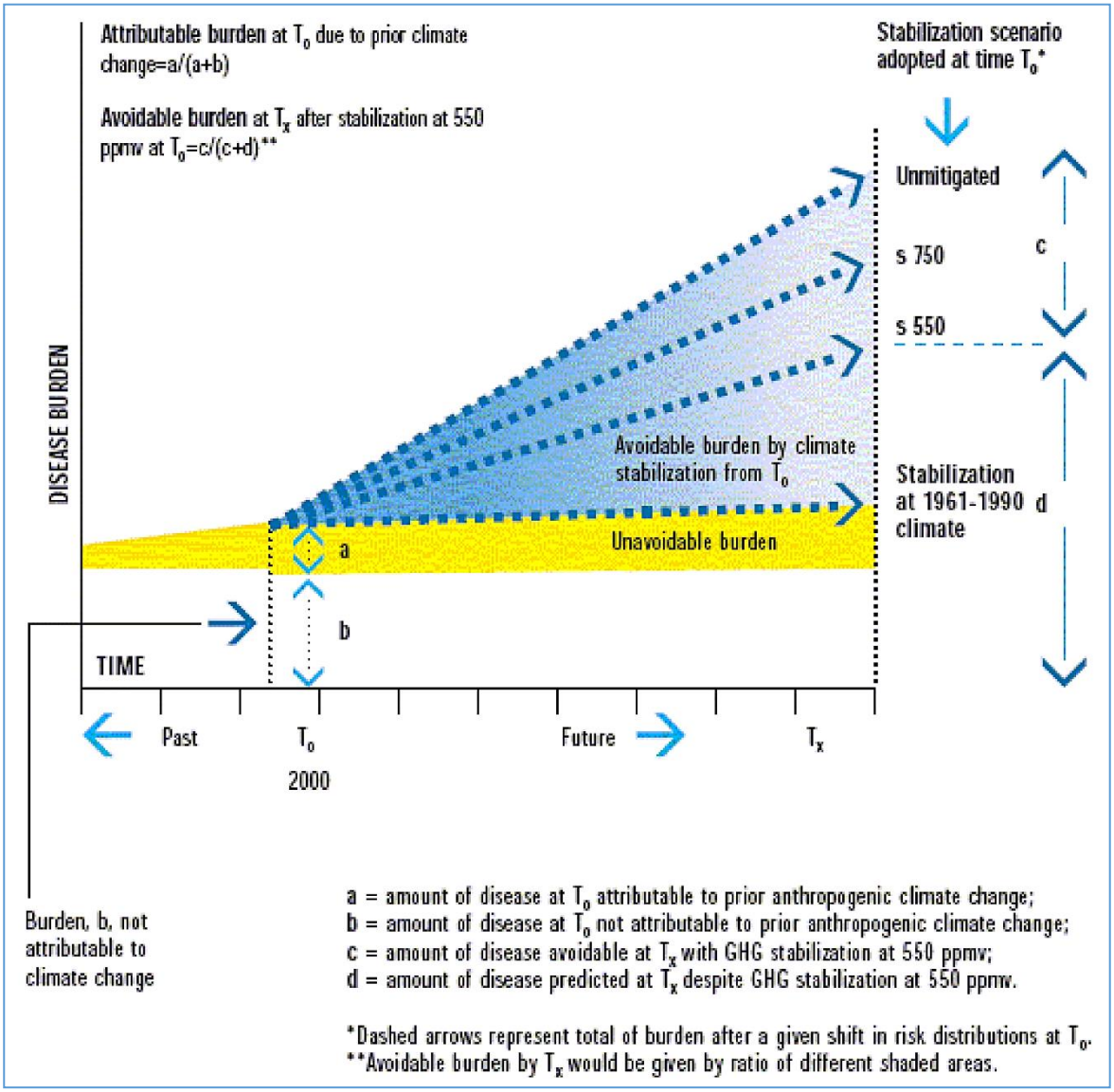
Source: Pruss-Ustun et al. 2003.

Figure 41. Causal web for the effects of climate change on infectious diseases



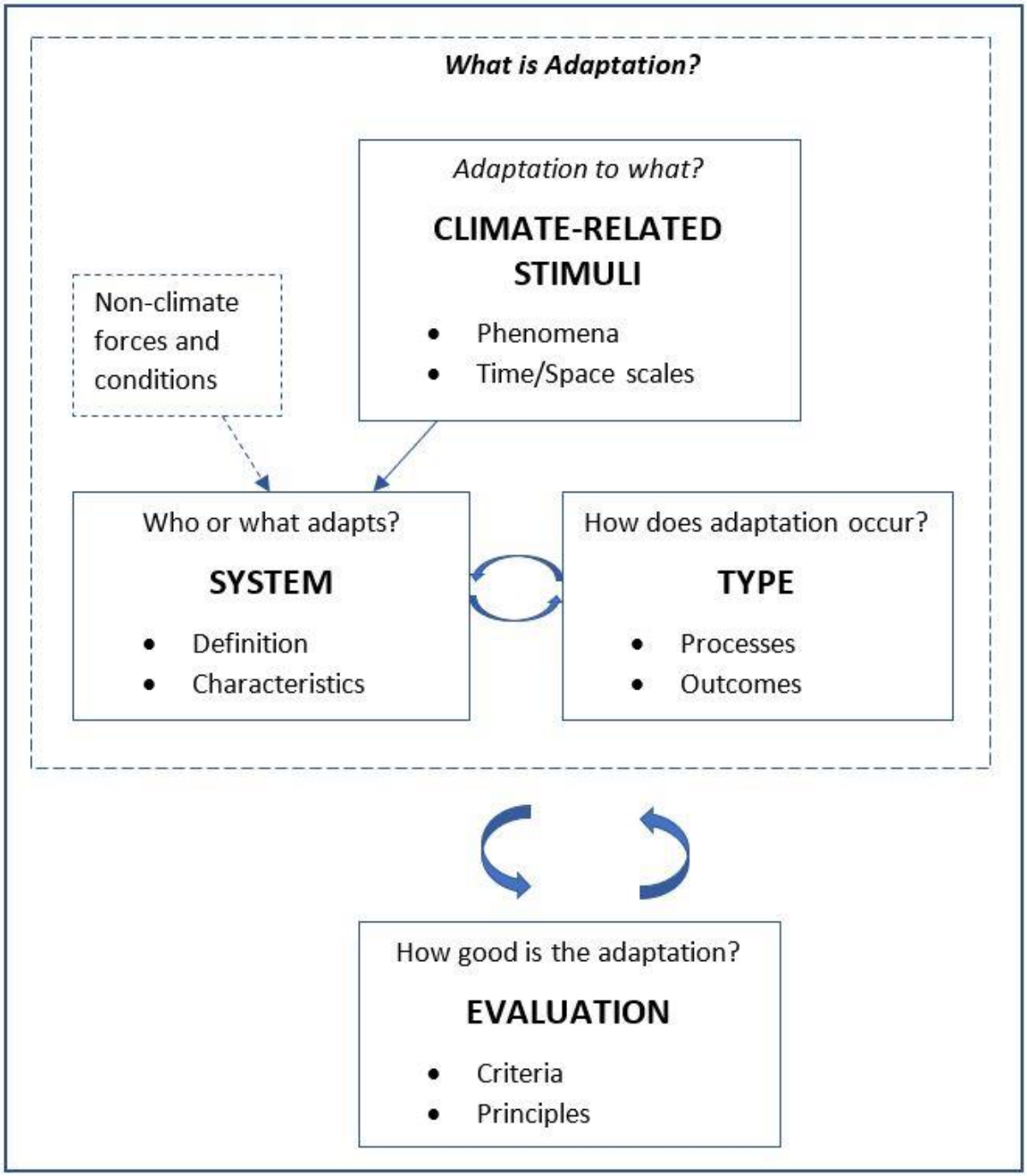
Source: Kay et al. 2000.

Figure 42. Application of definitions from Burden of Disease assessment to climate change



Source: Kovats et al. 2003.

Figure 43. Anatomy of adaptation to climate change and variability



Source: Smit et al. 2000.